REPORT

Tonkin+Taylor

Preliminary Slope Hazard Assessment

Shelly Bay Road Upgrades

Prepared for

Wellington City Council

Prepared by

Tonkin & Taylor Ltd

Date

July 2020

Job Number

1014113.v1

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Document Control

Title: Preliminary Slope Hazard Assessment					
Date	**Version**	**Description**	**Prepared by:**	**Reviewed by:**	**Authorised by:**
26.06.20	1	Draft for client review	Tim Haxell	Nick Peters	Richard Cole
17.07.20	2	Final issue	Tim Haxell	Nick Peters	Richard Cole

Distribution:

Wellington City Council	1 copy
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Executive summary

Wellington City Council (WCC) have engaged Tonkin and Taylor (T+T) to undertake a high-level coastal assessment to assist with the planning of the upgrade of Shelly Bay Road. This is to better align with Waka Kotahi NZ Transport Agency (Waka Kotahi) guidance and the vision for the Great Harbour Way.

1 Introduction

Tonkin & Taylor Ltd (T+T) have been engaged by Wellington City Council (WCC) to explore options for upgrading Shelly Bay Road. The objective of the upgrade will be to provide an environment on Shelly Bay Road that better aligns with Waka Kotahi NZ Transport Agency guidance and the Great Harbour Way plan to provide a safer and more inviting setting for pedestrians, cyclists, and other road users along the Wellington coast. The extent of the assessment site is approximately 2.3 km, extending from Miramar Avenue to the south end of Shelly Bay, as shown in **Figure 1**.

To assist with the assessment of the options for upgrades, T+T has been engaged to undertake a high-level slope hazard assessment along this section of Shelly Bay Road. The results of the slope hazard assessment are outlined in this report. The purpose of the assessment is to inform the geotechnical implications of the options, including effects on consenting, the environment, feasibility, and cost. The assessment is high-level only; a detailed slope hazard assessment should be undertaken at a later stage in the project to inform detailed design.

Figure 1: Physical scope of work (extent of the project scope (study area) shown in red; coastal areas outside of scope highlighted in yellow)

1.1 Scope of work

The terms and conditions of our engagement are set out in the Tonkin & Taylor Ltd. (T+T) Offer of Service, dated 22 May 2020.

This report provides the results of the high-level slope hazard assessment of the study area. The key tasks undertaken as part of this assessment are in line with T+T's Offer of Service, dated 22 May 2020, as follows:

- Undertake a desktop study of available information including:
  - Published geological documentation to understand the wider geological context and identify the location of previously mapped active or inactive faults;
  - Historic aerial photographs to identify locations of prior and active instability;
  - Land Information New Zealand (LINZ) Wellington LIDAR survey (2013) to identify slopes that are likely to pose the highest risk (for example, due to their height, angle, or distance from the road);
  - GNS slope hazard assessment study (we have assumed that GNS will be able to provide us with the study for Shelly Bay Road);
  - Relevant empirical information provided by WCC (for example, records of prior instability);
  - An initial inspections report undertaken by T+T along the road;
- Complete a site walkover with two engineering geologists. This will include a healthy and safety assessment prior to the site visit and preparation of required documentation; and
- Produce a Preliminary Slope Hazard Assessment Report based on the desktop study and site walkover in general accordance with the WCC Qualitative Risk Assessment Framework to determine current risk to the road. We note that this not a detailed geotechnical assessment and will be based primarily on available existing information and walkover observations, as outlined above.

2 Basis of assessment

2.1 Site walkover

Inspection of geological, geomorphic, and hydrological features was undertaken to develop an understanding of the current condition and possible slope hazards present at the site. This was completed by two T+T Engineering Geologists on 19 June 2020.

A discussion of the instability observed during this site walkover is included in **Section 3.1**. General observations are presented as part of the risk assessment in Table B1, **Appendix B**.

2.2 Desktop study

A desktop study of the following information has been undertaken to support the slope hazard assessment of slopes above Shelly Bay Road:

- Digital Elevation Model (DEM) using Light Detection and Ranging (LiDAR) data captured for Greater Wellington Regional Council by Aerial Surveys in 2013 and downloaded from Land Information New Zealand (LINZ);
- Published geological documentation:
  - Geological mapping of the Wellington region scale 1:50,000 (Begg & Mazengarb, 1996);
  - GNS Science Te Pū Ao (GNS) NZ active fault database, http://data.gns.cri.nz/af;
- Historic aerial photographs (c. 1939, 1951,1954, 1961, 1975, 1987 and 2017), http://retrolens.nz and licensed by LINZ; and
- T+T Geotechnical database.

2.2.1 Topographical setting

The site topography has been assessed using Blue Marble Geographics Global Mapper (v21.0.2). This software was used to identify locations of prior instability, and slopes with an elevated risk due to their slope angle, height, and distance from Shelly Bay Road. **Figure 2** presents the general slope angles between Chainage 1530 and 2290 m. In summary:

- Shelly Bay Road is located at the base of a west-facing coastal escarpment approximately 3 m above sea level and follows the coastline of Miramar Peninsular between Cobham Road and Shelly Bay;
- The coastal escarpment is naturally steep (40 to 50 degrees) and typically between 20 to 40 m high. The shallower slope above the escarpment is moderately steep (20 to 30 degrees);
- Earthworks cutting has locally steepened the escarpment to 60 degrees, and up to 4 high. The purpose of these cuttings was to form a desired road width during formation of the road;
- There are some localised areas of rock outcrop on the escarpment that exceeds 60 degrees;
- The existing road shoulder width is limited. The road generally less than 1 m from the base of the escarpment; and
- The crest of the escarpment is undulating, which is inferred to be the result of pre-historic retrogressive land sliding. The remnant features on the escarpment are narrow and wide gullies.

