REPORT

Tonkin+Taylor

NZTA National Resilience PBC

Regional Risk Assessment Summary

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1 Introduction

New Zealand faces a range of natural hazards and risks, which are increasing in complexity and uncertainty because of climate change. The Waka Kotahi New Zealand Transport Agency (the Transport Agency) is working to better understand the resilience of their land transport system to withstand these increasing and ever-changing natural hazard risks through the development of their National Resilience Programme Business Case (PBC).

The National Resilience PBC aims to provide context, initial evidence, coordination, priority and initial direction to interventions and activities seeking to improve the New Zealand's land transport system's resilience.

This report details the outcome of a Portfolio Risk Assessment (PRA) completed across New Zealand's land transport system. The identification of priority risks through this approach is one of the responses identified in the development of the National Resilience PBC. Applying the risk assessment provides a view on priority risks across the national land transport system. The methodology adopted is presented in NZTA National Resilience PBC - Portfolio Risk Assessment Methodology (Appendix F).

For the purpose of the National Resilience PBC the PRA focused on state highways (SH), local roads which provide alternate routes to SHs, and the KiwiRail network. In some cases, the improved resilience of local roads is a potential solution to address risks on a SH. This means risks to local roads may also be identified where relevant.

1.1 Approach

The Portfolio Risk Assessment (PRA) methodology is described in detail within the accompanying *Risk Assessment Methodology Report* however at a high level, the approach consisted of:

- Compiling background information to provide a consistent evidence base for identifying hazards.
- Completing a desktop evaluation of resilience related risks based on hazard and asset data and other relevant resilience related documents.
- Testing the preliminary analysis and identifying key risk locations at a regional stakeholder workshop. This has been done on a regional basis (based on the Network Outcomes Contract (NOC) regions) but could also be undertaken on a corridor, journey or other basis.
- Utilising available hazard information, the regional stakeholder workshop results were cross checked and updated where deemed appropriate.
- Developing initial 'response' options with stakeholders for priority risks, drawing on stakeholder knowledge, and recommending next steps.

As per the detail in the *Portfolio Risk Assessment Methodology*, a *combined consequence* rating with scores of 1 to 5 is combined with the *combined likelihood* (scale ranging from unlikely (UL) to very likely (VL)) to assess the overall risk to the asset or section of network. Risks are rated as minor, moderate, major or extreme (refer Table 1.1).

Table 1.1: Risk matrix

Combined Consequence	Combined Likelihood		
	UL	L	VL
1	1UL	1L	1VL
2	2UL	2L	2VL
3	3UL	3L	3VL
4	4UL	4L	4VL
5	5UL	5L	5VL

Rating Key
Minor
Moderate
Major
Extreme

Note: UL – Unlikely, L – Likely, VL – Very Likely. For example, 1UL = a combination of a consequence score of 1 and a likelihood score of Unlikely.

1.2 Suggested response category and next steps

Through the regional stakeholder workshops, a range of suggested response options (grouped in wider response categories) were identified and have been documented within the summary tables against each risk in the 'Suggested Response Category' column. The discussions within the workshops focussed primarily on direct Transport Agency interventions, such as physical works, maintenance or emergency management responses.

As noted in the *Portfolio Risk Assessment Methodology Report*, the majority of identified risks will require further investigation and development of specific business cases. During these processes a broader suite of response categories should be considered. These could include:

- Physical works (NZTA)
- Physical works (third party – e.g. local road detour improvements, stop banks)
- BAU maintenance, monitoring and/or emergency response planning
- Enhanced maintenance and/or monitoring
- Enhanced emergency response plans and/or preparedness
- Land use and/or development controls
- Real time info, community emergency information systems and/or education.

For all major and extreme risks identified, two categories of 'next steps' have been recommended which indicate next steps in the process rather than the proposed solution. The process should identify the most appropriate solution considering an entire suite of potential response categories (as listed above), along with the suggested solution from the regional stakeholder workshop. As such, the two next step categories are:

- *Business Case funded or underway*: The next step is to proceed with the current business case development ensuring that an appropriate suite of response options is considered.
- *Business Case required*: The next step is development of a 'right sized' business case to address the identified risk, considering an appropriate suite of response options. The business case point of entry will determine the level of effort required.

2 National PRA summary

2.1 National hazard and risk overview

Some 370 risks were identified across the whole country (Figure 2.1). In accordance with the approach set out in the *Portfolio Risk Assessment Methodology Report.* The risks are grouped by regions that correlate with the Transport Agency NOC areas.

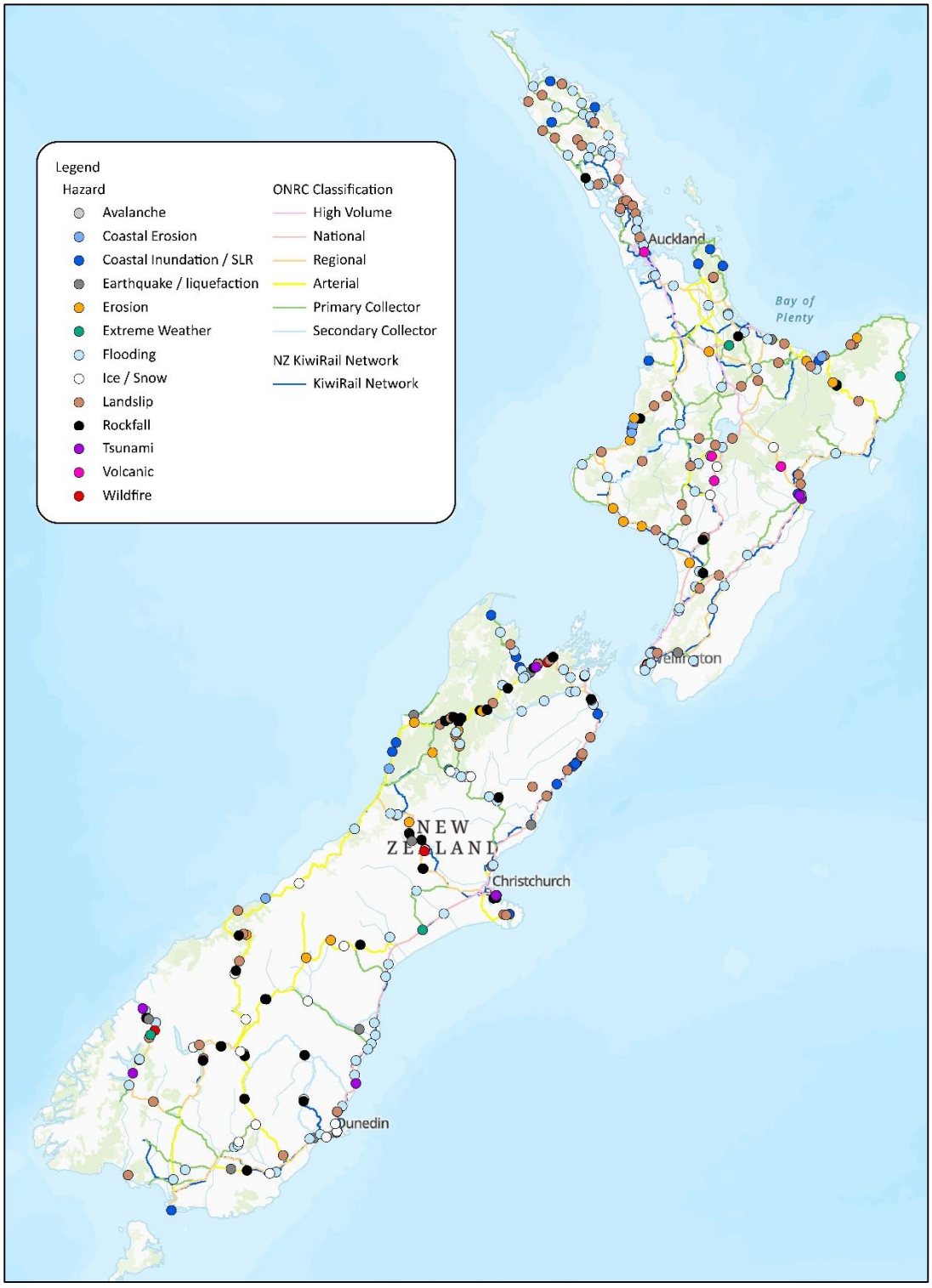

Figure 2.1: Distribution of risks by hazard type

Figure 2.2 shows the risks by region according to hazard type. The Top of the South (Marlborough, Nelson and Tasman Districts), Otago and Canterbury have the greatest number of risks across the regions, with the majority of these being related to flooding, landslip, rockfall, snow and ice. The lowest numbers of risks are within the Gisborne[1], Auckland[2], Hawke's Bay and Southland regions.

The most common hazard is flooding, followed by landslip.

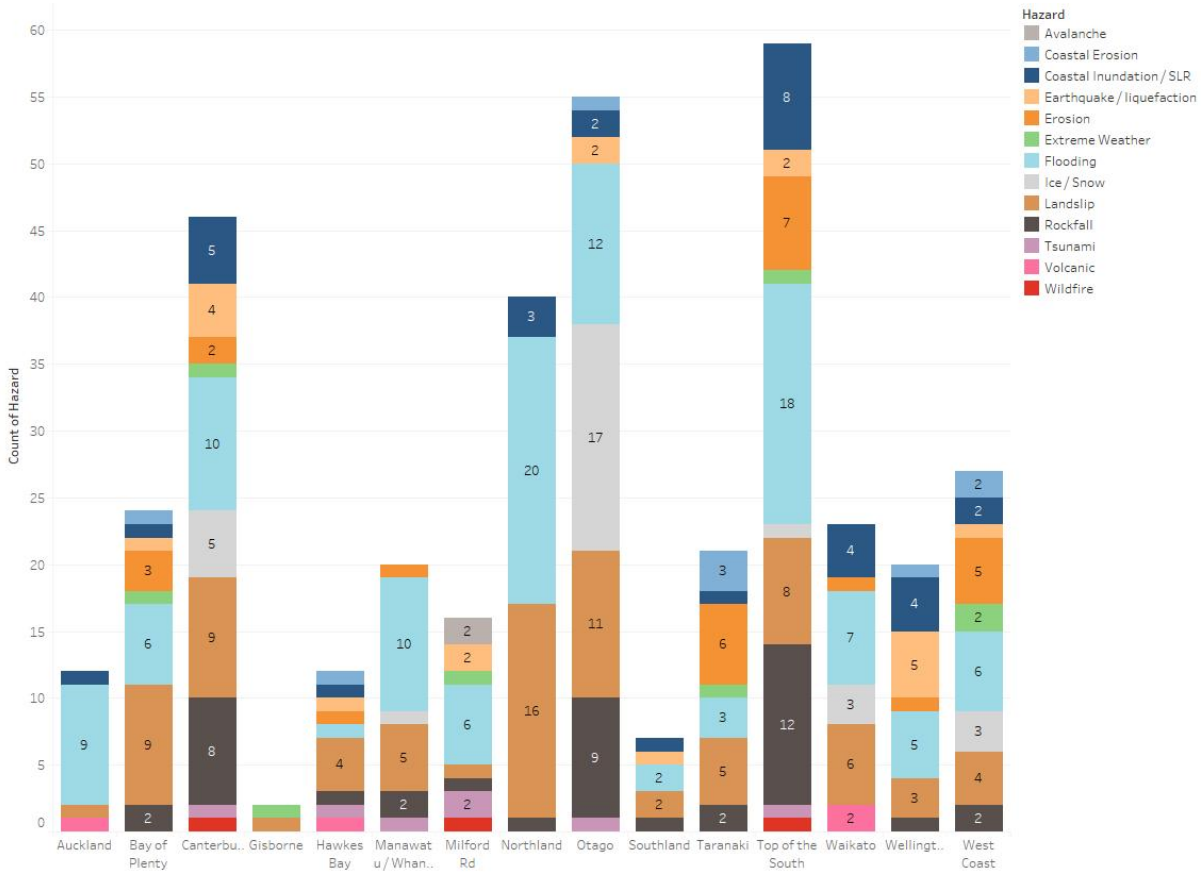

Figure 2.2: Summary of the number of risks by region and hazard type

2.2 National present-day risk summary

This section presents a summary of the present-day risks which were identified as *extreme* or *major* across the country through the regional stakeholder workshops. These represent the risks which pose the greatest risk to the Transport Agency national transport system due to their likelihood of damage and consequence of failure[3]. These should be prioritised in terms of mitigation responses.

Figure 2.3 presents the present-day risks within each region along with the risk rating as determined during the regional stakeholder workshops. Since participants were asked to focus on the most important risks within their region, there is likely a natural bias towards higher risks.

[1] The small number of risks within Gisborne is partially due to the fact that many are located within adjacent regions - Hawkes Bay and the Bay of Plenty.
[2] The relatively small number of documented risks within Auckland is predominantly due the high level of investment over the years in network upgrades and resilience.
[3] Refer to *Portfolio Risk Assessment Methodology* for detailed description of likelihood and consequence ratings (T+T, 2020).

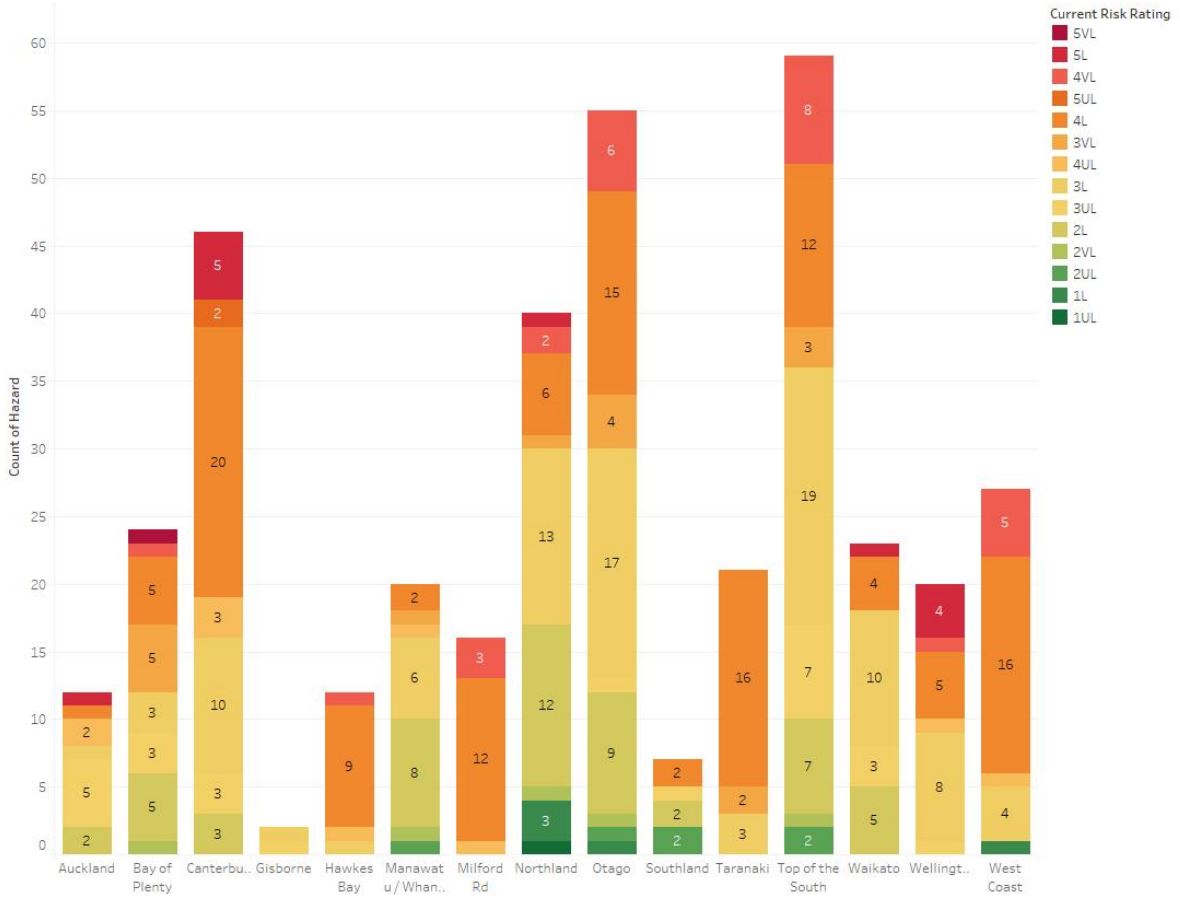

Figure 2.3: Summary of the number of present day risks by region and risk rating

Figure 2.4 shows the extreme (5VL, 5L, 4VL) and major (5UL, 4L, 3VL) risks, broken down by subcategory. As shown, Canterbury, Otago, Top of the South (Marlborough, Nelson and Tasman Districts), West Coast have the highest numbers of extreme and major risks, with Auckland, Southland and Gisborne[4] identifying the lowest number. The Bay of Plenty has the only 5VL[5] extreme risk.

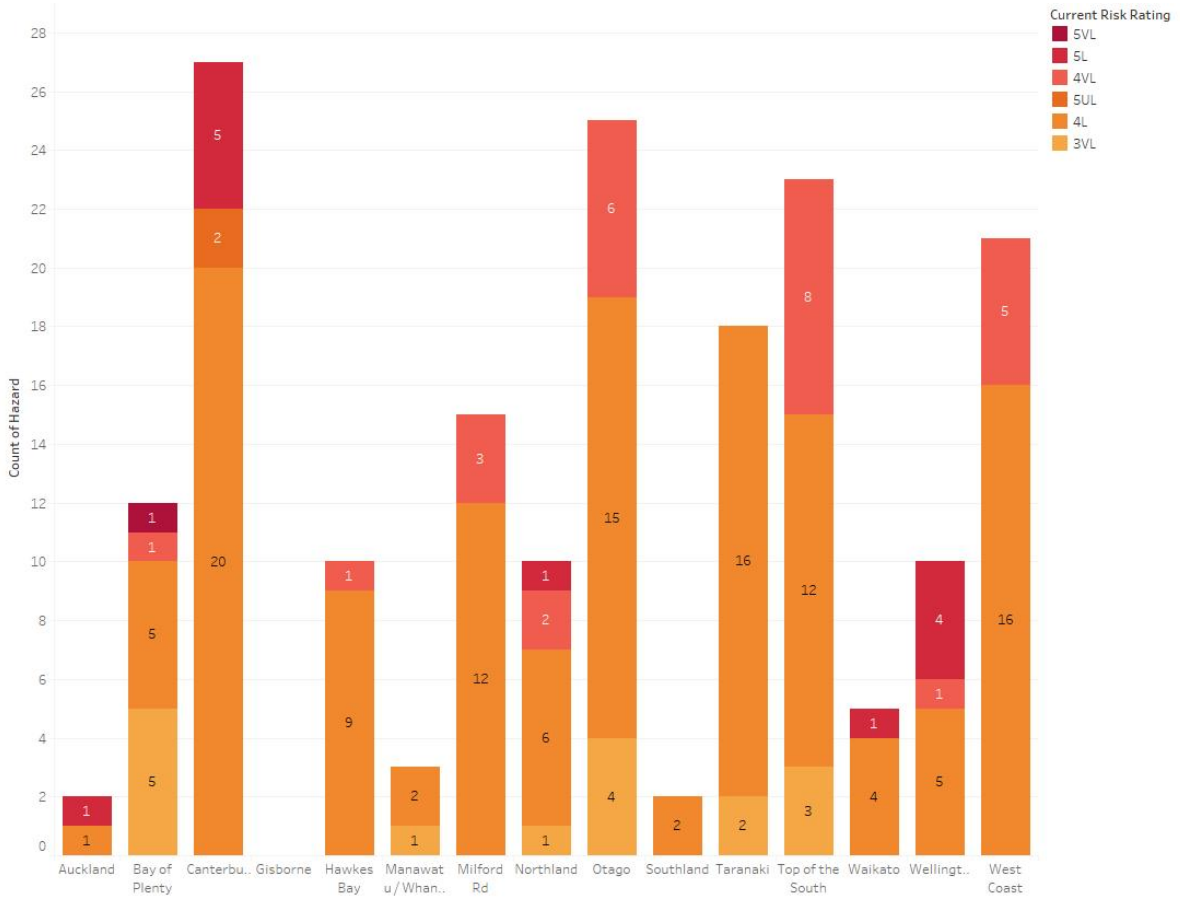

Figure 2.4: Summary of number of major and extreme risks by region

2.2.1 Interpretation of risk summary tables

The following should be noted when interpreting each table:

- Risk ID: This is a unique identification number which can be cross referenced to each map
- SH No, Location Name, Asset Type, Hazard: These are key identifiers for each risk. The location name is often a 'colloquial' name as provided during the workshops.
- Description of hazard: This is a description of the risk as provided during the workshop / engagement.
- Current risk rating: This is the present-day risk rating as provided by attendees (see *PRA Methodology Report* for list of attendees in section 3.2.1) at the engagement meetings – as

[4] There are no major and extreme risks captured within Gisborne. This is due the relatively small network extent, and the fact that the majority of the network has a low ONRC rating (SH35 – primary collector). Higher rated risks ((SH2) are located within the Hawkes Bay and BOP regions. Southland recorded no major/extreme risks - as verified through the engagement workshops. Auckland has only 2 major/extreme risks. This is due to the high-density of the transport network and the high availability of alternate routes, which result in lower impacts across the land transport network as a whole.
[5] The Waioeka Gorge is rated as 5VL (extreme risk) due to rockfall, with impacts related to connectivity for Gisborne. The location of the risk is in the Bay of Plenty Region, however is also acknowledged as the key risk for the Gisborne region.

per the risk framework detailed within the accompanying *Risk Assessment Methodology Report*. This accounts for criticality of the route, hazard likelihood, availability/suitability of detour and likely outage duration.

- 2050 risk rating: This is an estimate of a future level of risk considering the impacts of climate change (including sea level rise). This relates to coastal hazards, as well as flooding and landslips and other hazards, and has resulted in the likelihood being uprated by 'one step' (e.g. 'L' to 'VL'). In some cases, the current likelihood was already set at 'VL', in which case the cell has been shaded a darker colour to indicate the additional risk posed from climate change. Where no change is anticipated due the impacts of climate the cell is grey.
- Already funded? This indicates where there is already funding in place to mitigate the risk – based on comments provided at regional stakeholder workshops.
- Suggested Response Category: These indicate the most likely mitigation response as suggested by participants within the workshops. It is noted that unless the suggested responses have been determined through a full business case process, other options will need to be investigated through an appropriately detailed business case process. The categories suggested at the workshops included:
  - 'Physical works' broken into 4 bands as follows (derived through discussions in workshops):
    - Physical works ($): < $1,000,000
    - Physical works ($$): $1,000,000 - $5 Million
    - Physical works ($$$): $5 - 25 Million
    - Physical works ($$$$): > $25 Million
  - 'BAU maintenance'
  - 'Enhanced proactive maintenance'
  - 'Emergency response plans / preparedness'
  - 'Land use / development controls'
  - 'Unknown / further investigations required'.
- Suggested solution: This describes the suggested solution proposed by regional workshop participants.
- Next steps: This indicates likely next steps to develop an appropriate response (refer response categories above). Options include:
  - *Business Case funded or underway:* The next step is to proceed with the current business case development ensuring that an appropriate suite of response options are considered.
  - *Business Case required:* The next step is development of a 'right sized' business case to address the identified risk, considering an appropriate suite of response options. The business case point of entry will determine the level of effort required.

In some cases there are multiple extreme risks on a corridor, for example SH1 north of Kaikoura (C10, C16, C17, C18, C19), the Waioeka Gorge between Opotiki and Gisborne (BP8, BP9) and SH6 south of Nelson (TS7, TS9, TS10, TS12, TS28, TS30). In these cases, developing a programme business case to consider multiple responses is a logical next step.

In other cases, current or proposed projects present an opportunity to address resilience issues. Examples include SH1 Whangarei to Ruakaka (N4[6]), SH1 Petone to Ngauranga (W1[7]) and flooding issues at SH1 at Kuku (W6[8]).

2.2.2 Present-day risk summary tables

Table 2.1 summarises the 39 present day-extreme risks identified across the country. . Where risk is anticipated to change as a result of climate change the revised rating is noted in the column headed 2050 risk rating.

[6] The corridor will be upgraded as part of the recently announced upgrade to the Whangarei to Marsden Point project
[7] The implementation of the Ngauranga to Petone cycleway provides an opportunity to address resilience related risks for the highway and railway.
[8] This section of SH1 is scheduled to be upgraded as part for the recently announced Otaki to north of Levin project.

