

**Appendix B****References & Acknowledgements**

## Report Footnote References:

1. **Omokoroa Coastal Walkway Options Report for WBOPDC** 11.10.17 (Draft)  
Tonkin & Taylor Ltd job no 10029003000
2. **Best Practice Note 10.1** NZ Institute of Landscape Architects  
Practitioners Documentation <https://nzila.co.nz>
3. **WBOPDC Consultation May 2017** (refer Appendix A this report)
4. **New Plymouth Foreshore - Urban Design Case Study** Ministry for Environment  
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(communication Fullcircle Arboriculture: Hosking G - Forest Research Bulletin)
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Nautilus Contracting August 2011

## Photographic Images:

- Cover (Omokoroa Peninsula & Tauranga Harbour) - Priority1 Tauranga  
<http://www.taurangabusinesscase.co.nz/omokoroa>
- Page 4 (Omokoroa Northwest Peninsula) - Omokoroa Environmental Managers Inc
- Page 6 (Omokoroa-Tauranga Cycle/walkway) – Omokoroa Community  
<http://omokoroabeach.nz/amenities/omokoroa-cycleway>
- Page 7 (Gerald Crapp Reserve) – Disc Golf NZ  
<http://www.discgolf.co.nz/coursesTauranga.php>
- Page 7 (Harbour tidal area west of Omokoroa) - Miranda Hensleigh, Blogspot website
- Page 8 (Landscape Character Area Map) – Aerial data WBOPDC MAPI
- Page 9 (Omokoroa Western Hillside) – LOAM Landscape Architects
- Page 10(Peninsula Terrace Escarpment Area) – Omokoroa Environmental Managers Inc,  
ThomasS
- Page 11(Omokoroa Headland) - by Santafejazzy, Blipfoto website
- Page 16(Sunset) – LOAM Landscape Architects

ATTACHMENT 

## Options Report for Omokoroa Coastal Walkway

Prepared for  
Western Bay of Plenty District Council  
Prepared by  
Tonkin & Taylor Ltd  
Date  
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Job Number  
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## 1 Introduction

The Omokoroa coastal walkway situated on the western side of the Omokoroa Peninsula has been affected by landslips over several years and more recently following the April 2017 storm event (Cyclone Cook). Tonkin & Taylor Ltd (T+T) has been engaged by Western Bay of Plenty District Council (WBOPDC) to conduct a condition assessment of the walkway between the Gerald Crapp Historic Reserve and Precious Reserve including an options assessment to improve the walkway. This assessment considers both short and long term solutions for the walkway, and where practical, includes stability improvements for the coastal cliffs. It is understood that this report will be used in discussions with the local community as part of consultations for the Long Term Plan 2018-2028.

Authorisation to proceed with this work was received by WBOPDC (Council) on 21 September 2017<sup>1</sup>.

In respect to the recent instability which occurred along the coastal cliffs as a result of the April 2017 storm event, T+T undertook a landslip assessment for WBOPDC soon after this event<sup>2</sup>.

## 2 Scope of works

Our scope of work as outlined in our September 2017 proposal included the following:

1. Desktop assessment to include:
  - a. Identify the location of the existing walkway and utility services that may be affected by instability;
  - b. Establish areas of damage from recent coastal erosion and slope failure including older instability (e.g. Bramley Drive landslip);
  - c. Research WBOPDC Long Term Plan incentives for the Omokoroa area; and
  - d. Split the study area up in to four zones as suggested by Peter Clark, and formulate walkway options for each zone.
2. Consult with a landscape architect nominated by WBOPDC to discuss proposed options and landscaping considerations;
3. Complete a walkover of the study area with Peter Clark to better assess the viability of implementing options identified in the desk top assessment;
4. Issue a list of draft concept options to WBOPDC for comment;
5. Prepare rough order cost estimates and benefits for each option identified - note where private funding has been offered, or any other known funding splits;
6. Propose a sensible order of works;
7. Comment on future changes, obvious risks, impact of sea level rise, NIWA studies, maintenance regimes for projects, possible iwi impacts, and potential for new technology to stabilise the cliffs; and
8. Summarise our findings in a report.

This report represents scope item No. 8.

<sup>1</sup> Tonkin + Taylor Offer of Service, 'Options Report for Omokoroa Coastal Walkway'. Letter to WBOPDC dated 14 September 2017.

<sup>2</sup> Tonkin + Taylor, 2017. *Omokoroa Peninsula Landslip Mapping*. Report to WBOPDC dated August 2017.

### 3 Zoning

The walkway study area has been split up into Zones A, B, C and D as shown in Figure 3.1 below and in the Figures in Appendix A, as identified by WBOPDC. Splitting the peninsula into zones based on the current walkway condition, allows for easier definition of works to be considered in these zones.

The location of each zone was based on the current walkway around the peninsula. A general description is provided below:

- Zone A spans the existing Omokoroa Foreshore Waterview Terrace Reserve and Precious Reserve;
- Zone B includes the area along Hamurana Road, where there is no existing walkway or reserve, aside from the Hamurana Reserve;
- Zone C covers the Clifftop Esplanade Reserve from the historic Bramley Drive landslip, along to the Gerald Crapp Historic Reserve; and
- Zone D comprises the Gerald Crapp Historic Reserve down to the beach at the Omokoroa Beach Domain.

Along the base of the cliffs, Zone C can be identified by existing rock revetments protecting the toe of the slopes. The other zones have minor, if any, toe of slope protection at beach level.

Walkway improvement options for consideration are described in Section 7 including rough order cost estimates with our assessment of their suitability outlined in Section 9.



Figure 3.1: Outline of walkway Zones around the western side of Omokoroa Peninsula, modified from WBOPDC GIS viewer, image sourced October 2017.

## 4 Western Bay of Plenty District Council Long Term Plan

As part of the WBOPDC Long Term Plan, the Omokoroa Structure Plan (Appendix 7)<sup>3</sup>, refers to two walkway development projects:

- Project number: X-03-1: Stage 1 Walkways and Cycleways (Schedule A867061); timeframe: 2014-2025; with a project cost of \$1,976,000; and
- Project number: X-03-2: Stage 1 Walkways and Cycleways; timeframe: 2035; with a project cost of \$1,000,000.

The Coastal Erosion Responses Policy 2017 Decision Story, dated September 2017<sup>4</sup> outlines the development of the policy around how Council will respond to erosion and subsidence of Council owned coastal land. The document outlines that for Omokoroa, this options report will be used within consultations with the public for the Long Term Plan 2018-2028.

We note that WBOPDC are currently requesting public feedback for reserve development at Precious Reserve, to the south of the Omokoroa Foreshore Waterview Terrace Reserve. The proposal for this area includes car parking and toilet facilities. Development in this location would link in well with the southern part of the Omokoroa walkway in this report.

## 5 Site appreciation

### 5.1 General

Omokoroa Peninsula is located 12 km north-west of Tauranga CBD (Figure 5.1). Exposed coastal cliffs are prominent along the western and northern sides of the peninsula. These cliffs are moderately to steeply sloping (20-70 degrees), undulating, and are heavily vegetated with native bush and trees. Along the eastern coast of the peninsula, the land slopes gently down to the beach.

The Omokoroa area is rapidly developing, with a population of approximately 2500 in the 2013 Census, projected to be a population over 6000 by 2021<sup>5</sup>. Creating a more connected walkway around the peninsula, starting at the Omokoroa Beach Domain to the north-east, provides a great recreation activity and attraction to the area.



Figure 5.1: Site location (yellow rectangle) with respect to Tauranga CBD and Tauranga Airport. Image sourced from TTMapViewer, 2017.

<sup>3</sup> Appendix 7: Omokoroa Structure Plan, January 2016, Western Bay of Plenty District Council

<sup>4</sup> Coastal Erosion Responses Policy 2017 Decision Story, September 2017, Western Bay of Plenty District Council

<sup>5</sup> Omokoroa Community Development Plan, Western Bay of Plenty District Council, August 2010.