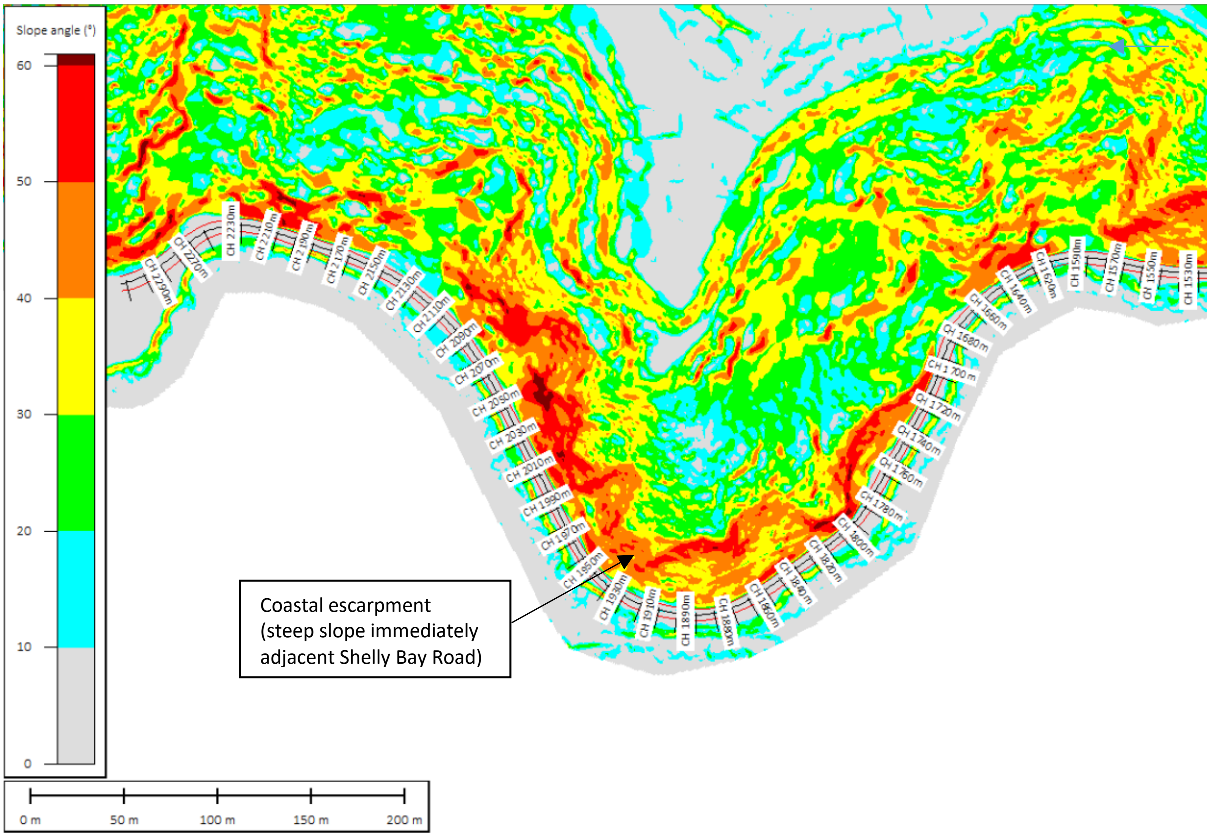

Figure 2: Extract from GIS software presenting slope angles as colours

2.2.2 Geological setting

Shelly Bay Road in the context of the regional geology is presented in **Figure 3** below. The geological map[1] indicates that the slopes are comprised of very steeply bedded, alternating sandstone/mudstone (known commonly as "Greywacke" rock) of the Rakaia Terrane (Late Triassic). A discrete block mapped separately as 'melange and broken' is located between approximately Chainage 660 and 810, and 980 and 1100 m. Greywacke rock is extensively fractured in multiple directions which is attributed to the rockfalls that are commonly observed on road cuts and natural rock slopes in the Wellington region, including Shelly Bay Road.

Although not mapped, a layer of colluvium soil overlies the rock in some areas across the slopes. The thickness of colluvium will likely be variable and predominantly thin or non-existent on steep slopes and ridges, and thicker in shallow slopes and gullies.

[1] Begg, J.G., Mazengarb, C., 1996. Geology of the Wellington area, scale 1:50 000. Institute of Geological & Nuclear Sciences geological map 22. 1 sheet + 128 p. Lower Hutt, New Zealand. Institute of Geological & Nuclear Sciences Limited.

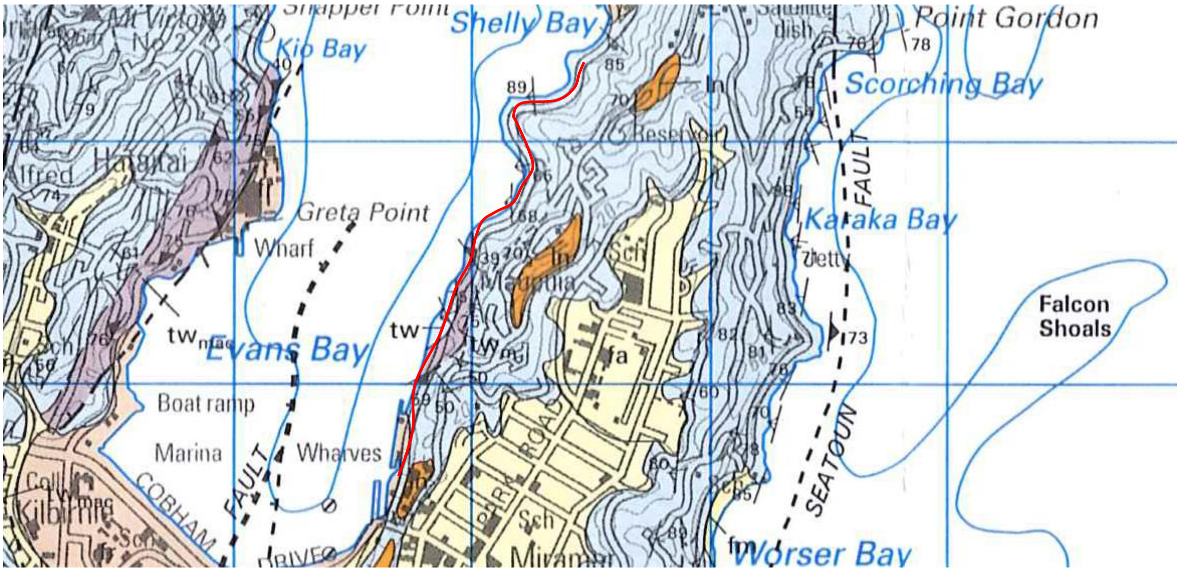

Figure 3: Geological setting and extent of study (red line). Note that this map only describes the general geology of the area and does not provide site-specific detail

The coastal escarpment has formed by the persistent erosion at the toe of the slope by the sea, in conjunction with the progressive tectonic uplift and tilting of the Miramar Peninsula. Maximum erosion by the sea is inferred to have occurred during the mid-Holocene Climatic Optimum from 7550 to 2000 BP where relative sea level was approximately 1 m higher than today Subsequent uplift of land attributed to the 1855 Wairarapa earthquake has resulted in the exposure of rock platform marginally above sea level, upon which Shelly Bay Road has been constructed.

Shelly Bay Road is near a number of significant active faults, capable of producing large-magnitude and surface-rupturing earthquakes (M≥7) that will generate strong ground-shaking throughout the Wellington region[2] and negatively impact slope stability. No significant faults have been identified beneath the project site therefore the risk of ground rupture is low. Any future slope design should consider the slopes' performance under seismic load.

A summary of these nearby active faults (those less than 5 km away) is presented in **Table 2.1**. Distances from the site are approximated with limited accuracy. We note that the Hikurangi Subduction Zone and other active faults greater than 5 km from the site can also generate strong ground-shaking.

Table 2.1: Nearby active faults (GNS Science Te Pū Ao, Active Fault Database)

Fault name	Distance from site	Direction from site	Recurrence interval
Evans Bay Fault	0.5 km	West	Unknown
Aotea Fault	2.5 km	West	2,200 to > 6,400 years2
Wellington Fault	4.6 km	West	500 to 1,000 years3

[2] Philip M. Barnes, Scott D. Nodder, Susi Woelz & Alan R. Orpin (2019) The structure and seismic potential of the Aotea and Evans Bay faults, Wellington, New Zealand, New Zealand Journal of Geology and Geophysics, 62:1, 46-71.
[3] Rhoades, D. A. et al., 2011. Re-Evaluation of Conditional Probability of Rupture of The Wellington-Hutt Valley Segment of The Wellington Fault. *Bulletin of The New Zealand Society for Earthquake Engineering,* June.44(2)

2.2.3 Historic aerial photographs

Table 2 presents a review of historic aerial photographs. Historic aerial photographs are available upon request.

Table 2: Summary of observations

Year	Observations
1939	• Numerous small to intermediate-scale landslides on slopes above the escarpment. • Slopes are grass-covered and free from vegetation. Terracettes (shallow soil slumping) are common. • Some side-cast fill is present on the side of the road (likely during construction) at the top of the slope – now Main Road, Akaroa Drive, Prison Road, and Maupuia Walkway. • Most of the escarpment is exposed and appears to be actively sloughing in some areas, particularly between Chainage 1930 to 2090 m. • Significant retrogressive landslide features in gully upslope from Chainage 2240 and 2260m (headscarp fully regressed). • A 20 m wide landslide appears to have occurred at approximately Chainage 2320 m (note that this has been removed by subsequent earthworks cutting). • Some local quarrying of rock may have occurred between Chainage 280 and 400. A dwelling is now located on the flat land in this area.
1951/1954	• Some establishment of vegetation generally on the south side of ridges. • Most of the escarpment remains exposed and appears to be actively sloughing. • Significant cutting made before c.1951 between Chainage 2290 and 2330 in the order of 4,000 m3. A bench appears to have been constructed and is likely to prevent rockfall from reaching the road.
1961	• Vegetation cover becoming more established. • Some areas of escarpment exposed, and no significant land instability identified.
1975	• Established vegetation cover. • Only minor areas of escarpment exposed, and no significant land instability identified.

