

SWDC - Whakatomotomo Road Slip – Remedial Options Memorandum

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Options Memorandum

To: SDWC

Attention: [REDACTED]

Project Name 2026 Emergency Works
From: Stantec New Zealand
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Project/File: 310206618
Date: 31 July 2026

Reference: SWDC - Whakatotomomo Road Slip – Remedial Options Memorandum

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1 Background

Following the rainfall (25 to 27 June 2026 and 7 to 8 July 2026) event in the Wairarapa region, South Wairarapa District Council (SWDC) requested Stantec to undertake site walkover inspections and drone surveys of slope failures (landslides) located on Whakakatomotomo between RP 2.650 to RP 2.850 (email dated 28 June 2026 and 9 July 2026), as part of the emergency works. The site location is shown in

Figure 1.

Whakatomotomo (RP 2.650 to RP 2.850) road is classified as an Access Road under the ONRC system, with an estimated ADT of 102 vehicles, including approximately 9% heavy vehicles (2025 data). This section is an unsealed gravel road. **There is no alternative route available. Approximately 200 m of roadway is unstable on both the upslope and downslope sides and has sustained severe damage. For safety reasons, the road was closed following the landslide, preventing local residents from accessing or leaving the area. The road currently remains restricted to temporary access only. As the road has been assessed as having a High to Very High risk of ongoing slope instability, future landslide, heavy rainfall, or earthquake events could result in further road closures, isolating the local community until access is restored.**

Stantec Geotechnical Engineers inspected the site on 29 June 2026 and 13 July 2026, accompanied by a SWDC representative. The inspections comprised a visual assessment of the slopes from road level; no detailed geological mapping was undertaken during the site visit. A drone survey has been carried out on 02 July 2026.

Following the visual inspection, Stantec issued an immediate action plan to SWDC on 14 July 2026 to enable temporary reopening of the road for resident access. On 22 July 2026, SWDC requested Stantec to prepare and submit an optioneering memorandum outlining and assessing potential remedial options.

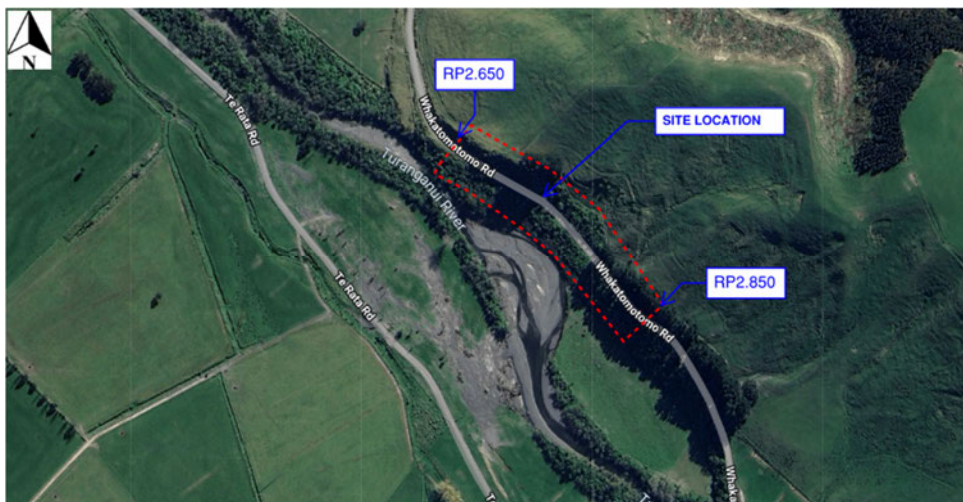


Figure 1: Site location (200m impacted length)

2 Site Observations

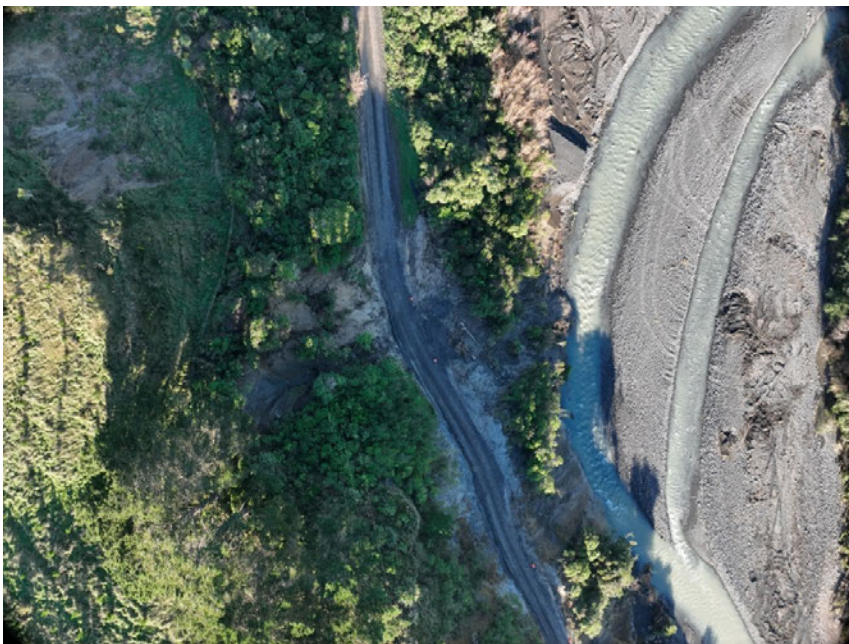
As per the site inspection, the following observations were noted:

- The road is an unsealed gravel carriageway.
- Both upslope and downslope have experienced slope failures over an approximate impacted length of 200 m as shown in Figure 2.
- Failure of the upslope has resulted in debris being deposited onto the road carriageway, blocking the culvert inlet and swale, and causing stagnant water to accumulate on the road surface, as shown in Figure 8 and Figure 9. The debris primarily comprises saturated Silty CLAY with rock fragments and falling trees.
- Based on the drone survey, the upslope comprises a steep lower section with an average slope angle exceeding 60° up to around 25 m from the road level, where rock outcrops have been observed. The slope gradually flattens to approximately 10°– 20° at an elevation of about 25 m above the road level. In other surveyed cross-sections, where colluvial soils have been identified, the upslope has slope angles ranging from 30° to 40° and extends to heights exceeding 100 m above the road.
- Exposed rock was observed at several locations on the upslope as shown in Figure 7.
- The upslope materials comprise residual colluvial soils overlying highly to completely weathered rock.
- The upslope and downslope materials were observed to be moist to wet at the time of the inspection.
- The downslope failure (underslip) along the road has resulted in a vertical drop of more than 10 m.
- The downslope materials predominantly comprise residual soil (Silty CLAY).
- Electricity poles are located on the upslope above the failed area.
- The existing road is approximately 4 m wide, based on Mobile Road data. However, the underslip has resulted in the loss of the road shoulder and outer edge of the carriage way at some locations, reducing the effective carriageway width (single lane has been affected).
- During the site inspection undertaken on 13 July 2026, evidence of significant ground deformation, including cracking and slumping of the entire road carriageway, was observed between RP 2.800 and RP 2.840, as shown in Figure 12 and Figure 13.
- The Turanganui River is located immediately below the downslope failure. **Active scour by the river has undermined the toe of the underslip, reducing toe support and increasing the risk of further slope instability and progressive failure affecting the Whakatomotomo Road.** The extent and severity of scouring (i.e., scour depth and extent, undermining and overhanging) at the toe of underslip is unknown.

Reference: SWDC - Whakatomotomo Road Slip – Remedial Options Memorandum



*Figure 2: Landslide on both upslope and downslope at Whakatomotomo Road RP 2.650 to RP 2.850
(Drone image taken 02/07/2026)*



*Figure 3: Landslide on both upslope and downslope at Whakatomotomo Road RP 2.650 to RP 2.850
(Drone image taken 02/07/2026)*

Reference: SWDC - Whakatomotomo Road Slip – Remedial Options Memorandum



Figure 4: Landslide on both upslope and downslope at Whakatomotomo Road RP 2.650 to RP 2.850 (view from Te Rata Road)



Figure 5: Road shoulder has been lost due to under-slip (Looking Southeast)

Reference: SWDC - Whakatomotomo Road Slip – Remedial Options Memorandum



Figure 6: Road shoulder has been lost due to under-slip (Looking Southwest)

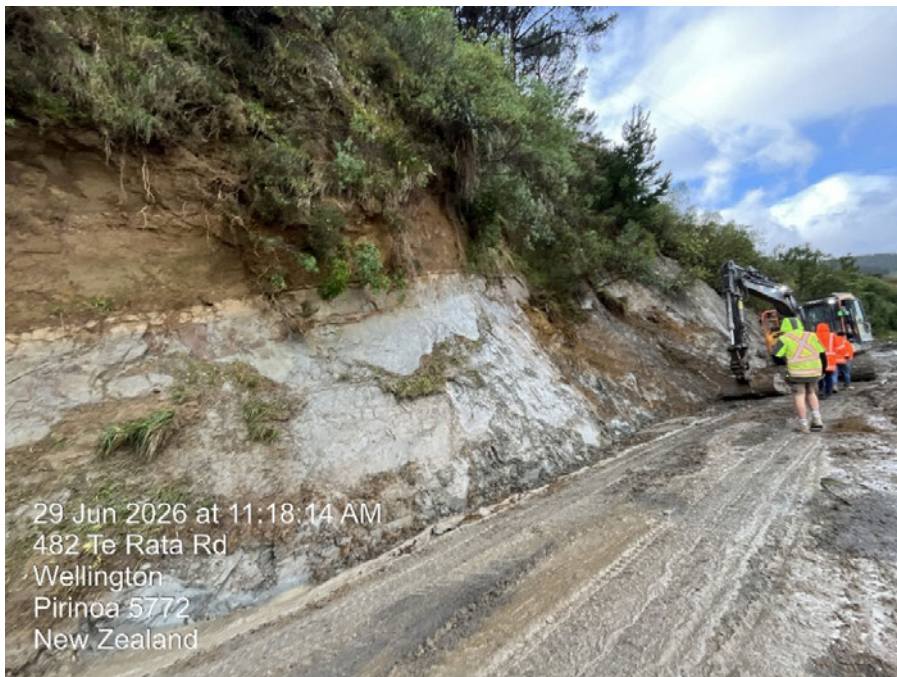


Figure 7: Exposed rock on upslope

Reference: SWDC - Whakatomotomo Road Slip – Remedial Options Memorandum



Figure 8: Deris from upslope deposited on road carriageway



Figure 9: Debris from the upslope blocking the swale and culvert inlet, causing ponding and stagnant water on the road surface

Reference: SWDC - Whakatomotomo Road Slip – Remedial Options Memorandum



Figure 10: Toe of the underslip undermined by river scour (drone imagery captured on 2 July 2026)