## 5.2 Site geology

The subsurface conditions presented in this report are based on a review of published literature and geological field mapping. It should be noted that subsurface conditions could vary from that provided below.

### 5.2.1 Published geology

The geology of the Omokoroa Peninsula, as mapped by Briggs et al<sup>6</sup>, is presented in Figure 5.2 and described below. Formed primarily from volcanic derived airfall and estuarine sediments, the geology is noted to be variable both in lateral and vertical extent.



Figure 5.2: Published geology of the site includes the Te Puna Ignimbrite and Matua Subgroup, overlain by modern sediments (tp = Te Puna Ignimbrites, tm = Matua Subgroup, fa = Holocene sediments).

#### Holocene sediments (fa)

Holocene sediments are located around the margins of the peninsula and typically comprise silts, sands, clays and gravels deposited by alluvial, estuarine and marine processes. Within the field area these sediments were primarily observed in areas on the eastern side of the peninsula and within the present day estuary/harbour.

#### Younger Ash

This comprises multiple tephra units (volcanic ash), up to 3 m thick. The Younger Ash comprises firm to stiff orange-yellow silt underlain by greyish white fine to medium sand (Rotoehu Ash). Where observed, the Younger Ash was located at the top of the coastal exposures.

#### Matua Subgroup (tm)

The Matua Subgroup underlies the Younger Ash and is made up of the following:

- *Hamilton Ash* – this unit is the uppermost unit of the Matua Subgroup and can be up to 2.5 m thick. Typically this was observed as an obvious dark brown paleosol (buried soil) approximately 1.0 m in thickness;

<sup>6</sup> Briggs, R.M., et al. 1996: Geology of the Tauranga Area, 1:50,000. Department of Earth Sciences, University of Waikato, Occasional Report No 22. 1 sheet +56p. Hamilton, New Zealand.

- Ashes and sedimentary units. Typically the lithologies comprising the Matua Subgroup include fluvial pumiceous and rhyolitic silts, sands and gravels, lacustrine and estuarine muds, lignites and peats, interbedded with airfall tephras (such as the Pahoia Tephras). Sensitive silt layers, typically lighter in colour, appear to control the base of some of the larger landslips. The majority of the cliff sections along Omokoroa Peninsula comprised orange-brown Matua Subgroup lithologies; and
- *Te Puna Ignimbrite (tp)* – This ignimbrite is typically massive and pale brownish-white. At Omokoroa Point (the northern headland of the Peninsula), the Te Puna Ignimbrite is approximately 2 m thick and overlies a layer of dark brown-black lignite (low grade coal).

### 5.2.2 Landslip history

Omokoroa Peninsula has a history of cliff instability, the most obvious of which is the Bramley Drive landslip which occurred initially in 1979. Debris from this landslip still extends well out into the estuary. Coastal processes including tidal undercutting of the toe of the slope, along with water sensitive silt layers within the Matua Subgroup (which is typically observed in the cliff faces), act together to result in slopes that are prone to instability around the peninsula.

Ongoing monitoring of landslips at Omokoroa by T+T in recent years has given us knowledge of the local area and an understanding of the processes resulting in the instability and landslips of the cliffs around the Peninsula.

Several large rainfall events occurred in March and April 2017 which resulted in multiple landslips around the peninsula. These landslips were mapped by T+T<sup>7</sup> for WBOPDC. The landslips and other areas of tension cracking identified in that project are shown on the Figures in Appendix A. Landslip mechanisms from these storm events comprised both translational and rotational or block-type (deep-seated) landslips of varying sizes.

### 5.3 Existing walkway

The existing walkway around the Omokoroa Peninsula is shown in Figure 5.3 below as indicated by red dashed lines with our study area marked in dark blue. The location of the existing walkway is also shown in more detail on Figures 1 to 8 in Appendix A.

With respect to our study area, the walkway can be split into four zones comprising:

- The western zone, where the walkway runs along the Omokoroa Foreshore Waterview Terrace Reserve to Precious Reserve, is approximately 400 m in length. Access to this reserve is adjacent to No. 84 Hamurana Road and a path off Waterview Terrace. This reserve has two sets of steps down to the beach, one of which passes through Precious Reserve towards the Omokoroa golf course;
- The next zone runs in line with McDonnell Street and Hamurana Road and is approximately 1150 m in length. In this zone, the walkway diverts onto roads and pathways, as no clifftop walk exists in this zone;
- From here, the scenic walkway continues north for approximately 550 m. The clifftop walk began at the Bramley Drive landslip but now starts at a set of stairs immediately in front of No. 26 Ruamoana Place due to path closures from recent landslips. The walk runs along the crest of the cliffs, through the Clifftop Esplanade Reserve, to the Gerald Crapp Historic Reserve; and
- The most eastern zone (approximately 400 m long) where the walkway runs along the crest of the coastal cliffs. The eastern start point of the walkway is from the Omokoroa Beach Domain,

<sup>7</sup> Landslip mapping report prepared by Tonkin & Taylor Ltd for WBOPDC, dated August 2017: *Omokoroa Peninsula Landslip Mapping*, T+T Reference: 1002900.

north of the jetty. The walk gently climbs up the cliffs at the northern-most point of the peninsula, through the Gerald Crapp Historic Reserve.

At low tide only, you can also walk around the peninsula at the base of the cliffs with access points at the following locations:

- Omokoroa Beach Domain;
- Clifftop Walkway Reserve in line with No. 26 Ruamoana Place;
- Hamurana Reserve;
- Omokoroa Foreshore Waterview Terrace Reserve; and
- Precious Reserve.

We note that landslip debris from the Bramley Drive landslip has overlain the beach for a number of years. The landslip debris extends into the harbour far enough that it is not safe to walk around at low tide. The debris is also generally impassable due to sinking under foot through very soft landslip debris and is considered dangerous to walk over. In summary, the landslip debris is considered impassable and prevents the public from walking all the way around the peninsula. We note also that regression of the Bramley Drive landslip over recent years including the recent March-April 2017 instability has cut off the walkway along the cliff tops between 13 Bramley Drive and 26 Ruamoana Place.



Figure 5.3: Map from WBOPDC and Department of Conservation leaflet "Walking tracks of the Western Bay". Red dashed lines represent existing walkways. Blue line indicates the study area for this report. Image sourced from westernbay.co.nz, 2017.

## 6 Site walkover assessment

### 6.1 General

A site walkover was undertaken on 4 October 2017 by an Engineering Geologist and Geotechnical Engineer from T+T. The walkover enabled us to better validate the suitability of improvement options (described in Section 7) that were identified during our desktop assessment and to assess the condition of the existing walkway, locations of existing rock revetments currently in place, and the beach access points. The main features of the walkway within each zone are described below. Site photographs are provided in Appendix B.

### 6.2 Zone A

This zone spans the Omokoroa Foreshore Waterview Terrace Reserve and Precious Reserve (refer Photo A1) to the south of the site between approximately No. 24 Waterview Drive and No. 84 Hamurana Road. Access to these reserves are provided in three locations; a footpath adjacent to No. 84 Hamurana Road, a pathway in the turning circle of Waterview Terrace and the beach in front of Precious Reserve.

There are two beach access points from this reserve. The first beach access point is towards the southern end of the reserve, which is a gently winding walkway of steps which extend south, beyond the reserve, to beach level within Precious Reserve (Photo A4). These steps were in good condition. The second is a sloping grassed track which leads down to a set of steps at beach level. The beach access itself is in good condition; however, a large tree trunk located at the base of the cliff is currently shielding these steps from view at beach level (Photo A2).

Along the beach, the cliffs are around 20 m high, and unsupported. The slopes are vegetated down to beach level. Some large trees are growing at beach level.

Some landslips have occurred on the slopes in this zone, downslope from the reserve (see Figure 8 in Appendix A). Most are shallow, translational landslips. Two large, rotational landslips have developed up to the level of the reserve (Photo A3).

Storm water outlets in this zone appear to be in good condition and comprise 300 mm diameter concrete encased steel pipes (Photo A6).