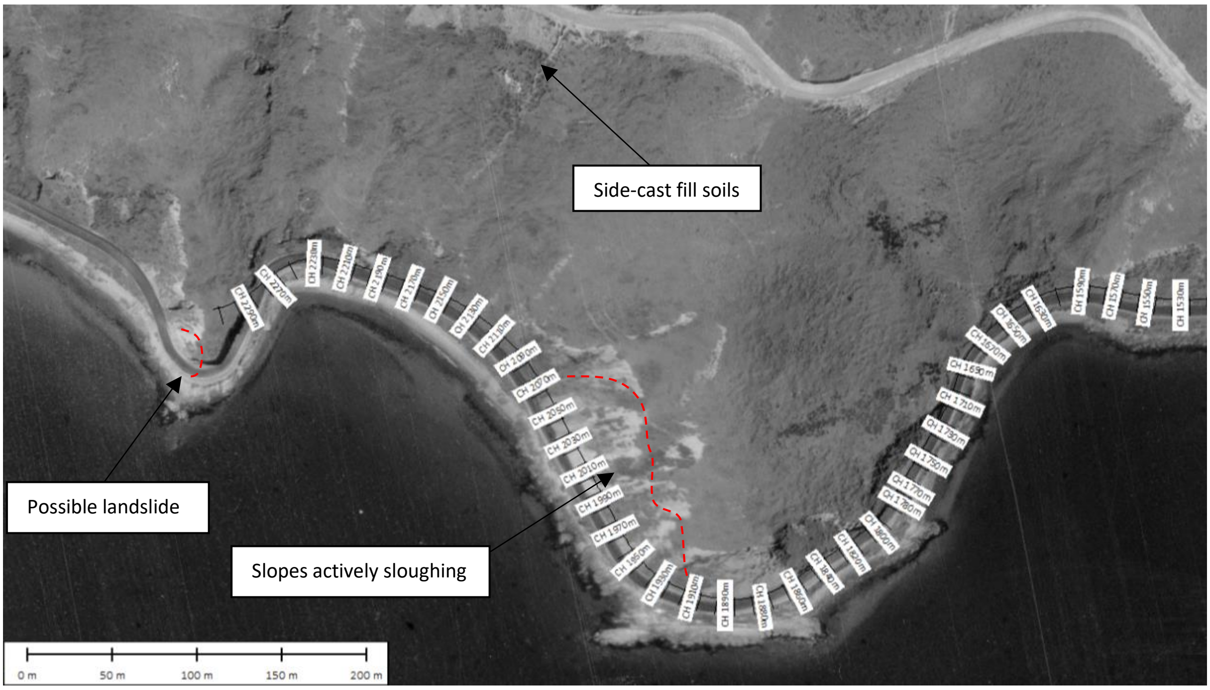

Figure 4: Historic aerial photograph c.1939

3 Slope hazard assessment

An assessment of the existing slopes has been carried out using a Qualitative Risk Assessment Framework in general accordance with AGS (2007c)[4] and has been adapted to suit WCC requirements i.e. consequence to private property, roads, and footpaths. This framework and adaptations have been used by WCC Transport & Infrastructure to assess slope hazard risks on other Wellington roads and slopes.

This framework measures risk based on Likelihood (annual probability of occurrence) and Consequence (damage) for a given landslide scenario. Generalised implications for risk management are provided in **Table 3**.

Table 3: Implications for risk management

Risk level		Implications for risk management
VH	Very High Risk	Detailed investigation, design, planning and implementation of treatment options to reduce risk to acceptable levels: May involve very high costs.
H	High Risk	Detailed investigation, design, planning and implementation of treatment options to reduce risk to acceptable levels.
M	Moderate Risk	Broadly tolerable provided treatment plan is implemented to maintain or reduce risks. May require investigation and planning of treatment options.
L	Low Risk	Acceptable. Treatment requirements to be defined to maintain or reduce risk.
VL	Very Low Risk	Acceptable. Manage by normal maintenance procedures.

The road has been divided into zones that have similar ground conditions and geometry. The likelihood consequence of various potential landslide scenarios has been assessed for each zone and a risk level for each zone established based on the framework. Zones are presented in the drawings in **Appendix A**.

The results of the slope hazard assessment and the risk framework are presented in **Appendix B**. Potential landslide scenarios are discussed in detail in **Section 3.1**.

3.1 Potential landslide scenarios

3.1.1 Small-scale soil and rock failures

Shallow slides of surficial soils and vegetation are expected to occur on any slopes with a loose surficial soil cover.

Frittering and small-scale block dropouts are expected to occur on steep and exposed rock slopes due to ongoing physical weathering.

Such small-scale slope instability is expected to occur occasionally under normal rainfall conditions (<1 to 5-year return interval (0.2 to 1.0 annual probability of occurrence)).

[4] Australian Geomechanics Society Landslide Taskforce, Landslide Practice Note Working Group, Practice Note Guidelines for Landslide Risk Management (2007), Australian Geomechanics Journal and News of the Australian Geomechanics Society, Volume 42, No 1, March 2007

Debris (in the order of 1.0 m^3 or less) may accumulate locally on the road shoulder and part of a single lane requiring removal, but the road will remain usable. Some or all the debris may be captured by vegetation and not inundate the shoulder or road.

Several small-scale landslides were observed during the T+T site walkover, as shown in **Figure 5**.

Figure 5: Shallow slide of loose surficial soils and rock observed on 19 June 2020. Approximately 1 m^3 debris inundating road shoulder

3.1.2 Intermediate-scale soil and rockmass slides

Translational sliding of soils may occur where colluvium soil is found to be thicker whereby sliding occurs within the soil or along an interface with the underlying rock.

Rockmass-controlled plane or wedge failure may occur where discontinuity (bedding, fault, joint) orientation is unfavourable in relation to the slope orientation.

Such intermediate-scale slope instability is expected to occur under normal to adverse conditions (2 to 100-year return interval (0.01 to 0.5 annual probability of occurrence)) due to heavy rainfall and/or earthquake.

Debris (up to 100 m^3) including vegetation stripped from run-out is likely to inundate one or both lanes requiring removal. One or both lanes will be blocked until debris cleared (up to one day).

A rockmass slide occurred on the 19th June 2020 at Chainage 1100 m and was inspected by T+T as shown in **Figure 6**. The landslide inundated both lanes blocking the road. Approximately 50 m^3 of debris including boulders up to 1 m wide was removed over one day. One lane was open during that time.

We consider the landslide to be the direct result of the rainfall that occurred over the previous two days. Approximately 44 mm of rainfall measured by a nearby rain gauge[5] over 24 hours on 18 June

[5] Miramar at Miramar Bowling Club, Greater Wellington Regional Council Environmental Monitoring and Research (http://graphs.gw.govt.nz/)

2020 (this depth/rate of rainfall has a return interval of between 1 and 2 years[6], i.e. would be expected to occur every 1 to 2 years)).

Figure 6: Rockmass slide at CH 1100 m on 19 June 2020 blocking the road (photograph sourced from stuff.co.nz)

3.1.3 Major rockslide

A large-scale rockslide exploiting a significant unfavourable and persistent discontinuity may be possible, however no discernible surface features have been identified. Furthermore, no evidence historic or recent instability on this scale has been identified.

Instability of this nature could be expected to occur under high to extreme conditions (>100-year return interval (<0.1 annual probability of occurrence)) e.g. major rupture of a nearby active fault. We note that in the context of the wider Wellington area, numerous slopes would also be affected by instability.