Figure 11: Road carriageway has been lost approximately 1m due to under-slip

Reference: SWDC - Whakatomotomo Road Slip – Remedial Options Memorandum

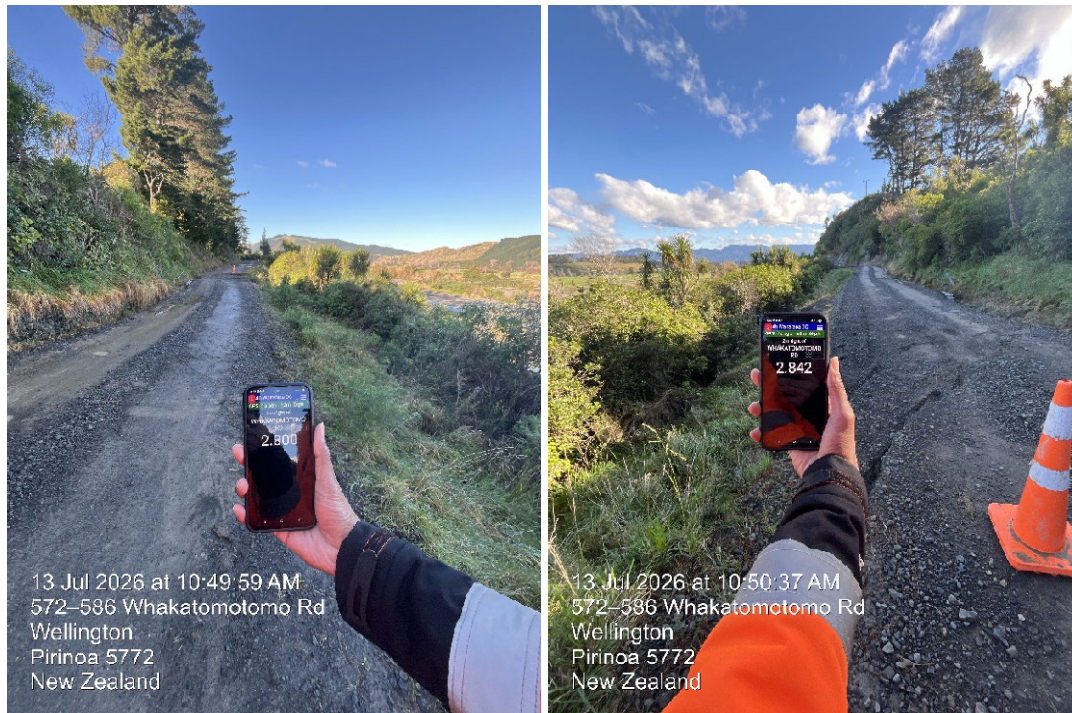


Figure 12: Cracks and slumping observed between Road RP 2.800 and RP 2.840.

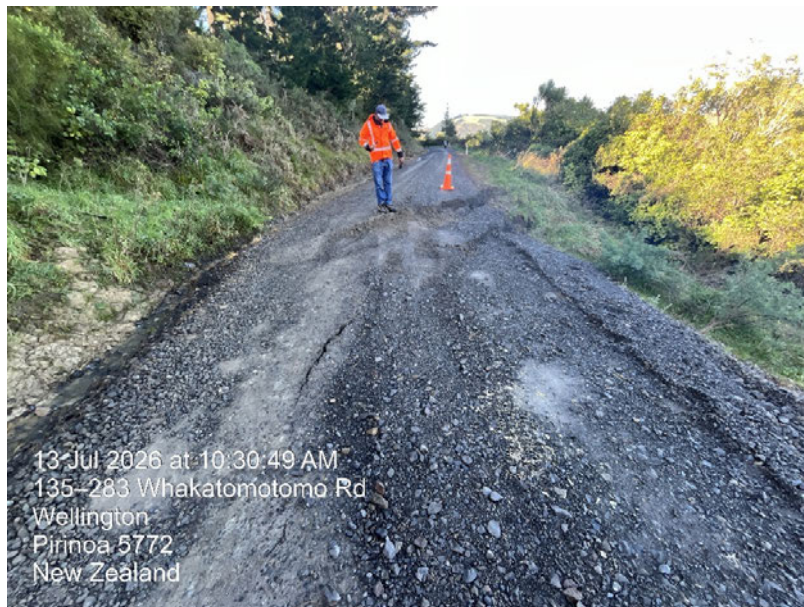


Figure 13: Cracks and slumping observed between Road RP 2.800 and RP 2.840 (Looking South-East).

3 Geotechnical Assessment

3.1 Historical Information

Available Google Earth imagery is presented in Figure 14 to Figure 18. The imagery indicates that, up to 2021, the road was protected by a natural river berm. However, since 2023, the river channel appears to have progressively migrated towards the road, reaching the location of the observed failure.



Figure 14: Aerial image of the site (Google Earth, March 2010).

Reference: SWDC - Whakatomotomo Road Slip – Remedial Options Memorandum

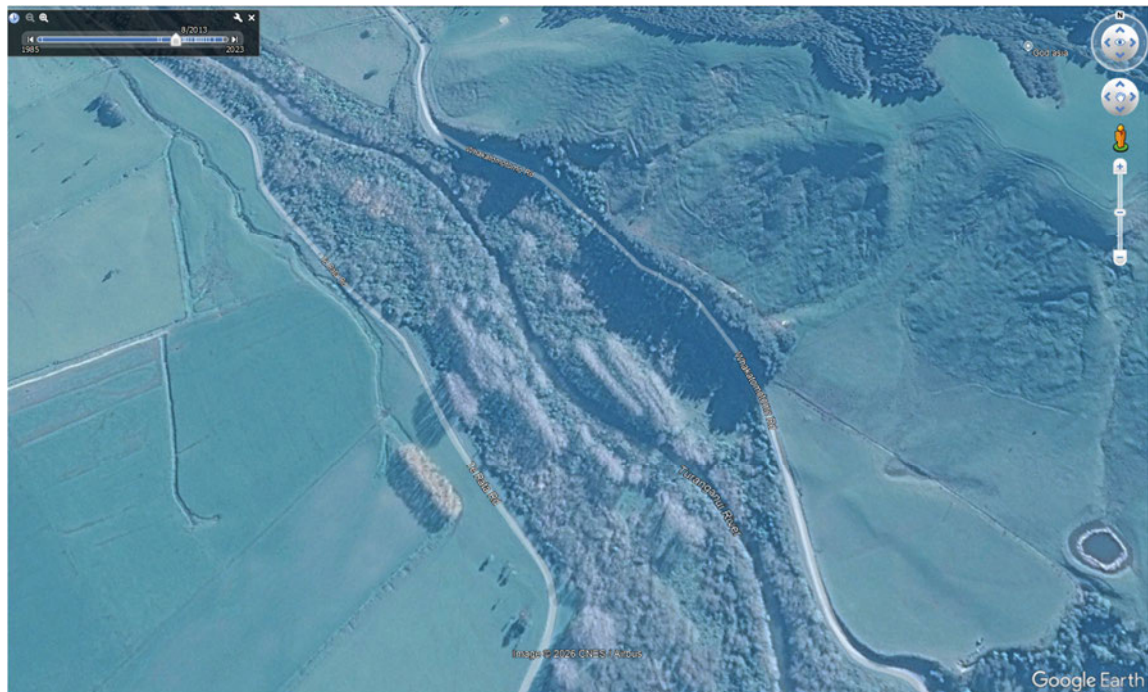


Figure 15: Aerial image of the site (Google Earth, August 2013).



Figure 16: Aerial image of the site (Google Earth, September 2015).

Reference: SWDC - Whakatomotomo Road Slip – Remedial Options Memorandum



Figure 17: Aerial image of the site (Google Earth, December 2021).

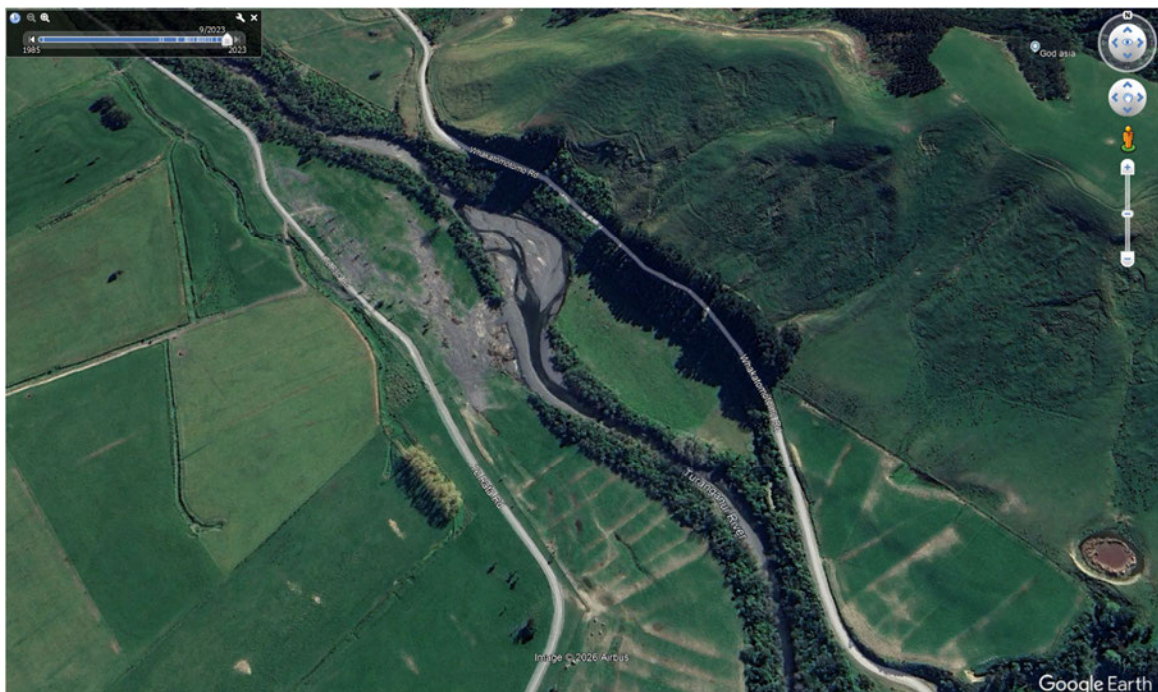


Figure 18: Aerial image of the site (Google Earth, September 2023).

3.2 Geological Conditions

According to the GNS Science 1:250,000 geological map shown in Figure 19, the site is underlain by Late Pliocene limestone of the Managamaire Group and Onoke Group, comprising poorly to well-cemented shelly limestone, coquina, calcareous sandstone, and siltstone and sandy mudstone with minor grit.