Table 2.1: Summary of present day extreme risks

Risk ID	SH No	Location name	Asset type	Hazard	Description of hazard	Current risk rating	2050 risk rating	Already funded?	Suggested response category	Suggested solution	Next steps
WK1	1	Along Lake Karapiro	Road	Erosion	Erosion of riverbank can undermine road. There are significant detour issues along this road if it were out of service.	5L	-	No	Physical works ($$$)	Realignment, new bridge or possible retaining wall. Also invest in upgrades to Maungatautari Road (detour route) through strengthening of structures to carry HMPV's.	Business Case required
C16	1	Blue Slip	Road	Landslip	Site at risk to mass earth movement, which would likely affect both road and KiwiRail. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	-	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance.	Business Case required
N1	1	Brynderwyn to Ruakaka	Road	Landslip	Landslip risk on Brynderwyn hills with limited detour HPMV incapable. No HMPV both ways. Detour route has a number of one-way bridges. If the Brynderwyn route is out, the whole upper north is out. Currently working on the major detour route to address the risk to Brynderwyn. There are also a lot of outages because of accidents and breakdowns etc. Southern side has more issues. Traffic going south goes through Mangawhai and north goes through Paparoa.	4VL	-	No	Physical works ($$$$)	Short term solution is to upgrade alternate routes. Costs for this will likely be less than construction of a new alignment. There is a wider PBC under way to look at a range of options.	Business Case funded or underway
TS6	6	Canvastown along Pelorus River	Road	Flooding	River floods and inundates the road.	4VL	4VL	No	Physical works ($$$)	Raise the road.	Business Case required
C19	1	Clarence Bridge	Bridge	Flooding	Clarence river bridge is at risk to river and surface flooding - requiring ongoing groyne maintenance. High sediment loads can cause the riverbed to aggrade up to 2m. This risk also extends across most of the streams along the Northern Kaikoura coastline. Some sediment retention devices are being built to address this. This risk is manageable in individual locations, however in a significant event such as Tropical Cyclone Fehi / Gita there is the potential for all rivers to flood, which could cause significant remedial works. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	5VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance.	Business Case required
MR2	94	Cleddau River	Road	Flooding	Cleddau River - flood risk. There are regular flooding events which inundate the road and damage structures.	4VL	4VL	No	Unknown. Pending further investigations	Difficult to address. Further work required.	Business Case required
O7	6	Cromwell to Frankton	Road	Rockfall	Sites at risk to rockfall throughout the Kawarau Gorge.	4VL	-	No	Physical works ($$$)	Scaling, stabilisation and catch fences / structures.	Business Case required
O8	6	Cromwell to Frankton	Road	Landslip	Landslip risk throughout the Kawarau Gorge. There is some Low Cost Low Risk (LCLR, projects less than $1M capital spend) investigation work underway, however still residual risk.	4VL	4VL	No	Physical works ($$$)	Retaining walls and drainage improvements.	Business Case required
TS7	6	Dallows Bluff	Road	Rockfall	Frequent rockfall on SH6 stretch between intersections with SH65 and SH63 (Murchison to St Arnaud). High priority for the Top of the South	4VL	-	No	Physical works ($$)	Requires netting.	Business Case required
HB1	2	Devil's Elbow	Road	Landslip	~10km of Devil's Elbow (north of Napier pm SH2) is at risk to landslip.	4VL	4VL	No	Unknown. Pending further investigations	An alternative local road can be utilised however it is unsealed and narrow and cannot take heavy vehicles. Upgrading the local road is potentially a better use of money.	Business Case required

Risk ID	SH No	Location name	Asset type	Hazard	Description of hazard	Current risk rating	2050 risk rating	Already funded?	Suggested response category	Suggested solution	Next steps
O48	6	Frankton to Kingston	Road	Landslip	Landslips along the side of Lake Wakatipu.	4VL	-	No	Unknown. Pending further investigations	Corridor investigation to determine vulnerable areas and possible solutions to mitigate.	Business Case required
TS9	6	Granity Rockfall	Road	Rockfall	Frequent rockfall on SH6 stretch between intersections with SH63 and WC boundary. High priority for the Top of the South.	4VL	-	No	Physical works ($$)	Requires netting.	Business Case required
WC6	6	Greymouth to Westport	Road	Coastal Erosion	Coastal erosion during a cyclone has the potential to affect the whole region. Increased frequency to approx. once a year. Typically, NZTA will still be carrying out repair works from the previous event when then next one comes. Still recovering from Fehi 2018. All works are currently reactive. There are 4 sites where preventative works would significantly help, these could be prioritised.	4VL	4VL	No	Enhanced proactive maintenance	Rock protection.	Business Case required
WC9	6	Haast Pass	Road	Landslip	Route at risk from landslip. Currently all reactive works with proactive management on some sites, however there is still a risk of losing the whole road. A few landslip sites could potentially be managed more proactively.	4VL	4VL	Yes	Enhanced proactive maintenance	Some areas could have more proactive work undertaken. Further investigation required.	Business Case required
O50	6	Haast to Hawea	Road	Rockfall	Numerous large scale rockfall locations along the corridor. Improved funding would be a starting point to improve resilience but not resolve the issue in its entirety. Funding currently allocated through the National Rockfall programme to address isolated high priority sites with a supporting Rockfall Hazard Rating System (RHRS) score.	4VL	-	No	Physical works ($$$)	Scaling, stabilisation and catch fences/structures.	Business Case required
TS28	65	Higgins Bluff	Road	Rockfall	Rockfall risk along the bluff.	4VL	-	No	Physical works ($$)	Requires netting.	Business Case required
MR16	94	Homer Tunnel	Tunnel	Rockfall	Reinvestment issues for tunnel and portals but there is a Business Case being developed for replacement portal/protection structures. Resilience for future EQ/Rockfall. The structure is ageing, soon to be a historic site – heritage assessment currently in draft but recommends some very intensive improvement and maintenance works to protect nature of the site.	4VL	-	No	Physical works ($$$)	A smart design for replacement of the tunnel portals could deal with strengthening and upgrading, aiding avalanche and rockfall risks at the same time. In short term, Rockfall prevention measures e.g. scaling, fences and bunds. But has cross over with avalanche zone - avalanches will destroy rockfall structures. Longer term needs to reinforce and upgrade the portals/tunnel before it is designated as a historical site. A smart design for replacement of the tunnel portals could deal with strengthening and upgrading, aiding avalanche and rockfall risks at the same time. Portals are under the largest avalanche zones. In addition, remote control avalanche systems could be employed. This is a significant tourism route and also safety issues.	Business Case funded or underway.
TS10	6	Hope saddle	Road	Landslip	Ongoing landslip risk.	4VL	4VL	No	Physical works ($$)	Requires netting.	Business Case required
WC12	6	Knights Point	Road	Landslip	Most vulnerable piece of road to landslip in New Zealand and currently only has reactive work underway.	4VL	4VL	No	Enhanced proactive maintenance	Also, would require further investigation.	Business Case required
O47	6	Lake Hawea and Lake Wanaka	Road	Landslip	Landslips along the side of lakes Wanaka & Hawea. This links to risk Id WC9 which identifies landslip issues along Haast Pass.	4VL	-	No	Unknown. Pending further investigations	Corridor investigation to determine vulnerable areas and possible solutions to mitigate.	Business Case required
TS30	65	Mauria River	Road	Erosion	Surface flooding and undercutting / erosion where river is next to the road.	4VL	4VL	No	Physical works ($$$)	Rock protection along river to protect road.	Business Case required

Risk ID	SH No	Location name	Asset type	Hazard	Description of hazard	Current risk rating	2050 risk rating	Already funded?	Suggested response category	Suggested solution	Next steps
MR15	94	Milford Rd - Te Anau Downs to Milford	Road	Landslip	Landslides and under slip risk in a number of locations.	4VL	-	No	Enhanced proactive maintenance	Preventative works and repairs.	Business Case required
O51	6	Nevis Bluff	Road	Rockfall	Nevis Bluff is a significant unstable feature between Cromwell and Queenstown. Proactive monthly inspections are undertaken and programmed rock scaling pre & post winter to remove fractured material is funded and managed through the NOC. Regular additional funding is required to address high other priority/urgent unstable features in the order of $1M-$5M per intervention. Alternate long-term options could be investigated such as a tunnel.	4VL	-	No	Enhanced proactive maintenance	More detailed investigation required which would assess all possible options. Continued proactive monitoring and maintenance intervention.	Business Case required
C10	1	North of Kaikoura - Clarence Bridge	Road	Landslip	Landslip and mass movement risk (site similar to Blue Slip, see for details). No known solution, and if a landslip or mass movement were to occur the road and rail will be completely destroyed. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Further investigations needed.	Business Case required
C17	1	Ohau Point	Road	Coastal Inundation / SLR	Ohau Point is at risk from coastal inundation– it overtopped three times in 2019 in a combined high tide and storm event. There is a potential design in NCTIR to address this, however with the effects of climate change this may not address the issues. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	5VL	No	Unknown. Pending further investigations	Monitor.	Business Case required
TS12	6	O'Sullivans Bluff	Road	Rockfall	Frequent rockfall on SH6 stretch between intersections with SH65 and SH63. High priority for the Top of the South.	4VL	-	No	Physical works ($$)	Requires netting.	Business Case required
N4	1	Ruakaka and Whangarei	Road	Flooding	Flood risk between Ruakaka and Whangarei. Both river and tidal flooding during king tides. Typically, when there are issues on the SH there are issues on the local roads so there are no alternate options.	5L	5VL	No	Unknown. Pending further investigations	Requires further detailed study.	Business Case required
WC20	6	Scout Lodge Straight	Road	Erosion	Significant river erosion risk.	4VL	4VL	No	Physical works ($$$)	River protection works (groynes) to train river and realign road.	Business Case required
W3	1	SH1 Centennial Highway	Road	Rockfall	Rock, debris comes down off the steep slopes and covers the road and rail network. NZTA are trying to get KiwiRail to input into funding. Risk will be reduced once Transmission Gulley is open. Even with completion of Transmission Gully, access will still be required for the rail line.	5L	-	No	Physical works ($$$)	Ongoing slope stabilisation works required.	Business Case required
W4	1	SH1 Centennial Highway	Road	Coastal Inundation / SLR	Coastal inundation and SLR risk with water over topping the road in larger events. Currently reactive maintenance is prioritised as opposed to proactive. A culvert near Paekakariki blocks frequently due to lose material causing flooding in the town. Catchments flood in short duration events causing slips and debris/blockages. KiwiRail assets are adjacent (up-catchment) and also are affected. Even with completion of Transmission Gully, access will still be required for the rail line.	5L	5VL	No	Physical works ($$$)	Will continue to flood in the long term but will require ongoing repair and maintenance. More work required to determine appropriate solutions.	Business Case required
W5	1	SH1 Centennial Highway	Road	Coastal Erosion	Sea level rise, storm events, high seas causing damage to seawall.	5L	5VL	No	Physical works ($$$)	Ongoing armouring. More work required to determine appropriate solutions.	Business Case required

Risk ID	SH No	Location name	Asset type	Hazard	Description of hazard	Current risk rating	2050 risk rating	Already funded?	Suggested response category	Suggested solution	Next steps
W6	1	SH1 Kuku	Road	Flooding	Flooding occurs frequently in low lying area - caused by a land drainage issue where water builds up on the highway approx. once a year. Flooding can often reduce traffic down to one lane and has affected both lanes for a couple of hours. With help from Council it could be improved. Risk could also be reduced if Otaki to Levin is confirmed.	5L	5VL	No	Physical works ($$)	Requires Council to address adjacent land drainage and runoff - less of an issue once O2NL is constructed. Could significantly improve the flood issue - especially considering the detour is extensive.	Business Case required
W1	2	SH2 Petone to SH1	Road	Coastal Inundation / SLR	Coastal inundation and SLR are the biggest issue for this area. Regular events over recent years have caused outages and damage.	4VL	4VL	Yes	Physical works ($$$$)	There is a proposed seawall/cycleway which will help mitigate this risk.	Business Case required
C18	1	Shingle Fans	Road	Landslip	Shingle Fans - North of Clarence is at risk to landslip. There are three shingle fans which flow through culverts however, in large events these flow over the road. Landslip overtopping occurs approximately once every 3-4 years. Generally, response teams can keep the shingle within the water way. Generally, there is a quick response, with short term closures and damage to infrastructure is unlikely. Smaller retention dams are being located upstream. KiwiRail relies on NZTA for clearing the culverts. This is still flagged as a high risk due to the frequency and importance of the road. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	-	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance.	Business Case required
WC21	6	South of Ross to Haast Pass	Road	Flooding	All rivers south of Ross (~15 rivers) need training/stop banking and active management to reduce flood risk.	4VL	4VL	No	Enhanced proactive maintenance	Ongoing training works and management	Business Case required
TS20	60	Takaka Hill	Road	Landslip	Landslip risk with both under and over slips. Mainly on the Nelson side. Occurs at least once a year. There are also a number of drainage issues.	4VL	4VL	No	Physical works ($$$)	Realignment improve drainage and catchment management. Even with improvements, there would still be ongoing issues, requiring response and BAU maintenance.	Business Case required
BP8	2	Waioeka Gorge	Road	Rockfall	Significant rockfall issues along the entirety of Waioeka Gorge for both the Bay of Plenty and Gisborne / Hawke's Bay. Very significant issue for Gisborne community as in the event of a long closure communities have the potential to be isolated. Also affects time critical delivery of food produce to the port and Auckland. Supplies to the hospital could also become an issue quickly. Regional managers support a change to the ONRC classification to 'Regional' level. Significant crash rates and safety issues with response limited due to poor telephone coverage. Waioeka Gorge PBC identifies all major sites and pinch points.	5VL	-	No	Physical works ($$$)	Geotechnical improvements: combinations of rock fall protection, slope stabilisation etc over a multiple year programme. In an ideal world you would do a multi-year programme across all significant sites - that links to the PBC that Simon Barnett / Gisborne is working on. Aurecon has previously carried out an assessment to identify the sites.	Business Case required
BP9	2	Waioeka Gorge	Road	Landslip	Landslip risk for the entirety of Opotiki to the Bay of Plenty boundary. Potential for significant effects commercially and for small communities.	4VL	4VL	No	Physical works ($$$$)	Over a multiple year programme. In an ideal world you would do a multi-year programme across all significant sites - that links to the PBC that Simon Barnett / Gisborne is working on.	Business Case required
N10	1	Wayby Road on SH1	Road	Landslip	Existing landslip, however, there has been no work done to understand the landslip risk. Ongoing land movement.	4VL	-	No	Unknown. Pending further investigations	Requires further detailed study.	Business Case required

Risk ID	SH No	Location name	Asset type	Hazard	Description of hazard	Current risk rating	2050 risk rating	Already funded?	Suggested response category	Suggested solution	Next steps
A11	1	Lonely Track Road North Slip	Road	Landslip	Landslip issues. This is currently viewed as being one of the highest risks on the Auckland network - which has potential to cause a loss of system availability. Significant land instability issues detected with ongoing movement since construction in late 90's as part of the SH1 ALPURT A1 Project. Close monitoring and proactive sealing of tension cracks to slow down failures is currently funded under ASM TOC for initial investigation (only).	5L	5VL	No	Unknown. Pending further investigations	Significant issue - Currently investigation works are underway to better understand the scale of the risk and any resultant work needs. This includes additional monitoring and investigation of the likelihood and consequence of a slip. Auckland System Management (ASM) TOC funding to a capped budget is available for the current investigation stage. Monitoring in various forms has been occurring since 2008. ASM TOC funding for investigation in the last year has been made available to confirm the risk profile and any recommendations on mitigation. Additional funding would be needed for any physical works.	Business Case funded or underway

2.3 National climate-related risks summary

In total, approximately 160 climate change related risks were identified throughout the country. These relate to coastal inundation and sea level rise (SLR), erosion (both coastal and along river banks), flooding, rainfall induced landslips, extreme weather, wildfire and avalanche (Figure 2.5). The highest number of identified climate risks are within the Top of the South, West Coast and Bay of Plenty regions.

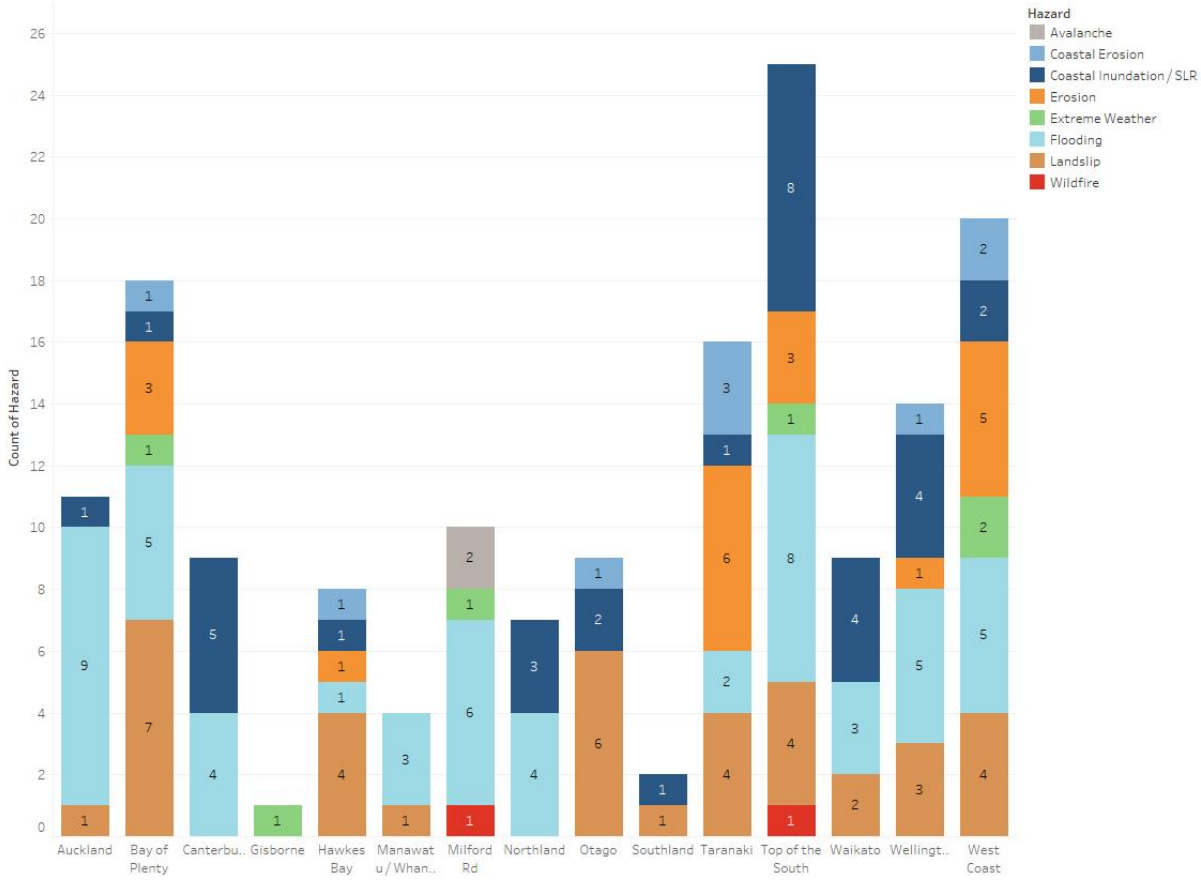

Figure 2.5: Summary of the number of climate related hazards by region

Figure 2.6 illustrates the same risks within each region along with the risk rating as determined during the regional stakeholder workshops.

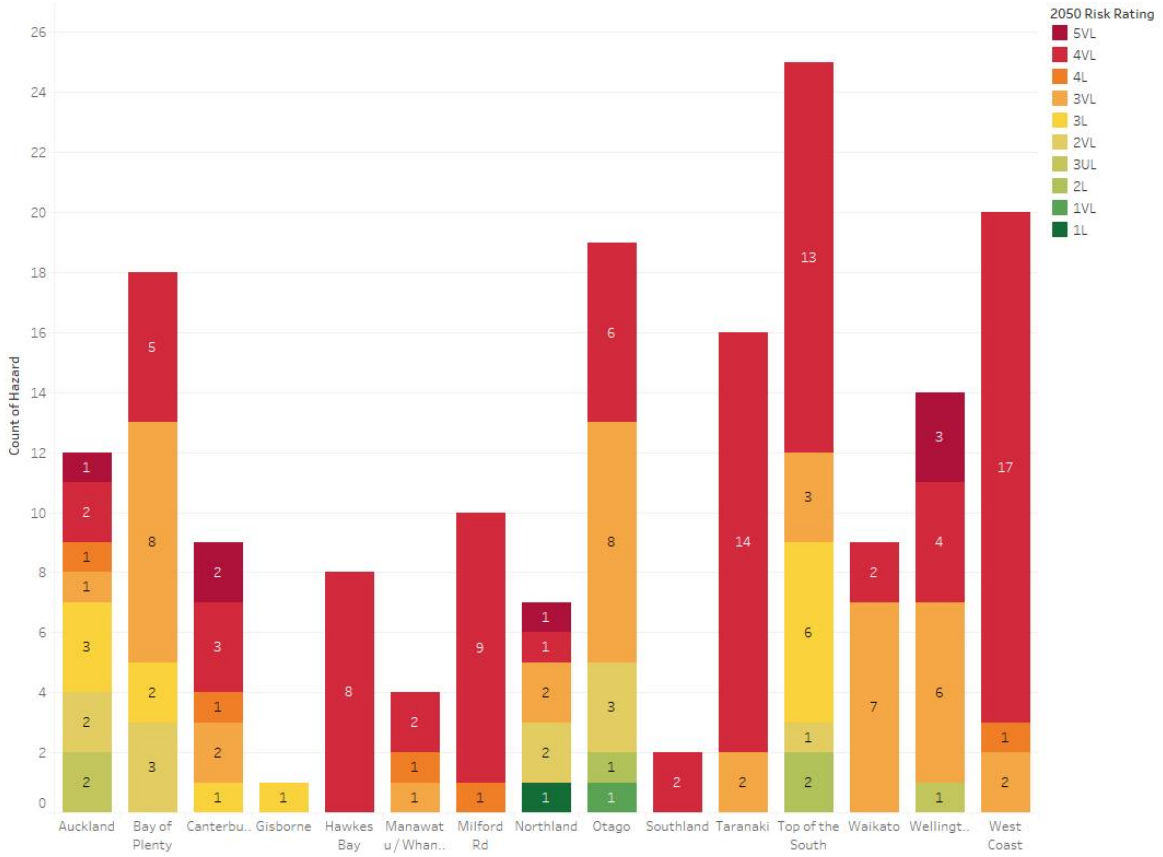

Figure 2.6: Summary of climate related risks in 2050 by region

Figure 2.7 shows only the extreme (5VL, 5L, 4VL) and major (5UL, 4L, 3VL) risks, broken down by subcategory. The highest numbers of extreme and major risks occur within the West Coast, Top of the South, Taranaki, Otago and Bay of Plenty.

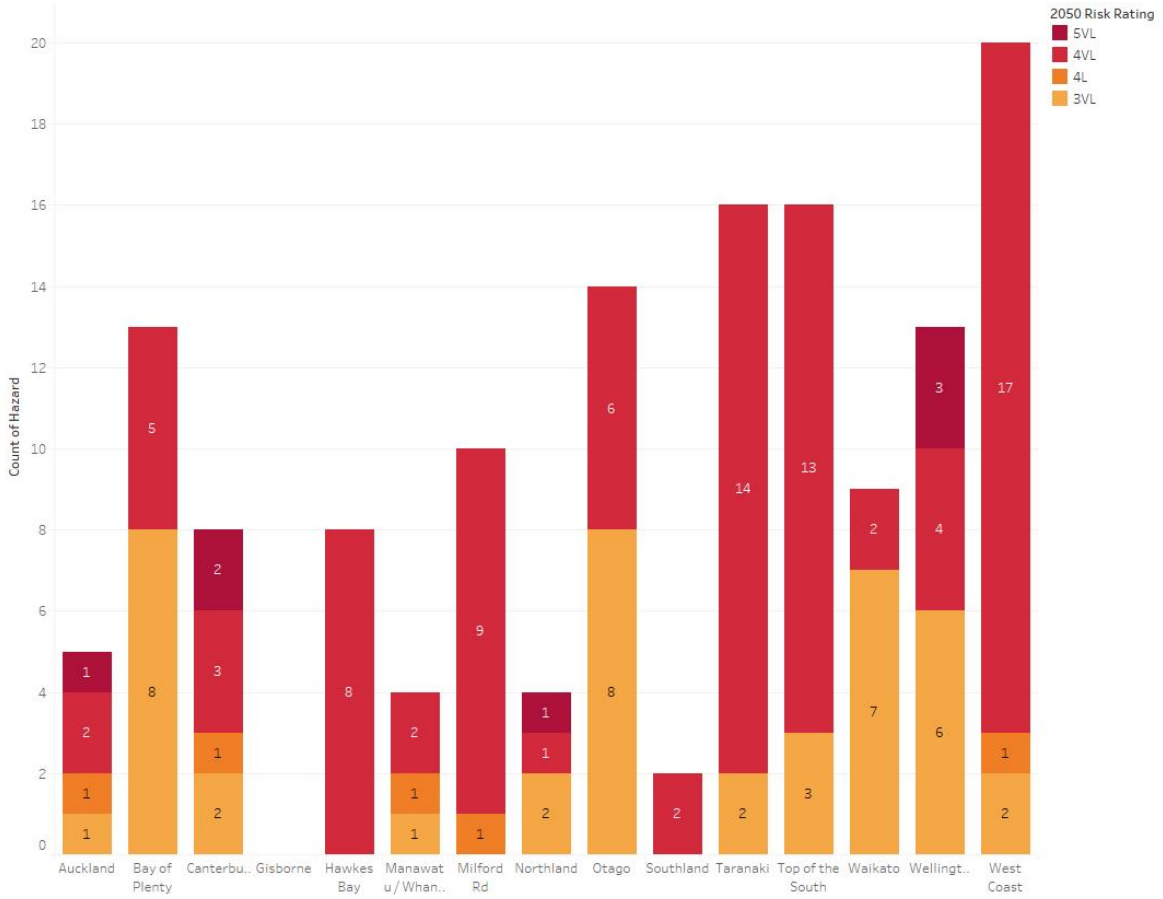

Figure 2.7: Summary of major and extreme climate related risks in 2050 by region

The climate related risks have been divided into two categories: *coastal hazards* (including coastal erosion and coastal inundation); and *other* (including flooding, rainfall induced landslide, erosion, extreme weather and wildfire).