For this scenario, debris could exceed 200 m^3, block both lanes and cause significant traffic delays.

3.2 Limitations slope hazards assessment

This preliminary assessment is based on the desktop review of existing documentation and visual observation of the geological, geomorphic, and hydrological features exposed at the ground surface. No subsurface investigation has been carried out to support this assessment. It must be appreciated that subsurface conditions may vary from those inferred in this report. As such, a more detailed assessment should be undertaken during design development.

This assessment considers risk to Shelly Bay Road and does not consider risk to life or private property. An increase in traffic volumes will increase the life risk due to the exposure to the slope hazard. The risk to life should be considered in any future slope design.

Field mapping was carried out from road level and only due to the steepness of the slope and dense cover of vegetation. Some areas of slope were therefore not visually inspected.

[6] NIWA High Intensity Rainfall Design System V4 (https://hirds.niwa.co.nz/)

This assessment only considers the slope hazard from slopes above the road. Hazards affecting the stability of the road itself have not been considered as part of this assessment.

No risk mitigation options have been presented as part of this assessment.

In the context of the wider region, should a significant regional earthquake occur (e.g. rupture of a nearby active fault), numerous slopes could be affected by instability.

3.3 Summary of results

Table 4 presents a summary of the assessed highest risk levels for the existing 2.3 km of road assessed.

Some slopes above Shelly Bay Road have an elevated risk level i.e. 'Moderate to High'. We consider that this risk level, in the context of other slopes in the Wellington region are generally comparable. The elevated risk level can be attributed to the ongoing physical deterioration of rock, the steepness of slopes, and the limited road shoulder width whereby small-scale instability can affect the road.

Table 4: Summary of results

Zone	Chainage (m)	Zone Length (m)	Highest Risk Level
A	010 – 200	190	'Moderate'
B	200 – 390	190	'Very Low'
C	390 – 710	320	'Moderate'
D	710 – 790	80	'Very Low'
E	790 – 1320	530	'Moderate to High'
F	1320 – 1400	80	'Moderate'
G	1400 – 1580	180	'Moderate'
H	1580 – 1605	25	'Low'
I	1605 – 1660	55	'Moderate'
J	1660 – 1695	35	'Low'
K	1695 – 1715	20	'Moderate'
L	1715 – 1780	65	'Moderate'
M	1780 – 2080	300	'Moderate to High'
N	2080 – 2185	105	'Low'
O	2185 – 2235	50	'Moderate to High'
P	2235 – 2260	25	'Low'
Q	2260 – 2330	70	'Low to Moderate'
R	2330 – 2360	30	'Moderate to High'

4 Geotechnical considerations for road upgrades

Based on our slope hazard assessment, the following geotechnical issues should be considerations for future road design:

- The establishment of vegetation post c.1939 on the slopes has also improved the overall stability. Any future slope design should allow for appropriate erosion protection for exposed cut slopes e.g. hydroseed, erosion blanket and restorative planting;
- There are several nearby active faults. Seismic shaking will negatively impact the stability of all slopes. Any future slope design should consider the slopes performance under seismic loading;
- There is limited road shoulder width (often less than 1 m) for much of the road. Therefore, a landslide of any size will likely inundate portions of the carriageway. Road design should include rockfall analysis for both existing slopes and proposed cut slopes. Where possible, future road upgrades should allow for a minimum 3 m wide catch ditch and barrier to allow for the accumulation of debris and protection of the road and users. The catch ditch could also be a stormwater swale, however ongoing maintenance and removal of rock debris will be required to prevent ponding of stormwater;
- Any earthworks cuttings of the slope may result in instability. Therefore, design of such earthworks should be undertaken by a suitably qualified geotechnical professional.

  For the purpose of developing road upgrade options, the following preliminary slope angles are considered appropriate. Detailed investigation and mapping by an Engineering Geologist would be required to confirm that these slope angles are feasible;

  - Permanent slopes cut in highly weathered rock should not exceed an overall slope angle of 50 degrees. It is likely that for some slopes 50 degrees will result in very high rock cuts. Specific slope design based on the ground conditions may enable steeper cuts;
  - Permanent slopes cut in moderately weathered rock or better should not exceed an overall slope angle of 60 degrees; and
  - Permanent slope cut in colluvial soils should not exceed 40 degrees or 2 m in height without retaining support;

  We note that it may be possible to cut rock slopes with preferential defect orientations to be steeper. However, rock slopes with adverse defect orientations, or saturated slopes will likely require mitigation and drainage measures; and
- Instability could be mitigated by localised reduction of cut slope angles, providing catch benching (4 m wide), rock bolting, shotcrete and wire mesh stabilisation, passive downslope attenuation / protection, or a combination of these options.

5 Applicability

This report has been prepared for the exclusive use of our client Wellington City 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.

Recommendations and opinions in this report are based on desktop review of existing documentation and visual assessment during a site walkover. It must be appreciated that subsurface conditions may vary from those inferred in this report.

Tonkin & Taylor Ltd

Report prepared by:

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Tim Haxell
Engineering Geologist

Authorised for Tonkin & Taylor Ltd by:

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Richard Cole
Project Director

Reviewed by:

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Nick Peters
Senior Engineering Geologist

<u>Attachments:</u>

Appendix A: Slope Hazard Assessment Zones

Appendix B: Risk Assessment

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Appendix A: Slope Hazard Assessment Zones

LEGEND

- EXISTING KERB
- 25 GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID SEA WALL LOCATIONS
- SLOPE HAZARD ASSESSMENT ZONES (REFER TO TABLE B1 IN THE SLOPE HAZARD ASSESSMENT REPORT FOR THE IDENTIFIED SLOPE HAZARDS AND QUALITATIVE RISK ASSESSMENT)

NOTES:
1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. AERIAL PHOTO SOURCED FROM WELLINGTON 0.10m URBAN AERIAL PHOTOS (2017), LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
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A3 SCALE 1:500
0 5 10 15 20 25 (m)

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PROJECT No.	1014113	
DESIGNED	JASZ	Jun.20
DRAWN	JASZ	Jun.20
CHECKED		
APPROVED	DATE	

CLIENT	**WELLINGTON CITY COUNCIL**
PROJECT	**SHELLY BAY ROAD, MAUPUIA**
TITLE	SLOPE HAZARD ASSESSMENT SITE PLAN - SHEET 1 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F200
REV	1

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A3 SCALE 1:500
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CLIENT	WELLINGTON CITY COUNCIL
PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	SLOPE HAZARD ASSESSMENT SITE PLAN - SHEET 2 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F201
REV	1