### 6.3 Zone B

This zone extends north from Zone A, past the Bramley Drive landslip, between approximately No. 76 Hamurana Road and No. 26 Ruamoana Place. Hamurana Reserve is located in the centre of this zone (Photo B1). The walkway in this area is mostly only via roadside paths along Hamurana Road and McDonnell Street, to the end of the Bramley Drive turning circle where the clifftop walkway starts. Road access continues round to Ruamoana Place. The clifftop walkway that starts in Bramley Drive continues along into Zone C. Note that the clifftop walkway is currently closed from Bramley Drive due to the recent landslip events. The walkway now follows the roads along Vivian Drive, Harbour View Road, and then Ruamoana Place to the walkway entrance at No. 26 Ruamoana Place.

Parking and picnic tables are available at the Hamurana Reserve, which provides the only beach access in this zone. The beach access is in good condition, and the grassy reserve is supported by a rock revetment which covers the length of Hamurana Reserve.

Along the beach, south of the Hamurana Reserve beach access, the cliffs are unsupported and have some large trees at the base of the cliffs. The cliffs vary between 15 and 25 m high. North of the reserve, for approximately 200 m, some toe erosion protection was observed in the form of privately owned concrete or stone brickwork sea walls. In this area, no landslips were observed.

Several recent landslips have occurred within Zone B as a result of the April 2017 storm event (refer Figures 4 to 7), generally in locations where no toe erosion protection was observed. The landslips comprised both shallow and rotational failures. The majority of these landslips occurred halfway up the slope, whilst a few landslips were very large and extended back into private property along the top of the cliff (Photo B3).

Storm water main outlets observed in this area included 150 to 600 mm diameter plastic or concrete lined pipes. These all appeared to be in good condition (refer photographs B5 and B6). Landslips in this zone have damaged or destroyed some overland plastic storm water pipework that was observed over the cliff face.

#### **6.4 Zone C**

This zone extends from No. 26 Ruamoana Place, to the northern end of the Clifftop Esplanade Reserve between approximately No. 26 Ruamoana Place and No. 13 Myrtle Drive. The clifftop walkway normally begins in the turning circle of Bramley Drive and extends along the top of the cliff around to Gerald Crapp Historic Reserve. Note that the walkway is currently closed from Bramley Drive to 26 Ruamoana Place. The walkway is grassy and well maintained, with private gardens backing onto the walkway (Photo C1). Access to the walkway can also be provided from a pathway adjacent to No. 26 Ruamoana Place.

Beach access steps are situated to the south of the pathway from Ruamoana Place which are in a reasonable condition (Photo C2). From discussions with WBOPDC, the steps were constructed by private individuals and are not a Council asset. It is worth noting that, from an access and safety perspective, the last step down to the beach is very high, and can be hard to climb up. Picnic benches are located in an overgrown vegetated area to the north of the steps.

Other old, and no longer used steps were observed on the slope from beach level, approximately in line with Gerald Place properties (Photo C5). These steps/pathways could be reconstructed to allow for extra access points on and off the beach. It is likely that these steps are privately owned and also not Council assets.

In this zone, the toe of the slope is mostly protected by a rock revetment against the lower 1-3 m of cliff. North of the Ruamoana Place beach access steps, the cliff heights are approximately 10 m high (Photo C3). To the south of the beach access, the cliff height is roughly 15-20 m. It was noted that, where the cliffs were lower, only a few, small landslips were observed. Where the cliffs were higher, large rotational landslips were observed to have overtopped the rock revetments at the toe of the slope, and the landslide debris had extended out over the beach (Photo C4). Some of these landslips have undermined the walkway.

Water and waste water utilities are located in the walkway in this zone. Storm water outlets in this zone comprise 100 mm to 565 mm diameter plastic or concrete lined pipes. Most of these appeared to be in good condition, however, the 450 mm diameter pipe has a large hole and will likely require repair (Photo C6). A large number of horizontal bored drains are also present in this zone, helping to relieve pressure in sensitive soil layers (see figure provided by WBOPDC in Appendix C).

#### **6.5 Zone D**

This zone covers the Gerald Crapp Historic Reserve from No. 13 Myrtle Drive, around to the Omokoroa Beach Domain to the east of the peninsula. The walkway continues around from the Clifftop Esplanade Reserve. Both the Pa site and the memorial to Gerald Crapp are located in this zone. The walkway in this zone is typically paved in comparison to the grassy walkways in the other zones (Photo D1).

The only beach access in this zone is at the Omokoroa Beach Domain after you have walked down the path to sea level.

The cliffs in this zone are largely unsupported at the toe and are up to 20 m high. Large landslips have occurred that are mostly shallow translational landslips with some smaller rotational landslips (Photographs D3 and D4). Some of these landslips are reasonably close to the top of the cliff in line with the walkway (Photo D2).

We are unaware of storm water outlets located within Zone D.

## **7 Possible walkway improvement options for consideration including rough order cost estimates**

In line with the Coastal Erosion Response Policy 2017, provided by WBOPDC, the three main options for coastal protection were outlined as follows:

- “Let nature take its course” – coastal processes of erosion and accretion are left to occur naturally, with scope for natural sea level rise to occur;
- “Adaptive approach” – managing hazard situations by abandoning or relocating assets and activities away from the coastal processes threatening them, taking into account at least a 100 year view for sea level rise and climate change; and
- “Holding the line” – protecting the existing foreshore and/or strategic assets from further erosion, by promoting the use of soft engineering options (dune replanting) over hard engineering solutions (rock revetments) where appropriate.

Further discussions with Peter Clark (WBOPDC) and Doug Harbutt (T+T) on 29 September 2017 resulted in more detailed variations for these options, including, but not limited to, the following:

### **7.1 Option 1 – Let nature take its course**

This option is to keep the walkway as it is currently, possibly with some diversion onto public roads where instability has impaired access. This option would also include ongoing monitoring of the walkway corridor following rainfall events especially within locations of known instability.

Costs associated with this option will likely be low, such as maintenance costs associated with the existing walkway and beach access points, as well as maintenance of current rock revetments.

### **7.2 Option 2 – Land acquisition**

This option involves shifting the walkway further back from the top of the slope via land acquisition of private land. This option is likely to be considered where landslips have affected the width of the current walkway corridor. This could also be considered where beach access points (such as near No. 26 Ruamoana Place) are privately owned and could be purchased/acquired to be incorporated into the Omokoroa walkway scheme.

This option could have large cost implications from purchasing private land. Rough order cost estimates for land acquisition is considered to be outside our scope. However, there is a potential for residents to offer easements over land at a lesser cost.

### **7.3 Option 3 – Stabilise areas of instability**

This option would involve stabilising areas of instability where landslips have occurred, or reducing the likelihood of further regression of landslide headscarp. Stability options may include the following:

- Soil nailing exposed slip faces;
- Anchored retaining walls;
- Buttreassing the slip face with rock fill;
- Installing horizontal drains at soil interface where seepage occurs;
- Earthworks to re-profile the slip face; and
- A combination of the above.

Each area of instability would need site-specific assessments for suitable retaining structures which have varying costs associated with them which could range in the order of tens of thousands to hundreds of thousands of dollars. Stabilising landslips by these measures would provide protection to the walkway corridor and likely prevent further regression of the steep headscarps in those areas. They are unlikely, however, to prevent large scale deep seated failures such as deep seated block failure slip mechanisms which occurred at the 'Bramley Drive' landslip site and other landslip locations. The cost of implementing a solution to prevent large scale instability may be in the order of millions of dollars and given the scale and cost is not considered further.

We note that with respect to horizontal drains, identifying areas of seepage on the slope to target for installing drains is easier following landslips on the cliff face. Where no instability has been observed, site walkovers would be required to observe the slopes and stake areas of seepage. Note that intercepting the correct elevation of the correct soil types to install horizontal drains into is difficult with this methodology. It could be that ground investigations may be required to better estimate locations where drains should be installed. We also note that while slopes around Omokoroa with horizontal drains and rock revetments in place appear to be more stable, the effectiveness of the horizontal drains is difficult to quantify.