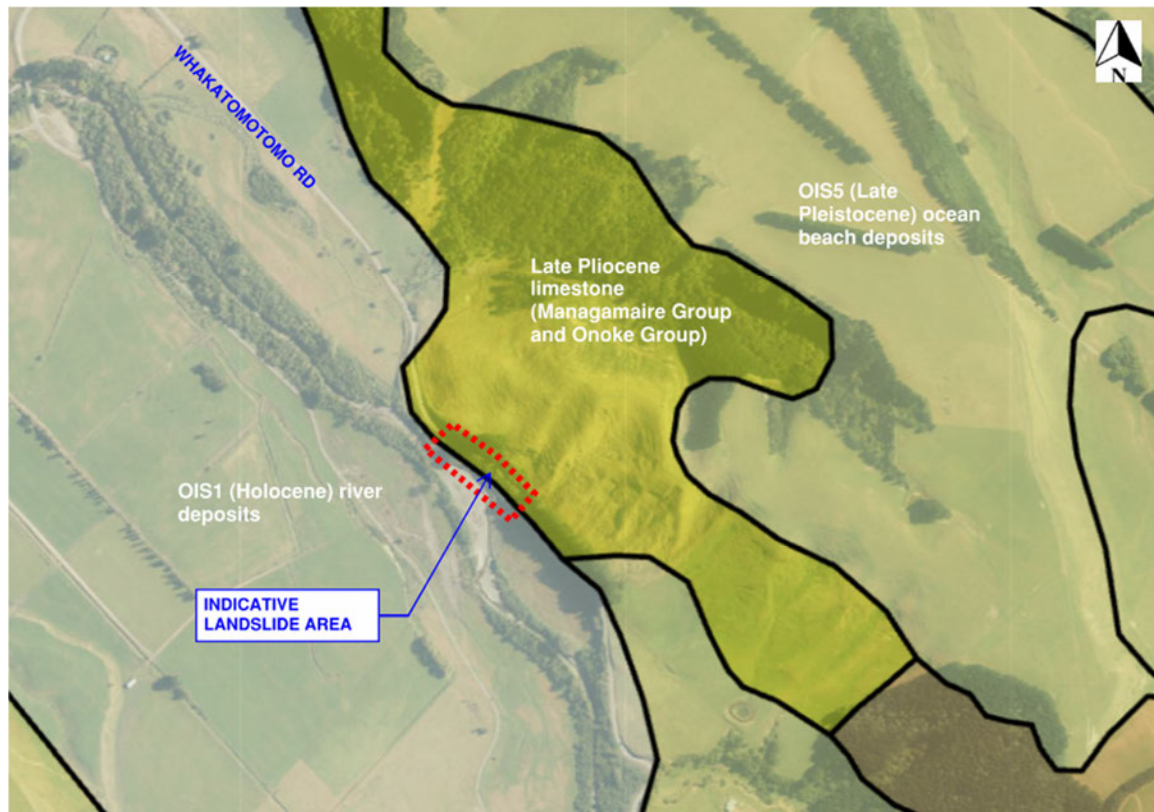


Figure 19: GNS Science 1:250,000 geological map at the landslide location

3.3 Failure Mechanism

The typical failure mechanism on the upslope is inferred to be a translational (planar) slide occurring along the interface between the colluvial soils and the underlying rock. The failure is considered to have been initiated by a combination of factors, including the loss of support provided by the underlying soil & rock materials and the saturation of the colluvial soils, which reduced their shear strength.

Reference: SWDC - Whakatomotomo Road Slip – Remedial Options Memorandum

Site observations identified numerous gullies on the upslope that concentrate and convey significant runoff towards the road corridor during rainfall events. This concentrated surface water has likely increased infiltration into the colluvial soils, contributing to elevated pore water pressures and reduced soil strength. In addition, mature trees located on the slope impose surcharge loading that may have locally increased driving forces. Surface runoff and debris flows from the upslope have also eroded the upper colluvial soils, exposing and undermining tree root systems. This loss of root reinforcement is considered to have contributed to the observed tree failures, with several trees falling onto the roadway.

The typical downslope failure is also inferred to be a translational (planar) slide along the interface between the colluvial soils and the underlying rock. The instability is considered to result from the combined effects of prolonged saturation of the colluvial soils due to stagnant water on the road surface and concentrated runoff from the upslope, leading to a reduction in soil shear strength.

We note that the land area (Property 34) situated on the river has already been washed away as shown in Figure 20. **It is indicated that the active scour by the river has undermined the toe of the underslip, reducing toe support and increasing the risk of further slope instability and progressive failure affecting the Whakatomotomo Road.** The extent and severity of scouring (i.e., scour depth and extent, undermining and overhanging) at the toe of underslip is unknown.

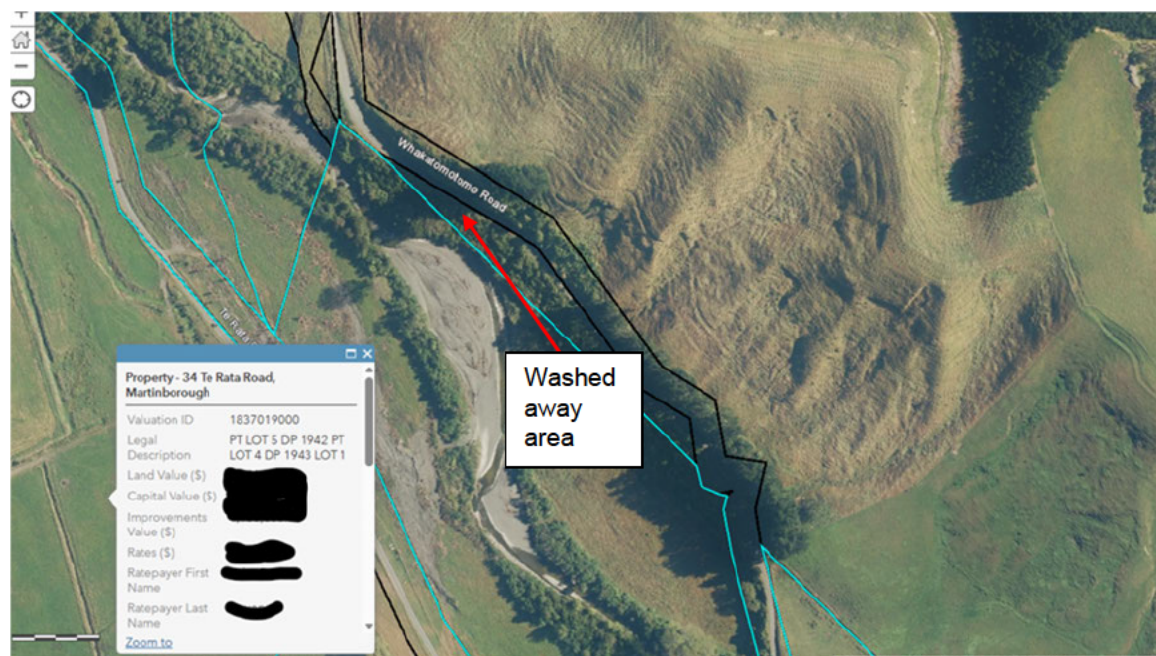


Figure 20: A portion of Property 34 adjacent to the river has been eroded due to river scour

3.4 Geotechnical Risk Assessment

An initial qualitative risk assessment has been carried out to provide the Council with a high-level understanding of the current level of risk as an indicator.

The modified version of the Wellington City Council Qualitative Risk Assessment Framework (QRAF) was used for the risk assessment, in the absence of a project specific framework. This framework is based on the Australian Geomechanics Society Landslide Risk Management Guide (AGS, 2007).

The framework is provided in *Figure 21*, and the site-specific assessment is provided in the Table 3-1.

It is noted that the risk assessment is based on the site walkover inspection and drone photographs.

Table 3-1: Risk assessment for the landslide sites on Whakatomotomo road (RP 2.650 to RP2.850)

Site Location	Description	Likelihood	Consequence rating	Current Risk
Whakatomotomo road (RP 2.652 to RP2.865)	Underslip and overslip	Likely to Very Likely (5%-100% AP)	Major to Disastrous	High to Very High

Reference: SWDC - Whakatomotomo Road Slip – Remedial Options Memorandum

Wellington City Council's (WCC) Qualitative Risk Assessment Framework (QRAF) – Modified Version

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%
B	Very Likely	The event is expected to occur.	20% to 100%
C	Likely	The event is expected to occur under somewhat adverse conditions	5% to 20%
D	Possible	The event is expected to occur under adverse conditions	1 to 5%
E	Unlikely	The event is expected to occur under high to extreme conditions	0.2 to 1%
F	Rare	The event could occur under extreme conditions	Less than 0.2%

Measures of Consequence (see notes below) – Updated by Stantec

Level	Descriptor	Example Descriptions (Damage to Road/Private Property/Infrastructure)	Example Descriptions (Damage to Assets)
1	Catastrophic	Large scale damage to Road/Private Property(ies)/ Infrastructure	Significant routes and lifelines blocked for an extended length of time (several days) – significant effects to communities for extended periods or no alternative access available.
2	Disastrous	Large scale damage involving Road/Private Property(ies)/ Infrastructure requiring major engineering works for stabilisation	Both lanes of local road blocked/slipped for an extended length of time (several days); or significant route blocked causing major and extended delays to traffic; major emergency works or no alternative access available.
3	Major	Extensive damage to Road/Private Property(ies)/ Infrastructures.	Both lanes of local road temporarily blocked/slipped (few hours to a day) or one lane of significant route blocked with major delays; significant emergency works or no alternative access available.
4	Medium	Moderate damage to Road/Private Property(ies)/ Infrastructures.	One lane of local road blocked/slipped with some emergency works necessary, no alternative access available
5	Low	Limited damage to private land	Half of one lane of road blocked for short period of time; emergency works limited to clean up only; alternative access maybe/may not be available
6	Minor	No damage	Shoulder of road damaged/blocked only; reinstatement works can be delayed but still usable; reinstatement works can be delayed; alternative access maybe/may not be available

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	VL-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 may be defined to maintain or reduce risk
VL	Very Low Risk	Acceptable. Manage by normal maintenance procedures

Notes:

- 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.
- The risk matrices above are based on those given in Appendix G of AGS (2000): *Landslide Risk Management Concepts and Guidelines*

Figure 21: Modified version of Wellington City Council Qualitative Risk Assessment Framework (QRAF)

3.5 Option Assessments

Five (5) potential remedial options have been considered to address the downslope and upslope failure, restore the road to its intended function, and reduce the residual geotechnical risk. A summary of the options is provided below.

- **Option 1a: Partial Road Realignment:** This option involves a 2.5 m upslope shift of the road alignment between RP 2.650 and RP 2.750, and a 4.5 m upslope shift between RP 2.800 and RP 2.840. The option includes the provision of riprap protection at the slope toe (optional), ground improvement piles at road level (optional), and a cut-off drain along the road cut.
- **Option 1b: Full Road Realignment:** This option involves a 4.5 m upslope shift of the road alignment between RP 2.650 and RP 2.840. The option includes riprap protection at the slope toe (optional), ground improvement piles at road level (optional), and a cut-off drain along the road cut.
- **Option 2: Reinforced Buttress with Riprap Protection at the Base:** This option involves the construction of a Reinforced Earth (RE) slope, together with riprap protection at the slope toe.
- **Option 3a: Ecoreef Blocks:** This option involves the construction of Ecoreef blocks to remediate the underslip and reinstate the road shoulder.
- **Option 3b: Combined Reinforced buttress and Ecoreef Blocks:** A combination of Options 2 and 3a. This option is discussed in Appendix A.
- **Option 4: Palisade Wall with Shotcrete Facing and Capping Beam:** This option involves the construction of a palisade wall with shotcrete facing and a capping beam, together with riprap protection at the slope toe.
- **Option 5: Land Bridge:** This option involves the construction of a land bridge spanning the failed area, together with riprap protection at the slope toe.

Details of each option are provided in Appendix A, including a description of the proposed works, advantages, disadvantages, residual risks, and rough-order cost estimates. Indicative sketches for each option are presented in Appendix B.

4 Discussions and Recommendations

The site has significant geotechnical, construction, physical and other constraints, creating a complex slope instability issue that requires substantial remedial works.

The key challenges are summarised below:

- **Extensive road damage:** Approximately 200 m of the road has been affected by slope instability, with loss of the road shoulder and outer traffic lane. Tension cracks and slumping are evident across the full carriageway width between RP 2.800 to RP 2.840, indicating that the

Reference: SWDC - Whakatomotomo Road Slip – Remedial Options Memorandum

remaining pavement is progressively deteriorating. These observations suggest a high likelihood of a larger-scale underslip that could result in the loss of the entire carriageway during future triggering events such as prolonged rainfall or earthquakes.