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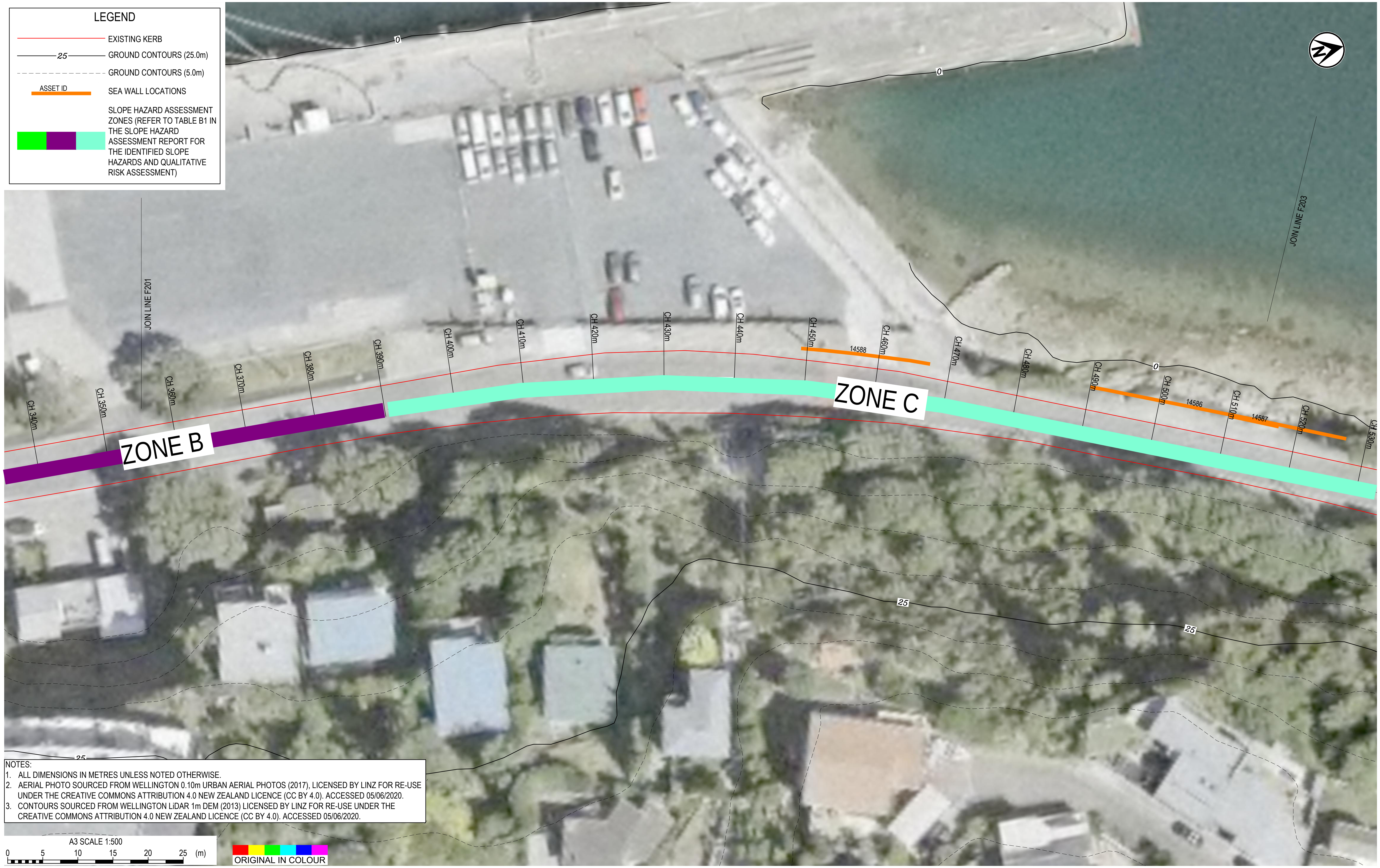

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CLIENT WELLINGTON CITY COUNCIL
PROJECT SHELLY BAY ROAD, MAUPUIA
TITLE SLOPE HAZARD ASSESSMENT
SITE PLAN - SHEET 3 OF 13

UNDER REVISION

SCALE (A3) 1:500   FIG No. 1014113-F202   REV 1

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CLIENT WELLINGTON CITY COUNCIL
PROJECT SHELLY BAY ROAD, MAUPUIA
TITLE SLOPE HAZARD ASSESSMENT
SITE PLAN - SHEET 4 OF 13

UNDER REVISION

SCALE (A3) 1:500   FIG No. 1014113-F203   REV 1

LEGEND

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25 GROUND CONTOURS (25.0m)
GROUND CONTOURS (5.0m)
ASSET ID SEA WALL LOCATIONS
SLOPE HAZARD ASSESSMENT ZONES (REFER TO TABLE B1 IN THE SLOPE HAZARD ASSESSMENT REPORT FOR THE IDENTIFIED SLOPE HAZARDS AND QUALITATIVE RISK ASSESSMENT)

NOTES:
1. ALL DIMENSIONS IN METRES UNLESS NOTED OTHERWISE.
2. AERIAL PHOTO SOURCED FROM WELLINGTON 0.10m URBAN AERIAL PHOTOS (2017), LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.
3. CONTOURS SOURCED FROM WELLINGTON LiDAR 1m DEM (2013) LICENSED BY LINZ FOR RE-USE UNDER THE CREATIVE COMMONS ATTRIBUTION 4.0 NEW ZEALAND LICENCE (CC BY 4.0). ACCESSED 05/06/2020.

A3 SCALE 1:500
0 5 10 15 20 25 (m)

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CLIENT WELLINGTON CITY COUNCIL
PROJECT SHELLY BAY ROAD, MAUPUIA
TITLE SLOPE HAZARD ASSESSMENT
SITE PLAN - SHEET 5 OF 13
UNDER REVISION
SCALE (A3) 1:500 FIG No. 1014113-F204 REV 1

LEGEND

- EXISTING KERB
- 25 GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID — SEA WALL LOCATIONS
- SLOPE HAZARD ASSESSMENT ZONES (REFER TO TABLE B1 IN THE SLOPE HAZARD ASSESSMENT REPORT FOR THE IDENTIFIED SLOPE HAZARDS AND QUALITATIVE RISK ASSESSMENT)

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A3 SCALE 1:500
0 5 10 15 20 25 (m)

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CLIENT	WELLINGTON CITY COUNCIL
PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	SLOPE HAZARD ASSESSMENT SITE PLAN - SHEET 6 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F205
REV	1

UNDER REVISION

T:\Wellington\TT Projects\1014113\WorkingMaterial\CAD\FIG\1014113-F200_F212.dwg 2020-Jun-25 7:32:59 PM Plotted By: JANINE SZIKLASI

LEGEND

- EXISTING KERB
- 25 GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID SEA WALL LOCATIONS
- SLOPE HAZARD ASSESSMENT ZONES (REFER TO TABLE B1 IN THE SLOPE HAZARD ASSESSMENT REPORT FOR THE IDENTIFIED SLOPE HAZARDS AND QUALITATIVE RISK ASSESSMENT)

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A3 SCALE 1:500
0 5 10 15 20 25 (m)

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CLIENT	WELLINGTON CITY COUNCIL
PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	SLOPE HAZARD ASSESSMENT SITE PLAN - SHEET 7 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F206
REV	1

UNDER REVISION

LEGEND

- EXISTING KERB
- 25 GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID SEA WALL LOCATIONS
- SLOPE HAZARD ASSESSMENT ZONES (REFER TO TABLE B1 IN THE SLOPE HAZARD ASSESSMENT REPORT FOR THE IDENTIFIED SLOPE HAZARDS AND QUALITATIVE RISK ASSESSMENT)

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A3 SCALE 1:500

0 5 10 15 20 25 (m)

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CLIENT	WELLINGTON CITY COUNCIL
PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	SLOPE HAZARD ASSESSMENT SITE PLAN - SHEET 8 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F207
REV	1

UNDER REVISION

LEGEND

- EXISTING KERB
- GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID — SEA WALL LOCATIONS
- SLOPE HAZARD ASSESSMENT ZONES (REFER TO TABLE B1 IN THE SLOPE HAZARD ASSESSMENT REPORT FOR THE IDENTIFIED SLOPE HAZARDS AND QUALITATIVE RISK ASSESSMENT)

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A3 SCALE 1:500
0 5 10 15 20 25 (m)

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CLIENT WELLINGTON CITY COUNCIL
PROJECT SHELLY BAY ROAD, MAUPUIA
TITLE SLOPE HAZARD ASSESSMENT
SITE PLAN - SHEET 9 OF 13
UNDER REVISION

SCALE (A3) 1:500 FIG No. 1014113-F208 REV 1

LEGEND

- EXISTING KERB
- 25 GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID SEA WALL LOCATIONS
- SLOPE HAZARD ASSESSMENT ZONES (REFER TO TABLE B1 IN THE SLOPE HAZARD ASSESSMENT REPORT FOR THE IDENTIFIED SLOPE HAZARDS AND QUALITATIVE RISK ASSESSMENT)