Any engineering solutions for this option would require site specific investigations and design to establish the most suitable option and to confirm more accurate cost estimates.

It should also be noted that areas of cliff and walkway not previously affected by instability may be the subject of regression. The use of engineered solutions to stabilise all potentially susceptible slopes could conceivably require modifications to be made along most of the peninsula.

#### **7.4 Option 4 – Construct a rock causeway**

Construction of a rock causeway that is offset from toe of slope would provide both a walkway platform above high tide as well as acting as a debris containment bund for debris that may occur from future landslips. We understand the minimum preferred width of the walkway is 3 m to allow access for small construction plant (i.e. small excavators and small tip trucks) to enable maintenance of the causeway.

Based on recent landslip run out distances (i.e. below No. 37 McDonnell Street), our suggested offset (from the toe of the coastal cliffs) to avoid overtopping, would be approximately 25 m. To provide freeboard in the order of 0.5 m above the mean high water springs (MHWS) level, the crest of the rock causeway would need to be approximately 3 m high (i.e. 3 m above the existing sea floor) at this location to achieve a crest level of approximately 2.6 to 3.0 mRL. We understand that the crest level height can be increased to allow for sea level rise throughout the lifetime of the structure. The rock causeway would likely consist of a central core of GAP 100 rock wrapped in geotextile, overlain by a layer of larger under armour rock which would be overlain with an outer layer of armour rock with side slopes of between 1.5H:1V and 2H:1V. The top of the causeway would be overlain with a nominal 300 mm thick layer of compacted aggregate (i.e. AP20 or AP40) over its 3 m (minimum) width. The geotextile wrapped core would prevent fines from slip debris to wash through the rock structure. To prevent undercutting of the rock structure during storm surges, the seaward side of the causeway would need to penetrate the sea floor in the order of 0.5 to 1m.

Figure 7.1 presents a cross section through the rock causeway (not to scale). We note that a rock structure of this scale, off set from the coastal cliffs will have a significant visual impact on the foreshore. Rough order construction cost estimates are in the order of \$10,000/ lineal metre.

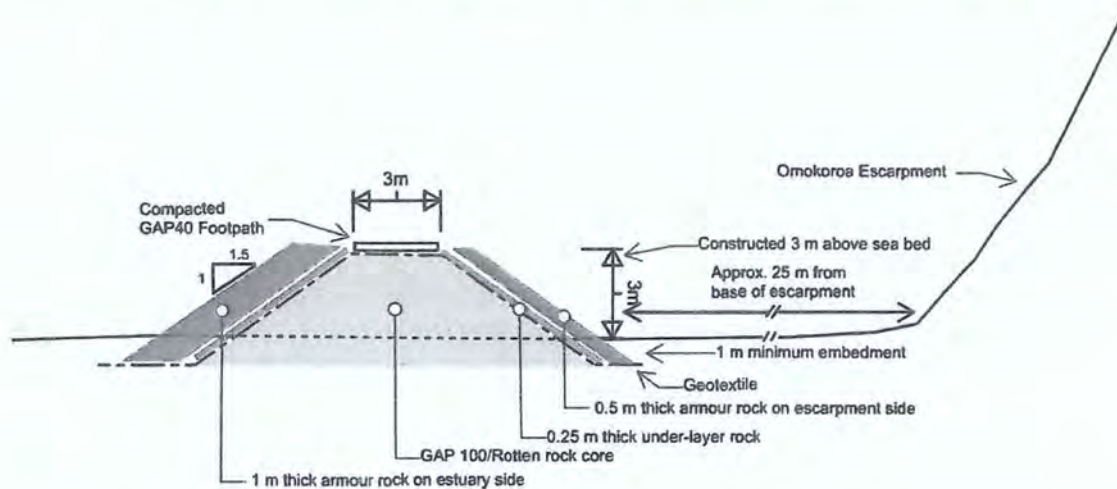


Figure 7.1: Example of a potential rock causeway. Rough order cost estimates have been based on these dimensions.

## 7.5 Option 5 – Construct a timber board walk

Construction of a timber board walk in the Coastal Marine Area, offset from the toe of slope, is an option that could link up different areas of the walkway, particularly along Zone B. Figure 7.2 presents a cross section through a timber boardwalk of the type being considered. This option would not add any stability protection to the base of the cliffs.

A typical timber boardwalk structure supported by 150SED to 250SED poles could be constructed near to the base of the coastal cliffs (i.e. within say 5 m distance). However, extensive pruning would be necessary over much of the low tide margin where large overhanging pohutukawa trees are established, particularly within Zones A and B. Further to this, a timber board work within this location would be subject to significant structural damage from future landslips due to debris impact strikes. We note that where a person could fall greater than 1 m height, handrails are likely to be required in accordance with the building code.

To reduce the risk of impact damage, the board walk could be situated at further distance from the cliff base (i.e. in the order of 25 to 50 m). However, to provide a board walk above high tide in this location the walking platform level would likely be in the order of 2 to 4 m above sea bed level. Such a structure would likely require 300 to 400 mm SED poles with substantial timber bracing similar to a marine jetty and may still be vulnerable to impact strikes from large landslips. A timber structure of this scale is considered impractical and cost prohibitive and is therefore not considered further.

Rough order construction cost estimates for a timber board walk situated within 5 m distance to the base of the coastal cliffs are in the order of \$5,000/ lineal metre.

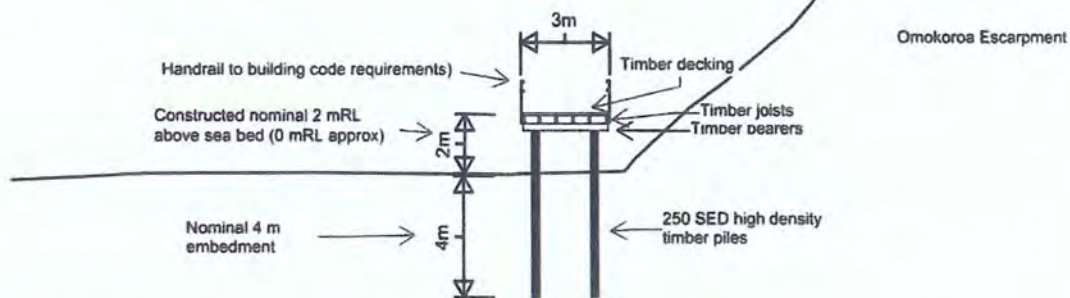


Figure 7.2: Sketch of a timber board walk.

## 7.6 Option 6 – Extend existing rock revetment

Rock revetments are currently in place at the toe of slopes in some areas around the Omokoroa Peninsula. Where these revetments are in place, and should a low level walkway be determined as desirable, this option would involve extending them to achieve a higher elevation above sea level and to create a 3 m wide walkway platform at the top.

As observed onsite, the majority of the coastal cliffs situated above the existing rock revetments (situated within Zone C) are generally no higher than 10 to 15 m (apart from the area between No. 26 Ruamoana Place and Bramley Drive) and did not undergo any significant instability during or following the March-April 2017 storm events. We also note that a series of horizontal drains were installed within lower slope over the revetment extent to relieve excessive pore pressures at contact boundaries between silty sandy soils overlying sensitive silty layers. Therefore, extending the existing revetment to provide a 3m wide walkway would seem appropriate within Zone C where there appears to be a lower risk of landslips originating above the revetment compared to other areas along the peninsula such as Zones A and B.

Figure 7.3 presents a cross section through a revetment extension. Rough order construction cost estimates are in the order of \$3,000/ lineal metre. We note, where the existing walkway remains intact, at its existing higher level, this option is not considered critical but could be considered as part of long term planning.