2.3.1 Coastal climate-related risks

This section summarises the coastal climate related risks identified and rated. Top of the South, Wellington and Canterbury have the greatest number of coastal risks of which the majority relate to coastal inundation and SLR (Figure 2.8).

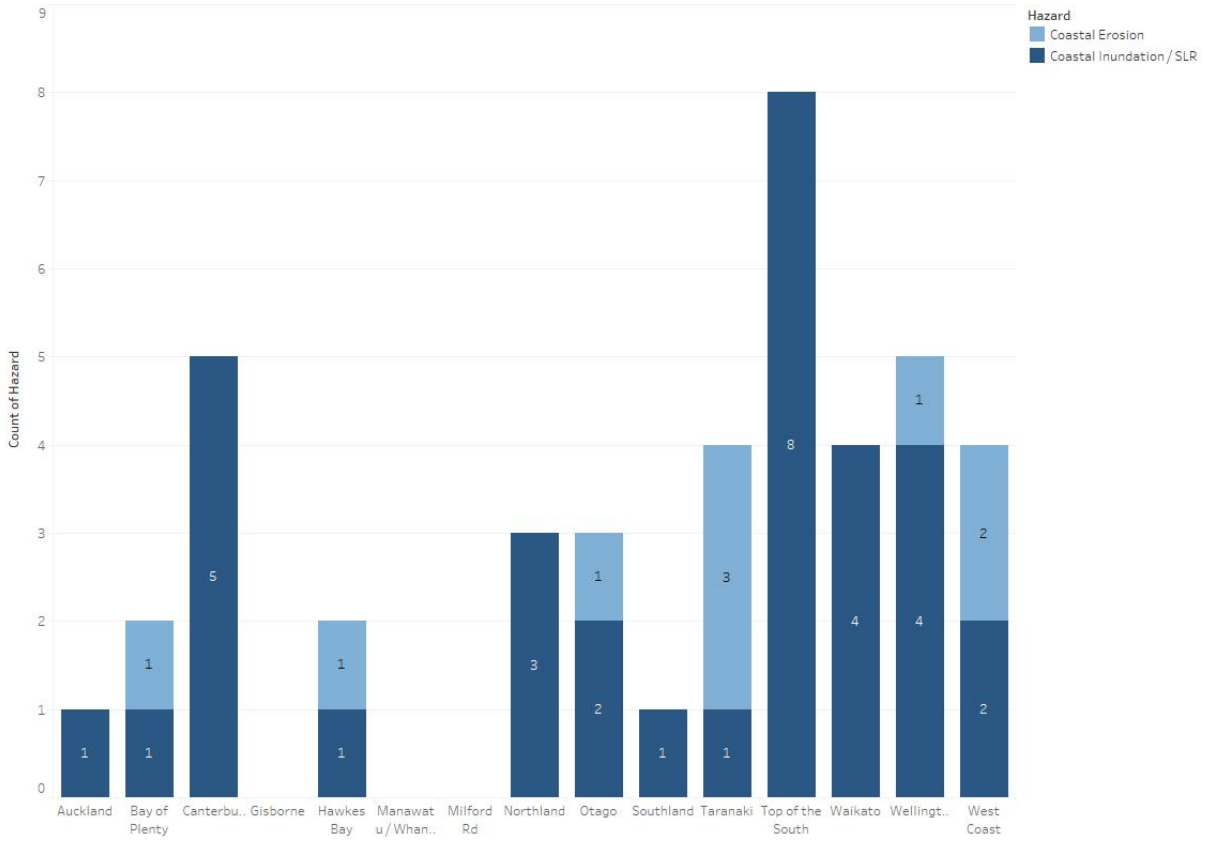

Figure 2.8: Coastal climate related hazards by region

Figure 2.9 details the extreme (5VL, 4VL, 4L) and major (3VL) coastal climate-related risks by region. Wellington, Canterbury and the West Coast show the greatest number of extreme and major coastal climate related risks with both Wellington and Canterbury having risks rated at 5VL in the future.

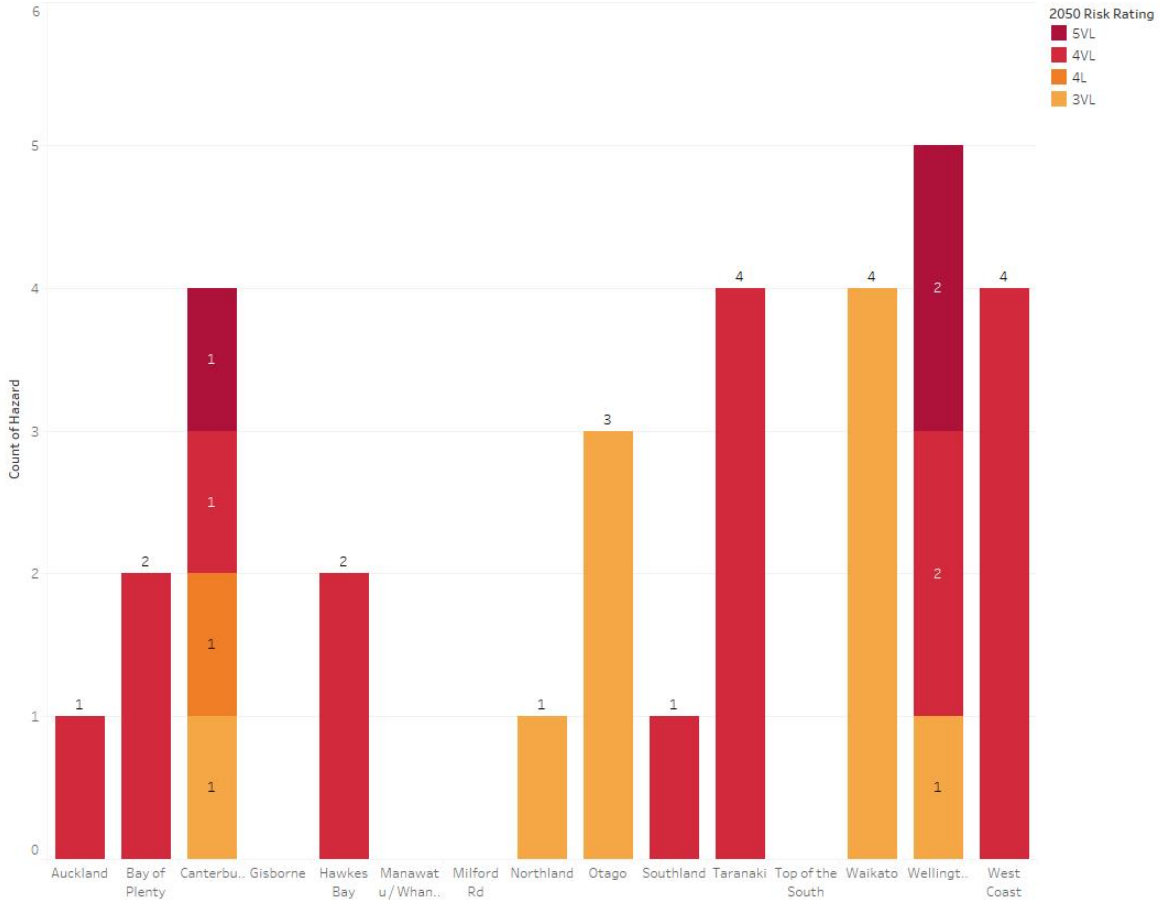

Figure 2.9: Major and extreme coastal climate related hazards with 2050 risk rating

Table 2.2 summarises the national extreme (5VL, 4VL, 4L) coastal climate related risks in 2050. Refer to section 2.2.1 for interpretation of the risk tables.

Table 2.2: National summary of extreme coastal climate related risks

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
W21	1	Along Porirua Harbour	Road	Coastal Inundation / SLR	KiwiRail and road has the potential to be subject to coastal inundation in the future.	4UL	4VL	No	Physical works ($$$)	Various high-risk areas across the region that require slope stabilisation.	Business Case required
A1	1	Tank Farm Culvert to Exmouth Footbridge	Road	Coastal Inundation / SLR	Southbound lanes between Tank Farm Culvert and Exmouth St Footbridge get inundated during high tides (and storm surge). This results in varying amounts of inundation across 4 lanes: from bus lane only through to all lanes. This can cause significant disruption to the availability and resilience of the system. In extreme cases this results in significant disruption (and loss of multiple lanes) for about 2 hours at high tide.	4L	4VL	No	Physical works ($$)	There is a coastal inundation resilience study that is underway for this location. Funding is only for the investigation and options assessment. Several options are being explored such as raising the road (partial or fully), flood barriers, using new concrete barriers with pumps and/or non return systems. There are a range of other risks including to the Transpower NAaN 220kV.	Business Case funded or underway
T14	3	Awakino Village	Road	Coastal Erosion	Awakino Village at risk of coastal erosion.	4L	4VL	No	Physical works ($$)	In the short term continue rock fencing. Realignment and smoothing the corner and cut into the bluff is the long-term solution. ~60-70m bluff.	Business Case required
WC2	6	Bruce Bay	Road	Coastal Erosion	Route at risk from erosion. Rock protection measures are starting to be implemented through emergency works funding following Cyclone Fehi (2018). However, if there was another cyclone a large section of the road has the potential to be lost regardless of current resilience work.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Rock protection however there will still be residual risk.	Business Case required
C24	1	Clarence to Kaikoura	Road	Coastal Inundation / SLR	Overtopping occurs along the whole corridor, only out for a couple hours either side of high tide. Unsure whether this will damage the road as it is all new (NCTIR), likely this will no longer damage the road. However, this is ongoing and likely to increase with the impacts of CC. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	4L	4VL	No	Unknown. Pending further investigations	Further investigations needed.	Business Case required
S1	1	Entire coastal section at Ocean view north of Bluff	Road	Coastal Inundation / SLR	Ocean view route to the port - risk to coastal inundation that will need to be addressed within the next 10 years. Combination of coastal and rainfall flooding at high tide resulting in traffic lanes being submerged over a length of approximately ~70m. This is the key route to the port, with no detour. Compounding issue is that the lagoon doesn't drain.	4L	4VL	No	Physical works ($$)	Raise the road for around 70m.	Business Case required
WC5	6	Fox River	Road	Coastal Inundation / SLR	Fox River - low lying with sea level rise risk.	4L	4VL	No	Enhanced proactive maintenance	Ongoing monitoring and maintenance.	Business Case required
WC6	6	Greymouth to Westport	Road	Coastal Erosion	Coastal erosion during a cyclone has the potential to affect the whole region. Increased frequency to approx. once a year. Typically, NZTA are still carrying out repair works from the previous event when then next one comes. Still recovering from Cyclone Fehi (2018). All works are currently reactive. 4 sites where preventative works, these could be prioritised.	4VL	4VL	No	Enhanced proactive maintenance	Rock protection.	Business Case required
BP2	2	Kutarere	Road	Coastal Inundation / SLR	Tidal flooding occurs with significant rainfall.	4L	4VL	No	Physical works ($$)	Raise the road <1km.	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
T10	3	Mohakatino and Tongaporutu estuaries	Road	Coastal Inundation / SLR	Mohakatino and Tongaporutu estuaries could potentially have coastal inundation and erosion issues.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study.	Business Case required
T12	3	Mohakatino Bridge	Road	Coastal Erosion	Potential for erosion risk due to it being low lying and in an estuary. The causeway is very narrow and vulnerable to erosion due to wave action. Currently a low cost, low risk project to provide rock armour. One side of the wall had rock armour which has been washed out. Could have coastal inundation issues in the future, however the geomorphology of the estuary could change this.	4L	4VL	No	Physical works ($$)	Rock armour improvements in the short term, but needs a long-term plan.	Business Case required
HB5	2	Napier airport	Road	Coastal Inundation / SLR	Road to Napier airport is highly vulnerable to a number of hazards.	4L	4VL	No	Unknown. Pending further investigations	Regional problem and tied to climate change and emergency response issues.	Business Case required
C17	1	Ohau Point	Road	Coastal Inundation / SLR	Ohau Point is at risk from coastal inundation– it overtopped three times in 2019 in a combined high tide and storm event. There is a potential design in NCTIR to address this, however with the effects of climate change this may not address the issues. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	5VL	No	Unknown. Pending further investigations	Monitor.	Business Case required
W5	1	SH1 Centennial Highway	Road	Coastal Erosion	Sea level rise, storm events, high seas causing damage to seawall.	5L	5VL	No	Physical works ($$$)	Ongoing armouring. More work required to determine appropriate solutions.	Business Case required
W4	1	SH1 Centennial Highway	Road	Coastal Inundation / SLR	Coastal inundation and SLR risk with water over topping the road in larger events. Currently reactive maintenance is prioritised as opposed to proactive. Culvert near Paekakariki blocks frequently due to lose material causing flooding in the town. Catchments flood in short duration events causing slips and debris/blockages. KiwiRail assets are adjacent (up-catchment) and also are affected. Even with completion of Transmission Gully, access will still be required for the rail line.	5L	5VL	No	Physical works ($$$)	Will continue to flood in the long term but will require ongoing repair and maintenance. More work required to determine appropriate solutions.	Business Case required
W1	2	SH2 Petone to SH1	Road	Coastal Inundation / SLR	Coastal inundation and SLR are the biggest issue for this area. Regular events over recent years have caused outages and damage.	4VL	4VL	Yes	Physical works ($$$$)	There is a proposed seawall / cycleway which will help mitigate this risk.	Business Case funded or underway
WC22	6	Southern side of Punakaiki	Road	Coastal Inundation / SLR	Low lying and vulnerable to sea level rise.	4L	4VL	No	Physical works ($$$)	Rock protection.	Business Case required
T23	3	Tongaporutu estuary	Road	Coastal Erosion	Route has coastal erosion risk due to the estuary and also has potential to be at risk from coastal inundation.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Requires ongoing monitoring and potential stabilisation.	Business Case required
BP11	2	Waiotahi Bridge	Road	Coastal Erosion	Coastal erosion along the bridge is possible. Solvable in the short to medium term, but not long term with climate change. 6hr detour for HCV and HPMV.	4L	4VL	No	Physical works ($$)	Erosion protection required around bridge.	Business Case required
HB12	2	Whirinaki Bluff	Road	Coastal Erosion	Coastal erosion risk. Coastal erosion likely to cut off the entire road northward.	4L	4VL	No	Physical works ($$)	Need to understand the effects of climate change and develop options.	Business Case required

2.3.2 Other (non-coastal) climate related hazards

The following summarises the other (non-coastal) climate related hazards including erosion along riverbanks, extreme weather, flooding, avalanche, rainfall induced landslip and wildfire. Similar to the coastal hazards, Top of the South has the greatest number of non-coastal climate related hazards, specifically flooding and landslip (Figure 2.10). This is followed equally by the Bay of Plenty and the West Coast.

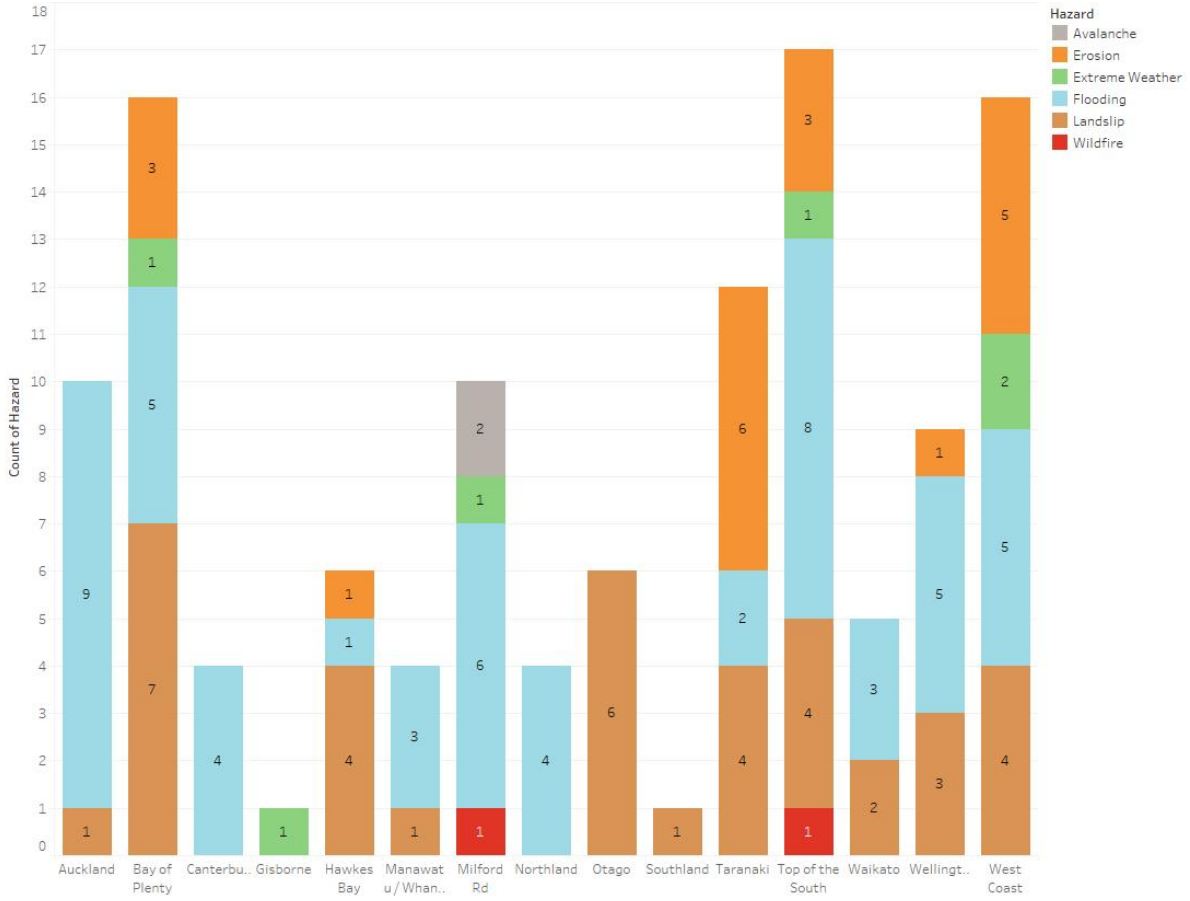

Figure 2.10: National summary of non-coastal climate related hazards

Figure 2.11 details the extreme (5VL, 4VL, 4L) and major (3VL) non-coastal climate related risks by region. West Coast, Top of the South and Taranaki show the greatest number of extreme and major non-coastal climate related risks with Northland, Wellington, Canterbury and Auckland having risks rated at 5VL in the future.

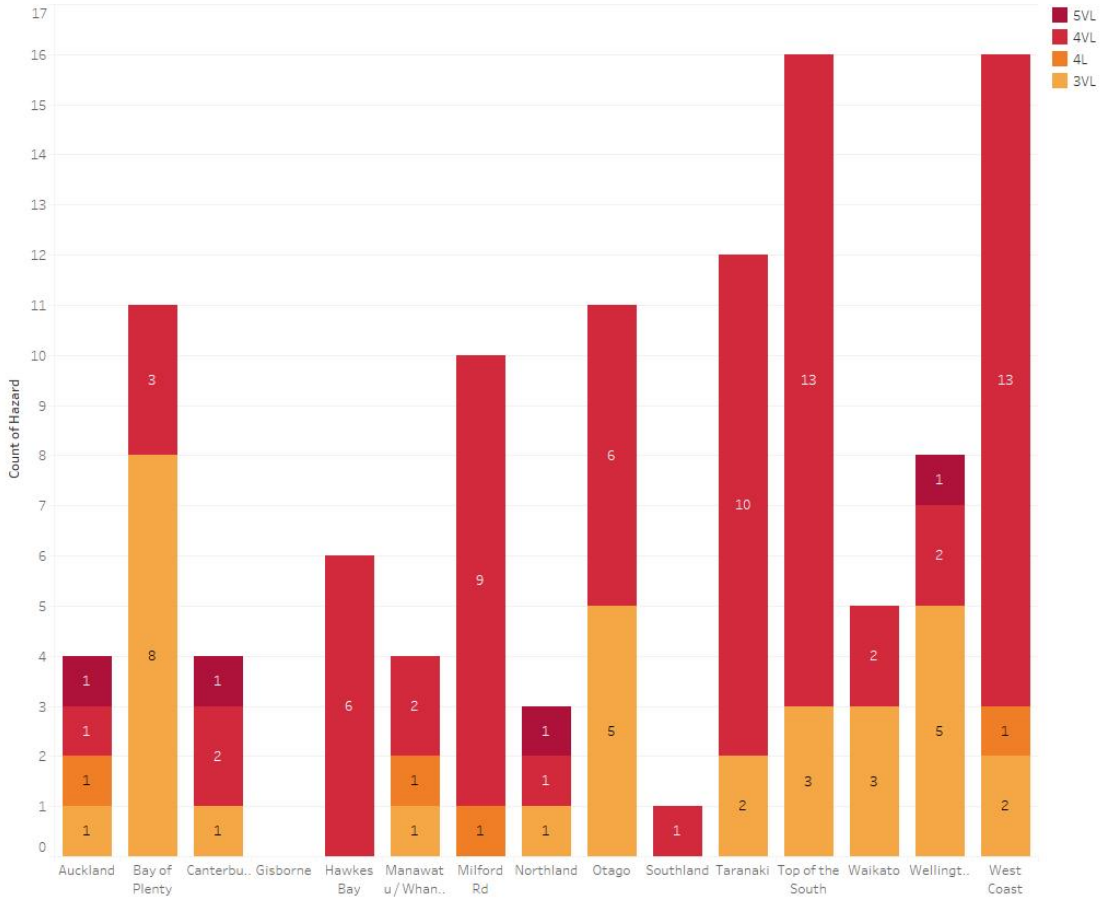

Figure 2.11: National summary of extreme and major non-coastal climate related hazard with 2050 risk rating

Table 2.3 summarises the national extreme (5VL, 4VL, 4L) non-coastal climate related risks in 2050. Refer to section 2.2.1 for interpretation of the risk tables.