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A3 SCALE 1:500
0 5 10 15 20 25 (m)

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CLIENT	WELLINGTON CITY COUNCIL
PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	SLOPE HAZARD ASSESSMENT SITE PLAN - SHEET 10 OF 13

UNDER REVISION

SCALE (A3) 1:500 FIG No. 1014113-F209 REV 1

LEGEND

- EXISTING KERB
- 25 GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID SEA WALL LOCATIONS
- SLOPE HAZARD ASSESSMENT ZONES (REFER TO TABLE B1 IN THE SLOPE HAZARD ASSESSMENT REPORT FOR THE IDENTIFIED SLOPE HAZARDS AND QUALITATIVE RISK ASSESSMENT)

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A3 SCALE 1:500
0 5 10 15 20 25 (m)

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PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	SLOPE HAZARD ASSESSMENT SITE PLAN - SHEET 11 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F210
REV	1

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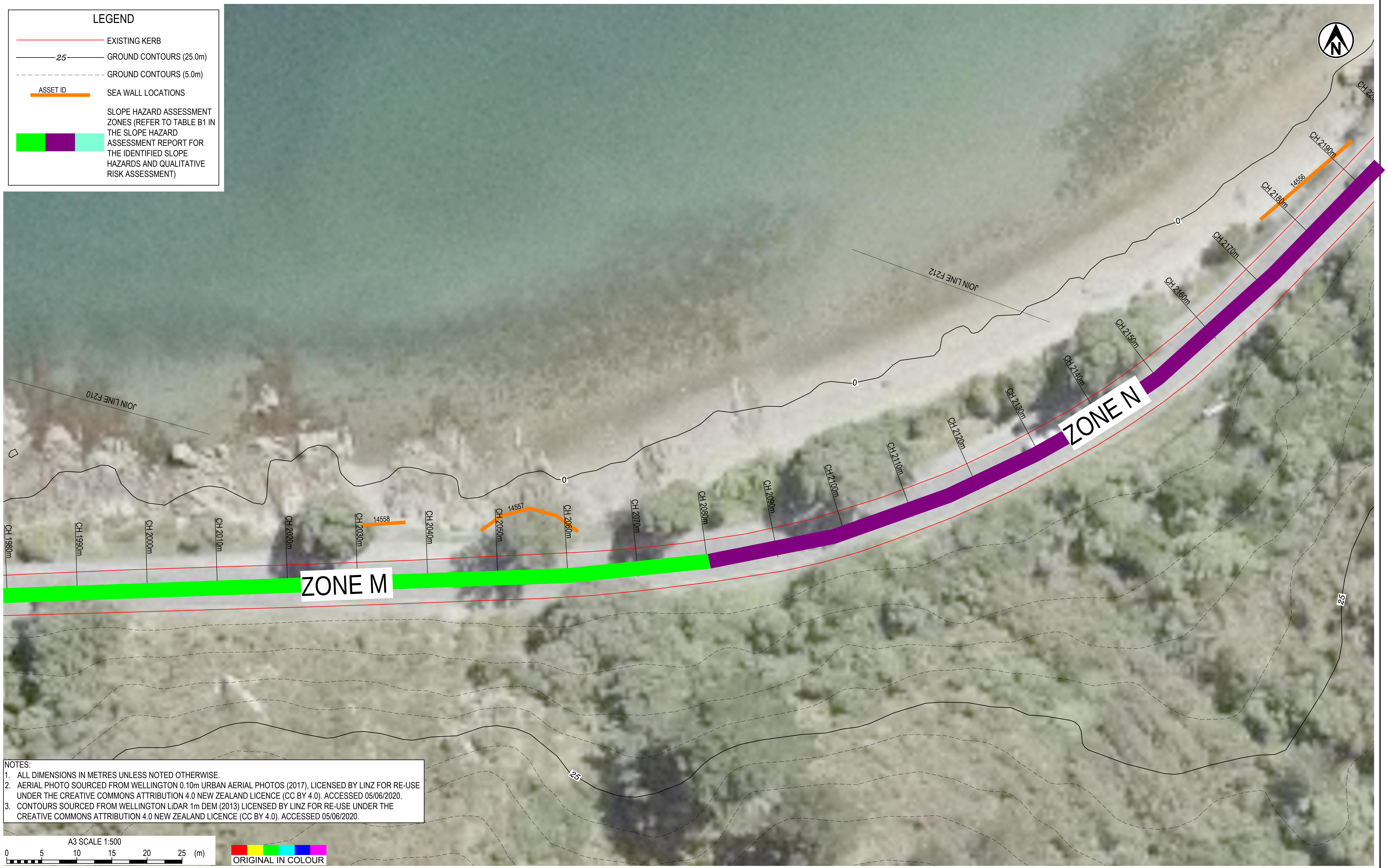

NOTES:
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PROJECT	SHELLY BAY ROAD, MAUPUIA
TITLE	SLOPE HAZARD ASSESSMENT SITE PLAN - SHEET 12 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F211
REV	1

UNDER REVISION

LEGEND

- EXISTING KERB
- 25 GROUND CONTOURS (25.0m)
- GROUND CONTOURS (5.0m)
- ASSET ID SEA WALL LOCATIONS
- SLOPE HAZARD ASSESSMENT ZONES (REFER TO TABLE B1 IN THE SLOPE HAZARD ASSESSMENT REPORT FOR THE IDENTIFIED SLOPE HAZARDS AND QUALITATIVE RISK ASSESSMENT)

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A3 SCALE 1:500
0 5 10 15 20 25 (m)

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CLIENT	**WELLINGTON CITY COUNCIL**
PROJECT	**SHELLY BAY ROAD, MAUPUIA**
TITLE	SLOPE HAZARD ASSESSMENT SITE PLAN - SHEET 13 OF 13
SCALE (A3)	1:500
FIG No.	1014113-F212
REV	1

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Appendix B: Slope Hazard Assessment

- **Table B1 Shelly Bay Road preliminary slope hazard assessment (June 2020)**
- **Qualitative Risk Assessment Framework**

TABLE B1: SHELLY BAY ROAD PRELIMINARY SLOPE HAZARD ASSESSMENT (JUNE 2020)

1. This assessment has been carried out to identify the level of risk to the road to support a long list assessment of road upgrade options. No risk mitigation options have been presented as part of this assessment.
2. This assessment has been carried out using a Qualitative Risk Assessment Framework in general accordance with Appendix C of AGS (2007): Landslide Risk Management Concepts and Guidelines. Refer to this framework when reviewing the assessed risk. This assessment considers risk to the road only and does not consider risk to life. A quantitative assessment of the risk to life should form part of any future slope design.
3. The extent of study has been separated into zones with similar geometrical (slope angle, height, and distance from road), geological (subsurface), geomorphic (surface) and hydrological (subsurface and surface water) conditions. Refer drawings in Appendix A for road layout.