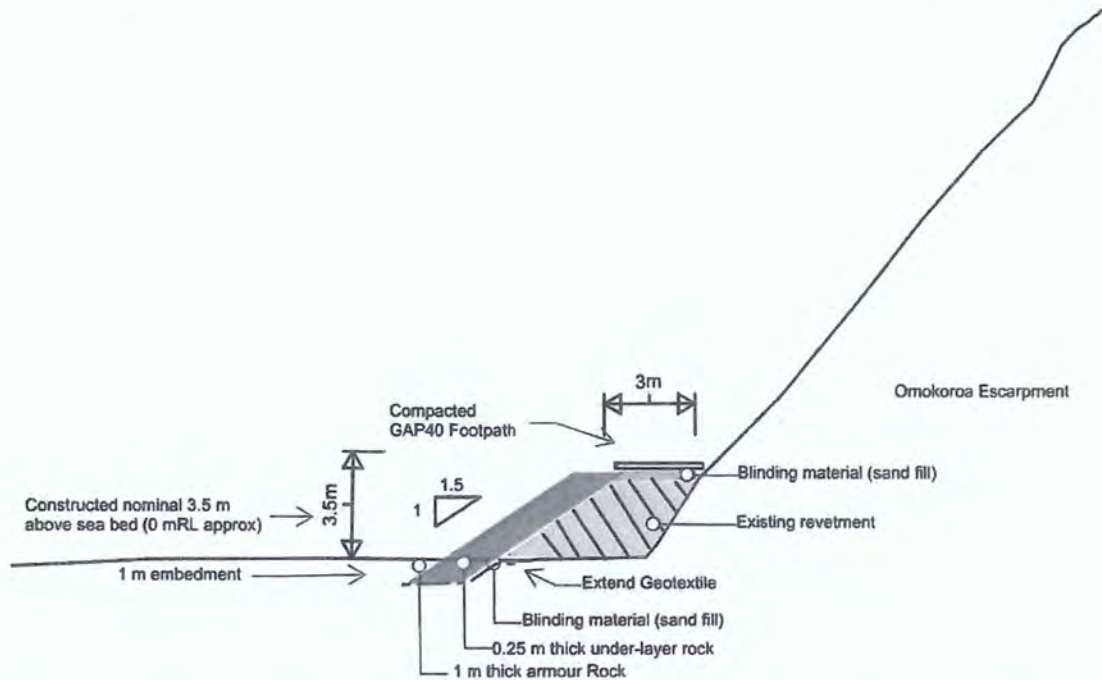


Figure 7.3: Example of revetment extension. Rough order cost estimates have been based on these dimensions.

## 7.7 Option 7 – Construct a new rock revetment

This option consists of new rock revetments constructed around the base of the slopes with the objective of increasing the stability of the base of the cliff as well as providing a 3 m wide walkway. A new revetment would improve the stability of the base of the cliff but are likely to be more suitable in areas where cliff tops are less than 10 to 15 m high such as Zone D.

The slope of the revetment would be roughly a 2H:1V slope down to the beach. For this type of heavy construction on soft beach sands, it is likely that the structure should be embedded a minimum of 1.0m into the sands to act as a founding layer.

Figure 7.4 presents a typical cross section through a rock revetment (not to scale). It is likely that the revetments would be 0.5 to 1 m above high tide level to allow for the forecast sea level change in the future.

Rough order construction cost estimates are in the order of \$6,000 / lineal metre.

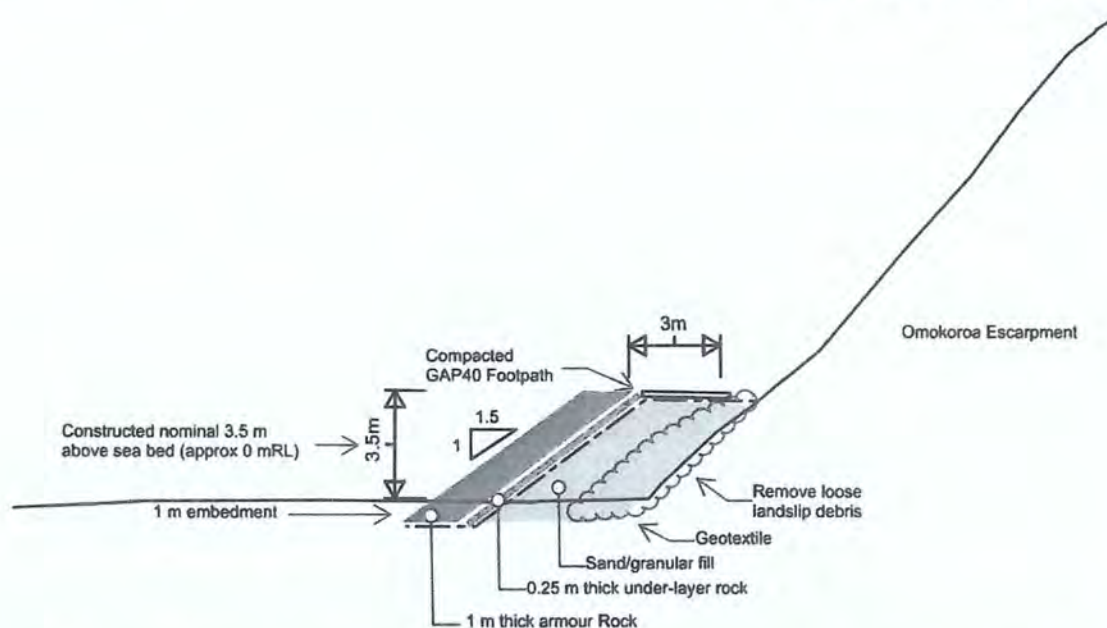


Figure 7.4: Example sketch of a new rock revetment. Rough order cost estimates have been based on these dimensions.

## 7.8 Option 8 – Minor engineering

Other options that could be utilised would be ‘soft’ engineering approaches instead of the ‘hard’ engineering construction options outlined above. This could involve the following:

- Shifting the footpath back away from landslip headscarps and install protective fencing in line with the headscarps;
- Management of slopes by pruning of selected trees which may impact the access to walkways or be in a position where they could lead to instability at the top of the slopes. Specialist advice from arborists and/or ecologists would be necessary; and
- Replanting of exposed soils with appropriate plant species as recommended by ecologists and landscape architects.

These options would be easier to initiate in the short to medium term and would not require large amounts of construction or engineering. The horizontal drain installation would require investigations to establish where water is likely to perch in high groundwater conditions following high intensity of prolonged rainfall events. To implement such solutions, rough order cost estimates could vary from tens of thousands to hundreds of thousands of dollars.

## 7.9 Consenting considerations

The escarpment itself is affected by a “stability – landslip” and “significant ecological feature” (U14/130) overlay under the WBOPDC District Plan. Therefore, for Options 3, 6, 7, and 8 where earthworks, construction of structures and native vegetation removal are likely to be required, resource consents will be required from WBODPC. Options 3, 6, 7 and 8 are also likely to involve earthworks within 20 m of the Coastal Marine Area (“CMA”) and therefore require discretionary consent under the Bay of Plenty Regional Council (BOPRC) Water and Land Plan. Overall, resource consents for Options 3, 6, 7 and 8 to both WBODPC and the BOPRC are likely to be of medium complexity (potentially publicly notified) to obtain, dependant on the actual nature and scale of the works proposed once future design detail becomes available.

Options 4, 5, 6, 7 and 8 involve structures within the CMA and require discretionary consent under the BOPRC Regional Coastal Environment Plan. These options are likely to have a higher resource consent complexity when compared to the other options. For example, the rock revetment and causeway options are all likely to require public notification. Further, the rock revetment and causeway options are likely to occupy a large portion of the CMA and/or coastal environment. Therefore, the effects of the structures on natural character, coastal processes and coastal ecology would need to be carefully considered in the design, consenting and construction process. The boardwalk option is likely to be less complex from a resource consent perspective when compared to the rock revetment and causeway options.

We note that it is possible that resource consents may be required for Option 2 should WBOPDC decide to form a walkway which necessitates earthworks and native vegetation clearance.

It would be prudent to obtain Archaeological Authority for all options.