- **Critical access route:** There is no alternative access route for this road. Any future landslide is likely to result in a complete road closure, isolating the local community and disrupting access for residents, emergency services, utility providers, and maintenance crews until the road can be reinstated.
- **Highly unstable downslope:** The downslope is steep and is being actively undermined by river erosion at its toe. Combined with the presence of loose colluvial materials and mature trees, these conditions create a high likelihood of progressive slope failure during severe rainfall or seismic events.
- **Unstable upslope hazards:** The upslope contains unstable colluvial soils, overhanging trees, and loose debris that present an ongoing rockfall and debris fall hazard to the road. Continued movement may block surface drainage, increase surcharge loading on the carriageway, and further accelerate the development of the underslip.
- **Restricted construction environment:** Remedial options are significantly constrained by private property boundaries on both the upslope and downslope, limiting opportunities to flatten batters or undertake large-scale earthworks.
- **Critical infrastructure:** Existing power poles are located along the crest of the unstable upslope. Continued slope movement could compromise these assets, potentially resulting in disruption to essential utility services in addition to road closure.
- **High geotechnical risk:** Based on the site observations, geomorphology, and assessed failure mechanisms, the site has been classified as having a ****High to Very High**** risk of continued slope instability.
- **River scouring:** The Turanganui River is located immediately below the downslope failure. Active scour by the river has undermined the toe of the underslip, reducing toe support and increasing the risk of further slope instability and progressive failure affecting the Whakatomotomo Road. The extent and severity of scouring (i.e., scour depth and extent, undermining and overhanging) at the toe of underslip is unknown.
- **Construction:** River access constraints may increase the complexity and duration of the scour protection works. Construction should ideally be undertaken during dry weather conditions, as river flow and weather conditions may affect construction sequencing and productivity, resulting in additional temporary works and associated costs. Access for local residents may also be restricted during the construction period, leading to significant traffic management requirements. Consequently, preliminary and general (P&G) costs and overall construction costs are expected to increase.

Reference: SWDC - Whakatomotomo Road Slip – Remedial Options Memorandum

- **Consenting:** Activities within the riverbed, including riprap placement and associated temporary works, are likely to result in greater environmental impacts and more extensive consenting requirements.

Given these constraints, there is **no low-cost or simple engineering solution** capable of providing a safe and durable long-term solution. The scale of the instability, the absence of an alternative route, the presence of critical infrastructure, and the potential consequences of further slope failure justify the need for a comprehensive permanent remediation scheme.

Several feasible remedial options have been developed and assessed, as presented in Appendix A. The options have been designed to provide a long-term reduction in geotechnical risk, maintain reliable access for the local community, and enhance the resilience of this critical transport corridor against future extreme weather and seismic events, while minimising future maintenance obligations and whole-of-life costs to Council.

Based on this, the recommendations are:

- Install warning signage advising of the landslide hazard, reduce the speed limit through the affected area, and restrict access of heavy vehicles (e.g. heavy trucks and heavy trailers). Limit road use to residential and local traffic until permanent remedial works have been implemented.
- Implement single lane road operation (e.g., priority giveaway or as approved equivalent by SWDC) between RP 2.640 and RP 2.850 with shifting the road towards the hill side at particular locations until permanent remedial works have been implemented. Implement traffic barriers to maintain single-lane operation through the affected section of road.
- Notify residents and other regular road users of the current hazards and advise that the road should only remain open during dry weather conditions. The road shall be closed during periods of heavy rainfall or severe weather/seismic events (in case of intense or prolonged rainfall, indicatively exceeding 30 mm in one day or 50 mm in 6 hours or 65 mm in 2 days or 180 mm monthly or in any other case SWDC considers appropriate).
- Advise local residents to monitor weather forecasts regularly and maintain sufficient food, water, medications, and other essential supplies in case road access is restricted or closed due to heightened slope instability risk.
- Continue monitoring the slope movement weekly, and after heavy rainfall or severe weather/seismic events.
- Undertake a detailed geotechnical investigation, including geological mapping, topographic survey, ground investigation, and river scour assessment based on a bathymetric survey, to establish the slope failure mechanisms and inform the detailed design of appropriate long-term remedial measures.
- Staged implementation (if funding is constrained): If full funding is not immediately available, the works could be delivered in stages. As a minimum, Option 1a or Option 1b could be

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implemented initially to address the most critical geotechnical risks and maintain road access. However, these options should be considered as the first stage of a comprehensive remediation programme rather than a standalone long-term solution. To maximise the long-term value of the investment, it is recommended that all provisional items identified in Appendix A be included where practicable. Completing these works during the initial construction phase will improve the long-term resilience of the site, reduce the likelihood of further slope deterioration, minimise future maintenance and emergency repair costs, and avoid the higher costs and disruption associated with returning to the site for additional works at a later date.

5 Limitations

The geotechnical options and cost estimates included in this report is subject to the following limitations:

- Topographical ground or drone survey has not been undertaken. Dimensions, slope geometries, and site features have been estimated from publicly available information, site observations and drone survey.
- Geotechnical ground investigation (e.g. boreholes, test pits, in-situ testing, laboratory testing) or detailed geological - geomorphological mapping have not been carried out. Ground conditions have been inferred from surface observations, published geological information, and engineering judgement.
- All options included in the report have not been verified by detailed geotechnical analyses or numerical modelling.
- Existing underground services, utilities, and buried infrastructure have not been confirmed and may influence the configuration of the proposed options. A utility search and service location survey will be required prior to detailed design and construction.
- This report focuses primarily on the geotechnical aspects of the proposed remedial works.

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Appendix A Comparison of Long-Term Remedial Options

Comparison of Remedial Options (Whakatomotomo Road, RP 2.650 to RP 2.850)

Option No	Option Description	Advantages	Disadvantages	Level of residual risk	Highlevel Indicative Cost (excl. GST)
Option 1a Partial Road Realignment (Refer Sketch in Appendix B)	- This option realigns the road upslope by 2.5 m between RP 2.650 and RP 2.750, and by 4.5 m between RP 2.800 and RP 2.840, with smooth transitions between chainages. - Indicative cut slope angles are 50° for rock and 30° for soil. These angles will be confirmed or optimised during detailed design and construction using an observational approach. The cut volume will be optimised during detailed design once the site-specific topographical survey is completed. - The option includes a drainage swale and extension of the existing uphill culvert inlet to suit the revised road alignment. - It also includes cut-off drains at the top of the cut slope, sub-horizontal drains on the cut slope face, and Hyrosoil treatment (erosion protection) on the cut face. - Riprap scour protection at the downslope toe may be provided as a provisional or optional measure to address river scour. - This option will require relocation of the existing uphill power poles. - Approval will be required from private landowners and other affected stakeholders. - Consents or consent exemptions may be required. Design departures may be required to optimise cost and manage risk systematically. Required land take plan area on uphill: 5400m² Expected duration of construction: 2 months (without PROVISIONAL/OPTION MEASURES) Expected duration of construction: 4 months (with PROVISIONAL MEASURES)	- By shifting the road away from the unstable downslope, this option reduces the risk of further road damage from downslope failure. - It reduces the risk of uphill instability by adopting a stable cut slope angle that is flatter than the existing slope, thereby lowering ongoing maintenance requirements. - The flatter slope angle may reduce the need for costly slope stabilisation measures. - Most of the works can be completed by general earthworks contractors, without the need for specialist plant, machinery, or equipment such as large piling rigs. - Surface water runoff from the uphill catchment onto the road can be managed in a controlled manner, reducing associated risks. - The required cut volume is lower than for Option 1B. - The existing power poles will be relocated to more stable ground. - If provisional or optional measures are not adopted, the extent of works required on the downslope side adjacent to the river will be reduced. - If all provisional or optional measures are implemented, the residual risk for this option is expected to be Low to Medium.	- Requires substantial uphill excavation, vegetation removal and tree cutting. - Localised slope stabilisation measures, such as soil nails or shotcrete, may be required in some areas of the uphill cut face (if found necessary). - Temporary road closures or traffic management may be required during construction. - Land acquisition will be required to accommodate the proposed road realignment. - Existing power poles and associated utilities will need to be relocated. - Any works within the river channel, such as scour protection measures, should be undertaken during dry periods when construction windows are limited. - Without provisional remedial measures, such as river scour protection and ground improvement works, there remains a medium residual risk of losing part of the newly aligned road carriageway due to potential downslope landslide activity. - If provisional or optional measures are not implemented, the residual risk for this option is expected to be Medium.	Medium (Realignment option only without considering scour protection measures & Ground Improvement Piles) Low to Medium (incorporating all PROVISIONAL ITEMS)	<u>Realignment cost only without scour protection measures</u> Base cost: \$1.6M +30% P&G: \$2.1M +30% Contingency: \$2.8M <u>Realignment cost with scour protection measures</u> Base cost: \$1.6M Riprap: \$650k (assumed 60% volume of Option 2) Total: \$2.25M +30% P&G: \$2.9M +30% Contingency: \$3.8M <u>Realignment cost with scour protection measures and ground improvement piles</u> Base cost: \$1.6M Riprap: \$650k (assumed 60% volume of Option 2) Ground improvement piles: \$928k Total: \$3.2M +30% P&G: \$4.14M +30% Contingency: \$5.4M Refer below notes for exclusions.
Option 1b Full Road Realignment (Refer Sketch in Appendix B)	- This option is similar to Option 1a, except that the road alignment is shifted 4.5 m upslope over the entire affected length, with smooth transitions at both ends. - Indicative cut slope angles are 50° for rock and 30° for soil. These angles will be confirmed or optimised during detailed design and construction using an observational approach. The cut volume will be optimised during detailed design once the site-specific topographical survey is completed. - The option includes a drainage swale and an extension of the existing uphill culvert inlet to accommodate the new road alignment following the road shift. - The option includes a drainage swale and extension of the existing uphill culvert inlet to suit the revised road alignment.	- By shifting the road away from the unstable downslope, this option reduces the risk of further road damage from downslope failure, lower risk than Option 1a. - It reduces the risk of uphill instability by adopting a stable cut slope angle that is flatter than the existing slope, thereby lowering ongoing maintenance requirements. - The flatter slope angle may reduce the need for costly slope stabilisation measures. - Most of the works can be completed by general earthworks contractors, without the need for specialist plant, machinery, or equipment such as large piling rigs.	- Requires substantial uphill excavation, vegetation removal and tree cutting. - The required cut volume is higher than for Option 1A. - Localised slope stabilisation measures, such as soil nails or shotcrete, may be required in some areas of the uphill cut face (if found necessary). - Temporary road closures or traffic management may be required during construction. - Land acquisition will be required to accommodate the proposed road realignment. - Existing power poles and associated utilities will need to be relocated. - Any works within the river channel, such as scour protection measures, should be undertaken	Medium (Realignment option only without considering scour protection measures & Ground Improvement Piles) Low (incorporating all PROVISIONAL ITEMS)	<u>Realignment cost only without scour protection measures</u> Base cost: \$1.7M +30% P&G: \$2.3M +30% Contingency: \$3.0M <u>Realignment cost with scour protection measures</u> Base cost: \$1.7M Riprap: \$650k (assumed 60% volume of Option 2) Total: \$2.4M +30% P&G: \$3.1M +30% Contingency: \$4.0M