Zone	Approximate chainage (m)	Identified slope hazard	Consequence	Likelihood	Assessed risk	Observations / Notes
A	**010 – 200**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than $1.0m^3$)	Low: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Moderate**	• No evidence of significant previous/existing instability • Limited road shoulder width (<1m between toe of slope and road) • Escarpment up to 25m above road • Exposed rock steeper than 60° up to 20m above the road at CH 070m • Wastewater pipe (150mm dia.) and manholes sidling the slope • Immediately adjacent upslope private property
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to $100m^3$)	Medium: Inundation of debris blocking one or both lanes requiring removal that takes up to 1 day	Likely	**Moderate**	
		Major rockslide (greater than $200m^3$)	Medium – Major: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Rare	**Very Low**	
B	**200 – 390**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than $1.0m^3$)	Cannot occur due to distance from slope	N/A	**N/A**	• Evidence of prior instability of rock slope and rock anchor mesh stabilisation • Increased shoulder width (typically 5m between slope and road) • Escarpment up to 20m above road • Walkway sidling track to Aranui Street acts as a bench and will prevent some debris from upper slopes reaching the road • Wastewater pipe (150mm dia.) and manholes sidling the slope • Storm and mains waterpipe intersect slope at approximately CH 260 • Immediately adjacent upslope and downslope private property
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to $100m^3$)	Minor: Debris unlikely to inundate road shoulder or road due to distance from slope. Road remains usable.	Possible	**Very Low**	
		Major rockslide (greater than $200m^3$)	Medium: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Rare	**Very Low**	
C	**390 – 710**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than $1.0m^3$)	Low: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Moderate**	• 2 – 3m high cut immediately adjacent road • Moderately weathered greywacke subvertical bedded, very closely spaced • > 2m gravelly colluvium soil exposed at CH 620 • Limited road shoulder width (<1m between toe of slope and road) • Escarpment up to 35m above road • Numerous exposures of very steep rock up to 25 m above the road • Immediately adjacent upslope private property
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to $100m^3$)	Medium: Inundation of debris blocking one or both lanes requiring removal that takes up to 1 day	Likely	**Moderate**	
		Major rockslide (greater than $200m^3$)	Medium – Major: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Rare	**Very Low**	
D	**710 – 790**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than $1.0m^3$)	Cannot occur due to distance from slope	N/A	**N/A**	• Slope set back approximately 20m from road behind private property. • Concentration of surface water discharge down slope
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to $100m^3$)	Cannot occur due to distance from slope	N/A	**N/A**	
		Major rockslide (greater than $200m^3$)	Minor: Debris unlikely to inundate road shoulder or road due to distance from slope. Road remains usable.	Rare	**Very Low**	
E	**790 – 1320**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than $1.0m^3$)	Low: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Moderate**	• Evidence of prior instability including small block dropouts and rockfall at CH 970 and 1150 inundating shoulder and part of one lane (Google Street View, July 2019) • Rockmass failure at CH 1100 on 19 June 2020, approximately $50m^3$ debris blocking both lanes • Concentration of surface water discharge down slope at CH 910, 950, 1085, 1145, 1170 • Moderately weathered sandstone subvertical bedded, very closely spaced • Limited road shoulder width (<1m between toe of slope and road) • Escarpment up to 40m above road. Exposed rock steeper than 60° up to 35m above road along the majority of this section
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to $100m^3$)	Medium: Inundation of debris blocking one or both lanes requiring removal that takes up to 1 day	Likely to Very Likely	**Moderate to High**	
		Major rockslide (greater than $200m^3$)	Medium – Major: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Unlikely	**Very Low to Low**	
F	**1320 – 1400**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than $1.0m^3$)	Low: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Moderate**	• 2 m high cut in colluvium immediately adjacent road • No evidence of significant previous/existing instability • > 2m gravelly colluvium soil exposed at CH 1370 • Concentration of surface water discharge down slope • Limited road shoulder width (<1m between toe of slope and road) • Slope in this section generally shallower at approximately 30 – 40° • Predominantly colluvium soil observed at road level
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to $100m^3$)	Medium: Inundation of debris blocking one or both lanes requiring removal that takes up to 1 day	Likely to Possible	**Low to Moderate**	
		Major rockslide (greater than $200m^3$)	Medium: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Rare	**Very Low**	

TABLE B1: SHELLY BAY ROAD PRELIMINARY SLOPE HAZARD ASSESSMENT (JUNE 2020)

1. This assessment has been carried out to identify the level of risk to the road to support a long list assessment of road upgrade options. No risk mitigation options have been presented as part of this assessment.
2. This assessment has been carried out using a Qualitative Risk Assessment Framework in general accordance with Appendix C of AGS (2007): Landslide Risk Management Concepts and Guidelines. Refer to this framework when reviewing the assessed risk. This assessment considers risk to the road only and does not consider risk to life. A quantitative assessment of the risk to life should form part of any future slope design.
3. The extent of study has been separated into zones with similar geometrical (slope angle, height, and distance from road), geological (subsurface), geomorphic (surface) and hydrological (subsurface and surface water) conditions. Refer drawings in Appendix A for road layout.

G	**1400 – 1580**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than 1.0m³)	Low: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Moderate**	• 2 m high cut in rock immediately adjacent road • Frittering of rock at CH 1550m • Limited road shoulder width (<1m between toe of slope and road) • Escarpment up to 50m above road • Exposed rock steeper than 60° up to 50m above road at CH 1400 - 1430m • Exposed rock steeper than 60° up to 20m above road at CH 1475m
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to 100m³)	Medium: Inundation of debris blocking one or both lanes requiring removal that takes up to 1 day	Likely	**Moderate**	
		Major rockslide (greater than 200m³)	Medium – Major: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Rare	**Very Low**	
H	**1580 – 1605**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than 1.0m³)	Minor: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Low**	• Slope in this section generally shallower at approximately 20 – 30° • No cut immediately adjacent the road • Concentration of surface water discharge • Limited road shoulder width (<1m between toe of slope and road) • Stormwater pipe intersects slope at approximately CH 1590
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to 100m³)	Low: Inundation of debris may block one or lane requiring removal that takes up to 1 day	Likely	**Low**	
		Major rockslide (greater than 200m³)	Medium: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Rare	**Very Low**	
I	**1605 – 1660**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than 1.0m³)	Low: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Moderate**	• 2 m high cut in colluvium immediately adjacent road • Loosely packed surface soils • No evidence of significant previous/existing instability • Limited road shoulder width (<1m between slope and road) • Escarpment up to 25m above road
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to 100m³)	Medium: Inundation of debris blocking one or both lanes requiring removal that takes up to 1 day	Likely	**Moderate**	
		Major rockslide (greater than 200m³)	Medium – Major: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Rare	**Very Low**	
J	**1660 – 1695**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than 1.0m³)	Minor: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Low**	• Slope in this zone generally shallower than other zones at approximately 20 – 30° • Increased shoulder width (typically 5m between slope and road) • No cut immediately adjacent the road • No evidence of significant previous/existing instability • Concentration of surface water discharge down slope
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to 100m³)	Low: Inundation of debris may block one or lane requiring removal that takes up to 1 day	Likely	**Low**	
		Major rockslide (greater than 200m³)	Medium: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Rare	**Very Low**	
K	**1695 – 1715**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than 1.0m³)	Low: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Moderate**	• 2 – 3m high rock cut immediately adjacent road steeper than 60° • No evidence of significant previous/existing instability • Limited road shoulder width (typically <1m between toe of slope and road)
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to 100m³)	Medium: Inundation of debris blocking one or both lanes requiring removal that takes up to 1 day	Likely	**Moderate**	
		Major rockslide (greater than 200m³)	Medium – Major: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Rare	**Very Low**	
L	**1715 – 1780**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than 1.0m³)	Minor: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Low**	• Evidence of historic instability within gully but >20m from the road. Mechanism inferred to be shallow translational sliding of soils. • Increased shoulder width (typically 5m between slope and road) • Slope in this section generally shallower at approximately 20 – 30°
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to 100m³)	Medium: Inundation of debris may block one lane requiring removal that takes up to 1 day	Likely	**Moderate**	
		Major rockslide (greater than 200m³)	Medium: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Rare	**Very Low**	

TABLE B1: SHELLY BAY ROAD PRELIMINARY SLOPE HAZARD ASSESSMENT (JUNE 2020)

1. This assessment has been carried out to identify the level of risk to the road to support a long list assessment of road upgrade options. No risk mitigation options have been presented as part of this assessment.
2. This assessment has been carried out using a Qualitative Risk Assessment Framework in general accordance with Appendix C of AGS (2007): Landslide Risk Management Concepts and Guidelines. Refer to this framework when reviewing the assessed risk. This assessment considers risk to the road only and does not consider risk to life. A quantitative assessment of the risk to life should form part of any future slope design.
3. The extent of study has been separated into zones with similar geometrical (slope angle, height, and distance from road), geological (subsurface), geomorphic (surface) and hydrological (subsurface and surface water) conditions. Refer drawings in Appendix A for road layout.