### **7.10 Landscape architecture**

We understand that LOAM Architects have been engaged to provide considerations for landscape matters for the study area. We note that the design and implementation of selected improvement options described above will also need to consider landscape objectives endorsed for the site.

### **7.11 Construction considerations**

Access for construction machinery would need to be carefully considered for the options above. The current access points onto the beach from upslope are typically small sets of steps or narrow pathways. Access to the beach from sea level can be found at the Precious Reserve and the Omokoroa Beach Domain, the southern and northern-most points of the four zones.

Importantly, tides would need to be considered during construction. High tide around most of the Omokoroa Peninsula comes right up to the base of the cliffs. This will reduce the amount of time that can be used for construction, resulting in increased time to undertake the developments.

The beach material is mostly sands and landslip debris which are very soft. It is likely that heavy machinery may need to be adapted to prevent settling into the beach while construction is underway. These factors would be taken into account during detailed design for each option.

Council storm water service outlets at beach level will need to be assessed and incorporated into any toe of slope designs.

### **7.12 Safety in design**

To implement any of these walkway improvement options, there will need to be a strong focus on Safety in Design during concept or detailed design given the apparent and identifiable risk of working beneath steep and unstable ground. Workshops between all relevant parties should be arranged to better identify these risks.

### **7.13 Other Considerations**

- If low level walkway options are considered further, predicted sea level rise may need to be incorporated into the design of these structures. We note that for the rock causeway and revetment options, their crest levels can be elevated by adding additional rock at a later stage;
- Additional beach access points may need to be considered to allow for better emergency access or for tsunami evacuation; and
- With increased population and recreation usage (especially if cycle ways increase) additional parking and toilet facilities may need to be considered.

## **8 Assessment of suitable walkway improvement options**

### **8.1 General**

Our assessment of those improvement options considered suitable for each zone are provided below based on short, medium and long term time frames. From discussions with WBOPDC, the time frames have been defined as:

- Short term – 0 to 3 years;
- Medium term – 4 to 10 years; and
- Long term – 10+ years.

In the short term, unless funding is made available immediately, it is likely that the 'let nature take its course' option will be in place for the majority of the zones. This may allow time to plan the development and construction of the medium and long term options that have been suggested.

### **8.2 Zone A**

#### **8.2.1 Discussion**

Within Zone A, the existing Omokoroa Foreshore Waterview Terrace Reserve could be left as it is. The access points from Waterview Terrace and in front of No. 84 Hamurana Road are in good condition. The beach access points from this reserve are likely to require some maintenance or landscaping in the short term. It would be recommended that for the northern beach access point in this area, the dead tree is removed from the beach that is blocking the entrance to the steps (refer Photograph A2). The Precious Reserve area is under public discussions for potential developments in the future including toilets and car parking.

Rock revetments at the base of the slope are unlikely to prevent instability occurring higher up the slope such as the recent instability in front of No's 8 and 12 Waterview Terrace (refer Photograph A3). To prevent further regression of the headscarp of these landslips, an in-ground palisade wall could be considered. However, given that there is approximately 15 m width of existing walkway area behind the headscarp this is not considered critical.

Reshaping or benching of the near vertical head scarp could be considered to reduce the risk of further regression. However, this would reduce the width of the existing walkway. Therefore, maintaining a safety fence with an appropriate set back with continued monitoring is considered sensible. Installation of horizontal drains within the slip face extent where target soil boundaries can be readily identified may assist in reducing the risk of further instability.

Construction of new timber access steps in front of No. 84 Hamurana Road could be considered to provide beach access at the north eastern end of Zone A with a view of linking into a low level walkway for Zone B. Further assessment in regard to the stability of the slope in this location will need to be undertaken.

#### **8.2.2 Short term, medium term and long term plans**

Suggested short term, medium term and long term plans are summarised below.

**Short term** - 'let nature take its course' will utilise the existing track as it is, due to being it being well established and maintained with beach access already in place. Removing the dead tree at beach level would increase access ability to the second beach access point. Monitoring of existing landslips following heavy rainfall events (i.e. checking for signs of instability including the development of tension cracks, particularly within the walkway).

**Medium term** - if population and usage increase is expected, as well as a likely addition of bicycles, the footpath could be developed to have a paved/gravel section to reduce wear on the grassy reserve. In line with this, the beach access steps could be upgraded. Some pruning of select trees could also be considered. Install horizontal drains in areas of land instability where seepage observed and reshape landslip headscarps where they are deemed to be at risk of further regression.

**Long term** - with local area developments, the walkway in this zone could be linked to the proposed reserve upgrade at Precious Family Reserve to the south. To provide a beach level walkway at high tide, a rock causeway option could be considered.

## 8.3 Zone B

### 8.3.1 Discussion

Zone B is the one zone that does not contain a reserve walkway at the top of the cliffs. The only beach access point is at Hamurana Road Reserve.

Given that this zone contains the highest cliff tops (i.e. up to 30 m) and has seen extensive instability comprising translational and deep seated block failures occurring high up the slope, a rock revetment is not considered suitable due to future similar landslip mechanisms which are likely to run out over top of the revetment.

Similarly, a timber board walk situated close to the toe (i.e. within 5 m) is likely to undergo significant structural damage from impacting debris strikes and would require extensive pruning of large Pohutukawa trees cantilevering out over the sea floor at the base of the cliffs.

Therefore, the only other option available to provide walkway access during high tide is the rock causeway structure. To create linkages with the existing clifftop walkways, the causeway could tie into new access steps suggested in Zone A (i.e. in front of No. 84 Hamurana Road) including the Hamurana Reserve access and potentially new access steps or a sloping track constructed in the vicinity of No. 20 Ruamoana Place. Further assessment and investigations in regard to the stability of the slope in this location will need to be undertaken. To cross the large debris mass runout from the Bramley Drive landslip, which contains a small forest of trees, the causeway could butt into either side of this small island with a low level timber boardwalk or walking track constructed through the established trees.

We note that if a rock causeway was constructed at great cost, then there would be less emphasis on implementing costly stabilisation solutions outlined in Section 7.3 as the objective of the causeway is not only to provide a walkway platform but to also contain slip debris from future instability.

Partial land acquisition of the cliff top properties to provide continuation of the cliff top walkway could be considered as an alternative to constructing a walkway structure at the base of the cliffs (as described immediately above). However, this would involve partial purchase of 35 properties as well as the Omokoroa Bowling Club, along the length of this area.

Reshaping or benching of the near vertical headscarps could be considered in select locations but is unlikely to be suitable where headscarps are situated either within the residential property boundaries or very near to the upslope properties. Installation of horizontal drains within the slip face extent where target soil boundaries can be readily identified may also assist in reducing the risk of further instability.

### 8.3.2 Short term, medium term and long term plans

Suggested short term, medium term and long term plans are summarised below.

**Short term** - 'let nature take its course', and clearly mark road walkway linkages from Zone A to Zone C along existing walkways, remove areas of landslips debris in line with Kowai Grove, McDonnell Street and adjacent to the Bramley Drive landslips that have covered the beach in debris to increase walking access at low tide.

**Medium term** - install horizontal drains in areas of land instability where seepage observed and reshape landslip headscarps in select areas.

**Long term** – to provide a walkway at beach level during high tide, a rock causeway could be considered including new timber access step or sloped path linkages as described above.

## 8.4 Zone C

### 8.4.1 Discussion

The Clifftop Esplanade Reserve has a well maintained, grassy corridor that runs from the north of Bramley Drive landslip to the Gerald Crapp Historic Reserve. The walkway is easily accessed from Ruamoana Place pathway and through Walnut Grove Reserve, however there is only road parking in these areas. Beach access in line with the Ruamoana Place pathway has steps in good condition but has a very high step down to the beach at the end of the steps. It would be recommended, from a safety and access perspective, that an additional step is placed at the end of the steps, or a ramp of sorts is constructed. Maintenance of the area where picnic benches were observed by these steps would increase the usage of the benches in this area. We again note that the picnic benches and steps were installed by persons unknown and are not considered to be a Council owned asset.