Table 2.3: National summary of extreme non-coastal climate related risks

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
O4	1	Balclutha Bridge	Bridge	Flooding	Flooding of the Balclutha river has potential to impact / compromise the Balclutha Bridge. This is the only bridge and detour routes are significant.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study.	Business Case required
O15	1	Big Kuri River	Road	Flooding	Big Kuri River north of Hampden deposits a large amount of gravels which causes water to flow over the bridge. 4-5-hour detour.	4L	4VL	No	Physical works ($$$)	The plan is to wait for the bridge to get to the end of its life then construct a new bridge with improved freeboard.	Business Case required
WC1	7	Black Point	Road	Erosion	A few river erosion sites near Reefton river. Ongoing rock armouring.	4L	4VL	No	Enhanced proactive maintenance	Rock protection.	Business Case required
WC3	6	Buller Gorge	Road	Extreme Weather	Extreme weather risk with tree fall along gorge.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Regular maintenance in tree cutting.	Business Case required
TS6	6	Canvastown along Pelorus River	Road	Flooding	River floods and inundates the road.	4VL	4VL	No	Physical works ($$$)	Raise the road.	Business Case required
C19	1	Clarence Bridge	Bridge	Flooding	Clarence river is at risk to river and surface flooding - requiring ongoing groyne maintenance. High sediment loads can cause the riverbed to aggrade up to 2m. This risk also extends across most of the streams along the Northern Kaikoura coastline. Some sediment retention devices are being built to address this. This risk is manageable in individual locations, however in a significant event such as Tropical Cyclone Fehi / Gita there is the potential for all rivers to flood, which could cause significant remedial works. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	5VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance.	Business Case required
MR2	94	Cleddau River	Road	Flooding	Cleddau River - flood risk. There are regular flooding events which inundate the road and damage structures.	4VL	4VL	No	Unknown. Pending further investigations	Difficult to address. Further work required.	Business Case required
TS22	63	Connors Bend along Wairau River	Road	Flooding	Flooding risk where land drains river.	4L	4VL	No	Physical works ($$)	Better drainage required.	Business Case required
O8	6	Cromwell to Frankton	Road	Landslip	Landslip risk throughout the Kawarau Gorge. Some LCLR investigation work underway.	4VL	4VL	No	Physical works ($$$)	Retaining walls and drainage improvements.	Business Case required
HB1	2	Devil's Elbow	Road	Landslip	~10km of Devil's Elbow is at risk to landslip.	4VL	4VL	No	Unknown. Pending further investigations	An alternative local road can be utilised however it is unsealed and narrow and cannot take heavy vehicles. Upgrading the local road is potentially a better use of money.	Business Case required
MR3	94	Eglington River	Road	Flooding	There are regular flooding events which inundate the road and damage structures. The river is a wide braided river which aggrades. There are current operating flood protection structures. Each year material is removed from under the bridge as it builds up.	4L	4VL	No	Unknown. Pending further investigations	Difficult to address. Further work required.	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
T3	3	Entire length of SH3 north of New Plymouth	Road	Landslip	Landslip risk to strategic highway on Taranaki network. Lack of viable alternative route with the nearest detour being SH4, adding a large amount of time and distance. Substantial geotechnical structures for slope instability along the road south of Piopio (in the gorges). Some structures are very old.	4L	4VL	No	Physical works ($$)	Requires a detailed study.	Business Case required
HB14	5	Entire length of SH5	Road	Landslip	Significant issues with Landslips and instability along entire route. Highest ONRC and connects the Bay to inland. The detour is long and less resilient, via Palmerston North.	4L	4VL	No	Physical works ($$$)	Response plan for the route needs to be developed. A large number of geotechnical solutions would be required to address the landslips.	Business Case required
TS8	6	Entire Region	Road	Wildfire	Wildfire risk to wooden structures such as bridges and retaining walls which exist across the entire region.	4L	4VL	No	Enhanced proactive maintenance	Preparedness.	Business Case required
WK4	3	Entire stretch of SH3	Road	Landslip	Landslip risk with road instability. Key route for LPG to get trucked from New Plymouth to Auckland.	4L	4VL	No	Unknown. Pending further investigations	Business Case required.	Business Case required
WK20	1	Flooding just north of Turangi	Road	Flooding	Surface flooding issues along SH 1 through Waiotaka Straight (within Waiotaka Valley). This is a low-lying wetland area (South Taupo Wetlands) which is prone to flooding.	4L	4VL	No	Unknown. Pending further investigations	Business Case required.	Business Case required
S2	94	Gorge Hill	Road	Landslip	Landslip risk at Gorge Hill. Slip has failed previously, completely damaging the road. Currently no detour, however a subsidiary road could be built through farmers land. Has been stable, with preventative maintenance undertaken. Slumping is topped up approximately monthly. Annual visits to survey the movement. Low volume but strategic for tourist reasons. 4-hour detour.	4L	4VL	No	Emergency response and preparedness planning only (typically HI/LF)	Pre buy section in advance to be able to build an alternate/backup road.	Business Case required
WC7	73	Griffiths Bridge	Bridge	Erosion	Erosion and scour risk around the bridge.	4L	4VL	No	Physical works ($$$)	New bridge.	Business Case required
WC10	6	Haast Pass	Road	Erosion	Erosion risk along Haast River.	4L	4VL	No	Physical works ($$$$)	Expensive protection works.	Business Case required
WC9	6	Haast Pass	Road	Landslip	Route at risk from landslip. Currently all reactive works with proactive management on some sites, however there is still a risk of losing the whole road. A few landslip sites could potentially be more proactive some of it which would be less than $1m, however it is more like $5m altogether.	4VL	4VL	Yes	Enhanced proactive maintenance	Some areas could have more proactive work undertaken.	Business Case required
MR4	94	Hollyford Rd to Chasm	Road	Avalanche	Avalanche risk for the winter season is the major focus which drives most of the work throughout winter (April/May-October/November). Twice a day there is an avalanche hazard forecast put out which drives public access, restrictions and control work. Climate trends: winter is arriving later but staying longer. This affects tourism. Increased precipitation and snow – however more rain on snow increases the risk. Risk level is rising with annual increasing traffic volumes.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing prevention.	Business Case required
MR5	94	Hollyford River	Road	Flooding	Flood risk on the Hollyford River. There are regular flooding events which inundate the road and damage structures.	4L	4VL	No	Unknown. Pending further investigations	Difficult to address. Further work required.	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
MR17	94	Homer Tunnel	Tunnel	Avalanche	Significant reinvestment issues for tunnel and portals but there is a BC being developed for replacement portal/protection structures. Resilience for future EQ/Rockfall. The structure is ageing, soon to be a historic site – heritage assessment currently in draft but recommends some very intensive improvement and maintenance works to protect nature of the site.	4L	4VL	No	Physical works ($$$$)	A smart design for replacement of the tunnel portals could deal with strengthening and upgrading, aiding avalanche and rockfall risks at the same time. In short term, Rockfall prevention measures e.g. scaling, fences and bunds. But has cross over with avalanche zone - avalanches will destroy rockfall structures. Longer term needs to reinforce and upgrade the portals/tunnel before it is designated as a historical site. A smart design for replacement of the tunnel portals could deal with strengthening and upgrading, aiding avalanche and rockfall risks at the same time. Portals are under the largest avalanche zones. In addition, remote control avalanche systems could be employed. This is a significant tourism route and also safety issues.	Business Case funded or underway
TS10	6	Hope saddle	Road	Landslip	Ongoing landslip risk.	4VL	4VL	No	Physical works ($$)	Requires netting.	Business Case required
TS11	6	Kawatiri to Owen	Road	Erosion	At risk to river erosion and drop out.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance.	Business Case required
HB3	5	Kaweka Ranges - Mohaka River Rail and Road Bridge	Road	Landslip	Mohaka river at the road and rail bridge which has fundamental flaws in its design and is subject to landslip risk along the entire length of the ranges. It is a narrow road with minimal space to carry out physical works or install geotechnical solutions such as debris fences. Work is being done to cut the slip back further. A debris fence is however being installed in one section from Pakipaki to Peka Peka.	4L	4VL	No	Physical works ($$$)	Investigation into options to retreat into hillside/ behind rail viaduct 'Raupunga retreat'.	Business Case funded or underway
WC12	6	Knights Point	Road	Landslip	Most vulnerable piece of road to landslip in New Zealand and currently only has reactive work underway.	4VL	4VL	No	Enhanced proactive maintenance	Also, would require further investigation.	Business Case required
C13	7	Lewis Pass	Road	Flooding	Currently a lot of maintenance work being carried out to stop flooding inundation of the road. The road and riverbed are currently at the same level.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Requires further investigation to develop a long-term solution.	Business Case required
WC15	7	Lewis Pass	Road	Flooding	Shingle fans depositing on the road, as well as surface flooding risk.	4L	4VL	No	Physical works ($$$)	Solvable with upgrade to double lane bridges and bridge realignment away from rockface.	Business Case required
O15	1	Maheno	Bridge	Flooding	Flooding issues within a number of river catchments. Options have been scoped. Overland flow path floods the road between Clarks Mill and where the road crosses the railway. There is a plan to put culverts in to allow water to run from one side of the road to the other to stop flooding. When this floods the bridge also floods and the detour is ~ 4-5 hours.	4L	4VL	No	Physical works ($$)	Upgrade culverts and overland flow paths.	Business Case required
T8	3	Mangaotaki gorge	Road	Landslip	Mangaotaki Gorge is at risk of landslip. Currently has no geotechnical barriers.	4L	4VL	No	Physical works ($$$)	Active/priority sites have been funded but the whole corridor has a resilience issues. Retaining walls.	Business Case required
MW2	2	Mangatainoka	Road	Flooding	SH2 Mangatainoka - moderate flood risk (1 every 10 years).	4L	4VL	No	Physical works ($)	Drainage improvements required.	Business Case required
TS30	65	Mauria River	Road	Erosion	Surface flooding and undercutting / erosion where river is next to the road.	4VL	4VL	No	Physical works ($$$)	Rock protection along river to protect road.	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
MR10	94	Milford Road	Road	Extreme Weather	Tree fall due to extreme weather is a significant risk that is partly managed through an extensive tree removal programme however this is still resulting in significant residual risk which is likely to increase due to climate change. Tree fall hazard has led to fatalities in the last 5 years. The tree fall risk strategy in place primarily focuses on investment over time for managing (>3000 at present) and removing trees from along the roadside.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance.	Business Case required
MR7	94	Milford Road Bridges	Bridge	Flooding	In addition to the individually listed bridges, there are a number of 1-way truss and concrete bridges that are at risk to flooding. Greater than 30 bridges experience 8-9m of rain every year. Currently the alliance handles this well, however a single failure will break the entire network. A number of the bridges require ongoing work however, a reduction in bridge maintenance funds by NZTA will limit the amount of work that can be completed.	4L	4VL	No	Enhanced proactive maintenance	Enhanced maintenance.	Business Case required
MR9	94	Milford Township	Road	Flooding	Flood risk. Currently there are a number of flood protection works being carried out to protect property. However, there is residual risk, but this is less of a highway risk. DOC have some ongoing work that involves increasing the ground level of Milford by 0.5-1m, as a significant portion of Milford is on reclaimed land and flood plain/fan. To provide slightly more protection for SLR and tsunami.	4L	4VL	No	Physical works ($$)	Raise village height and build higher stop banks. Some work is already underway.	Business Case required
T13	3	Mokau Bluff	Road	Erosion	Mokau Bluff, at risk of coastal erosion.	4L	4VL	No	Physical works ($$)	In the short term continue rock fencing. Realignment and smoothing the corner and cut into the bluff is the long-term solution. ~60-70m bluff.	Business Case required
T15	3	Mt Messenger	Road	Landslip	South of Mt Messenger is at risk of landslip- Uruti Valley has a number of cuttings prone to slipping.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study.	Business Case required
N12	1	Oakley and Mata Flooding	Road	Flooding	Combined coastal inundation and river flooding risk. Key freight route. Used to occur every 5 years. Has been blocked twice in less than 10 years. Catchment boards involved in flood risk management were lost in the amalgamation of councils.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study.	Business Case required
WC17	73	Otira River at Otira	Road	Erosion	River erosion risk. Already funded but has ongoing issues in other areas as well.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Monitor and reactive maintenance.	Business Case required
T16	3	Patea Bridge	Bridge	Erosion	Bridge built between 60's-70's at risk to erosion.	4L	4VL	No	Physical works ($$)	Strengthening or realignment of the bridge would be a more beneficial outcome in comparison to a new route.	Business Case required
O19	6	Queenstown to Frankton	Road	Landslip	Highly vulnerable to rainfall induced landslips.	4L	4VL	No	Physical works ($$$)	Retaining walls and improving lakeside stability to minimise under slips.	Business Case required
WC19	7	Rahu Saddle	Road	Extreme Weather	Extreme weather risk with trees falling from high winds.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Annual inspections and selective removals where risk identified.	Business Case required
N4	1	Ruakaka and Whangarei	Road	Flooding	Flood risk between Ruakaka and Whangarei. Both river and tidal flooding during king tides. Typically, when there are issues on the SH there are issues on the local roads so there are no alternate options.	5L	5VL	No	Unknown. Pending further investigations	Requires further detailed study.	Business Case required
TS24	63	Salt Lake	Road	Flooding	Runoff leads to flooding of road.	4L	4VL	No	Physical works ($$)	Box culverts and raise road.	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
WC20	6	Scout Lodge Straight	Road	Erosion	Significant river erosion risk.	4VL	4VL	No	Physical works ($$$)	River protection works (groynes) to train river and realign road.	Business Case required
W6	1	SH1 Kuku	Road	Flooding	Flooding occurs frequently in low lying area - caused by a land drainage issue where water builds up on the highway approx. once a year. Flooding can often reduce traffic down to one lane and has affected both lanes for a couple of hours. With help from Council it could be improved. Risk could also be reduced if Otaki to Levin is confirmed.	5L	5VL	No	Physical works ($$)	Requires Council to address adjacent land drainage and runoff - less of an issue once O2NL is constructed. could significantly improve the flood issue - especially considering the detour is extensive.	Business Case required
W19	1	SH1 Ngauranga Gorge	Road	Landslip	Rockfall risk and landslides - targeting low cost, low risk funding. Multiple users including cyclists. Debris screen is a hard structure and the footpath has become a combined pathway with no room left for construction. Low cost, low risk would address most of these.	4L	4VL	No	Physical works ($$$)	Some minor works planned, but would require significant infrastructure to fully mitigate.	Business Case required
W2	1	SH1 Porirua	Road	Flooding	Some flooding. The roads go through wetland like material, some of the culverts and streams are full of gravel and upper reaches of streams need clearing and maintaining. NZTA ends up with the problem but they have very little control of what happens up or down stream of the road.	4L	4VL	No	Physical works ($$$)	Ongoing improvements to manage high intensity rainfall events - will require Council to improve stormwater catchment.	Business Case required
T19	3	SH3 Midhurst rail overbridge	Road	Erosion	SH3 Midhurst rail overbridge has the potential for erosion and scour - which may in turn affect the road below. The detour route is also very long and is not ideal for HPMV.	4L	4VL	No	Unknown. Pending further investigations	There is no specific risk at the moment, but the solution should be similar to what occurred in Normandy, bridge realignment and creation of a viable detour. Main pinch points are all bridges with no detour routes.	Business Case required
T18	3	SH3 Midhurst rail overbridge	Road	Flooding	SH3 Midhurst rail overbridge has the potential for flooding. The rail and river bridge are back to back with detours that are not ideal for HPMV. The detour route is also very long. There is no specific hazard at the moment, but the solution should be similar to what occurred in Normandy, bridge realignment and creation of a viable detour. Main pinch points are all bridges with no detour routes.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study.	Business Case required
T20	3	South of Mt Messenger	Road	Erosion	Erosion risk where river runs adjacent to SH3 South of Mt Messenger.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Requires ongoing monitoring and potential stabilisation.	Business Case required
WC21	6	South of Ross to Haast Pass	Road	Flooding	All rivers south of Ross (~15 rivers) need training/stop banking and active management to reduce flood risk.	4VL	4VL	No	Enhanced proactive maintenance	Ongoing training works and management.	Business Case required
C21	7	Stuarts Fan	Road	Flooding	Flooding risk to bridge when extreme events mobilise the shingle and cause overflow at culverts underneath the bridge. The culverts get cleaned out annually which closes the road for a few hours. Justification for funding in resilience measures could be difficult.	4L	4VL	No	Physical works ($$$)	There is a plan developed for realignment and box culverts however this hasn't received funding. Requires regular maintenance.	Business Case required
WC23	73	Taipo Bridge	Bridge	Flooding	Flood risk along one lane bridge.	4L	4VL	No	Physical works ($$$$)	replace whole bridge and double lane.	Business Case required
TS20	60	Takaka Hill	Road	Landslip	Landslip risk with both under and over slips. Mainly on the Nelson side. Occurs at least once a year. There are also a number of drainage issues.	4VL	4VL	No	Physical works ($$$)	Realignment improve drainage and catchment management. Even with improvements, there would still be ongoing issues, requiring response and BAU maintenance.	Business Case required
TS25	63	The wash	Road	Flooding	Flooding risk through the Wairau Valley as road follows river in floodplains.	4L	4VL	No	Physical works ($$)	Raise road and provide river protection.	Business Case required
T22	3	Tongahoe	Bridge	Erosion	Bridge built between the 60's-70's and is at risk to erosion. Tongahoe should be a high priority as it has a bluff and the river.	4L	4VL	No	Physical works ($$)	Strengthening or realignment of the bridge would be a more beneficial outcome in comparison to a new route.	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
TS2	1	Tuamarina to Picton	Road	Flooding	Surface flooding risk from adjacent catchment runoff.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study.	Business Case required
TS16	6	Upper Buller Gorge	Road	Erosion	Erosion risk along the Buller Gorge in both Top of South and West Coast.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance.	Business Case required
TS13	6	Upper Buller gorge	Road	Extreme Weather	Extreme weather risk with strong winds resulting in tree fall.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance.	Business Case required
TS14	6	Upper Buller gorge	Road	Landslip	At risk to landslips both over and under slips.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance.	Business Case required
MR11	94	Upukerora River	Road	Flooding	There are semi regular flooding events that inundate the road and damage structures.	4L	4VL	No	Unknown. Pending further investigations	Difficult to address. Further work required.	Business Case required
O15	1	Waikouati River	Road	Flooding	Waikouati River floods the highway.	4L	4VL	No	Physical works ($$)	Raise level of road to clear flood level.	Business Case required
WC24	73	Wainihinini Bridge	Bridge	Flooding	Flood risk to bridge. Bridge replacement is critical from a HMPV point of view. Currently reaching end of life.	4L	4VL	No	Physical works ($$$)	Replace bridge.	Business Case required
BP9	2	Waioeka Gorge	Road	Landslip	Landslip risk for the entirety of Opotiki to the Bay of Plenty boundary. Significant effects commercially and for small communities.	4VL	4VL	No	Physical works ($$$$)	over a multiple year programme. In an ideal world you would do a multi-year programme across all significant sites - that links to the PBC that Simon Barnett / Gisborne is working on.	Business Case required
BP24	2	Waioeka River	Road	Erosion	Erosion from Waioeka river and failure of the groynes could mean loss of road.	4L	4VL	No	Physical works ($$)	New groynes.	Business Case required
HB9	2	Wairoa River	Road	Erosion	Erosion risk along Wairoa River where the slip undercuts the road.	4L	4VL	No	Physical works ($$)	Opportunities to raise level of road alongside river corridor and/ or look at investing in improving resilience of local road network as alternative.	Business Case required
HB10	2	Wairoa River	Road	Flooding	Wairoa River Flood once a year with the road closed and the river is cutting into the road - Cyclone Bola took out the bridge. Removing every year flood risk would be better than trying to address the big events - which would involve raising the road. Sheer bank on one side of the road where you could raise the road and put in slip control. Wouldn't make this high priority above the other issues where this is only closed for a day vs the other ones closed for weeks.	4L	4VL	No	Physical works ($$)	Response plan for the route needs to be developed and look at improving resilience of Mohaka Bridge and approaches.	Business Case required
T24	3	Waitotara bridges	Bridge	Erosion	Erosion risk to the bridge. Built between 60's-70's.	4L	4VL	No	Physical works ($$)	Strengthening or realignment would be of more value than creating a new route.	Business Case required
BP13	29	West side of the Kaimai's	Road	Extreme Weather	Extreme weather can cause re-mobilisation of the fine/ash material. Could be difficult to clean up.	4L	4VL	No	Physical works ($)	Some sort of geotechnical response to stabilize slope. Needs investigation.	Business Case required
MW1	3	Whangaehu (link between Whanganui and Bulls)	Road	Flooding	SH3 Whangaehu area floods regularly (every 5 years). It is a critical link between Whanganui and Bulls where water generally flows over the road. The road could be built up to the same height as the bridge adjacent to it. Currently the surrounding houses and community are under water, they effectively dam the water causing it to significantly back up, significant stormwater management would be needed.	4L	4VL	No	Physical works ($$)	Raise the section of the road to the east of the bridge. However, the flood waters need to cross the road corridor or the Whangaehu town will get flooded. The options are a bridge or several very large culverts. A raised embankment will not work.	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
A11	1	Lonely Track Road North Slip	Road	Landslip	Landslip issues. This is currently viewed as being one of the highest risks on the Auckland network - which has potential to cause a loss of system availability. Significant land instability issues detected with ongoing movement since construction in late 90's as part of the SH1 ALPURT A1 Project. Close monitoring and proactive sealing of tension cracks to slow down failures is currently funded under ASM TOC for initial investigation (only).	5L	5VL	No	Unknown. Pending further investigations	Significant issue - Currently investigation works are underway to better understand the scale of the risk and any resultant work needs. This includes additional monitoring and investigation of the likelihood and consequence of a slip. Auckland System Management (ASM) TOC funding to a capped budget is available for the current investigation stage. Monitoring in various forms has been occurring since 2008. ASM TOC funding for investigation in the last year has been made available to confirm the risk profile and any recommendations on mitigation. Additional funding would be needed for any physical works.	Business Case funded or underway
HB11	2	Whirinaki Bluff	Road	Landslip	Landslip risk. Slip likely to cut off the entire road northward.	4L	4VL	No	Physical works ($$)	Need to understand the effects of climate change and develop options.	Business Case required

3 Regional PRA extreme and major risk summaries

This section summarises the extreme and major risks identified within each region following the regional stakeholder workshops. These relate to those risks identified as extreme or major in the present day. Climate related risks (2050) are shown as well. Refer to section 2.2.1 for interpretation of the risk tables.

Appendix A contains the detailed risk ratings for all risks captured, along with the sub-components which make up the risk rating.

Appendix B contains the detailed maps showing the locations of the regional extreme and major risks.

3.1 Auckland

A total of two major / extreme risks were identified for the Auckland Region. The small number of risks within Auckland is predominantly due to the high-density of the regional transport network and the availability of alternate routes which result in lower impacts across the land transport network as a whole.

Table 3.1: Summary of major and extreme risks in the Auckland

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
A1	1	Tank Farm Culvert to Exmouth Footbridge	Road	Coastal Inundation / SLR	Southbound lanes between Tank Farm Culvert and Exmouth St Footbridge get inundated during high tides (and storm surge). This results in varying amounts of inundation across 4 lanes: from bus lane only through to all lanes. This can cause significant disruption to the availability and resilience of the system. In extreme cases this results in significant disruption (and loss of multiple lanes) for about 2 hours at high tide.	4L	4VL	No	Physical works ($$)	There is a coastal inundation resilience study that is underway for this location. Funding is only for the investigation and options assessment. Several options are being explored such as raising the road (partial or fully), flood barriers, using new concrete barriers with pumps and/or non return systems. There are a range of other risks including to the Transpower NAaN 220kV.	Business Case funded or underway
A11	1	Lonely Track Road North Slip	Road	Landslip	Landslip issues. This is currently viewed as being one of the highest risks on the Auckland network - which has potential to cause a loss of system availability. Significant land instability issues detected with ongoing movement since construction in late 90's as part of the SH1 ALPURT A1 Project. Close monitoring and proactive sealing of tension cracks to slow down failures is currently funded under ASM TOC for initial investigation (only).	5L	5VL	No	Unknown. Pending further investigations	Significant issue - Currently investigation works are underway to better understand the scale of the risk and any resultant work needs. This includes additional monitoring and investigation of the likelihood and consequence of a slip. Auckland System Management (ASM) TOC funding to a capped budget is available for the current investigation stage. Monitoring in various forms has been occurring since 2008. ASM TOC funding for investigation in the last year has been made available to confirm the risk profile and any recommendations on mitigation. Additional funding would be needed for any physical works.	Business Case funded or underway

3.2 Bay of Plenty

A total of 12 major and extreme risks were identified within the Bay of Plenty region. These relate to rockfall, landslip, erosion, flooding and coastal inundation/erosion. The highest rated risk was the Waioeka Gorge which sits within both the Bay of Plenty and Gisborne areas. Coastal risks are high now and are anticipated to increase due to climate change.

Table 3.2: Summary of major and extreme risks in the Bay of Plenty

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
BP2	2	Kutarere	Road	Coastal Inundation / SLR	Tidal flooding occurs with significant rainfall.	4L	4VL	No	Physical works ($$)	Raise the road <1km.	Business Case required
BP3	35	Motu Bluff	Road	Landslip	Land stability issues at Motu Bluff	3VL	3VL	No	Physical works ($$)	Rockslide netting to divert the rocks. 10-20-year programme to improve rain / storm water control to avoid emergency works	Business Case required
BP4	2	Nukuhou	Road	Flooding	4 locations of flooding which generally occur at the same time. The local road has already been raised to provide a better route instead of raising the SH.	3VL	3VL	No	Physical works ($$$)	Raise 2km of road	Business Case required
BP5	29	Ruahihi Bluff	Road	Rockfall	Rockfall ~5 cubic m blocks which pose a significant safety risk. 30-40% of trucks would be HPMV which equals ~800 trucks on a 2-hour detour.	4L	-	No	Physical works ($$)	There is a significant resilience and safety benefit. Solution designed and ready to go, mesh and rockfall. Should be highest risk stretch of road.	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
BP6	35	Tirohanga to Bay of Plenty Boundary	Road	Landslip	Landslip issues along entire East Cape. Also, sedimentation with significant rainfall washing sediment down valleys.	3VL	3VL	No	Physical works ($$$)	Further investigations needed	Business Case required
BP12	2	Waimana Gorge	Road	Landslip	Both large and small slips through the gorge. Currently already spending $6million just to get it open from previous events.	3VL	3VL	No	Physical works ($$$)	Requires stabilizing slopes.	Business Case required
BP9	2	Waioeka Gorge	Road	Landslip	Landslip risk for the entirety of Opotiki to the Bay of Plenty boundary. Potential for significant effects commercially and for small communities.	4VL	4VL	No	Physical works ($$$$)	over a multiple year programme. In an ideal world you would do a multi-year programme across all significant sites - that links to the PBC that Simon Barnett / Gisborne is working on.	Business Case required
BP8	2	Waioeka Gorge	Road	Rockfall	Significant rockfall issues along the entirety of Waioeka Gorge for both the Bay of Plenty and Gisborne / Hawke's Bay. Very significant issue for Gisborne community as in the event of a long closure communities have the potential to be isolated. Also affects time critical delivery of food produce to the port and Auckland. Supplies to the hospital could also become an issue quickly. Regional managers support a change to the ONRC classification to 'Regional' level. Significant crash rates and safety issues with response limited due to poor telephone coverage. Waioeka Gorge PBC identifies all major sites and pinch points.	5VL	-	No	Physical works ($$$)	Geotechnical improvements: combinations of rock fall protection, slope stabilisation etc. over a multiple year programme. In an ideal world you would do a multi-year programme across all significant sites - that links to the PBC that Simon Barnett / Gisborne is working on. Aurecon has previously carried out an assessment of the sites.	Business Case required
BP24	2	Waioeka River	Road	Erosion	Erosion from Waioeka river and failure of the groynes could mean loss of road.	4L	4VL	No	Physical works ($$)	New groynes	Business Case required
BP10	2	Waiotahi Bluffs	Road	Landslip	Land instability issues along the Bluff. Ideally need to enhance detour route so that it can take HPMVs which will limit the impacts of outage.	3VL	3VL	No	Physical works ($$)	Roughly 10 -15kms of upgrading detour route. There are a few tight bends which could be widened.	Business Case required
BP11	2	Waiotahi Bridge	Road	Coastal Erosion	Coastal erosion along the bridge is possible. Solvable in the short to medium term, but not long term with climate change. 6hr detour for HCV and HPMV.	4L	4VL	No	Physical works ($$)	Erosion protection required around bridge	Business Case required
BP13	29	West side of the Kaimai's	Road	Extreme Weather	Extreme weather can cause re-mobilisation of the fine/ash material. Could be difficult to clean up.	4L	4VL	No	Physical works ($)	Some sort of geotechnical response to stabilize slope. Needs investigation	Business Case required

3.3 Canterbury

A total of 27 major and extreme risks were identified within the Canterbury region. These relate to rockfall, landslip, ice and snow, flooding, coastal inundation/erosion and earthquake/liquefaction. The highest rated risks relate to rockfall and landslip and are located on SH1 North of Kaikoura. SH1 North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (which is a vital freight route). SH1 south of Kaikoura has an alternative route (via the inland road). Otherwise, the alternate route involves a significant detour (via SH63 and Lewis Pass).