Option No	Option Description	Advantages	Disadvantages	Level of residual risk	Highlevel Indicative Cost (excl. GST)
	- It also includes cut-off drains at the top of the cut slope, sub-horizontal drains on the cut slope face, and Hyrosoil treatment (erosion protection) on the cut face. - Riprap scour protection at the downslope toe may be provided as a provisional or optional measure to address river scour. - This option will require relocation of the existing uphill power poles. - Approval will be required from private landowners and other affected stakeholders. - Consents or consent exemptions may be required. Design departures may be required to optimise cost and manage risk systematically. Required land take plan area on uphill: 5700m² Expected duration of construction: 3 months (without PROVISIONAL/OPTION MEASURES) Expected duration of construction: 5 months (with PROVISIONAL MEASURES)	- Surface water runoff from the uphill catchment onto the road can be managed in a controlled manner, reducing associated risks. - The existing power poles will be relocated to more stable ground. - If provisional or optional measures are not adopted, the extent of works required on the downslope side adjacent to the river will be reduced. - If all provisional or optional measures are implemented, the residual risk for this option is expected to be Low.	- during dry periods when construction windows are limited. - Without provisional remedial measures, such as river scour protection and ground improvement works, there remains a medium residual risk of losing part of the newly aligned road carriageway due to potential downslope landslide activity. - If provisional or optional measures are not implemented, the residual risk for this option is expected to be Medium.		<u>Realignment cost with scour protection measures and ground improvement piles</u> Base cost: \$1.7M Riprap: \$650k (assumed 60% volume of Option 2) Ground improvement piles: \$928k Total: \$3.32M +30% P&G: \$4.32M +30% Contingency: \$5.62M Refer below notes for exclusions.
Option 2 Reinforced buttress with Rip Rap Protection at the base. (Refer Sketch in Appendix B)	- This option involves reinstating the original width of failed road and 1m wide shoulder with reinforced earth buttress. The bottom portion of the reinforced earth slope will be supported by rockfill. The rockfill will form the part of the river scour protection to cater for minimum 50 Yr return period flood level with 0.5 m freeboard. - This solution relies on the bottom up construction approach. Toe protection/river scour protection should be installed from the riverbed with appropriate key-in to the riverbed up to the freeboard level. Over, the rockfill embankment, flexible reinforced embankment will be constructed by forming stable benches and keying the geogrid reinforcement into the stable in-situ materials. - This option includes a drainage management measure at the road level (swales and culverts). It also includes cut-off drains at the top of the upslope. - This option also considers minor maintenance work associated with uphill (e.g., minor trimming of loose unstable blocks/materials, drainage management). - Approval will be required from private landowners and other affected stakeholders. - Consents or consent exemptions may be required. Design departures may be required to optimise cost and manage risk systematically. Required Land Intake on the riverbed: TBC Expected duration of construction: 3 months (without PROVISIONAL/OPTION MEASURES)	- Given that Reinforced buttress is a flexible structure, it can accommodate larger displacements and easily repaired and managed, compared to other rigid concrete structures. - With the rip rap at the toe, provides a long-term solution. - Can be constructed by general earthworks contractors. - No specialist plant requirements (large piling rigs and anchor drilling rigs not needed) - Single lane can be operational during construction.	- Compared to other options, large quantity of soil and slip debris to be removed. - Temporary stability of the excavation face to be considered and addressed by the Contractor. - Overall performance of reinforced buttress depends on the rip rap toe protection. - Works required within the riverbed, increasing environmental and regulatory (Consenting) complexity - If a suitable founding stratum is not encountered at the base of RE slope, there is a need for undercutting and replacement at the base. *Largest quantity of riprap for buttress, backfill and footprint into river. - Larger footprint into river stream compared to Option 2. - Larger river diversion and formation of temporary bund will be required during construction. - Construction is to be carried out ideally during the dry weather. - Risk of instability of upslope remains	Medium	<u>Reinforced buttress with riprap protection at the base.</u> Base cost: \$2.2M Riprap: \$1.03M Other costs (drainage, pavement improvement, minor earthworks on upslope): \$350k Total: \$3.55M +30% P&G: \$4.63M +30% Contingency: \$6.0M

Option No	Option Description	Advantages	Disadvantages	Level of residual risk	Highlevel Indicative Cost (excl. GST)
Option 3a Ecoreef Concrete Blocks (Refer Sketch in Appendix B) Option 3b Combined Reinforced buttress and Ecoreef Blocks	- This option involves reinstating the original width of failed road and 1 m wide shoulder with the Ecoreef concrete blocks wall. The Ecoreef system will also provide protection against river scour. - This solution relies on the bottom up construction approach. Ecoreef blocks should be installed from the riverbed with appropriate key-in to the riverbed to form the wall up to road level. - Necessary road reinstatement will be required especially between RP 2.800 to 2.840 with geogrid. - This option includes a drainage management measure at the road level (swales and culverts). It also includes cut-off drains at the top of the upslope. - This option also considers minor maintenance work associated with uphill (e.g., minor trimming of loose unstable blocks/materials, drainage management). - Approval will be required from private landowners and other affected stakeholders. - Consents or consent exemptions may be required. Design departures may be required to optimise cost and manage risk systematically.	- In addition to the wall, it serves as the river scour protection at the toe - Minimal excavation is required - Faster construction compared to Option 2. - Modular units allow ease of installation. Prefabricated components reduce on-site construction time. - Single lane can be operational during construction. - Lesser footprint into river stream compared to Option 2. - Option 3b performs better than Option 2, as the Ecoreef blocks provide a more stable foundation than riprap due to their interlocking configuration, which improves overall stability and reduces the potential for movement or displacement of individual units	- Higher construction costs than alternative remediation options. - Works required within the riverbed, increasing environmental and regulatory (Consenting) complexity - Relatively new product with no proven long-term performance data in NZ conditions - High risk associated with material, plant, and machinery lead times - ECOREEF products not certified for seismic loading — potential performance issues during earthquakes - Need strong foundation for Ecoreef if ground condition is not good. This will increase cost and time and make construction more difficult, particularly at the river site. - Specialist installation crew required, limiting contractor options (proprietary product) - Risk of instability of upslope remains	Medium	<u>Option 3a Reinforced Ecoreef</u> Base cost: \$4.23M Other costs (drainage, pavement improvement, minor earthworks on upslope): \$350k Total: \$4.55M +30% P&G: \$5.9M +30% Contingency: \$7.7M <u>Option 3b Combined Reinforced buttress and Ecoreef Blocks</u> Ecoreef base cost: \$1.69M Reinforced buttress base cost: \$2.2M Other costs (drainage, pavement improvement, minor earthworks on upslope): \$350k Total: \$4.21M +30% P&G: \$5.5M +30% Contingency: \$7.1M
Option 4 Palisade Wall with Shotcrete Facing and Capping Beam (Refer Sketch in Appendix B)	- This option involves installation of bored concrete piles along the affected sections to reinstate the road shoulder, with a minimum embedment into competent ground; Construction of a reinforced concrete capping beam to connect the heads of the bored piles; Application of shotcrete facing to the exposed slope between adjacent bored piles. - Reinstate the original road width and 1 m shoulder area using engineered backfill wrapped in geogrid reinforcement. - Improve the pavement between RP 2.800 and RP 2.840 using geogrid reinforcement. - This option relies on providing scour protection measures at the toe of the slope using appropriately sized riprap. The rockfill will form the part of the river scour protection to cater for minimum 50 Yr return period flood level with 0.5 m freeboard. Toe protection/river scour protection should be installed from the riverbed with appropriate key-in to the riverbed up to the freeboard level. - This option includes a drainage management measure at the road level (swales and culverts). It also includes cut-off drains at the top of the upslope. - This option also considers minor maintenance work associated with uphill (e.g., minor trimming of loose unstable blocks/materials, drainage management). - Approval will be required from private landowners and other affected stakeholders. - Consents or consent exemptions may be required. Design departures may be required to optimise cost and manage risk systematically.	- Riprap erosion protection at the downslope toe will help mitigate scour. - Reduced earthworks will help limit construction impacts and costs. - Piling can be carried out from the existing road platform, avoiding the need for downslope access. - Single-lane traffic can be maintained during construction, subject to appropriate traffic management. - The scheme could be upgraded later with ground anchors if further slope movement occurs or additional stabilisation is required.	- Long bored piles will be needed to achieve sufficient embedment into competent rock. - Construction will require specialist contractors and equipment for bored pile installation. - Heavy piling equipment may add load and vibration to the existing slip area, potentially increasing geotechnical risk during construction. - River diversion and temporary bunds may be required to enable the scour protection works. - Riverbed activities, including riprap placement, will increase environmental impacts and consenting requirements. - Riverbed access constraints may increase the complexity and duration of scour protection works. Construction should ideally be undertaken during dry weather, as weather and river flow conditions may affect sequencing and productivity. - Risk of instability of upslope remains	Medium	<u>Palisade wall with capping beam</u> Base cost: \$2.0M Riprap: 829\$M (assumed 80% volume of Option 2) Other costs (drainage, minor earthworks on upslope): \$275k Total: \$3.1M +40% P&G: \$4.36M +30% Contingency: \$5.7M

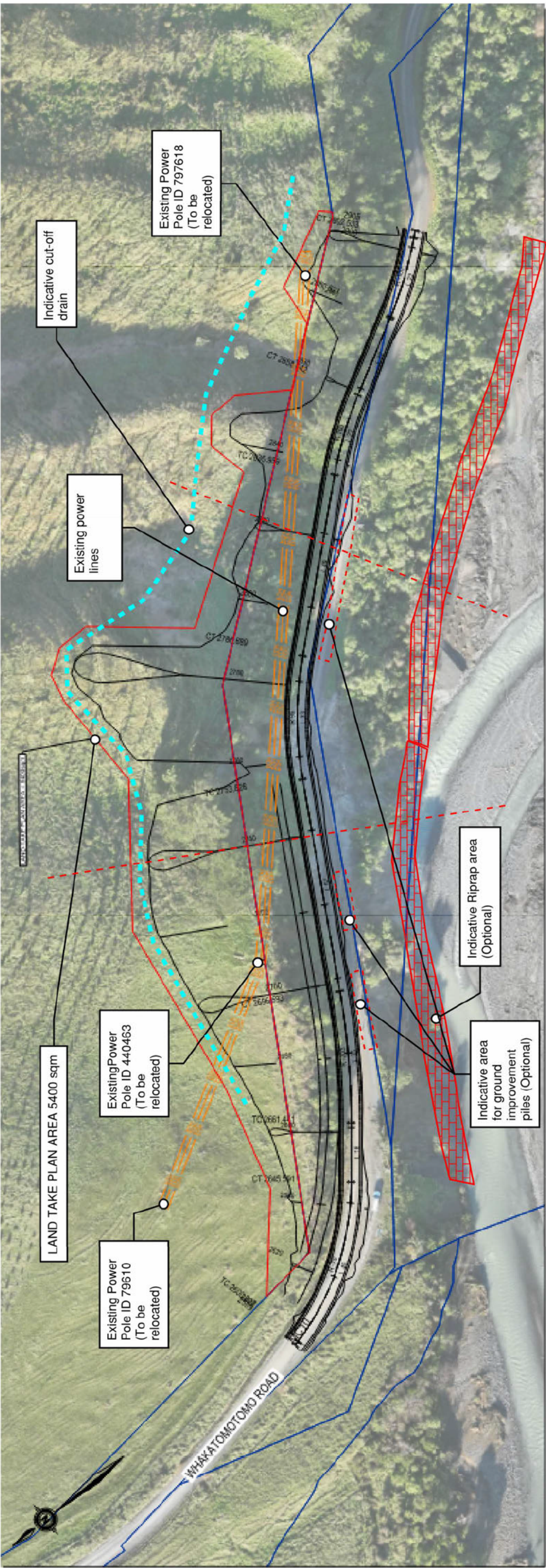
Option No	Option Description	Advantages	Disadvantages	Level of residual risk	Highlevel Indicative Cost (excl. GST)
Option 5 Land Bridge	- Construct a new bridge to span the length of the road washout. - Bridge is 200m long and 6m wide (including 1m shoulders on each side of the road). - TL4 barriers can be provided on each side of the bridge. - Provide scour protection at the toe of the slope using appropriately sized riprap	- Provides a very robust solution for the current length of the scour (most resilient option). - Design will be done with compliance to the WK Bridge Manual. - TL 4 barriers can be provided along both sides of the bridge - Reduced rip rap requirements when compared to the other options.	- The bridge solution only addresses the section currently affected by scour. Additional bank armouring will still be required to prevent scour from extending beyond the bridge footprint. - Construction is expected to have a relatively long programme compared to other remediation options. - Specialist plant and equipment, including a large crane and piling rigs, will be required for bridge and foundation construction. - Maintaining public access within the existing road corridor during construction is likely to be challenging and may require significant traffic management measures. - Routine inspection and maintenance of the bridge substructure will be difficult, requiring specialist access equipment. - A central pier will likely be required, and foundation depths may be significant depending on the underlying ground and geological conditions. - The bridge option represents the highest capital cost of all options considered. - Construction activities are likely to result in greater environmental, consenting, and logistical complexities than alternative stabilisation solutions. - Future maintenance obligations and whole-of-life costs are expected to be higher than for non-bridge options.	Low	Very expensive (Not considered further)