Part of this clifftop walkway was closed at the time of this site walkover due to the presence of landslips that have undermined the edge of the reserve (between No. 26 Ruamona Place and Bramley Drive Landslip). Stability works could be undertaken in the short to medium term to reinstate this portion of the walkway to allow the reserve to be reopened and to reconnect it with the Bramley Drive footpath. A combination of stability works (as outlined in Option 3 above) could be adopted to prevent localised regression of the over steep headscarps appropriate to support a walkway. The cost of implementing these works, excluding site specific ground investigations and detailed design could be in excess of \$500,000. We would recommend progressing concept level designs to enable more accurate costings.

It must be appreciated following implementation of such stability improvements, there would always remain a risk of larger scale instability occurring as outlined in Section 7.3.

At beach level in this reserve, a rock revetment is already in place which could be utilised by increasing the height and width to allow a walkway to be formed on top if a low level walkway is desired at a later stage.

### 8.4.2 Short term, medium term and long term plans

Suggestions for the short term, medium term and long term plans are summarised below.

**Short term** – implement stability works between No. 26 Ruamona Place and Bramley Drive Landslip to reopen the walkway (as described immediately above). If population and usage increase is expected, also with the addition of bicycles likely, the walkway could be developed to have a paved/gravel section to reduce wear on the grassy reserve. Along the beach, 'let nature take its course' due to the rock revetment currently in place.

**Medium term** – northeast of No. 26 Ruamona Place install horizontal bored drains and reshape existing headscarps in select areas.

**Long term** – To provide a walkway at beach level during high tide, the existing revetment could be extended with a view of installing of a second beach access point by upgrading existing beach access steps in line with Gerald Place (which we note is a private asset and not owned by the Council).

## 8.5 Zone D

### 8.5.1 Discussion

Zone D is likely to require the least amount of work going forward. The clifftop is an established reserve with access to the Gerald Crapp monument and the Pa site, over gravel paths. The pathway begins at beach level from the Omokoroa Beach Domain to the south of the reserve. There is generally a lot of space in which to shift the walkway alignment away from areas of instability if required.

Parking and toilet facilities are available within the beach domain, as well as café facilities.

### 8.5.2 Short term, medium term and long term plans

Suggestions for the short term, medium term and long term plans are summarised below.

**Short term** - utilise the existing track in the short term as it is well maintained and already paved for bike usage going forward. Some protective fencing could be installed in areas where landslips have occurred close to the top of the cliff. Along the beach, 'let nature take its course' is recommended due to the partial rock revetment currently in place.

**Medium term** - shifting the footpath back where it is in close proximity to slip headscarps could be considered for future-proofing the tracks.

**Long term** – constructing a rock revetment around the toe of the slope in this zone to connect along the revetment could be considered which would likely improve the stability of the slope in this area and prevent future long term erosion. This would also provide a walkway along the beach at high tide.

## 9 Summary

Our walkway improvement options assessment is summarised in Table 9.1 and Table 9.2 below. We note that the construction options described in this report including rough order cost estimates are a guide only. Concept designs and/or detailed design would be required to better confirm their suitability and to establish more accurate cost estimates.

Table 9.1: Summary of walkway improvement options for Zones A to D

| Options and [rough order cost estimates] <sup>1</sup> |                                                                                                                                                          | Zone A – Omokoroa Foreshore Waterview Terrace                                                                                                                                                                                                                                      | Zone B – Hamurana Road and Reserve                                                                                                                        | Zone C – Clifftop Esplanade Reserve                                                                                                                                                                                                                                        | Zone D – Gerald Crapp Historic Reserve                                                                                           |
|-------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| 1                                                     | Let nature take its course<br><br>[Rough order cost estimate - low cost]                                                                                 | Considered suitable for the <b>short term</b> includes removal of a dead tree at beach level to increase access ability to the second beach access point and ongoing monitoring of the walkway corridor following rainfall events.                                                 | Considered suitable for the ' <b>short term</b> ' including ongoing monitoring of the walkway corridor following rainfall events.                         | Considered suitable for the ' <b>short term</b> ' including ongoing monitoring of the walkway corridor following rainfall events                                                                                                                                           | Considered suitable for the ' <b>short term</b> ' including ongoing monitoring of the walkway corridor following rainfall events |
| 2                                                     | Land acquisition<br>[Rough order cost estimate - to be advised by others]                                                                                | -                                                                                                                                                                                                                                                                                  | -                                                                                                                                                         | -                                                                                                                                                                                                                                                                          | -                                                                                                                                |
| 3                                                     | Stabilise areas of instability downslope of clifftop reserves<br><br>[Rough order cost estimate - tens of thousands to hundreds of thousands of dollars] | <b>Medium term</b> – installation of horizontal drains in select areas.                                                                                                                                                                                                            | <b>Medium term</b> – installation of horizontal drains and reshaping landslip headscarps in select areas.                                                 | <b>Short term</b> – implement stability works between No. 26 Ruamona Place and Bramley Drive Landslip to reopen the walkaway<br><br><b>Medium term</b> – northeast of No. 26 Ruamona Place install horizontal bored drains and reshape existing headscarps in select areas | -                                                                                                                                |
| 4                                                     | Construct a rock causeway<br><br>[Rough order cost estimate - \$10,000 / lineal metre]                                                                   | <b>Long term</b> – the walkway in this zone could be linked to the proposed reserve upgrade at Precious Reserve to the south, a rock causeway option could be considered to provide beach level walkway at high tide including new access steps in front of No. 84 Haumarana Road. | <b>Long term</b> – to provide a walkway at beach level during high tide, a rock causeway could be considered including linkages to new timber access step | -                                                                                                                                                                                                                                                                          | -                                                                                                                                |

ATTACHMENT C

| Options and [rough order cost estimates] <sup>1</sup> |                                                                                                              | Zone A – Omokoroa Foreshore Waterview Terrace                                                                                                                                                                      | Zone B – Hamurana Road and Reserve                                                                                                                                                                                       | Zone C – Clifftop Esplanade Reserve                                                                                                                              | Zone D – Gerald Crapp Historic Reserve                                                                                                                                                                          |
|-------------------------------------------------------|--------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 5                                                     | Construct a timber board walk<br><br>[Rough order cost estimate - \$5000 / lineal metre]                     | -                                                                                                                                                                                                                  | -                                                                                                                                                                                                                        | -                                                                                                                                                                | -                                                                                                                                                                                                               |
| 6                                                     | Extend existing rock revetments<br><br>[Rough order cost estimate - \$3000 / lineal metre]                   | -                                                                                                                                                                                                                  | -                                                                                                                                                                                                                        | <b>Long term</b> – extending the rock revetment around the toe of the slope to provide low level walkway during high tide could be considered.                   | -                                                                                                                                                                                                               |
| 7                                                     | Construct new rock revetment<br><br>[Rough order cost estimate - \$6,000 / lineal metre]                     | -                                                                                                                                                                                                                  | -                                                                                                                                                                                                                        | -                                                                                                                                                                | <b>Long term</b> – constructing a rock revetment around the toe of the slope in this zone to connect along the revetment could be considered which would likely improve the stability of the slope in this area |
| 8                                                     | Minor engineering<br><br>[Rough order cost estimate - tens of thousands to hundreds of thousands of dollars] | <b>Medium term</b> – a footpath could be developed to have a paved/gravel section to reduce wear on the grassy reserve. In line with this, the beach access steps could be upgraded with pruning of selected trees | <b>Short term</b> – remove areas of landslips debris in line with Kowai Grove, McDonnell Street and adjacent to the Bramley Drive landslips that have covered the beach in debris to increase walking access at low tide | <b>Short term</b> - the footpath could be developed to have a paved/gravel section to reduce wear on the grassy reserve and with a view to accommodate cyclists. | <b>Short term</b> - install protective fencing in line with the headscarps<br><b>Medium term</b> - shifting the footpath back where it is in close proximity to slip headscarps                                 |

Note 1: Rough order cost estimates are a guide only. Concept designs and/or detailed design would be required to better confirm their suitability and to establish more accurate cost estimates.