Table 3.3: Summary of major and extreme risks in Canterbury

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
C8	73	Arthurs Pass	Road	Ice / Snow	SH73 through Arthurs Pass is subject to snow and ice disruptions. Arthurs Pass is one of three key routes which link the West Coast with the East Coast of the South Island.	4L	-	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	Business Case required
C9	73	Arthurs Pass	Road	Rockfall	SH73 through Arthurs Pass is subject to rockfall. Arthurs Pass is one of three key routes which link the West Coast with the East Coast of the South Island.	4L	-	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
C4	1	Ashburton Bridge	Road	Extreme Weather	SH1 at the Ashburton bridge is subject to extreme weather events. This is a significant pinch point on the network and has a limited detour with resilience and capacity issues. KiwiRail and electricity lines also follow parallel to the road and are likely to be subject to the same risk.	4L	-	No	Physical works ($$$)	Duplicate bridge required	Business Case required
C7	73	Bealey Bridge	Bridge	Earthquake / liquefaction	SH73 at the Bealey bridge is at risk from seismic shaking, scour and capacity issues.	4L	-	No	Physical works ($$$$)	Replace bridge	Business Case required
C16	1	Blue Slip	Road	Landslip	Site at risk to mass earth movement, which would likely affect both road and KiwiRail. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	-	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	Business Case required
C5	8	Burkes Pass	Road	Ice / Snow	SH6 through Burkes Pass is subject to snow and ice risk resulting in closures and disruption. Burkes Pass is a key tourist and freight route between the East Coast and Central Otago.	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Business Case required
C19	1	Clarence Bridge	Bridge	Flooding	Clarence river is at risk to river and surface flooding - requiring ongoing groyne maintenance. High sediment loads can cause the riverbed to aggrade up to 2m. This risk also extends across most of the streams along the Northern Kaikoura coastline. Some sediment retention devices are being built to address this. This risk is manageable in individual locations, however in a significant event such as Tropical Cyclone Fehi / Gita there is the potential for all rivers to flood, which could cause significant remedial works. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	5VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	Business Case required
C24	1	Clarence to Kaikoura	Road	Coastal Inundation / SLR	Overtopping occurs along the whole corridor, only out for a couple hours either side of high tide. Unsure whether this will damage the road as it is all new (NCTIR), likely this will no longer damage the road. However, this is ongoing and likely to increase with the impacts of CC. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	4L	4VL	No	Unknown. Pending further investigations	Further investigations needed	Business Case required
C23	1	Clarence to Kaikoura	Road	Rockfall	Clarence to Kaikoura is subject to rockfall risk, some of which will have been addressed in the NCTIR project. However, behaviour is unpredictable due to Kaikoura works but it is assumed that there will be residual risk for rockfall and debris flows. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5UL	-	No	Unknown. Pending further investigations	Monitor	Business Case required
C28	73	Craigieburn	Road	Landslip	Landslip risk at Craigieburn along SH73.	4L	-	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
C30	1	Hapuku Dam	Road	Landslip	Landslide dam but not significant. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5UL	-	No	Physical works ($$)	Could remove the landslide dam to eliminate dam outbreak flood risk.	Business Case required
C26	1	Hundalees	Road	Landslip	Soft soils and landslip risk. Large number of truck crashes. Large landslips can occur every ~10 years with smaller annual events. The BAU response to the smaller events typically results in the road being back to one lane within 12 hours. The larger events cause traffic to be diverted through the alternate route for 48 hours. Slip generally comes onto the road rather than under cutting.	4L	-	No	Physical works ($$)	Solution could be to revegetate the farm area to stabilise slopes.	Business Case required
C11	1	Hurunui River Bridge	Bridge	Earthquake / liquefaction	The single lane Hurunui bridge on SH1 is subject to seismic risk and safety issues involving a large number of accidents and safety issues for cyclists. This is a high volume and significant freight route with a poor detour route.	4L	-	No	Physical works ($$$)	Replace bridge and upgrade to two lanes	Business Case required
C13	7	Lewis Pass	Road	Flooding	Currently a lot of maintenance work being carried out to stop flooding inundation of the road. The road and riverbed are currently at the same level.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Requires further investigation to develop a long-term solution	Business Case required
C25	7	Lewis Pass	Road	Ice / Snow	Snowstorms on the Lewis Pass cut off the route and all routes to the north.	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Business Case required
C27	1	Movern	Road	Flooding	Surface flooding due to land use changes, short duration. SH culverts undersized.	4L	-	No	Enhanced proactive maintenance	Improved drainage required	Business Case required
C10	1	North of Kaikoura - Clarence Bridge	Road	Landslip	Landslip and mass movement risk (site similar to Blue Slip, see for details). No known solution, and if a landslip or mass movement were to occur the road and rail will be completely destroyed. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Further investigations needed	Business Case required
C17	1	Ohau Point	Road	Coastal Inundation / SLR	Ohau Point is at risk from coastal inundation– it overtopped three times in 2019 in a combined high tide and storm event. There is a potential design in NCTIR to address this, however with the effects of climate change this may not address the issues. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	5VL	No	Unknown. Pending further investigations	Monitor	Business Case required
C29	73	Porters Pass to Arthurs Pass	Road	Ice / Snow	Ice and snow risk - occurs throughout winter along the passes.	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
C3	1	Rakaia Bridge	Road	Flooding	SH1 at the Rakaia bridge is subject to extreme weather events and flooding due to limited drainage capacity around the bridge. This is a nationally significant road with a poor detour. Outage of this bridge was experienced in the lead up to Christmas 2019 and caused significant disruption throughout Canterbury. KiwiRail and electricity lines are parallel to the road and are likely subject to the same risk. Currently a large number of accidents cause disruptions on the bridge. Bridge also thought to have poor seismic strength.	4L	-	No	Physical works ($$$)	Duplicate bridge required	Business Case required
C1	77	Rakaia Gorge Bridges	Road	Flooding	This is a major tanker route for the Darfield Fonterra plant and Phillip Wareing as well as the detour route for SH1 around the Rakaia and Ashburton bridges. Some of the bridges have restrictions and limits for HPMVs. There are significant flooding issues throughout the route and the road often goes down to one lane. It's likely this road would be significantly damaged in an earthquake which would leave no detour for SH1. Electricity lines and KiwiRail are parallel to SH1 line.	4L	-	No	Physical works ($$$)	Upgrade both one lane bridges at the gorge to provide a more robust detour route. Improve traffic management procedures during outages.	Business Case required
C48	1	Rangitata and Arundel Bridges	Bridge	Flooding	Flooding has potential to cause bridge washouts through scour for both bridges on the Rangitata River.	4L	-	No	Enhanced proactive maintenance	Enhanced maintenance of river groynes	Business Case required
C14	75	Road to Akaroa	Road	Landslip	Landslip risk on either side of the summit, along the road to Akaroa through Banks Peninsula.	4L	-	No	Enhanced proactive maintenance	Maintenance and monitor	Business Case required
C18	1	Shingle Fans	Road	Landslip	Shingle Fans - North of Clarence is at risk to landslip. There are three shingle fans which flow through culverts however, in large events these flow over the road. Landslip overtopping occurs approximately once every 3-4 years. Generally, response teams can keep the shingle within the water way. Generally, there is a quick response, with short term closures and damage to infrastructure is unlikely. Smaller retention dams are being located upstream. KiwiRail relies on NZTA for clearing the culverts. This is still flagged as a high risk due to the frequency and importance of the road. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	-	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	Business Case required
C21	7	Stuarts Fan	Road	Flooding	Flooding risk to bridge when extreme events mobilise the shingle and cause overflow at culverts underneath the bridge. The culverts get cleaned out annually which closes the road for a few hours. Justification for funding in resilience measures could be difficult.	4L	4VL	No	Physical works ($$$)	There is a plan developed for realignment and box culverts however this hasn't received funding. Requires regular maintenance.	Business Case required
C2	7a	Waiau Ferry Bridge	Bridge	Rockfall	The Waiau Ferry bridge is at risk from rockfall and is the key route into Hanmer Springs which is the most significant tourism / economic hub for the Hurunui district, hence a higher consequence rating was assigned. There are also some concerns around the bridge abutments. Note during workshops there was differing opinions of the criticality of this route from a regional perspective.	4L	-	No	Physical works ($$$$)	Bridge replacement and alternative alignment.	Business Case required
C6	73	Waimakariri Bluff	Road	Rockfall	SH73 at Waimakariri Bluff is subject to rockfall risk at many locations. There is currently one location being addressed under LCLR, however the issue extends over a wider area.	4L	-	No	Physical works ($$$)	more funding would mean that more sites can be addressed.	Business Case required

3.4 Gisborne / Hawke's Bay

A total of 10 major and extreme risks were identified within the combined Gisborne and Hawke's Bay area. These relate to landslip, flooding, coastal inundation/erosion and earthquake/liquefaction. Of particular note are the risks at Whirinaki Bluff and Napier Airport - relating to coastal inundation and erosion which will exacerbated by climate change and sea level rise. The Devil's elbow is the highest rated current risk in the region.

Table 3.4: Summary of major and extreme risks in Gisborne / Hawke's Bay

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
HB1	2	Devil's Elbow	Road	Landslip	~10km of Devil's Elbow is at risk to landslip.	4VL	4VL	No	Unknown. Pending further investigations	An alternative local road can be utilised however it is unsealed and narrow and cannot take heavy vehicles. Upgrading the local road is potentially a better use of money.	Business Case required
HB14	5	Entire length of SH5	Road	Landslip	Significant issues with Landslips and instability along entire route. Highest ONRC and connects the Bay to inland. The detour is long and less resilient, via Palmerston North.	4L	4VL	No	Physical works ($$$)	Response plan for the route needs to be developed. A large number of geotechnical solutions would be required to address the landslips.	Business Case required
HB3	5	Kaweka Ranges - Mohaka River Rail and Road Bridge	Road	Landslip	Mohaka river at the road and rail bridge which has fundamental flaws in its design and is subject to landslip risk along the entire length of the ranges. It is a narrow road with minimal space to carry out physical works or install geotechnical solutions such as debris fences. Work is being done to cut the slip back further. A debris fence is however being installed in one section from Pakipaki to Peka Peka.	4L	4VL	No	Physical works ($$$)	Investigation into options to retreat into hillside/ behind rail viaduct 'Raupunga retreat'	Business Case funded or underway
HB4	5	Kaweka Ranges - Mohaka River Rail and Road Bridge	Road	Rockfall	Mohaka river at the road and rail bridge which has fundamental flaws in its design and is subject to rockfall risk along the entire length of the ranges. It is a narrow road with minimal space to carry out physical works or install geotechnical solutions such as debris fences. A debris fence is however being installed in one section from Pakipaki to Peka Peka.	4L	-	No	Physical works ($$$)	Investigation into options to retreat into hillside/ behind rail viaduct 'Raupunga retreat'	Business Case funded or underway
HB5	2	Napier Airport	Road	Coastal Inundation / SLR	Road to Napier airport is highly vulnerable to a number of hazards.	4L	4VL	No	Unknown. Pending further investigations	Regional problem and tied to climate change and emergency response issues	Business Case required
HB6	50	Napier Port	Road	Earthquake / liquefaction	An earthquake in Wellington could cause Centre Port to be out of service. Consideration of routes to other ports such as Napier and Tauranga become more relevant- equally if there is an earthquake in Napier. CDEM accept that some things will likely stop economically. The road to the port is an urban highway and is less likely to be impacted by slips or a highly frequent event.	4L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Link into work being undertaken by Civil defence around risks of Hikurangi Trench and Alpine Fault to understand the Agency's role in being able to respond to these large-scale events.	Business Case required
HB9	2	Wairoa River	Road	Erosion	Erosion risk along Wairoa River where the slip undercuts the road.	4L	4VL	No	Physical works ($$)	Look at opportunities to raise level of road alongside river corridor and/ or look at investing in improving resilience of local road network as alternative.	Business Case required
HB10	2	Wairoa River	Road	Flooding	Wairoa River Flood once a year with the road closed and the river is cutting into the road - Cyclone Bola took out the bridge. Removing every year flood risk would be better than trying to address the big events - which would involve raising the road. Sheer bank on one side of the road where you could raise the road and put in slip control. Wouldn't make this high priority above the other issues where this is only closed for a day vs the other ones closed for weeks.	4L	4VL	No	Physical works ($$)	Response plan for the route needs to be developed and look at improving resilience of Mohaka Bridge and approaches.	Business Case required
HB12	2	Whirinaki Bluff	Road	Coastal Erosion	Coastal erosion risk. Coastal erosion likely to cut off the entire road northward	4L	4VL	No	Physical works ($$)	Need to understand the effects of climate change and develop options	Business Case required
HB11	2	Whirinaki Bluff	Road	Landslip	Landslip risk. Slip likely to cut off the entire road northward.	4L	4VL	No	Physical works ($$)	Need to understand the effects of climate change and develop options	Business Case required

3.5 Manawatu / Whanganui

A total of 3 major risks were identified within the Manawatu/ Whanganui area. These relate to landslip and flooding. One of the risks is the Manawatu Gorge which is currently closed due to landslip and a PBC is underway. Flooding at SH3 Whangaehu is considered a significant risk that would require further investigations to determine the best solution and is likely to increase to extreme due to climate change. Similarly flooding at Whangaehu is also likely to increase to extreme in the long term.

Table 3.5: Summary of major and extreme risks in Manawatu / Whanganui

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
MW24	3	Manawatu Gorge	Road	Landslip	Significant land instability issues through the entire Manawatu Gorge. Currently closed and a PBC underway to decide the best option moving forward. Traffic goes through a local road which is requiring significant strengthening to deal with large vehicles and increased traffic loads.	3VL	3VL	No	Physical works ($$$$)	Business case underway	Business Case funded or underway
MW2	2	Mangatainoka	Road	Flooding	SH2 Mangatainoka - moderate flood risk (1 every 10 years).	4L	4VL	No	Physical works ($)	Drainage improvements required	Business Case required
MW1	3	Whangaehu (link between Whanganui and Bulls)	Road	Flooding	SH3 Whangaehu area floods regularly (every 5 years). It is a critical link between Whanganui and Bulls where water generally flows over the road. The road could be built up to the same height as the bridge adjacent to it. Currently the surrounding houses and community are under water, they effectively dam the water causing it to significantly back up, therefore significant stormwater management would be needed.	4L	4VL	No	Physical works ($$)	Raise the section of the road to the east of the bridge. However, the flood waters need to cross the road corridor or the Whangaehu town will get flooded. The options are a bridge or several very large culverts. A raised embankment will not work.	Business Case required

3.6 Milford Road

A total of 15 major and extreme risks were identified along Milford Road. These relate to rockfall, avalanche, earthquake, tsunami, landslip and flooding. Key risks include numerous, significant landslip and flooding risks along the route, affecting both roads and bridges. Avalanche is also a key risk in winter and requires significant, ongoing proactive maintenance and likely to increase with the impacts of climate change. Treefall during extreme weather is also a risk that requires ongoing management even with the extensive programme which already occurs, this is also likely to increase with climate change.

The Homer Tunnel has a number of risks associated with it – including seismic, rockfall and avalanche. There is a current Business Case underway for strengthening of the portal and for protection structures, however further work would also be required.

Table 3.6: Summary of major and extreme risks on the Milford Road

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
MR1	94	Along Lake Te Anau	Road	Tsunami	Significant risk of landslide induced tsunami which could be triggered in a significant earthquake event such as the Alpine Fault.	4L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Emergency response planning only	Business Case required
MR2	94	Cleddau River	Road	Flooding	Cleddau River - flood risk. There are regular flooding events which inundate the road and damage structures.	4VL	4VL	No	Unknown. Pending further investigations	Difficult to address. Further work required. Address through integrated route strategy with MR3, MR5 and MR11	Business Case required
MR3	94	Eglington River	Road	Flooding	There are regular flooding events which inundate the road and damage structures. The river is a wide braided river which aggrades. There are current operating flood protection structures. Each year material is removed from under the bridge as it builds up.	4L	4VL	No	Unknown. Pending further investigations	Difficult to address. Further work required. Address through integrated route strategy with MR2, MR5 and MR11	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
MR4	94	Hollyford Rd to Chasm	Road	Avalanche	Avalanche risk for the winter season is the major focus which drives most of the work throughout winter (April/May-October/November). Twice a day there is an avalanche hazard forecast put out which drives public access, restrictions and control work. Climate trends: winter is arriving later but staying longer. This affects tourism. Increased precipitation and snow – however more rain on snow increases the risk. Risk level is rising with annual increasing traffic volumes.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing prevention	Business Case required
MR5	94	Hollyford River	Road	Flooding	Flood risk on the Hollyford River. There are regular flooding events which inundate the road and damage structures.	4L	4VL	No	Unknown. Pending further investigations	Difficult to address. Further work required. Address through integrated route strategy with MR2, MR3 and MR11	Business Case required
MR6	94	Homer Tunnel	Tunnel	Earthquake / liquefaction	Reinvestment issues for tunnel. There is a BC being developed for replacement portal/protection structures to build resilience for future earthquake, rockfall and avalanche events. The structure is ageing and will soon become a historic site, this will limit the works that can occur on the tunnel. A heritage assessment is currently in draft but recommends some very intensive improvement and maintenance works to protect the nature of the site.	4L	-	No	Physical works ($$$)	A smart design for replacement of the tunnel portals could deal with strengthening and upgrading, aiding avalanche and rockfall risks at the same time. In short term, Rockfall prevention measures e.g. scaling, fences and bunds. But has cross over with avalanche zone - avalanches will destroy rockfall structures. Longer term needs to reinforce and upgrade the portals/tunnel before it is designated as a historical site. A smart design for replacement of the tunnel portals could deal with strengthening and upgrading, aiding avalanche and rockfall risks at the same time. Portals are under the largest avalanche zones. In addition, remote control avalanche systems could be employed. This is a significant tourism route and also safety issues.	Business Case funded or underway
MR17	94	Homer Tunnel	Tunnel	Avalanche	Significant reinvestment issues for tunnel and portals but there is a BC being developed for replacement portal/protection structures. Resilience for future EQ/Rockfall. The structure is ageing, soon to be a historic site – heritage assessment currently in draft but recommends some very intensive improvement and maintenance works to protect nature of the site.	4L	4VL	No	Physical works ($$$$)		Business Case funded or underway
MR16	94	Homer Tunnel	Tunnel	Rockfall	Reinvestment issues for tunnel and portals but there is a BC being developed for replacement portal/protection structures. Resilience for future EQ/Rockfall. The structure is ageing, soon to be a historic site – heritage assessment currently in draft but recommends some very intensive improvement and maintenance works to protect nature of the site.	4VL	-	No	Physical works ($$$)		Business Case funded or underway
MR15	94	Milford Rd - Te Anau Downs to Milford	Road	Landslip	Landslides and under slip risk in a number of locations.	4VL	-	No	Enhanced proactive maintenance	Preventative works and repairs	Business Case required
MR14	94	Milford Road	Road	Earthquake / liquefaction	Significant earthquake risk across entire length of Milford road.	4L	-	Yes	Enhanced proactive maintenance	Monitoring and response procedures	Business Case required
MR10	94	Milford Road	Road	Extreme Weather	Tree fall due to extreme weather is a significant risk that is partly managed through an extensive tree removal programme however this is still resulting in significant residual risk which is likely to increase due to climate change. Tree fall hazard has led to fatalities in the last 5 years. The tree fall risk strategy in place primarily focuses on investment over time for managing (>3000 at present) and removing trees from along the roadside.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	Business Case required
MR7	94	Milford Road Bridges	Bridge	Flooding	In addition to the individually listed bridges, there are a number of 1-way truss and concrete bridges that are at risk to flooding. Greater than 30 bridges experience 8-9m of rain every year. Currently the alliance handles this well, however a single failure will break the entire network. A number of the bridges require ongoing work however, a reduction in bridge maintenance funds by NZTA will limit the amount of work that can be completed.	4L	4VL	No	Enhanced proactive maintenance	Enhanced maintenance	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
MR9	94	Milford Township	Road	Flooding	Flood risk. Currently there are a number of flood protection works being carried out to protect property. However, there is residual risk, but this is less of a highway risk. DOC have some ongoing work that involves increasing the ground level of Milford by 0.5-1m, as a significant portion of Milford is on reclaimed land and flood plain/fan. To provide slightly more protection for SLR and tsunami.	4L	4VL	No	Physical works ($$)	Raise village height and build higher stop banks. Some work is already underway	Business Case required
MR8	94	Milford Township	Road	Tsunami	Significant risk of landslide induced tsunami which could be triggered in a significant earthquake event such as the Alpine Fault. Also, tsunami waves at Milford Township from offshore sources.	4L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Emergency response planning only	Business Case required
MR11	94	Upukerora River	Road	Flooding	There are semi regular flooding events that inundate the road and damage structures.	4L	4VL	No	Unknown. Pending further investigations	Difficult to address. Further work required. Address through integrated route strategy with MR2, MR3 and MR5	Business Case required

3.7 Northland

A total of 10 major and extreme risks were identified within the Northland region. These relate predominantly to landslip and flooding. It is noted that some well-known risks in more remote areas do not appear on this list but do in the regional catalogue (refer Appendix A) as the risk rating is driven by both likelihood and consequence (criticality). The lower ONRC ratings in these remote areas result in a lower criticality and hence lower overall risk. Of note is the section of SH1 from the Brynderwyn's to Whangarei which is subject to both landslip and flooding – which is likely to increase in the future due to the impacts of sea level rise.

Table 3.7: Summary of major and extreme risks in Northland

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
N1	1	Brynderwyn to Ruakaka	Road	Landslip	Landslip risk on Brynderwyn hills, and limited detour HPMV incapable. No HMPV both ways. Detour route has a number of 1-way bridges. If the Brynderwyn route is out, the whole upper north is out. Currently working on the major detour route to address the risk to Brynderwyn. There are also a lot of outages because of accidents and breakdowns etc. The southern side has more issues. Traffic going south goes through Mangawhai and north goes through Paparoa.	4VL	-	No	Physical works ($$$$)	Short term solution is to upgrade alternate routes. Costs for this will likely be less than construction of a new alignment. There is a wider PBC under way to look at a range of options.	Business Case funded or underway
N3	16	Entire length of SH16	Road	Flooding	Flood risk to route. It is the only alternate route for SH1, but it is not a high-quality section of road. During the holiday season they strongly advise people to take SH16. Due to it being a key alternate route it should be higher than a primary collector. The ONF will look to address this.	4L	-	No	Unknown. Pending further investigations	Requires a detailed study	Business Case required
N9	16	Lookout slip	Road	Landslip	Significant landslip risk - Slip has occurred, there is a solution, but it has not been funded.	4L	-	No	Physical works ($)	Realign road as it could be a significant issue. Low cost low risk. Already designed.	Business Case required
N12	1	Oakley and Mata Flooding	Road	Flooding	Combined coastal inundation and river flooding risk. Key freight route. Used to occur every 5 years. Has been blocked twice in less than 10 years. Catchment boards involved in flood risk management were lost in the amalgamation of councils.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study	Business Case required
N4	1	Ruakaka and Whangarei	Road	Flooding	Flood risk between Ruakaka and Whangarei. Both river and tidal flooding during king tides. Typically, when there are issues on the SH there are issues on the local roads so there are no alternate options.	5L	5VL	No	Unknown. Pending further investigations	Requires further detailed study.	Business Case required
N15	1	South of Kawakawa	Road	Landslip	Landslip risk. Lack of detour unless travellers go onto SH 15 (> 4 hours detour), detour would cause issues for trucks.	4L	-	No	Unknown. Pending	Requires a detailed study	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
									further investigations		
N34	12	Te Pouahi to Waiotemarama	Road	Landslip	No detour, relevant for tourism (ONRC increase)	4L	-	No	Unknown. Pending further investigations	Requires a detailed study	Business Case required
N13	Twin Coast Discovery Road	Twin Coast Discovery Road - Herekino Forest	Road	Landslip	Largest area of slips/geological movement in the area, probably most exposed area.	3VL	-	No	Physical works ($$$)	BC developed, multi hazard area needs thought.	Business Case funded or underway
N18	12	Waipoa Forest	Road	Flooding	Removing trees due to Kauri Die back has increased flooding issues along SH12 through Waipoa Forest. $1.5M has already been spent to repair roads from damage caused by excavating trees.	4L	-	No	Unknown. Pending further investigations	Requires further detailed study.	Business Case required
N10	1	Wayby Road on SH1	Road	Landslip	Existing landslip, however, there has been no work done to understand the landslip risk. Ongoing land movement.	4VL	-	No	Unknown. Pending further investigations	Requires further detailed study.	Business Case required

3.8 Otago

A total of 25 major and extreme risks were identified within the Otago region. These relate predominantly to rockfall, landslip, flooding and ice / snow along State Highways 6, 8 and 88. The steep and unstable terrain presents significant risk that in many cases has both a high likelihood and significant consequence should the hazard occur.