Note:

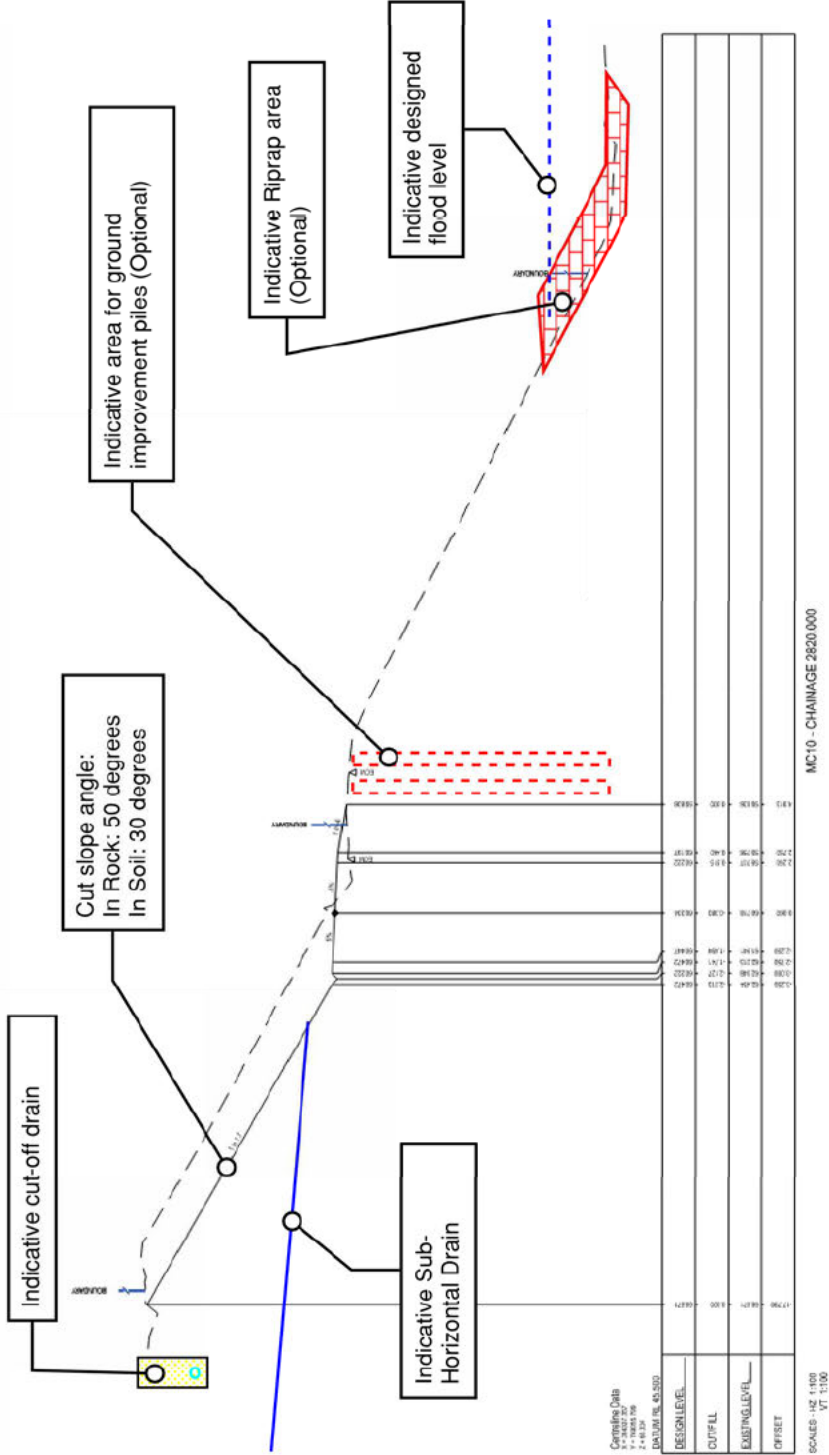
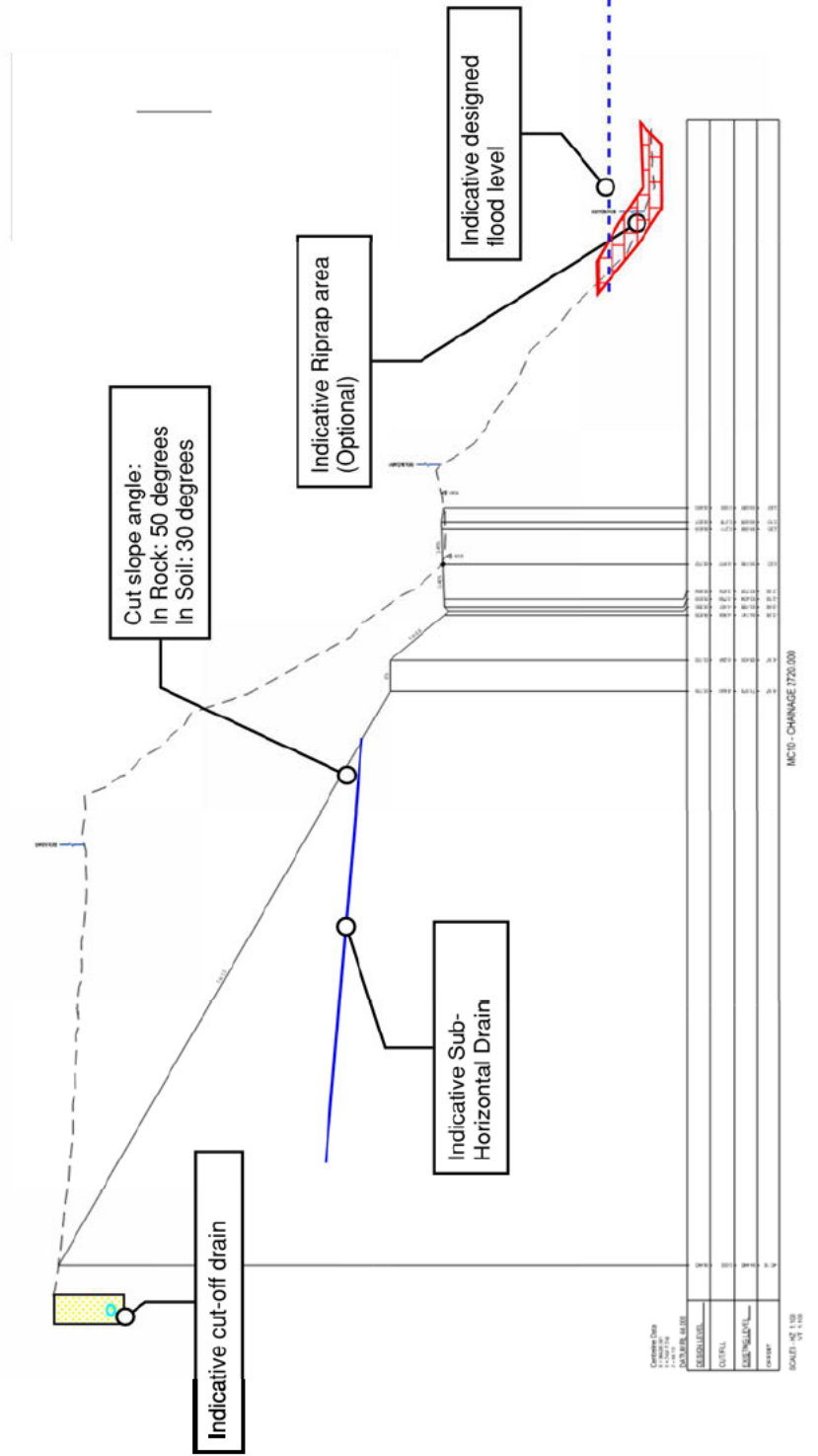
1. The above indicated cost does not include investigations, design, procurement of physical work, land purchase, power pole relocation, consenting, MSQA and GST.