Table 9.2: Summary of design, consenting and construction considerations

| Design                                                                                                                                                                                                                                                                                                                                                                    | Consenting                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | Construction                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> <li>• Council storm water service outlets at beach level will need to be assessed and incorporated into any toe of slope designs or repaired as required.</li> <li>• Safety in Design workshops with all relevant parties will be required to outline risks during construction, and possible risks for future maintenance.</li> </ul> | <ul style="list-style-type: none"> <li>• Long term hazards such as sea level rise may need to be taken into account in detailed design stage to provide relevant heights of escarpments or boardwalks to future proof for this hazard.</li> <li>• Any earthworks, construction of structures or native vegetation removal that are likely to be required for any option, will require resource consents from WBODPC.</li> <li>• Any earthworks within 20 m of the Coastal Marine Area ("CMA") will require discretionary consent under the Bay of Plenty Regional Council (BOPRC) Water and Land Plan.</li> <li>• Any structures within the CMA will require discretionary consent under the BOPRC Regional Coastal Environment Plan.</li> <li>• It would be prudent to obtain Archaeological Authority for all options.</li> <li>• A landscape architect will be required to provide recommendations for each of the options going forward during the detailed design stage of works.</li> </ul> | <ul style="list-style-type: none"> <li>• Beach access to undergo works is only available at the Omokoroa Beach Domain or Precious Reserve. Access over steps down the cliff face is also available throughout the zones but are not likely to be suitable for construction plant to construct low level walkway structures.</li> <li>• High tide around most of the Omokoroa Peninsula comes right up to the base of the cliffs. This will reduce the amount of time that can be used for construction, resulting in increased of time to construct low level walkway structures.</li> <li>• The beach material is mostly sands and landslip debris which are very soft which will need to be considered with utilising heavy machinery. Temporary haulage tracks may need to be constructed to prevent construction plant from sinking into soft deposits during construction.</li> <li>• Working directly below areas of instability is considered to be highly hazardous.</li> </ul> |

## 10 Limitations

This is not a detailed design report, the construction details described above are a guide only, with rough order costs only. These options are for consideration and detailed design would need to be undertaken to confirm their suitability and to establish more accurate costings.

## 11 Applicability

This report has been prepared for the exclusive use of our client Western Bay of Plenty District Council, with respect to the particular brief given to us and it may not be relied upon in other contexts or for any other purpose, or by any person other than our client, without our prior written agreement.

Tonkin & Taylor Ltd

Report prepared by:



.....  
Doug Harbutt

Geotechnical Engineer

Authorised for Tonkin & Taylor Ltd by:



.....  
Kevin Hind

Project Director

DSH

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**Appendix A: Figures 1 to 8**

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SCALE 1:1,250  
0 10 20 30 40 50 60 70 80 (m)

Aerial photo sourced from Linz Data Service, licensed by LINZ for re-use under the Creative Commons Attribution 3.0 New Zealand licence (CC BY 3.0 NZ)  
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**Tonkin+Taylor**  
Level 1, 525 Cameron Road, Tauranga  
www.tonkintaylor.co.nz

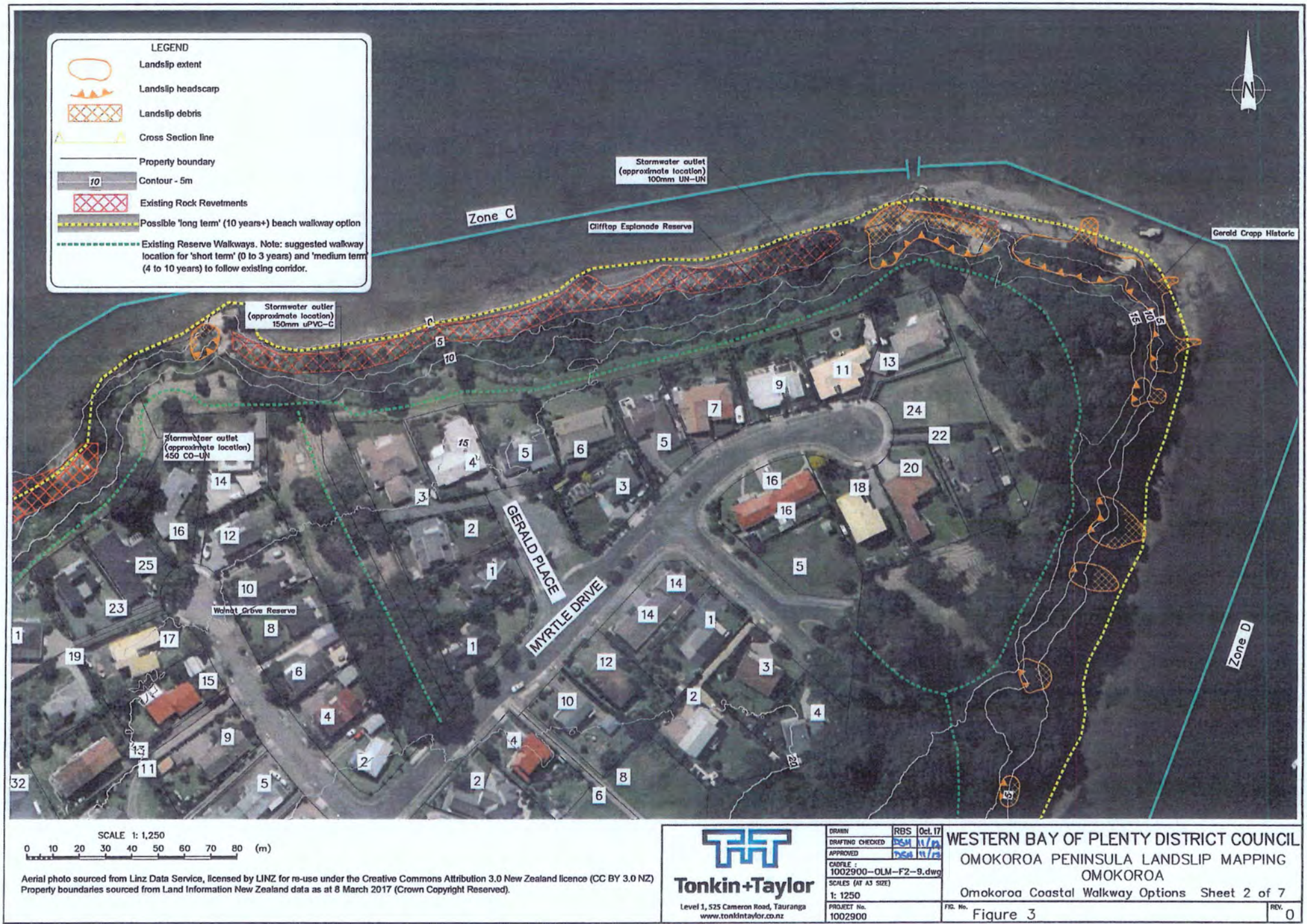
|                                |     |        |
|--------------------------------|-----|--------|
| DRAWN                          | RBS | Oct 17 |
| DRAFTING CHECKED               | DSH | 9/17   |
| APPROVED                       | DSH | 9/17   |
| CADFILE : 1002900-OLM-F2-9.dwg |     |        |
| SCALES (AT A3 SIZE)            |     |        |
| 1: 1250                        |     |        |
| PROJECT No. 1002900            |     |        |

**WESTERN BAY OF PLENTY DISTRICT COUNCIL**  
**OMOKORO PENINSULA LANDSLIP MAPPING**  
**OMOKORO**

Omokoroa Coastal Walkway Options Sheet 1 of 7

Figure 2

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T:\Nuciland\CAD\1002900\Working\Material\CAD\FIG\1002900-OLM-F2-9.dwg, F3, 9/11/2017 6:40:44 p.m., caduser, 1:1

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