Table 3.8: Summary of major and extreme risks in Otago

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
O1	8	Alexandra to Clarkes Junction (Milton)	Road	Ice / Snow	Risk from snow and ice.	4L	-	No	Physical works ($$)	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Business Case required
O4	1	Balclutha Bridge	Bridge	Flooding	Flooding of the Balclutha river has potential to impact / compromise the Balclutha Bridge. This is the only bridge and detour routes are significant.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study	Business Case required
O15	1	Big Kuri River	Road	Flooding	Big Kuri River north of Hampden deposits a large amount of gravels which causes water to flow over the bridge. 4-5-hour detour.	4L	4VL	No	Physical works ($$$)	The plan is to wait for the bridge to get to the end of its life then construct a new bridge with improved freeboard.	Business Case required
O46	8	Cromwell to Alexandra	Road	Landslip	Cromwell Gorge landslip risk. Numerous active landslips throughout the man-made Cromwell Gorge (part of the Clyde Dam construction). Actively dewatered on an ongoing basis to maintain slope stability.	4L	-	No	Physical works ($)	Corridor investigation to determine vulnerable areas and possible solutions to mitigate	Business Case required
O5	8	Cromwell to Alexandra	Road	Rockfall	Cromwell Gorge and Clyde Dam, current LCLR investigation project. A low number of rockfalls have occurred in the past, however there is potential for future rock fall. Relaxed and partially cracked benches which have accumulated debris and pose future risks.	4L	-	Yes	Physical works ($$)	Scaling, stabilisation and catch fences/structures	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
O8	6	Cromwell to Frankton	Road	Landslip	Landslip risk throughout the Kawarau Gorge. Some LCLR investigation work underway.	4VL	4VL	No	Physical works ($$$)	Retaining walls and drainage improvements	Business Case required
O6	6	Cromwell to Frankton	Road	Ice / Snow	Risk from snow and ice.	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter maintenance LOS and improved communication. Additional VMS required at selected locations along route where alternative routes exist	Business Case required
O7	6	Cromwell to Frankton	Road	Rockfall	Sites at risk to rockfall throughout the Kawarau Gorge.	4VL	-	No	Physical works ($$$)	Scaling, stabilisation and catch fences/structures	Business Case required
O9	88	Dunedin to Port Chalmers	Road	Landslip	Constructed as side cast fill – cut into the bank and the compacted the fill on the side so one good lane and one lane that is likely to slip in an EQ. Corridor which probably needs a holistic view across its whole length. Freight and rail would likely be knocked out as well as it is on fill and therefore would rely on shallower draft ships to drop off goods. This is the main trunk line from CHCH to Bluff. Slips occur during storm events as a result of water coming down from hillsides. Small washouts of roadside barriers also occur.	3VL	3VL	Yes	Physical works ($$$)	Retaining walls and drainage in the short term, with wider investigation required for the longer term	Business Case required
O34	6	Frankton to Kingston	Road	Ice / Snow	Risk from snow and ice.	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Business Case required
O48	6	Frankton to Kingston	Road	Landslip	Landslips along the side of Lake Wakatipu.	4VL	-	No	Unknown. Pending further investigations	Corridor investigation to determine vulnerable areas and possible solutions to mitigate	Business Case required
O11	6	Haast Pass to Lake Hawea	Road	Ice / Snow	Risk from ice and heavy snow. Passes through a national park with overhanging trees, prone to falling.	4L	-	Yes	Enhanced proactive maintenance	Winter maintenance LOS and improved communication	Business Case required
O50	6	Haast to Hawea	Road	Rockfall	Numerous large scale rockfall locations along the corridor. Improved funding would be a starting point to improve resilience but not resolve the issue in its entirety. Funding currently allocated through the National Rockfall programme to address isolated high priority sites with a supporting Rockfall Hazard Rating System (RHRS) score.	4VL	-	No	Physical works ($$$)	Scaling, stabilisation and catch fences/structures	Business Case required
O12	1	Katiki Coast	Road	Coastal Erosion	Both bottom up and top down erosion along the coast. Some coastal erosion funding has been provided. If coastal route is gone there is a light vehicle detour but heavy's will be 4-5 hours. Mini Kaikoura as KiwiRail is located directly next to the road. The only coastal section of SH1 and vulnerable to high seas and erosion.	3VL	3VL	No	Physical works ($$$)	Continuation of rock revetment. Assessment and development of overland flow measures to prevent top down erosion.	Business Case required
O13	1	Katiki Coast	Road	Coastal Inundation / SLR	Only coastal section of SH1 and vulnerable to high seas and inundation. Some bridges are within 2m of high tide level	3VL	3VL	No	Physical works ($$$)	Requires continuation of rock revetment.	Business Case required
O47	6	Lake Hawea and Lake Wanaka	Road	Landslip	Landslips along the side of lakes Wanaka & Hawea. This links to risk Id WC9 which identifies landslip issues along Haast Pass.	4VL	-	No	Unknown. Pending further investigations	Corridor investigation to determine vulnerable areas and possible solutions to mitigate	Business Case required
O15	1	Maheno	Bridge	Flooding	Flooding issues within a number of river catchments. Options have been scoped. Overland flow path floods the road between Clarks Mill and where the road crosses the railway. There is a plan to put culverts in to allow water to run from one side of the road to the other to stop flooding. When this floods the bridge also floods and the detour is ~ 4-5 hours.	4L	4VL	No	Physical works ($$)	Upgrade culverts and overland flow paths.	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
O51	6	Nevis Bluff	Road	Rockfall	Nevis Bluff is a significant unstable feature between Cromwell and Queenstown. Proactive monthly inspections are undertaken and programmed rock scaling pre & post winter to remove fractured material is funded and managed through the NOC. Regular additional funding is required to address high other priority/urgent unstable features in the order of $1M-$5M per intervention. Alternate long-term options could be investigated such as a tunnel.	4VL	-	No	Enhanced proactive maintenance	More detailed investigation required which would assess all possible options. Continued proactive monitoring and maintenance intervention	Business Case required
O16	8	Omarama to Tarras	Road	Ice / Snow	Continuous snow in winter. Winter events affect both sides of Lindis Pass. This is within the corridor management plan from Christchurch to Queenstown.	4L	-	Yes	Enhanced proactive maintenance	Winter maintenance LOS and improved communication	Business Case required
O17	8	Omarama to Tarras	Road	Rockfall	Rockfall risk predominantly to the south of Lindis Pass (Central Otago side).	4L	-	No	Physical works ($$)	Scaling, stabilisation and catch fences/structures. Detail in the corridor management plan.	Business Case required
O36	1	Palmerston to Dunedin	Road	Ice / Snow	Snow and ice risk.	4L	-	Yes	Enhanced proactive maintenance	Winter maintenance LOS and improved communication	Business Case required
O19	6	Queenstown to Frankton	Road	Landslip	Highly vulnerable to rainfall induced landslips.	4L	4VL	No	Physical works ($$$)	Retaining walls and improving lakeside stability to minimise under slips	Business Case required
O18	6	Queenstown to Kingston	Road	Rockfall	Highly vulnerable to rockfall.	4L	-	No	Physical works ($$$)	Scaling, stabilisation and catch fences/structures	Business Case required
O15	1	Waikouati River	Road	Flooding	Waikouati River floods the highway.	4L	4VL	No	Physical works ($$)	Raise level of road to clear flood level	Business Case required
O21	1	Wakouaiti to Evansdale	Road	Landslip	The Kilmog is a very unstable length of road. Grout columns have been installed through sections of highway but are now protruding through the road surface. Haven't considered options in depth due to multimillion-dollar need. Extremely slip prone ground. National Criticality. Light traffic can use Coast Road as a detour. There are a couple of sites with options which could greatly enhance or remove the issues with the right solution.	3VL	3VL	No	Physical works ($$$)	Piling works to retain active slopes. Drainage improvements and ongoing pavement and surfacing intervention to maintain LOS	Business Case required

3.9 Southland

A total of 2 major risks were identified within the Southland area. The most significant of these relates to a coastal section of SH1 to the Port. This is at risk from coastal inundation and sea level rise with current flooding likely to increase to extreme in the long term.

Table 3.9: Summary of major and extreme risks in Southland

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
S1	1	Entire coastal section at Ocean view north of Bluff	Road	Coastal Inundation / SLR	Ocean view route to the port - risk to coastal inundation that will need to be addressed within the next 10 years. Combination of coastal and rainfall flooding at high tide resulting in traffic lanes being submerged over a length of approximately ~70m. This is the key route to the port, with no detour. Compounding issue is that the lagoon doesn't drain.	4L	4VL	No	Physical works ($$)	Raise the road for around 70m	Business Case required
S2	94	Gorge Hill	Road	Landslip	Landslip risk at Gorge Hill. Slip has failed previously, completely damaging the road. Currently no detour, however a subsidiary road could be built through farmers land. Has been stable, with preventative maintenance undertaken.	4L	4VL	No	Emergency response and preparedness planning only	Pre buy section in advance to be able to build an alternate/backup road.	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
					Slumping is topped up approximately monthly. Annual visits to survey the movement. Low volume but strategic for tourist reasons. 4-hour detour.				(typically HI/LF)		

3.10 Taranaki

A total of 18 major and extreme risks were identified within the Taranaki area. These relate predominantly to rockfall, landslip, erosion and flooding - primarily along SH3. All of the risks are rated major in the short term, but the majority increase to extreme under a future climate scenario.

Table 3.10: Summary of major and extreme risks in Taranaki

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
T2	3	Awakino gorge	Road	Rockfall	Rockfall risk, erosion drop out, over and under slips and severe weather (>2m rainfall a year). This is a priority for significant rockfall and vegetation removal (due to rockfall). Currently Awakino Gorge tunnel only bypasses ~500m of the gorge. Difficult to predict where rockfall will occur next, therefore difficult to plan for unless the entire 8km was realigned. High risk gorge environment with no viable detour.	4L	-	No	Physical works ($$$)	Rockfall protection, mesh, clearing material and retaining walls.	Business Case required
T14	3	Awakino Village	Road	Coastal Erosion	Awakino Village at risk of coastal erosion.	4L	4VL	No	Physical works ($$)	In the short term continue rock fencing. Realignment and smoothing the corner and cut into the bluff is the long-term solution. ~60-70m bluff.	Business Case required
T3	3	Entire length of SH3 north of New Plymouth	Road	Landslip	Landslip risk to strategic highway on Taranaki network. Lack of viable alternative route with the nearest detour being SH4, adding a large amount of time and distance. Substantial geotechnical structures for slope instability along the road south of Piopio (in the gorges). Some structures are very old.	4L	4VL	No	Physical works ($$)	Requires a detailed study	Business Case required
T4	3	Entire length of SH3 north of New Plymouth	Road	Rockfall	Significant rockfall risk.	4L	-	No	Physical works ($$)	Requires a detailed study	Business Case required
T8	3	Mangaotaki gorge	Road	Landslip	Mangaotaki Gorge is at risk of landslip. Currently has no geotechnical barriers.	4L	4VL	No	Physical works ($$$)	Active/priority sites have been funded but the whole corridor has a resilience issue. Retaining walls.	Business Case required
T9	4	Mapara North road through to Ohura road	Road	Flooding	Occurs from approximately 12km in Mapara North road through to Ohura road - over slip, under slip and localised flooding during extreme weather. Requires preventative maintenance works. Waterfall Hills - reasonable geotechnical remediation being put in place to address under slip and bluff rock fall.	3VL	3VL	No	Physical works ($$)	Further investigations needed	Business Case required
T10	3	Mohakatino and Tongaporutu estuaries	Road	Coastal Inundation / SLR	Mohakatino and Tongaporutu estuaries could potentially have coastal inundation and erosion issues.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
T12	3	Mohakatino Bridge	Road	Coastal Erosion	Potential for erosion risk due to it being low lying and in an estuary. The causeway is very narrow and vulnerable to erosion due to wave action. Currently a low cost, low risk project to provide rock armour. One side of the wall had rock armour which has been washed out. Could have coastal inundation issues in the future, however the geomorphology of the estuary could change this.	4L	4VL	No	Physical works ($$)	Rock armour improvements in the short term, but needs a long-term plan	Business Case required
T13	3	Mokau Bluff	Road	Erosion	Mokau Bluff, at risk of coastal erosion.	4L	4VL	No	Physical works ($$)	In the short term continue rock fencing. Realignment and smoothing the corner and cut into the bluff is the long-term solution. ~60-70m bluff.	Business Case required
T15	3	Mt Messenger	Road	Landslip	South of Mt Messenger is at risk of landslip- Uruti Valley has a number of cuttings prone to slipping.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study	Business Case required
T16	3	Patea Bridge	Bridge	Erosion	Bridge built between 60's-70's at risk to erosion.	4L	4VL	No	Physical works ($$)	Strengthening or realignment of the bridge would be a more beneficial outcome in comparison to a new route.	Business Case required
T17	45	Ratahei to Whanganui	Road	Landslip	Raetihi to Whanganui major landslip which occurred in 2019. This already has a PBC underway.	3VL	3VL	Yes	Physical works ($$$$)	PBC already underway	Business Case funded or underway
T19	3	SH3 Midhurst rail overbridge	Road	Erosion	SH3 Midhurst rail overbridge has the potential for erosion and scour - which may in turn affect the road below. The detour route is also very long and is not ideal for HPMV.	4L	4VL	No	Unknown. Pending further investigations	There is no specific risk at the moment, but the solution should be similar to what occurred in Normandy, bridge realignment and creation of a viable detour. Main pinch points are all bridges with no detour routes.	Business Case required
T18	3	SH3 Midhurst rail overbridge	Road	Flooding	SH3 Midhurst rail overbridge has the potential for flooding. The rail and river bridge are back to back with detours that are not ideal for HPMV. The detour route is also very long. There is no specific hazard at the moment, but the solution should be similar to what occurred in Normandy, bridge realignment and creation of a viable detour. Main pinch points are all bridges with no detour routes.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study	Business Case required
T20	3	South of Mt Messenger	Road	Erosion	Erosion risk where river runs adjacent to SH3 South of Mt Messenger	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Requires ongoing monitoring and potential stabilisation	Business Case required
T22	3	Tongahoe	Bridge	Erosion	Bridge built between the 60's-70's and is at risk to erosion. Tongahoe should be a high priority as it has a bluff and the river.	4L	4VL	No	Physical works ($$)	Strengthening or realignment of the bridge would be a more beneficial outcome in comparison to a new route.	Business Case required
T23	3	Tongaporutu estuary	Road	Coastal Erosion	Route has coastal erosion risk due to the estuary and also has potential to be at risk from coastal inundation.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Requires ongoing monitoring and potential stabilisation	Business Case required
T24	3	Waitotara bridges	Bridge	Erosion	Erosion risk to the bridge. Built between 60's-70's.	4L	4VL	No	Physical works ($$)	Strengthening or realignment would be of more value than creating a new route,	Business Case required

3.11 Top of the South

A total of 23 major and extreme risks were identified within the Top of the South area. These relate predominantly to rockfall, landslip, erosion and flooding, as well as extreme weather, ice/snow and wildfire. The significant number of landslip risks on SH's 6 and 65 (including Dallows Bluff, Deadman's slip, Higgins Bluff, Hope Saddle and the Upper Buller Gorge) were considered to be the highest risk section of the regions transport system (as per commentary from regional stakeholders). A significant number of the major risks are likely to increase to extreme in the long-term.

Table 3.11: Summary of major and extreme risks in the 'top of the south'

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
TS6	6	Canvastown along Pelorus River	Road	Flooding	River floods and inundates the road	4VL	4VL	No	Physical works ($$$)	Raise the road -	Business Case required
TS22	63	Connors Bend along Wairau River	Road	Flooding	Flooding risk where land drains river.	4L	4VL	No	Physical works ($$)	Better drainage required	Business Case required
TS7	6	Dallows Bluff	Road	Rockfall	Frequent rockfall on SH6 stretch between intersections with SH65 and SH63. High priority for the Top of the South	4VL	-	No	Physical works ($$)	Requires netting.	Business Case required
TS27	65	Deadman's Slip	Road	Landslip	Undercutting of the road caused by the river	3VL	3VL	No	Physical works ($$)	Requires armouring and protection.	Business Case required
TS8	6	Entire Region	Road	Wildfire	Wildfire risk to wooden structures such as bridges and retaining walls which exist across the entire region.	4L	4VL	No	Enhanced proactive maintenance	Preparedness	Business Case required
T65	6	Glenhope to Murchison	Road	Ice / Snow	Ice and snow risk through hills from Glenhope to Murchison	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Business Case required
TS9	6	Granity Rockfall	Road	Rockfall	Frequent rockfall on SH6 stretch between intersections with SH63 and WC boundary. High priority for the Top of the South	4VL	-	No	Physical works ($$)	Requires netting.	Business Case required
TS28	65	Higgins Bluff	Road	Rockfall	Rockfall risk along the bluff.	4VL	-	No	Physical works ($$)	Requires netting.	Business Case required
TS10	6	Hope saddle	Road	Landslip	Ongoing landslip risk	4VL	4VL	No	Physical works ($$)	Requires netting.	Business Case required
TS11	6	Kawatiri to Owen	Road	Erosion	At risk to river erosion and drop out.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	Business Case required
TS30	65	Mauria River	Road	Erosion	Surface flooding and undercutting / erosion where river is next to the road.	4VL	4VL	No	Physical works ($$$)	Rock protection along river to protect road	Business Case required
TS29	65	Mauria river	Road	Flooding	Surface flooding and undercutting / erosion where river is next to the road	3VL	3VL	No	Physical works ($$$)	Rock protection	Business Case required
TS12	6	O'Sullivans Bluff	Road	Rockfall	Frequent rockfall on SH6 stretch between intersections with SH65 and SH63. High priority for the Top of the South	4VL	-	No	Physical works ($$)	Requires netting.	Business Case required
TS1	1	Redwood Pass	Road	Rockfall	Rockfall risk through Redwood Pass.	4L	-	No	Physical works ($$)	rockfall protection	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
TS24	63	Salt Lake	Road	Flooding	Runoff leads to flooding of road	4L	4VL	No	Physical works ($$)	Box culverts and raise road.	Business Case required
TS20	60	Takaka Hill	Road	Landslip	Landslip risk with both under and over slips. Mainly on the Nelson side. Occurs at least once a year. There are also a number of drainage issues.	4VL	4VL	No	Physical works ($$$)	Realignment improve drainage and catchment management. Even with improvements, there would still be ongoing issues, requiring response and BAU maintenance.	Business Case required
TS25	63	The wash	Road	Flooding	Flooding risk through the Wairau Valley as road follows river in floodplains.	4L	4VL	No	Physical works ($$)	Raise road and provide river protection	Business Case required
TS2	1	Tuamarina to Picton	Road	Flooding	Surface flooding risk from adjacent catchment runoff.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study	Business Case required
TS16	6	Upper Buller Gorge	Road	Erosion	Erosion risk along the Buller Gorge in both Top of South and West Coast.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	Business Case required
TS13	6	Upper Buller gorge	Road	Extreme Weather	Extreme weather risk with strong winds resulting in tree fall.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	Business Case required
TS14	6	Upper Buller gorge	Road	Landslip	At risk to landslips both over and under slips.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	Business Case required
TS15	6	Upper Buller Gorge	Road	Rockfall	Rockfall risk with rockfall occurring along the Buller Gorge in both Top of South and West Coast.	4L	-	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	Business Case required
TS26	63	Windy Point	Road	Rockfall	Constant Rockfall on the beginning stretch of SH63	3VL	-	No	Physical works ($$)	Requires netting.	Business Case required

3.12 Waikato

A total of 5 major and extreme risks were identified within the Waikato area. These relate predominantly to landslip, erosion, flooding along SH1, as well as the potential for and ice/snow along SH5 (Kaweka Ranges). The most significant risk was rated as erosion risk along Lake Karapiro.

Table 3.12: Summary of major and extreme risks in Waikato

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
WK1	1	Along Lake Karapiro	Road	Erosion	Erosion of riverbank can undermine road. There are significant detour issues along this road if it were out of service.	5L	-	No	Physical works ($$$)	Realignment, new bridge or possible retaining wall. Also invest in upgrades to Maungatautari Road through strengthening of structures to carry HMPV's. Realignment, bridge or possible retaining wall.	Business Case required
WK7	1	Bulli Point	Road	Landslip	Bulli point drop out combined with narrow carriage way significantly lowers the resilience. Typically to repair you need to close both sides of the road. Even for repairs you need to close the road.	4L	-	No	Physical works ($$$)	Build retaining wall(s) on Lakeside and/or cut into adjacent rock face. Ultimate solution is to construct the proposed Hatepe to Motuoapa realignment project.	Business Case required
WK4	3	Entire stretch of SH3	Road	Landslip	Landslip risk with road instability. Key route for LPG to get trucked from New Plymouth to Auckland.	4L	4VL	No	Unknown. Pending	Business Case required	Business Case required

									further investigations		
WK20	1	Flooding just north of Turangi	Road	Flooding	Surface flooding issues along SH 1 through Waiotaka Straight (within Waiotaka Valley). This is a low-lying wetland area (South Taupo Wetlands) which is prone to flooding.	4L	4VL	No	Unknown. Pending further investigations	Business Case required	Business Case required
WK8	5	Kaweka Ranges	Road	Ice / Snow	Major snow event caused power lines to drop and this blocked the road, preventing snow removal. This led to a significant event. Potential for undergrounding of the lines to stop the road from going out. Poor to no cell phone connection means if there are any issues its very hard to call any emergency services.	4L	-	No	Physical works ($$$)	Underground overhead lines and improve telecommunications/cell phone reception	Business Case required

3.13 Wellington

A total of 9 major and extreme risks were identified within the Wellington area. These relate to rockfall, landslip, erosion, flooding, coastal inundation and earthquake/liquefaction - along SH1 and SH2. A large number of the identified risks are projected to increase as a result of climate change.

Table 3.13: Summary of major and extreme risks in Wellington

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
W14	1	Aotea	Road	Earthquake / liquefaction	Seismic risk to Aotea off-ramp as it is thought that the Wellington fault is located underneath it.	4L	-	No	Physical works ($$$$)	Requires interface with various asset owners - WCC, KiwiRail & The Port Authority to agree full mitigation option	Business Case required
W15	1	CBD to Ngauranga	Road	Earthquake / liquefaction	A number of critical road and rail bridges, structures, utilities etc located in this corridor and within a high earthquake zone.	4L	-	No	Physical works ($$$$)	Would require a prioritised list and mitigation option for each structure	Business Case required
W5	1	SH1 Centennial Highway	Road	Coastal Erosion	Sea level rise, storm events, high seas causing damage to seawall.	5L	5VL	No	Physical works ($$$)	Ongoing armouring. More work required to determine appropriate solutions	Business Case required
W4	1	SH1 Centennial Highway	Road	Coastal Inundation / SLR	Coastal inundation and SLR risk with water over topping the road in larger events. Currently reactive maintenance is prioritised as opposed to proactive. Culvert near Paekakariki blocks frequently due to lose material causing flooding in the town. Catchments flood in short duration events causing slips and debris/blockages. KiwiRail assets are adjacent (up-catchment) and also are affected. Even with completion of Transmission Gully, access will still be required for the rail line.	5L	5VL	No	Physical works ($$$)	Will continue to flood in the long term but will require ongoing repair and maintenance. More work required to determine appropriate solutions.	Business Case required
W3	1	SH1 Centennial Highway	Road	Rockfall	Rock, debris comes down off the steep slopes and covers the road and rail network. NZTA are trying to get KiwiRail to input into funding. Risk will be reduced once Transmission Gulley is open.	5L	-	No	Physical works ($$$)	Ongoing slope stabilisation works required.	Business Case required
W6	1	SH1 Kuku	Road	Flooding	Flooding occurs frequently in low lying area - caused by a land drainage issue where water builds up on the highway approx. once a year. Flooding can often reduce traffic down to one lane and has affected both lanes for a couple of hours. With help from Council it could be improved. Risk could also be reduced if Otaki to Levin is confirmed.	5L	5VL	No	Physical works ($$)	Requires Council to address adjacent land drainage and runoff - less of an issue once O2NL is constructed. could significantly improve the flood issue - especially considering the detour is extensive.	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
W19	1	SH1 Ngauranga Gorge	Road	Landslip	Rockfall risk and landslides - targeting low cost, low risk funding. Multiple users including cyclists. Debris screen is a hard structure and the footpath has become a combined pathway with no room left for construction. Low cost, low risk would address most of these.	4L	4VL	No	Physical works ($$$)	Some minor works planned, but would require significant infrastructure to fully mitigate	Business Case required
W2	1	SH1 Porirua	Road	Flooding	Some flooding. The roads go through wetland like material, some of the culverts and streams are full of gravel and upper reaches of streams need clearing and maintaining. NZTA ends up with the problem but they have very little control of what happens up or down stream of the road.	4L	4VL	No	Physical works ($$$)	Ongoing improvements to manage high intensity rainfall events - will require Council to improve stormwater catchment	Business Case required
W17	2	SH2 Remutaka Hill	Road	Earthquake / liquefaction	Whole SH 2 Remutaka Hill (13km) is at risk to earthquake shaking. If there is an EQ it will be out of service due to many risks. Focus should be on SH1 first to get a route open to the north before addressing SH2.	4L	-	No	BAU / Ongoing maintenance / Reactive	Requires ongoing investment to improve resilience, but likely to always be a risk in large earthquakes	Business Case required

3.14 West Coast

A total of 21 major and extreme risks were identified within the West Coast area. These relate to extreme weather, ice/snow, erosion, rockfall, landslip and flooding - along state highways 6, 7, and 73.