Reference: SWDC - Whakatomotomo Road Slip – Remedial Options Memorandum

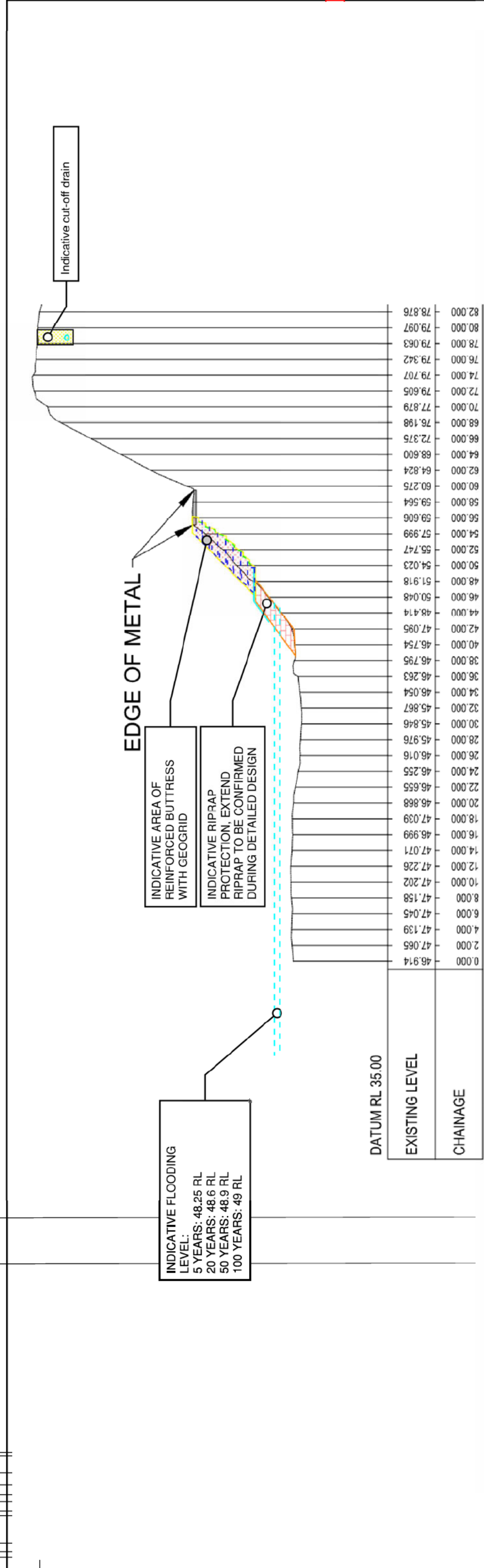
Appendix B Option Sketches



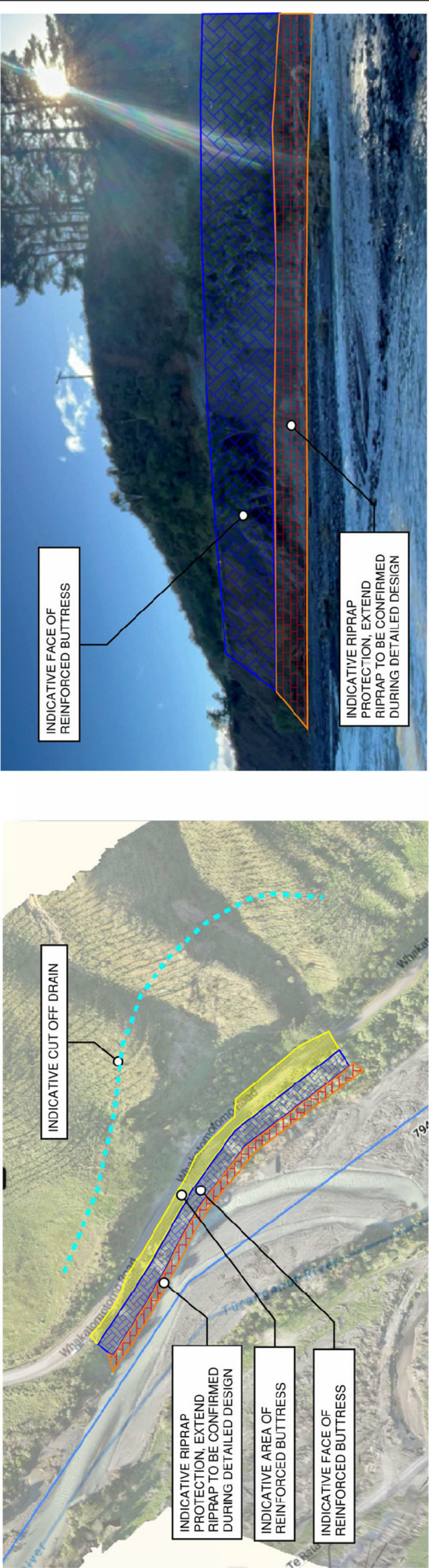
PLAN VIEW



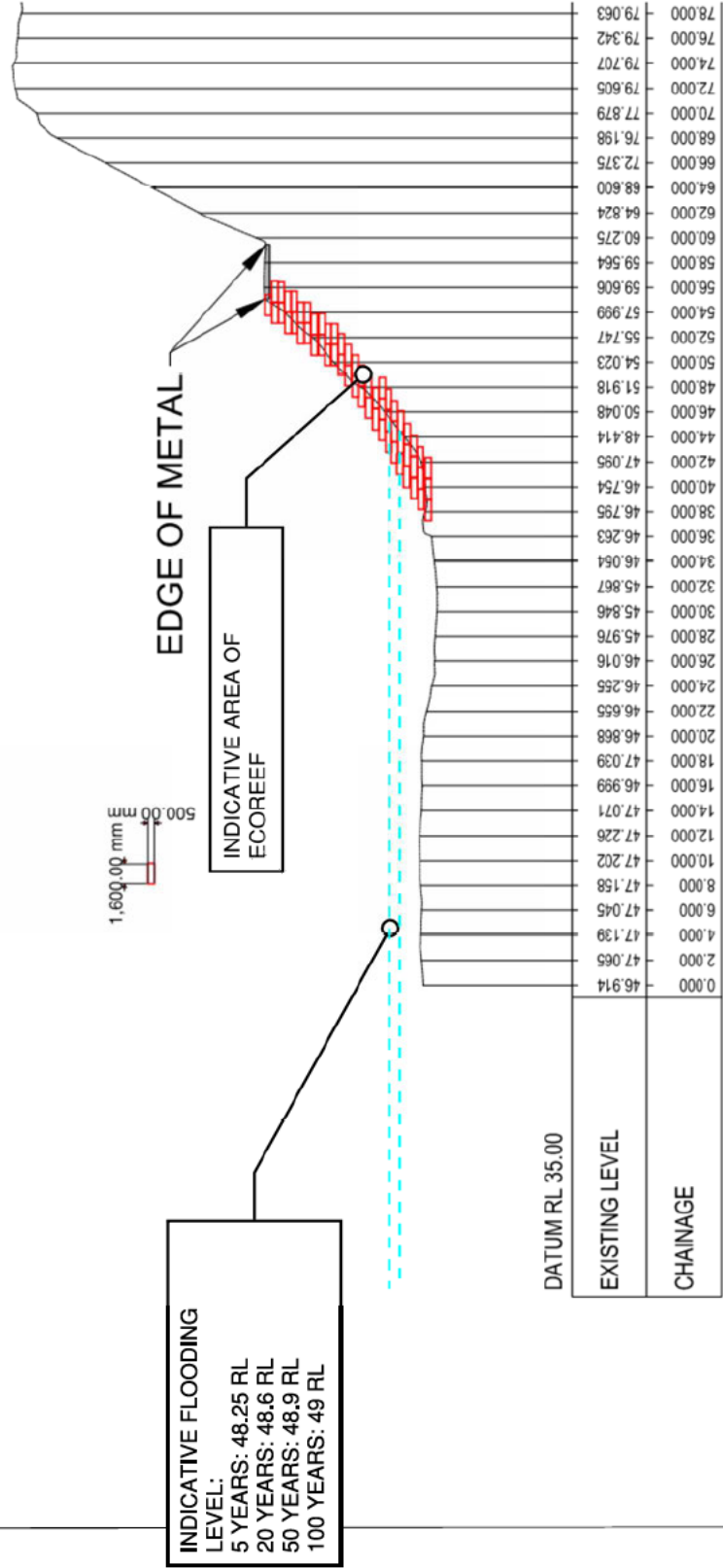
TYPICAL CROSS-SECTION



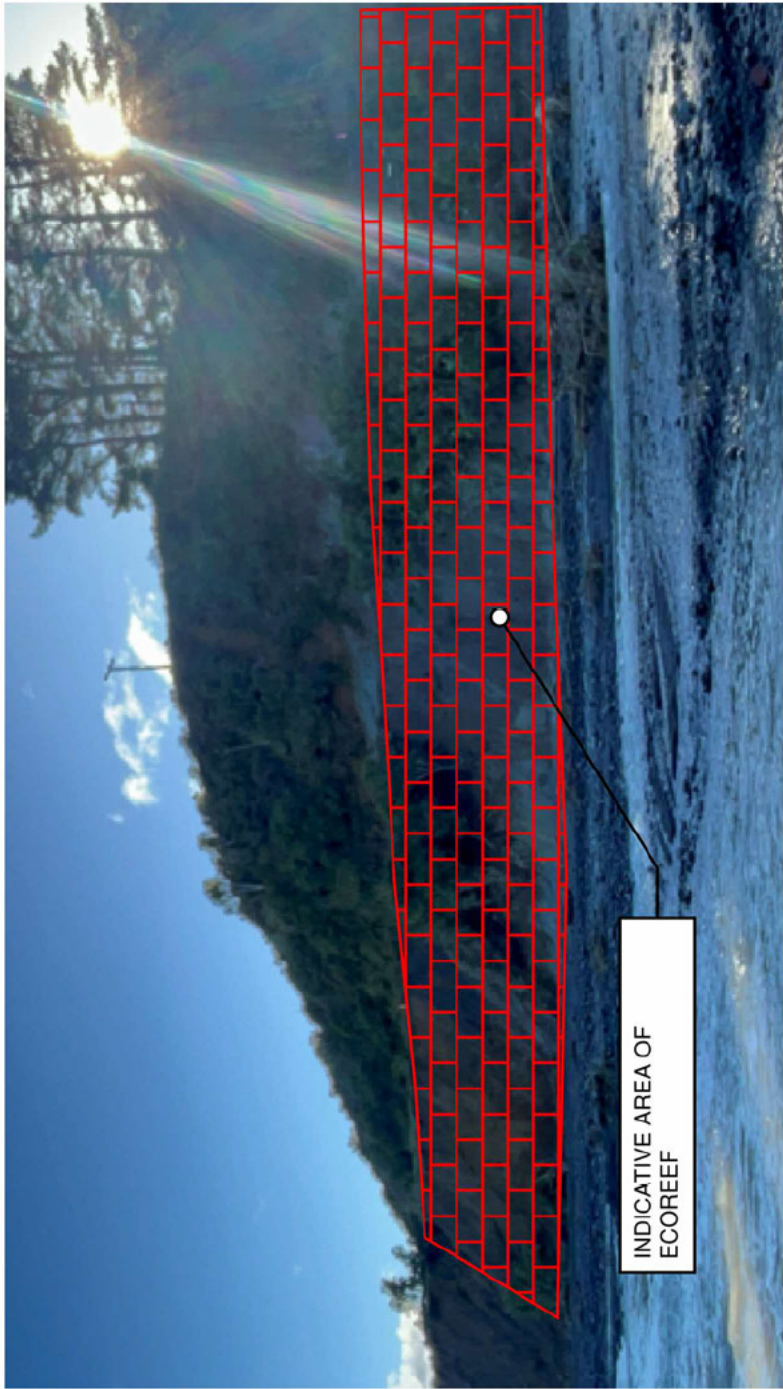
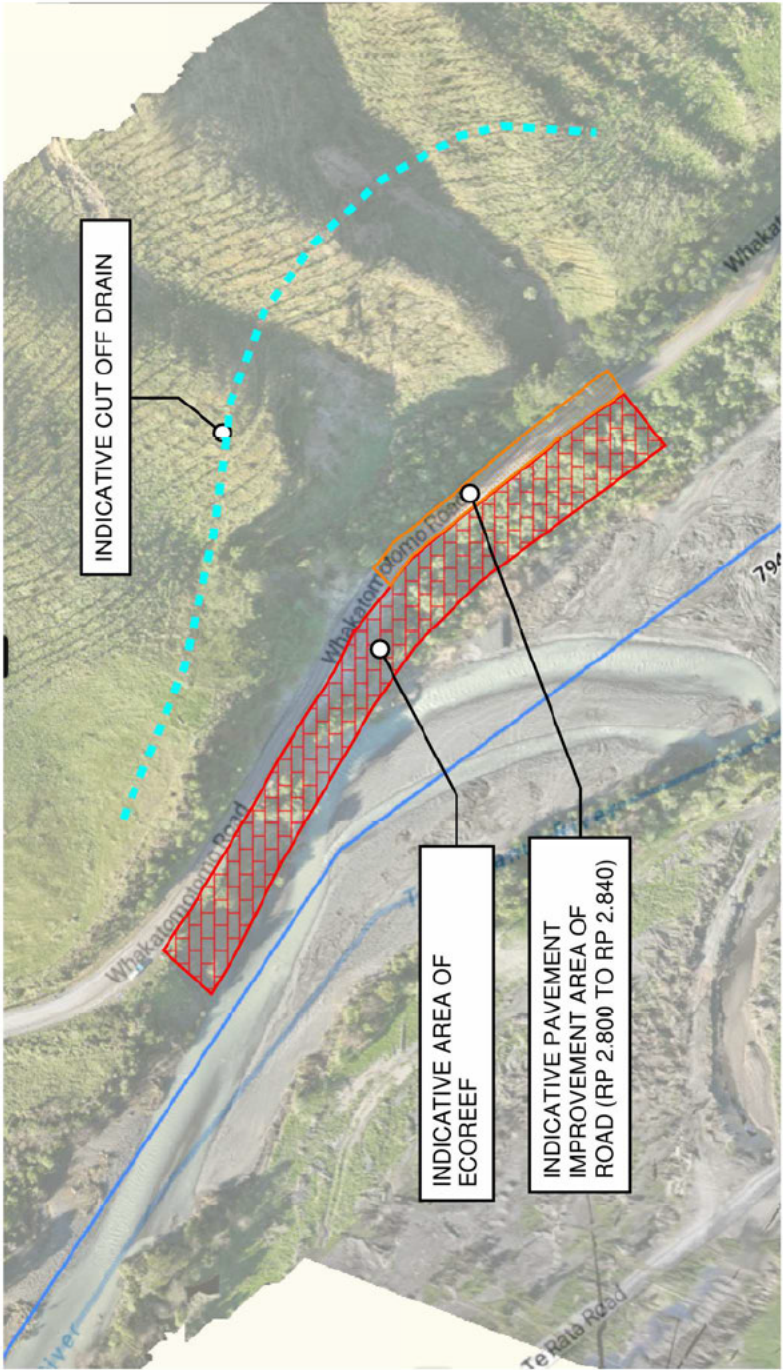
TYPICAL CROSS-SECTION