M	**1780 – 2080**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than 1.0m³)	Low: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Moderate**	• 3m high rock cut immediately adjacent road steeper than 60° • Interbedded sandstone and mudstone, subvertical bedding 100mm wide • Dilation of rock defects in cut at CH 1800 and 1955m • Evidence of prior instability – frittering and root jacking of rock CH 1930 • Escarpment up to 30m above road • Limited road shoulder width (typically <1m between toe of slope and road) • Exposed rock steeper than 60° up to 30m immediately above the road at CH 1790 and 2050m
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to 100m³)	Medium: Inundation of debris blocking one or both lanes requiring removal that takes up to 1 day	Likely to Very Likely	**Moderate to High**	
		Major rockslide (greater than 200m³)	Medium – Major: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Unlikely	**Very Low to Low**	
N	**2080 – 2185**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than 1.0m³)	Minor: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Low**	• Slope in this section generally shallower at approximately 20 – 30° • Increased shoulder width (typically 5m between slope and road) • No cut immediately adjacent the road • No evidence of significant previous/existing instability • Concentration of surface water discharge down slope
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to 100m³)	Low: Inundation of debris may block one or lane requiring removal that takes up to 1 day	Likely	**Low**	
		Major rockslide (greater than 200m³)	Medium: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Rare	**Very Low**	
O	**2185 – 2235**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than 1.0m³)	Low: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Moderate**	• Evidence of historic landslip at CH 2190m – 2m wide rockmass failure • Limited road shoulder width (typically <1m between toe of slope and road) • Exposed rock steeper than 60° up to 20m immediately above the road at CH 2210m
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to 100m³)	Medium: Inundation of debris blocking one or both lanes requiring removal that takes up to 1 day	Likely to Very Likely	**Moderate to High**	
		Major rockslide (greater than 200m³)	Medium – Major: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Unlikely	**Very Low to Low**	
P	**2235 – 2260**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than 1.0m³)	Minor: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Low**	• Evidence of prior instability within gully. Mechanism inferred to be shallow translational sliding of soils but at distance from the road • Concentration of surface water discharge • Slope in this section generally shallower at approximately 30 – 40° • Increased shoulder width (typically 5m between slope and road) • Stormwater pipe intersects slope at approximately CH 2250
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to 100m³)	Low: Inundation of debris may block one lane requiring removal that takes up to 1 day	Likely	**Low**	
		Major rockslide (greater than 200m³)	Medium: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Rare	**Very Low**	
Q	**2260 – 2330**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than 1.0m³)	Minor: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Low**	• Location of a significant cutting of ridge prior to c.1951. Slope cut at approximately 50° with a bench • Increased shoulder width (typically 5m between slope and road) • No cut immediately adjacent the road • No evidence of significant previous/existing instability
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to 100m³)	Low – Medium: Inundation of debris may block one lane requiring removal that takes up to 1 day	Likely	**Low to Moderate**	
		Major rockslide (greater than 200m³)	Medium: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Rare	**Very Low**	
R	**2330 – 2360**	Shallow slide of surficial soils and vegetation; or, Small scale rock failures including frittering and small block dropouts (less than 1.0m³)	Low: Inundation of debris in road shoulder or part of one lane requiring removal. Road remains usable.	Very Likely	**Moderate**	• 3m high rock cut immediately adjacent road steeper than 60° • Highly weathered to moderately weathered sandstone • Evidence of recent instability including small block dropouts and rockfall at CH 2340 inundating shoulder of road including boulders up to 0.5m wide • Evidence of historic instability approximately 4m wide rockslide. Debris likely inundated road in the order of 20m³ • Limited road shoulder width (typically <1m between toe of slope and road) • Escarpment up to 40m above the road
		Translational slides of colluvium soil; or, Rockmass slides / falls (up to 100m³)	Medium: Inundation of debris blocking one or both lanes requiring removal that takes up to 1 day	Likely to Very Likely	**Moderate to High**	
		Major rockslide (greater than 200m³)	Medium – Major: Inundation of debris blocking both lanes causing major delays. Debris clearance takes up to two days	Unlikely	**Very Low to Low**	

Wellington City Council

Qualitative Risk Assessment Framework

Tonkin+Taylor

Absolutely Positively Wellington

Collectors/Sub-collectors and Local/Residential Route

Measures of likelihood

Level	Descriptor	Description	Annual Probability of Occurrence	
A	Almost Certain	The event is on-going, or is expected to occur during the next year	100%	< 1 year
B	Very Likely	The event is expected to occur.	20% to 100%	1-5 years
C	Likely	The event is expected to occur under somewhat adverse conditions	5% to 20%	5-20 years
D	Possible	The event is expected to occur under adverse conditions	1 to 5%	20-100 years
E	Unlikely	The event is expected to occur under high to extreme conditions	0.2 to 1%	100-500 years
F	Rare	The event could occur under extreme conditions	Less than 0.2%	>500 years

Measures of consequence (see notes below)

Level	Descriptor	Collectors/Sub Collectors and Local/Residential Route		Damage to Footpaths
		Upslope	Downslope	
1	Catastrophic	Cannot occur	Cannot occur	Cannot occur
2	Disastrous	Cannot occur	Total evacuation of both lanes of road. Major remedial works with serious traffic delays over several weeks	Cannot occur
3	Major	Road blocked for an extended period causing major and extended delays to traffic; clean up /remedial works operation over several days to weeks	Half of road evacuated by underslippage; significant remedial works with serious traffic delays over one to two weeks	Cannot occur
4	Medium	Half of road inundated by overslip; clean up/remedial works operation takes one or two days	Shoulder of road evacuated to the edge of the outside lane; trafficable area of road narrowed to avoid region immediately above headscarp causing significant traffic delays or footpath destroyed over several metres	Several metres of footpath destroyed; no alternative access available
5	Low	Shoulder of road/footpath inundated; remedial works limited to clean up only and takes about one day	Insignificant damage	Footpath destroyed over several metres; alternative access is available
6	Minor	Insignificant damage	Insignificant damage	Footpath locally undermined but still usable; reinstatement works can be delayed

Risk matrix

		Consequences to Property/Assets					
		1: Catastrophic	2: Disastrous	3: Major	4: Medium	5: Low	6: Minor
Likelihood	A – Almost Certain	VH	VH	VH	H	H	M
	B – Very Likely	VH	VH	H	H	M	L
	C – Likely	VH	H	H	M	L	L
	D – Possible	VH	H	M	L	L	VL
	E – Unlikely	H	M	L	VL	VL	VL
	F – Rare	M	L	VL	VL	VL	VL

Risk level implications

Risk Level		Implications for Risk Management
VH	Very High Risk	Detailed investigation, design, planning and implementation of treatment options to reduce risk to acceptable levels: May involve very high costs.
H	High Risk	Detailed investigation, design, planning and implementation of treatment options to reduce risk to acceptable levels.
M	Moderate Risk	Broadly tolerable provided treatment plan is implemented to maintain or reduce risks, May require investigation and planning of treatment options.
L	Low Risk	Acceptable. Treatment requirements to be defined to maintain or reduce risk
VL	Very Low Risk	Acceptable. Manage by normal maintenance procedures

Notes:

1 The examples of consequence given should only be used as a general guide. The implications for a particular situation may be required to be specifically determined.

2 The risk matrices above are based on those given in Appendix C of AGS (2007): *Landslide Risk Management Concepts and Guidelines*

3 "Insignificant damage" – comprise small scale failures (e.g. minor rockfall or surficial sliding)

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