Table 3.14: Summary of major and extreme risks on the West Coast

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
WC1	7	Black Point	Road	Erosion	A few river erosion sites near Reefton river. Ongoing rock armouring.	4L	4VL	No	Enhanced proactive maintenance	Rock protection	Business Case required
WC2	6	Bruce Bay	Road	Coastal Erosion	Route at risk from erosion. Rock protection measures are starting to be implemented through emergency works funding following Cyclone Fehi (2018). However, if there was another cyclone a large section of the road has the potential to be lost regardless of current resilience work.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Rock protection however will still be residual risk	Business Case required
WC3	6	Buller Gorge	Road	Extreme Weather	Extreme weather risk with tree fall along gorge.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Regular maintenance in tree cutting	Business Case required
WC5	6	Fox River	Road	Coastal Inundation / SLR	Fox River - low lying with sea level rise risk.	4L	4VL	No	Enhanced proactive maintenance	Ongoing monitoring and maintenance	Business Case required
WC25	6	Franz Josef to Fox Glacier	Road	Ice / Snow	Snow and ice over hill between Franz Josef and Fox Glacier	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Business Case required
WC6	6	Greymouth to Westport	Road	Coastal Erosion	Coastal erosion during a cyclone has the potential to affect the whole region. Increased frequency to approx. once a year. Typically, still repairing from the previous event when then next one comes. Still recovering from Fehi 2018. All works are currently reactive. 4 sites where preventative works, these could be prioritised.	4VL	4VL	No	Enhanced proactive maintenance	Rock protection	Business Case required

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Next Steps
WC7	73	Griffiths Bridge	Bridge	Erosion	Erosion and scour risk around the bridge.	4L	4VL	No	Physical works ($$$)	New bridge	Business Case required
WC10	6	Haast Pass	Road	Erosion	Erosion risk along Haast River.	4L	4VL	No	Physical works ($$$$)	Expensive protection works	Business Case required
WC9	6	Haast Pass	Road	Landslip	Route at risk from landslip. Currently all reactive works with proactive management on some sites, however there is still a risk of losing the whole road. A few landslip sites could potentially be more proactive some of it which would be less than $1m, however it is more like $5m altogether.	4VL	4VL	Yes	Enhanced proactive maintenance	Some areas could have more proactive work undertaken.	Business Case required
WC8	6	Haast Pass	Road	Rockfall	Rockfall along the Haast River with only reactive works occurring.	4L	-	No	Enhanced proactive maintenance	could be more proactive	Business Case required
WC12	6	Knights Point	Road	Landslip	Most vulnerable piece of road to landslip in New Zealand and currently only has reactive work underway.	4VL	4VL	No	Enhanced proactive maintenance	Also, would require further investigation	Business Case required
WC15	7	Lewis Pass	Road	Flooding	Shingle fans depositing on the road, as well as surface flooding risk.	4L	4VL	No	Physical works ($$$)	Solvable with upgrade to double lane bridges and bridge realignment away from rockface.	Business Case required
WC13	7	Lewis Pass	Road	Ice / Snow	Ice and snow risk at summit.	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter operations	Business Case required
WC17	73	Otira River at Otira	Road	Erosion	River erosion risk. Already funded but has ongoing issues in other areas as well.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Monitor and reactive maintenance	Business Case required
WC19	7	Rahu Saddle	Road	Extreme Weather	Extreme weather risk with trees falling from high winds.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Annual inspections and selective removals where risk identified	Business Case required
WC18	7	Rahu Saddle	Road	Ice / Snow	Snowfall and ice risk.	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter operations	Business Case required
WC20	6	Scout Lodge Straight	Road	Erosion	Significant river erosion risk.	4VL	4VL	No	Physical works ($$$)	River protection works (groynes) to train river and realign road.	Business Case required
WC21	6	South of Ross to Haast Pass	Road	Flooding	All rivers south of Ross (~15 rivers) need training/stop banking and active management to reduce flood risk.	4VL	4VL	No	Enhanced proactive maintenance	Ongoing training works and management	Business Case required
WC22	6	Southern side of Punakaiki	Road	Coastal Inundation / SLR	Low lying and vulnerable to sea level rise.	4L	4VL	No	Physical works ($$$)	Rock protection	Business Case required
WC23	73	Taipo Bridge	Bridge	Flooding	Flood risk along one lane bridge.	4L	4VL	No	Physical works ($$$$)	replace whole bridge and double lane	Business Case required
WC24	73	Wainihinini Bridge	Bridge	Flooding	Flood risk to bridge. Bridge replacement is critical from a HMPV point of view. Currently reaching end of life.	4L	4VL	No	Physical works ($$$)	Replace bridge.	Business Case required

4 Closing comments

This report summarises the physical natural hazard and climate change risks for the NZTA network. The risks have been identified through both review of existing information and a series of stakeholder workshops around New Zealand. They have been rated using a specific risk assessment methodology and suggested solutions for risks were documented at workshops (based on knowledge of regional staff).

The next steps will be for NZTA to review the extreme and major risks for each region and make decisions on how to progress mitigation responses.

5 Applicability

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

Tonkin & Taylor Ltd

Report prepared by:	Authorised for Tonkin & Taylor Ltd by:
.....	.....
Rebekah Robertson	Richard Reinen-Hamill
Disaster Risk and Resilience Specialist	Project Director

Reviewed by:

.....

James Hughes

Climate and Infrastructure Resilience Specialist

Chris Purchas – Project Manager

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Appendix A: Regional PRA catalogues

A1.1 Auckland regional risk catalogue

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outa
A1	1	Tank Farm Culvert to Exmouth Footbridge	Road	Coastal Inundation / SLR	Southbound lanes between Tank Farm Culvert and Exmouth St Footbridge get inundated during high tides (and storm surge). This results in varying amounts of inundation across 4 lanes: from bus lane only through to all lanes. This can cause significant disruption to the availability and resilience of the system. In extreme cases this results in significant disruption (and loss of multiple lanes) for about 2 hours at high tide.	4L	4VL	No	Physical works ($$)	There is a coastal inundation resilience study that is underway for this location. Funding is only for the investigation and options assessment. Several options are being explored such as raising the road (partial or fully), flood barriers, using new concrete barriers with pumps and/or non return systems. There are a range of other risks including to the Transpower NAaN 220kV.	Yes	3	2	5	0	5	2	3	3
A2	1	Silverdale North Weiti Stream	Road	Flooding	Flooding of the road, loss of system access and availability. Potentially some secondary erosion in significant events.	3UL	3L	No	Physical works ($$)	Couple of options physical works or land use planning. Physical works would look to supplement existing infrastructure or build a new asset. Stand alone business case unlikely to be found justified due to the risk to cost ratio. Emergency response plan is available for flooding across roads.	Yes	1	2	5	0	5	1	2	3
A3	1	Titford Bridge Puhoi	Road	Flooding	Flooding of the highway at/adjacent to Titfords bridge which can be exacerbated by high sea/tides. Loss of system access and availability. Potentially some secondary erosion in significant weather events (rain/tide combination).	4UL	4VL	Yes	Physical works ($$$)	This hazard is being engineered out by current SH1 Puhoi to Warkworth project with a new road alignment, and viaduct system. Once the new highway is built the existing highway will be relocated to the local authority and risk will no longer fall with the agency and the road will no longer be ONRC band 5.	Yes	1	1	5	0	5	2	3	3

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A4	1	John Creek	Road	Flooding	Flooding across the highway resulting in loss of system access/availability. Contributing catchment area is being earmarked for significantly development under a Structure Plan Change. Without right development controls this could result in increased runoff and increased resilience risk. If/when South Silverdale Interchange floods it is a fairly lengthy detour with next interchanges at South at Oteha Valley.	4UL	4L	No	Physical works ($$)	Couple of options - either physical works or land use planning. Physical works would look to supplement existing infrastructure or build a new culvert/bridge asset. Stand alone business case unlikely to be found justified due to the risk to cost ratio. Emergency response plan is available for flooding across roads.	Yes	1	2	5	0	5	2	2	3
A5	1	Greville Interchange	Road	Flooding	Flooding of the road (from Southbound On Ramp to Mainline) reducing service at SH1 Southbound.	3UL	3L	No	Physical works ($$$)	Falls within the current northern corridor interchange (NCI) project which is supposed to be engineered to the agencies minimum standards. Not sure if the regional flood risk here is resolved. Stand alone business case unlikely to be found justified due to the risk to cost ratio. Emergency response plan is available for flooding across roads.	Unsure	1	1	5	0	5	1	2	2
A6	1	Hillcrest Stream	Road	Flooding	Flooding of the road at the culvert - only has a capacity of 13m3/s however demand from catchment is approximately 30m3/in a 1%AEP event. Loss of system access. Concrete barriers at the southern bound lanes at the busway and could result in damming of the road and loss of system access/availability resilience	3UL	3UL	No	Physical works ($$$)	Renewed bridge structure and or land use and planning development controls. Stand alone business case unlikely to be found justified due to the risk to cost ratio. Emergency response plan is available for flooding across roads.	Yes	1	1	5	0	5	1	2	1

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A7	1	Khyber to Gillies - Mountain Road	Road	Flooding	High potential for pooling of water. Is 100% reliant on soakage disposal. Surface water collection, conveyance and disposal systems area all of limited design capacity. A 1% AEP rainfall event could result in loss of system access and availability.	3UL	3L	No	Physical works ($$$)	A significant component of an alternative drainage system here be in securing land. For example to tunnel (via TMB) for stormwater management away from system would require purchasing of land away from infrastructure. Relatively convenient detours available but regional system disruption will be significant	Yes	1	1	5	0	5	1	2	2
A8	22	Whangapouri Stream	Road	Flooding	Flooding of the road due to the stream. Significant development occurring in the contributing catchment at this location.	2L	2VL	No	Physical works ($$)	Couple of options physical works or land use planning. Physical works would look to supplement existing infrastructure or build a new bridge/culvert asset. Major development occuring in contributing catchment will increase risk unless right development controls in place. Stand alone business case for bridge/culvert renewal unlikely to be found justified due to the risk to cost ratio. Emergency response plan is available for flooding across roads.	Yes	2	3	3	0	3	1	3	3
A9	22	Oira Stream	Road	Flooding	SH22 gets inundated by flooding at the Oira Stream	2L	2VL	No	Physical works ($$)	Couple of options physical works or land use planning. Physical works would look to supplement existing infrastructure or build a new bridge/culvert asset. Major development occuring in contributing catchment will increase risk unless right development controls in place. Stand alone business case for bridge/culvert renewal unlikely to be found justified due to the risk to cost ratio. Emergency response plan is available for flooding across roads.	Yes	2	2	3	0	3	1	3	3

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A10	2	SH1 to SH25	Road	Flooding	Significant vulnerability to road becoming impassable across the much of SH2 between SH1 through to SH25. There exist 97 culverts at this 30km section of SH2 with many significantly inadequate for performance capability (relative to demand) as well as being of marginal condition (limited life to structural failure). Plans for major Capital Project Upgrades across 5 sections (A-E) have been put on hold. Only the Mangatawhiri Deviation (section B) has good resilience.	3L	3VL	No	Physical works ($$$$)	Waka Kotahi already has capital project designs available which includes the correct designed culverts to deliver the correct level of service. Agency already has a PBC but for about 30 years upgrade needs have not been funded. In the interim this is dealt with in emergency preparedness and response planning, including traffic control measures (and detours available if/when required). There are 5 sections of individual capital project designs which could be funded individually. Some of the highway would be built in place other locations would be built in new green sites. SH2 Section A (SH1 to Mangatawhiri), and/or Section B (Mangatangi to SH25) is most likely to be the first section/s funded.	Yes	2	3	3	0	3	2	3	3
A11	1	Lonely Track Road North Slip	Road	Landslip	Landslip issues. This is currently viewed as being one of the highest risks on the Auckland network - which has potential to cause a loss of system availability. Significant land instability issues detected with ongoing movement since construction in late 90's as part of the SH1 ALPURT A1 Project. Close monitoring and proactive sealing of tension cracks to slow down failures is currently funded under ASM TOC for initial investigation (only).	5L	5VL	No	Unknown. Pending further investigations	Significant issue - Currently investigation works are underway to better understand the scale of the risk and any resultant work needs. This includes additional monitoring and investigation of the likelihood and consequence of a slip. Auckland System Management (ASM) TOC funding to a capped budget is available for the current investigation stage. Monitoring in various forms has been occurring since 2008. ASM TOC funding for investigation in the last year has been made available to confirm the risk profile and any recommendations on mitigation. Additional funding would be needed for any physical works.	Unsure	2	3	5	0	5	3	3	3

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A13	1	Khyber to Gillies Tomos	Road	Volcanic	Potential for Tomo's beneath the ground which have the potential to collapse or open up.	3L	-	No	Unknown. Pending further investigations	Currently would be addressing any failure under emergency response planning such as detours. There is some scope for proactive management in the form of enhanced geotechnical understand such as thorough ground penetrating radar assessment for more detailed analysis of any risks/residual risks. In event of a Tomo collapse the immediate response will be filling with concrete to reinstate availability of highway	Unsure	1	2	5	0	5	1	-	-

A1.2 Bay of Plenty regional risk catalogue

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
BP17	35	East Cape	Road	Erosion	Increased rainfall in the ranges will result in increased sedimentation along the coast and increased scour along bridges	3UL	3L	No	Unknown. Pending further investigations	Further investigations needed	No	1	2	2	0	2	3	2	3
BP14	29A	Greerton Flooding	Road	Flooding	Culvert stops flood waters	3UL	3L	No	Physical works ($$)	Could lift the road but would create other issues.	Yes	2	1	5	0	5	1	3	1
BP1	2	Kaikokopu Bridge	Road	Flooding	Flooding of approaches to the bridge. Traffic gets diverted through old coach road	3L	3VL	No	Physical works ($$)	Raise road and bridge	Yes	3	2	3	0	3	2	3	3
BP2	2	Kutarere	Road	Coastal Inundation / SLR	Tidal flooding occurs with significant rainfall.	4L	4VL	No	Physical works ($$)	Raise the road <1km.	Yes	2	2	3	0	3	3	3	3
BP18	30	Lynmore and Airport	Road	Flooding	Attenuation dams have been put in place to reduce the amount of water which can flood the roads. However, flooding still occurs when the ARI exceeds the attenuation dam's capacity.	2L	-	No	BAU / Ongoing maintenance / Reactive	BAU reactive maintenance	Unsure	2	2	3	0	3	1	-	-
BP23	2	Matata Straights	Road	Landslip	Big storms cause landslip / removal of bluffs takes the road out and can flood for days.	2L	2VL	No	Physical works ($$)	Remove slips	yes	2	3	3	0	3	1	3	3

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BP3	35	Motu Bluff	Road	Landslip	Land stability issues at Motu Bluff	3VL	3VL	No	Physical works ($$)	Rockslide netting to divert the rocks. 10-20-year programme to improve rain / storm water control to avoid emergency works	Yes	3	3	2	0	2	3	3	3
BP19	30	North of Lake Rotoiti	Road	Landslip	20km of the road sits on a razor back ridge which has resulted in a number of failures which have undermined the road.	2L	-	No	BAU / Ongoing maintenance / Reactive	BAU reactive maintenance	Unsure	2	2	3	0	3	1	-	-
BP4	2	Nukuhou	Road	Flooding	4 locations of flooding which generally occur at the same time. The local road has already been raised to provide a better route instead of raising the SH.	3VL	3VL	No	Physical works ($$$)	Raise 2km of road	Yes	3	3	3	0	3	2	3	3
BP22	2	Philip Walter Dr	Road	Flooding	Embankment / tributary low-lying valley. Massive culvert but the culvert cannot cope ~2m diameter. Less than 12 hours but should be higher than the Uretawa bridge.	3L	3VL	No	Physical works ($$)	Raise section of road and put in and additional culvert. should be included in the Kati Kati bypass	Yes	3	1	3	0	3	2	3	3
BP20	5	Pukehina to Pongakawa	Road	Landslip	Volcanic extension processes results in sediment piping, ground settlement and lateral spread of the ground beneath the road which then gets washed out in heavy rainfall.	2L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Currently investigating	Unsure	1	3	3	0	3	1	-	-
BP15	2	Rangiruru to Pukehina	Road	Earthquake / liquefaction	Settlement issues along SH2. Both rail and road. Soft soil settlement. Not immediate priority	3UL	-	No	Physical works ($$)	Need a long-term management plan	Yes	1	2	3	0	3	2	-	-
BP25	30	Rotoma Bluff	Road	Landslip	SH30 at Rotoma Bluff is subject to large amounts of material collapsing onto the road.	2L	2VL	No	Physical works ($$$)	Soil nails and rock netting etc	Yes	2	3	2	0	2	2	3	3
BP5	29	Ruahihi Bluff	Road	Rockfall	Rockfall ~5 cubic m blocks which pose a significant safety risk. 30-40% of trucks would be HPMV which equals ~800 trucks on a 2-hour detour.	4L	-	No	Physical works ($$)	There is a significant resilience and safety benefit. designed and ready to go, mesh and rockfall. Should be highest risk stretch of road.	Yes	2	2	5	0	5	2	-	-

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BP16	2	Tanetua (Pekatahi Bridge)	Bridge	Erosion	Significant scour issues. You have to wait until the water has dropped to do scour assessment before you can let people through. Same highway as Waioeka Gorge and could create the same issues re community severance and loss of productivity for fresh foodstuff business. Consider lifting ONC weighting	2VL	2VL	No	Physical works ($$)	Replace bridge - however have temp solution and not a priority	Yes	3	3	3	0	3	1	3	3
BP6	35	Tirohanga to Bay of Plenty Boundary	Road	Landslip	Landslip issues along entire East Cape. Also, sedimentation with significant rainfall washing sediment down valleys.	3VL	3VL	No	Physical works ($$$)	Further investigations needed	Unsure	3	3	2	0	2	3	3	3
BP21	2	Uretawa bridge	Bridge	Flooding	Approaches get submerged. rainfall plus high tide - tide related only. likely to get worse with climate change and SLR to 5-6hours. Half a km to the north also floods.	3L	3VL	No	Physical works ($$)	Raising the road could increasing issues further up. Potentially extra span in the bridge to allow more water to pass through. If you put in a stop bank you would also need pumps. Should be included in Kati Kati bypass	Yes	3	1	3	0	3	2	3	3
BP12	2	Waimana Gorge	Road	Landslip	Both large and small slips through the gorge. Currently already spending $6million just to get it open from previous events.	3VL	3VL	No	Physical works ($$$)	Requires stabilizing slopes.	Yes	3	3	3	0	3	2	3	3
BP9	2	Waioeka Gorge	Road	Landslip	Landslip risk for the entirety of Opotiki to the Bay of Plenty boundary. Potential for significant effects commercially and for small communities.	4VL	4VL	No	Physical works ($$$$)	Over a multiple year programme. In an ideal world you would do a multi-year programme across all significant sites - that links to the PBC that Simon Barnett / Gisborne is working on.	Yes	3	3	3	0	3	3	3	3

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BP8	2	Waioeka Gorge	Road	Rockfall	Significant rockfall issues along the entirety of Waioeka Gorge for both the Bay of Plenty and Gisborne / Hawke's Bay. Very significant issue for Gisborne community as in the event of a long closure communities have the potential to be isolated. Also affects time critical delivery of food produce to the port and Auckland. Supplies to the hospital could also become an issue quickly. Regional managers support a change to the ONRC classification to 'Regional' level. Significant crash rates and safety issues with response limited due to poor telephone coverage. Waioeka Gorge PBC identifies all major sites and pinch points.	5VL	-	No	Physical works ($$$)	Geotechnical improvements: combinations of rock fall protection, slope stabilisation etc. over a multiple year programme. In an ideal world you would do a multi-year programme across all significant sites - that links to the PBC that Simon Barnett / Gisborne is working on. Aurecon has previously carried out an assessment of the sites.	Yes	3	3	3	2	5	3	-	-
BP24	2	Waioeka River	Road	Erosion	Erosion from Waioeka river and failure of the groynes could mean loss of road.	4L	4VL	No	Physical works ($$)	New groynes	Yes	2	3	3	0	3	3	3	3
BP10	2	Waiotahi Bluffs	Road	Landslip	Land instability issues along the Bluff. Ideally need to enhance detour route so that it can take HPMVs which will limit the impacts of outage.	3VL	3VL	No	Physical works ($$)	Roughly 10 -15kms of upgrading detour route. There are a few tight bends which could be widened.	Yes	3	3	3	0	3	2	3	3
BP11	2	Waiotahi Bridge	Road	Coastal Erosion	Coastal erosion along the bridge is possible. Solvable in the short to medium term, but not long term with climate change. 6hr detour for HCV and HPMV.	4L	4VL	No	Physical works ($$)	Erosion protection required around bridge	Yes	2	2	3	0	3	3	3	3
BP13	29	West side of the Kaimai's	Road	Extreme Weather	Extreme weather can cause re-mobilisation of the fine/ash material. Could be difficult to clean up.	4L	4VL	No	Physical works ($)	Some sort of geotechnical response to stabilize slope. Needs investigation	Yes	3	1	5	0	5	2	3	3

A1.3 Canterbury regional risk catalogue

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C39	75	Akaroa Harbour	Road	Coastal Inundation / SLR	Coastal inundation and sea level rise risk	4UL	4L	No	Unknown. Pending further investigations	Further investigations needed	Unsure	2	1	3	0	3	3	3	2
C8	73	Arthurs Pass	Road	Ice / Snow	SH73 through Arthurs Pass is subject to snow and ice disruptions. Arthurs Pass is one of three key routes which link the West Coast with the East Coast of the South Island.	4L	-	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	No	3	2	3	0	3	3	-	-
C9	73	Arthurs Pass	Road	Rockfall	SH73 through Arthurs Pass is subject to rockfall. Arthurs Pass is one of three key routes which link the West Coast with the East Coast of the South Island.	4L	-	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	No	3	2	3	0	3	3	-	-
C15	73	Arthurs Pass	Road	Ice / Snow	Snow and ice disruption through the Pass due to high elevation.	3L	-	No	Unknown. Pending further investigations	Further investigations needed	No	3	2	3	0	3	2	-	-
C4	1	Ashburton Bridge	Road	Extreme Weather	SH1 at the Ashburton bridge is subject to extreme weather events. This is a significant pinch point on the network and has a limited detour with resilience and capacity issues. KiwiRail and electricity lines also follow parallel to the road and are likely to be subject to the same risk.	4L	-	No	Physical works ($$$)	Duplicate bridge required	Yes	2	3	4	0	4	3	-	-
C20	1	Ashley River Bridge	Bridge	Earthquake / liquefaction	SH1 at the Hurunui River is subject to seismic risk as well as safety issues involving a large number of accidents as well as safety issues for cyclists. This is a high volume and significant freight route with a poor detour available.	3L	-	No	Physical works ($$$)	upgrade bridge	Yes	2	3	4	0	4	2	-	-
C7	73	Bealey Bridge	Bridge	Earthquake / liquefaction	SH73 at the Bealey bridge is at risk from seismic shaking, scour and capacity issues.	4L	-	No	Physical works ($$$$)	Replace bridge	Yes	2	3	3	0	3	3	-	-

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C16	1	Blue Slip	Road	Landslip	Site at risk to mass earth movement, which would likely affect both road and KiwiRail. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	-	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	No	3	1	4	1	5	3	-	-
C5	8	Burkes Pass	Road	Ice / Snow	SH6 through Burkes Pass is subject to snow and ice risk resulting in closures and disruption. Burkes Pass is a key tourist and freight route between the East Coast and Central Otago.	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	No	3	2	3	0	3	3	-	-
C42	73	Canterbury Region	Road	Wildfire	The Canterbury side of both the Lewis and Arthurs pass has the potential for significant wildfire events. Train sparks can be a cause. Boundary to boundary mows currently occur twice a year which help with the risk but do not eliminate it. There needs to be better cross organisational management between NZTA and TA's to help push the vegetation out from the roads.	2L	-	No	Enhanced proactive maintenance	Don't build timber structures, all guard railing is timber. Not necessarily a capital maintenance response but should be included in regular maintenance. Discuss mitigation with KiwiRail.	Unsure	2	2	2	0	2	2	-	-