	DESCRIPTION	OPTION 2: REINFORCED BUTTRESS WITH RIPRAP PROTECTION AT THE BASE.			CONCEPT ONLY - NOT TO SCALE	31/07/26
	TITLE	S	DC	HAKATOMOTOMO ROAD RP 2.650 TO RP 2.850	PROJECT NO. 310206618	FIGURE NO. 3
				REV	A	



TYPICAL CROSS-SECTION



Stantec	DESCRIPTION	OPTION 3: ECOREEF CONCRETE BLOCKS		CONCEPT ONLY - NOT TO SCALE	31/07/26
	TITLE	S DC HAKATOMOTOMO ROAD RP 2.650 TO RP 2.850		PROJECT NO. 310206618	
		FIGURE NO. 4	REV A		

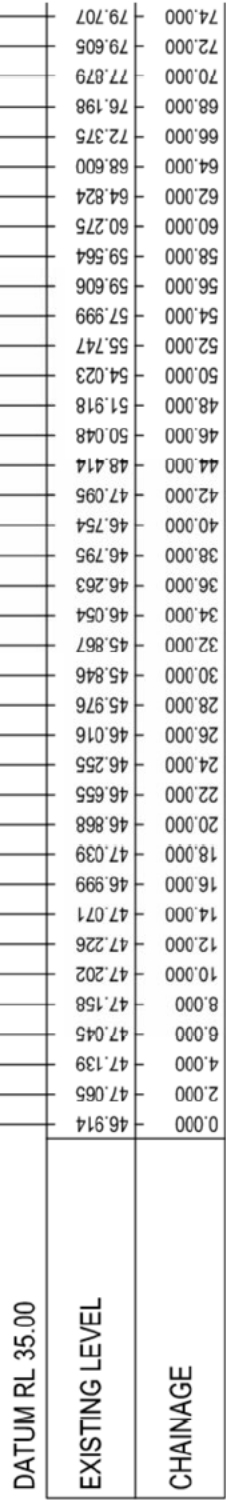
INDICATIVE FLOODING
LEVEL:
5 YEARS: 48.25 RL
20 YEARS: 48.6 RL
50 YEARS: 48.9 RL
100 YEARS: 49 RL

INDICATIVE RIPRAP
PROTECTION, EXTEND
RIPRAP TO BE CONFIRMED
DURING DETAILED DESIGN

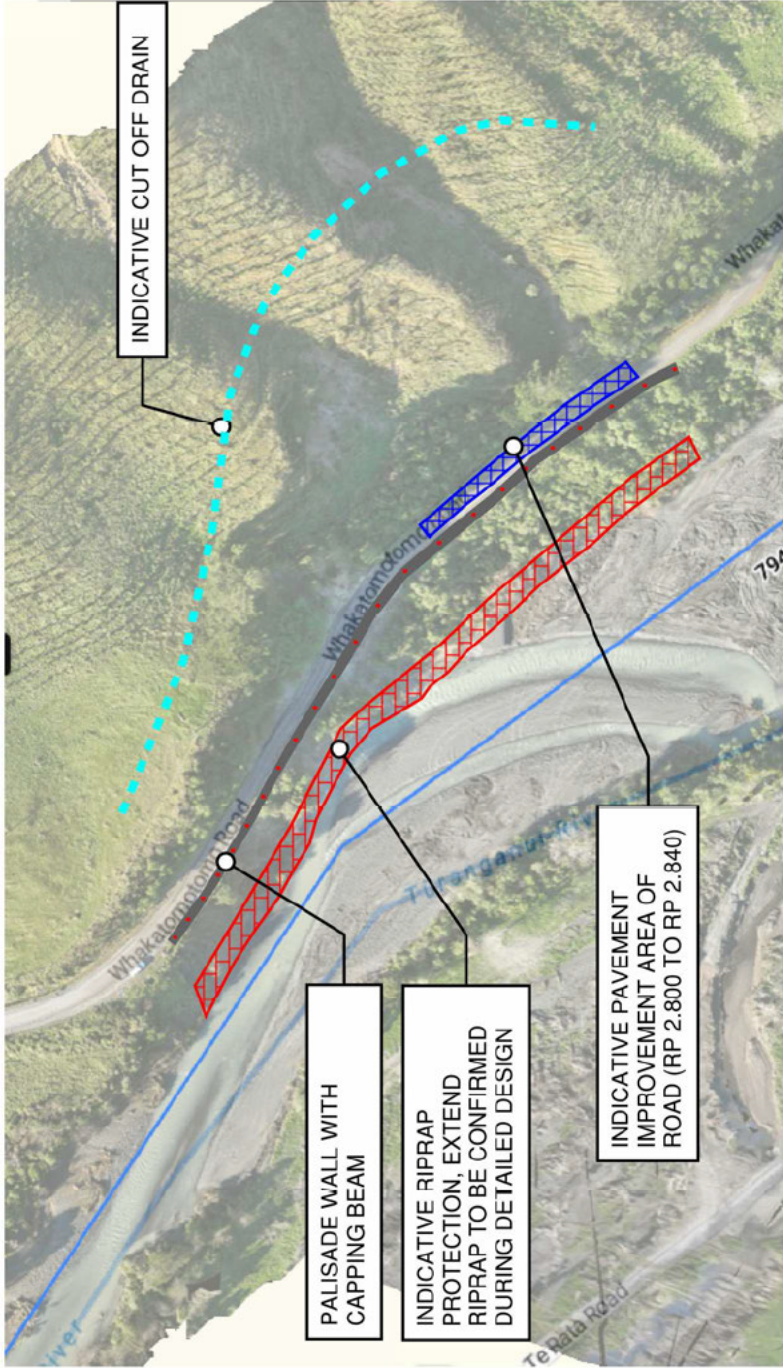
EDGE OF METAL

INDICATIVE BACKFILL AREA
BEHIND PALISADE WALL

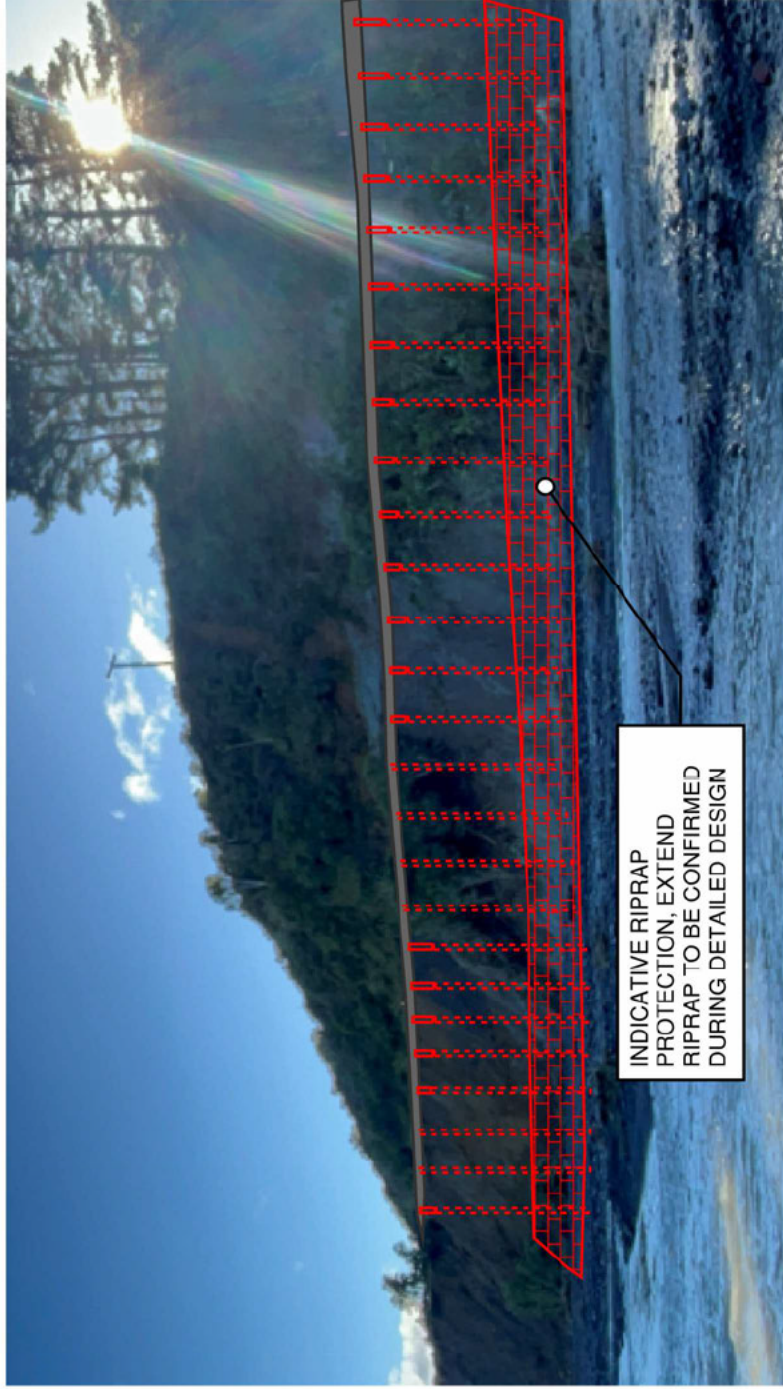
PALISADE WALL WITH
CAPPING BEAM



TYPICAL CROSS-SECTION



PLAN VIEW



CONCEPTUAL DESIGN VIEW

	DESCRIPTION	OPTION 4: PALISADE WALL WITH SHOTCRETE FACING AND CAPPING BEAM		CONCEPT ONLY - NOT TO SCALE	31/07/26
	TITLE	S	DC	HAKATOMOTOMO ROAD RP 2.650 TO RP 2.850	
		PROJECT NO.		310206618	
		FIGURE NO.		5	REV
					A