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C19	1	Clarence Bridge	Bridge	Flooding	Clarence river is at risk to river and surface flooding - requiring ongoing groyne maintenance. High sediment loads can cause the riverbed to aggrade up to 2m. This risk also extends across most of the streams along the Northern Kaikoura coastline. Some sediment retention devices are being built to address this. This risk is manageable in individual locations, however in a significant event such as Tropical Cyclone Fehi / Gita there is the potential for all rivers to flood, which could cause significant remedial works. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	5VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	Unsure	3	1	4	1	5	3	3	3
C24	1	Clarence to Kaikoura	Road	Coastal Inundation / SLR	Overtopping occurs along the whole corridor, only out for a couple hours either side of high tide. Unsure whether this will damage the road as it is all new (NCTIR), likely this will no longer damage the road. However, this is ongoing and likely to increase with the impacts of CC. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	4L	4VL	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	2	4	1	5	2	3	3

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C23	1	Clarence to Kaikoura	Road	Rockfall	Clarence to Kaikoura is subject to rockfall risk, some of which will have been addressed in the NCTIR project. However, behaviour is unpredictable due to Kaikoura works but it is assumed that there will be residual risk for rockfall and debris flows. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5UL	-	No	Unknown. Pending further investigations	Monitor	Unsure	1	2	4	1	5	3	-	-
C28	73	Craigieburn	Road	Landslip	Landslip risk at Craigieburn along SH73.	4L	-	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	Yes	2	2	3	0	3	3	-	-
C38	82	Elephant Hill	Bridge	Earthquake / liquefaction	Elephant hill stream bridge is deemed to be under strengthened and therefore subject to damage from earthquakes and liquefaction.	2L	-	No	Physical works ($$$)	realignment	Yes	3	2	2	0	2	2	-	-
C32	74A	Evans Pass	Road	Rockfall	Rockfall, substantially addressed on Lyttelton side but not the Sumner side. This is part of the Dangerous goods route.	3L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	2	2	3	0	3	2	-	-
C46	79	Geraldine to Fairlie	Road	Rockfall	Rockfall risk	3UL	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	1	2	3	0	3	2	-	-
C30	1	Hapuku Dam	Road	Landslip	Landslide dam but not significant. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5UL	-	No	Physical works ($$)	Could remove the landslide dam to eliminate dam outbreak flood risk.	Yes	1	1	4	1	5	3	-	-

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C26	1	Hundalees	Road	Landslip	Soft soils and landslip risk. Large number of truck crashes. Large landslips can occur every ~10 years with smaller annual events. The BAU response to the smaller events typically results in the road being back to one lane within 12 hours. The larger events cause traffic to be diverted through the alternate route for 48 hours. Slip generally comes onto the road rather than under cutting.	4L	-	No	Physical works ($$)	Solution could be to revegetate the farm area to stabilise slopes.	Yes	3	1	4	0	4	3	-	-
C11	1	Hurunui River Bridge	Bridge	Earthquake / liquefaction	The single lane Hurunui bridge on SH1 is subject to seismic risk and safety issues involving a large number of accidents and safety issues for cyclists. This is a high volume and significant freight route with a poor detour route.	4L	-	No	Physical works ($$$)	Replace bridge and upgrade to two lanes	Yes	2	2	4	0	4	3	-	-
C43	70	Inland Route - Whales Back Slip	Road	Landslip	Hurunui district route, whales back slip. This is a detour route through to Kaikoura. A wider issue around SH traffic using alternate routes which don't have funding. Huge amount of work to make it truly resilient, however this could potentially make more problems than you solve. NZTA doesn't have any oversight of the route and what state it's in, Council keeps trying to give it back to NZTA.	2L	-	No	Unknown. Pending further investigations	Further investigations needed	No	2	2	2	0	2	2	-	-
C37	8	Lake Pukaki	Road	Erosion	Erosion along lake edge but lake level managed by Meridian energy	4UL	-	No	BAU / Ongoing maintenance / Reactive	Monitor and reactive maintenance	Yes	1	2	3	0	3	3	-	-
C36	8	Lake Tekapo	Road	Erosion	Erosion along lake edge however lake level managed by Genesis energy	4UL	-	No	BAU / Ongoing maintenance / Reactive	Monitor and reactive maintenance	Yes	1	2	3	0	3	3	-	-
C13	7	Lewis Pass	Road	Flooding	Currently a lot of maintenance work being carried out to stop flooding inundation of the road. The road and riverbed are currently at the same level.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Requires further investigation to develop a long-term solution	Yes	2	2	2	1	3	3	3	3
C25	7	Lewis Pass	Road	Ice / Snow	Snowstorms on the Lewis Pass cut off the route and all routes to the north.	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	No	3	1	2	1	3	3	-	-

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
C40	75	Little River to Duvauchelle	Road	Landslip	Landslip either side of the Hill summit. Detour is available on the east side but not west side.	3L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	2	2	3	0	3	2	-	-
C33	74	Lyttleton Tunnel	Tunnel	Rockfall	Rockfall risk on both sides of the tunnel. Currently there is a temporary solution in place. The tunnel control building has been upgraded and therefore not at imminent risk.	3L	-	No	Enhanced proactive maintenance	can be managed through tunnel management plan.	Yes	2	2	5	0	5	1	-	-
C47	Main Rd	Main road around Monks Bay	Road	Coastal Inundation / SLR	Peacock's gallop and Monks bay, sea wall in place but low elevation, risk of inundation, however it's only a Dangerous Goods route so very low issue.	3L	3VL	No	Unknown. Pending further investigations	Further investigations needed	Yes	2	3	3	0	3	2	3	3
C12	Main Rd	Main road around Monks Bay	Road	Tsunami	Main road around Monks Bay ('dangerous goods' route) is at risk from tsunami inundation. This is a significant route for dangerous goods coming from Lyttleton Port to the South Island and cannot go through Lyttleton Tunnel.	3L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Emergency response planning only	No	1	3	3	0	3	2	-	-
C27	1	Movern	Road	Flooding	Surface flooding due to land use changes, short duration. SH culverts undersized.	4L	-	No	Enhanced proactive maintenance	Improved drainage required	Yes	3	1	4	0	4	3	-	-
C10	1	North of Kaikoura - Clarence Bridge	Road	Landslip	Landslip and mass movement risk (site similar to Blue Slip, see for details). No known solution, and if a landslip or mass movement were to occur the road and rail will be completely destroyed. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Further investigations needed	Unsure	1	3	4	1	5	3	-	-

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
C17	1	Ohau Point	Road	Coastal Inundation / SLR	Ohau Point is at risk from coastal inundation– it overtopped three times in 2019 in a combined high tide and storm event. There is a potential design in NCTIR to address this, however with the effects of climate change this may not address the issues. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	5VL	No	Unknown. Pending further investigations	Monitor	Unsure	3	1	4	1	5	3	3	3
C41	73	Porters Pass	Road	Rockfall	Rockfall along the pass.	3L	-	No	Enhanced proactive maintenance	Some preventative maintenance in rock sailing could help, however the risk is manageable	Yes	2	2	3	0	3	2	-	-
C29	73	Porters Pass to Arthurs Pass	Road	Ice / Snow	Ice and snow risk - occurs throughout winter along the passes.	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Yes	2	2	3	0	3	3	-	-
C44	1	Puketa to Oaro	Road	Coastal Inundation / SLR	Over topping and inundation of road	3UL	3L	No	Unknown. Pending further investigations	Further investigations needed	Unsure	2	1	4	0	4	2	3	2
C3	1	Rakaia Bridge	Road	Flooding	SH1 at the Rakaia bridge is subject to extreme weather events and flooding due to limited drainage capacity around the bridge. This is a nationally significant road with a poor detour. Outage of this bridge was experienced in the lead up to Christmas 2019 and caused significant disruption throughout Canterbury. KiwiRail and electricity lines are parallel to the road and are likely subject to the same risk. Currently a large number of accidents cause disruptions on the bridge. Bridge also thought to have poor seismic strength.	4L	-	No	Physical works ($$$)	Duplicate bridge required	Yes	2	3	4	0	4	3	-	-

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C1	77	Rakaia Gorge Bridges	Road	Flooding	This is a major tanker route for the Darfield Fonterra plant and Phillip Wareing as well as the detour route for SH1 around the Rakaia and Ashburton bridges. Some of the bridges have restrictions and limits for HPMVs. There are significant flooding issues throughout the route and the road often goes down to one lane. It's likely this road would be significantly damaged in an earthquake which would leave no detour for SH1. Electricity lines and KiwiRail are parallel to SH1 line.	4L	-	No	Physical works ($$$)	Upgrade both one lane bridges at the gorge to provide a more robust detour route. Improve traffic management procedures during outages.	Yes	2	3	2	1	3	3	-	-
C48	1	Rangitata and Arundel Bridges	Bridge	Flooding	Flooding has potential to cause bridge washouts through scour for both bridges on the Rangitata River.	4L	-	No	Enhanced proactive maintenance	Enhanced maintenance of river groynes	Yes	2	2	3	0	3	3	-	-
C14	75	Road to Akaroa	Road	Landslip	Landslip risk on either side of the summit, along the road to Akaroa through Banks Peninsula.	4L	-	No	Enhanced proactive maintenance	Maintenance and monitor	No	2	2	3	0	3	3	-	-
C31	1	Saltwater Creek	Road	Flooding	Tidal flooding, salt marshes and land run off cause surface flooding at high tide. We are seeing more unusual extreme events with all-weather events and high tide occurring at the same time to flood the road.	3L	3VL	No	Unknown. Pending further investigations	Further investigations needed	Unsure	2	2	4	0	4	2	3	3

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
C18	1	Shingle Fans	Road	Landslip	Shingle Fans - North of Clarence is at risk to landslip. There are three shingle fans which flow through culverts however, in large events these flow over the road. Landslip overtopping occurs approximately once every 3-4 years. Generally, response teams can keep the shingle within the water way. Generally, there is a quick response, with short term closures and damage to infrastructure is unlikely. Smaller retention dams are being located upstream. KiwiRail relies on NZTA for clearing the culverts. This is still flagged as a high risk due to the frequency and importance of the road. SH North of Kaikoura is considered higher criticality than south of Kaikoura due the importance of this route in terms of connecting to the north (including freight). In addition, the alternate route involves a significant detour (via SH63 and Lewis Pass).	5L	-	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	No	3	1	4	1	5	3	-	-
C21	7	Stuarts Fan	Road	Flooding	Flooding risk to bridge when extreme events mobilise the shingle and cause overflow at culverts underneath the bridge. The culverts get cleaned out annually which closes the road for a few hours. Justification for funding in resilience measures could be difficult.	4L	4VL	No	Physical works ($$$)	There is a plan developed for realignment and box culverts however this hasn't received funding. Requires regular maintenance.	Yes	3	1	2	1	3	3	3	3
C45	1	Temuka	Road	Flooding	Both rail and road bridge will fail if washed out	3UL	-	No	Enhanced proactive maintenance	Further investigations needed	Yes	1	2	4	0	4	2	-	-

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C2	7a	Waiau Ferry Bridge	Bridge	Rockfall	The Waiau Ferry bridge is at risk from rockfall and is the key route into Hanmer Springs which is the most significant tourism / economic hub for the Hurunui district, hence a higher consequence rating was assigned. There are also some concerns around the bridge abutments. Note during workshops there was differing opinions of the criticality of this route from a regional perspective.	4L	-	No	Physical works ($$$$)	Bridge replacement and alternative alignment.	Yes	2	3	2	1	3	3	-	-
C6	73	Waimakariri Bluff	Road	Rockfall	SH73 at Waimakariri Bluff is subject to rockfall risk at many locations. There is currently one location being addressed under LCLR, however the issue extends over a wider area.	4L	-	No	Physical works ($$$)	more funding would mean that more sites can be addressed.	Yes	3	2	3	0	3	3	-	-
C35	1	Washdyke	Road	Flooding	Road and bridge at risk of flooding from the creek and from pleasant point.	3L	-	No	Physical works ($$)	River control works	Yes	2	2	4	0	4	2	-	-

A1.4 Gisborne / Hawke's Bay regional catalogue

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
HB1	2	Devil's Elbow	Road	Landslip	~10km of Devil's Elbow is at risk to landslip.	4VL	4VL	No	Unknown. Pending further investigations	An alternative local road can be utilised however it is unsealed and narrow and cannot take heavy vehicles. Upgrading the local road is potentially a better use of money.	Unsure	3	3	3	0	3	3	3	3
HB14	5	Entire length of SH5	Road	Landslip	Significant issues with Landslips and instability along entire route. Highest ONRC and connects the Bay to inland. The detour is long and less resilient, via Palmerston North.	4L	4VL	No	Physical works ($$$)	Response plan for the route needs to be developed. A large number of geotechnical solutions would be required to address the landslips.	Yes	3	2	3	0	3	3	3	3
HB13	5	Entire length of SH5	Road	Volcanic	Potential ashfall disruption depending on wind direction	4UL	-	No	Emergency response and preparedness planning only (typically HI/LF)	Develop volcanic response plan	No	1	2	3	0	3	3	-	-
HB3	5	Kaweka Ranges - Mohaka River Rail and Road Bridge	Road	Landslip	Mohaka river at the road and rail bridge which has fundamental flaws in its design and is subject to landslip risk along the entire length of the ranges. It is a narrow road with minimal space to carry out physical works or install geotechnical solutions such as debris fences. Work is being done to cut the slip back further. A debris fence is however being installed in one section from Pakipaki to Peka Peka.	4L	4VL	No	Physical works ($$$)	Investigation into options to retreat into hillside/ behind rail viaduct 'Raupunga retreat'	Yes	3	2	3	0	3	3	3	3
HB4	5	Kaweka Ranges - Mohaka River Rail and Road Bridge	Road	Rockfall	Mohaka river at the road and rail bridge which has fundamental flaws in its design and is subject to rockfall risk along the entire length of the ranges. It is a narrow road with minimal space to carry out physical works or install geotechnical solutions such as debris fences. A debris fence is however being installed in one section from Pakipaki to Peka Peka.	4L	-	No	Physical works ($$$)	Investigation into options to retreat into hillside/ behind rail viaduct 'Raupunga retreat'	Yes	3	2	3	0	3	3	-	-
HB5	2	Napier airport	Road	Coastal Inundation / SLR	Road to Napier airport is highly vulnerable to a number of hazards.	4L	4VL	No	Unknown. Pending further investigations	Regional problem and tied to climate change and emergency response issues	Unsure	3	2	3	0	3	3	3	3

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
HB6	50	Napier Port	Road	Earthquake / liquefaction	An earthquake in Wellington could cause Centre Port to be out of service. Consideration of routes to other ports such as Napier and Tauranga become more relevant- equally if there is an earthquake in Napier. CDEM accept that some things will likely stop economically. The road to the port is an urban highway and is less likely to be impacted by slips or a highly frequent event.	4L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Link into work being undertaken by Civil defence around risks of Hikurangi Trench and Alpine Fault to understand the Agency's role in being able to respond to these large-scale events.	No	1	3	5	0	5	2	-	-
G3	2	Napier to Gisborne - south of Wairoa as well as over Whereas	Road	Landslip	Whilst there are areas, they would like to fix you basically just have to deal with it otherwise you would need to move the whole road out of the hills. There are a number of ongoing resilience issues which are monitored and dealt with as mitigating them would be unimaginable. A number of earth works would be required to reduce slips blocking the SH.	3L	-	No	Physical works ($$$$)	Realign whole road	Unsure	2	2	2	0	2	3	-	-
HB7	2B	Pandora Pond Bridge	Road	Tsunami	Single bridge carries all the main services - Pandora Pond - is also tsunami evacuation route. You could run something over the expressway. Expressway links the hospital	3L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Identified by vulnerability study in Civil Defence- no solutions available- may well be a response plan	No	1	3	3	0	3	2	-	-
G2	35	SH35 north of Gisborne and into Bay of Plenty.	Road	Extreme Weather	North of Gisborne - currently $12m to improve the resilience of that work. There will be a whole list that needs to be done that will likely be more than $12m. Major resilience issues where the bypass is SH2. SH35 is a good route to try and invest substantial subsidence impacts, lots of hills that are on the move under the highway. There is not a lot of traffic, but it is a community lifeline for northern communities to access doctors etc. ~100 sites of subsidence in Gisborne alone as well as on the northern section around to the BOP. there are two options of local roads, but they cannot get approval from the local council to get it officially recognised. Waimate valley road and whakatoutou road - need approval from Local council to let heavy vehicles through North of Te Puia springs - Kopuaroa Road is the alternative north of Te Puia Springs. Council district plan shows the land instability. There is an alternate new alignment to bypass slip areas. 5-10km - preliminary designs. SH35 route	3UL	3L	No	Unknown. Pending further investigations	Further investigations needed	Unsure	2	1	2	0	2	3	3	2

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HB9	2	Wairoa River	Road	Erosion	Erosion risk along Wairoa River where the slip undercuts the road.	4L	4VL	No	Physical works ($$)	Look at opportunities to raise level of road alongside river corridor and/ or look at investing in improving resilience of local road network as alternative.	Yes	3	2	3	0	3	3	3	3
HB10	2	Wairoa River	Road	Flooding	Wairoa River Flood once a year with the road closed and the river is cutting into the road - Cyclone Bola took out the bridge. Removing every year flood risk would be better than trying to address the big events - which would involve raising the road. Sheer bank on one side of the road where you could raise the road and put in slip control. Wouldn't make this high priority above the other issues where this is only closed for a day vs the other ones closed for weeks.	4L	4VL	No	Physical works ($$)	Response plan for the route needs to be developed and look at improving resilience of Mohaka Bridge and approaches.	Yes	3	2	3	0	3	3	3	3
HB12	2	Whirinaki Bluff	Road	Coastal Erosion	Coastal erosion risk. Coastal erosion likely to cut off the entire road northward	4L	4VL	No	Physical works ($$)	Need to understand the effects of climate change and develop options	Yes	3	2	3	0	3	3	3	3
HB11	2	Whirinaki Bluff	Road	Landslip	Landslip risk. Slip likely to cut off the entire road northward.	4L	4VL	No	Physical works ($$)	Need to understand the effects of climate change and develop options	Yes	3	2	3	0	3	3	3	3

A1.5 Manawatu / Whanganui regional risk catalogue

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
MW4	1	Bulls Bridge	Bridge	Erosion	SH1N Bulls bridge - rock armour built in 2016, the 2015 event washed all the rock out, rock armour is because the bridge behind that the piers are underpinned, half this bridge has disappeared down the river before ~70's/80's, scour along this bridge and pinch point on the network should that bridge go, there is a viable detour via kakariki road and Holcombe, not top of the list for resilience as long as the rock armour stays, in a massive event if the rock armour goes the bridge is at high risk, if this bridge goes there would be significant impact nationally as it would be out for a significant amount of time, Kakariki road has both the road and the train bridge, the kakariki road bridge is not high off the bank and potential if there is a significant event which takes out SH1 bridge then there could be potential for the kakariki bridge to go, Cycle path forces people to cross the SH and cyclists have to go over the small cycle path which only fits one bike wide, a lot of people cycle for	3L	-	No	Physical works ($$$$)	New bridge/new alignment/Bulls Bypass	Yes	2	3	3	0	3	2	-	-
MW21	3	Cobham Bridge	Bridge	Flooding	Cobham bridge on SH3 is subject to flooding of its approaches.	2L	-	No	Physical works ($$$)	Further investigations needed	Yes	3	1	3	0	3	1	-	-
MW9	54	Fielding and Palmerston North	Road	Rockfall	One lane bridges along SH54 which would mean the whole SH is out, for inspections the whole bridge is closed, not nationally significant but regionally significant. Between Fielding and Palmy - some low-lying road and flooding issues 1 every 10 years.	2L	-	No	Physical works ($$$)	Duplicate bridge	Yes	2	3	3	0	3	1	-	-
MW5	3	Kai Iwi	Road	Landslip	SH3 Over slips at Kai Iwi - but solved in maintenance / operations	3L	-	No	BAU / Ongoing maintenance / Reactive	Business as usual reactive works	Yes	2	2	3	0	3	2	-	-
MW24	3	Manawatu Gorge	Road	Landslip	Significant land instability issues through the entire Manawatu Gorge. Currently closed and a PBC underway to decide the best option moving forward. Traffic goes through a local road which is requiring significant strengthening to deal with large vehicles and increased traffic loads.	3VL	3VL	No	Physical works ($$$$)	Business case underway	Yes	3	3	4	0	4	2	3	3
MW22	3	Mangaone River Bridge	Bridge	Flooding	Flooding and debris on bridge	3L	-	No	Physical works ($$)	Further investigations needed	Yes	3	1	3	0	3	2	-	-

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MW14	56	Mangaone stream bridge	Road	Flooding	Significant flooding occurs Mangaone stream bridge which results in debris covering the bridge.	2L	-	No	BAU / Ongoing maintenance / Reactive	Business as usual reactive works	Yes	2	2	3	0	3	1	-	-
MW2	2	Mangatainoka	Road	Flooding	SH2 Mangatainoka - moderate flood risk (1 every 10 years).	4L	4VL	No	Physical works ($)	Drainage improvements required	Yes	2	2	3	0	3	3	3	3
MW16	3	Marybank	Road	Flooding	Marybank used to have flooding issue but in the last 4-5 years this seems to have reduced, low lying section of road, before that it was quite regular, Raising the road could mitigate some issues.	2UL	-	No	Physical works ($$)	Raise the road	Yes	2	1	3	0	3	1	-	-
MW7	2	Matamau	Road	Flooding	SH2 Matamau - flooding, not very regular, 1 every 10 years. North of Woodville - capital projects have solved issues.	4UL	4L	Yes	Physical works ($$)	Largely resolved.	Yes	1	1	3	0	3	3	2	2
MW15	51	Napier to Clive	Road	Tsunami	Tsunami risk along SH15 from Napier to Clive, however there are good alternate routes available.	2L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Emergency response planning only	No	1	3	3	0	3	1	-	-
MW12	1	Ohau	Road	Flooding	South of Levin through Ohau - gets flooded a lot with a bridge washout happen before, flooding particularly in the main town, currently a project in place for larger culverts which only gets rid of the water doesn't solve the issue, there are alternate routes via SH57 but to a much lower level of service, significant SW drainage system could help, happens ~1 a year and not full closure, typically over the middle of one lane so reduces width of road, hopefully solvable through better drainage, well over $1M so not in low cost.	2L	-	No	Enhanced proactive maintenance	Better drainage systems	Yes	3	2	4	0	4	1	-	-
MW6	56	Opiki	Road	Flooding	SH56 Opiki - over Manawatu river, floods 2-3 times a year closed for 3 days, known and relatively managed floodway, arterial road and it is solvable if you built a trestle structure, part of the accessing central strategy for freight routes and is likely to become more important, serves the inland port at long burn, solutions is doable, and is an increasingly important road which is shut regularly, currently not PBC to address this. This section of Highway acts a secondary overflow for the Manawatu flood plain so gaining resource consent will be very challenging.	2L	-	No	Physical works ($$$)	Further investigations needed	Yes	3	2	3	0	3	1	-	-

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MW23	4	Raetihi to Whanganui	Road	Landslip	Raetihi Landslip. Significant land instability through the entire length of SH4 from Raetihi to Whanganui	2VL	-	No	Unknown. Pending further investigations	Currently a PBC underway to respond to the Raetihi landslip which occurred in 2019. This has resulted in the decision to make repairs to the current Raetihi landslip location only instead of creating a bypass.	Yes	3	3	2	0	2	2	-	-
MW10	54	SH1 intersection to Waituna West	Road	Rockfall	SH54 Rockfall for first 12km from south of SH1 - Rewa rockfall down to 1 lane. SH54 Provides an alternate route for SH1 and not full HPMV compliant - this is just for bridges, can't divert freight from SH1 down 54.	3L	-	No	Physical works ($$)	The usual geotechnical solutions like retaining walls, soil nail, benching etc will be appropriate	Yes	3	1	4	0	4	2	-	-
MW8	2	South of Eketahuna	Road	Flooding	SH2 South of Eketahuna - series of dropouts, whole corridor dropouts, risk from river flooding. No significant issues	3L	-	Yes	Physical works ($)	Currently in construction. A LC/LR solution has been put in place so we expect this issue to arise in 10-20years - therefore a business case may be required in the future to address future risk	Yes	2	2	3	0	3	2	-	-
MW13	57	Tokomaru to Linton	Road	Landslip	SH57 Tokomaru - some under slips north of Tokomaru to Linton, this is getting worse at the shoulder is quite narrow, treatable under low cost low risk. Possible realignment of road through Linton.	2L	-	No	Physical works ($)	The usual geotechnical solutions like retaining walls, soil nail, benching etc will be appropriate	Yes	3	1	4	0	4	1	-	-
MW11	1	Vinegar hill / Hunterville,	Road	Landslip	SH1 at Vinegar hill to Huntersville, is subject to reoccurring landslip events. 'Slippery' material which comes down every winter with rainfall / extreme weather events and covers the road. Stakeholders note its likely a more significant landslip event could eventually occur.	2L	-	No	BAU / Ongoing maintenance / Reactive	Business as usual reactive works	Yes	3	2	4	0	4	1	-	-
MW3	1	Waiouru	Road	Ice / Snow	Waiouru - snow and ice which closes the road, alternative route is 49 / 4, significant snow does get as far south as Taihape, can't prevent it but can manage it.	3L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	2	4	0	4	2	-	-

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
MW1	3	Whangaehu (link between Whanganui and Bulls)	Road	Flooding	SH3 Whangaehu area floods regularly (every 5 years). It is a critical link between Whanganui and Bulls where water generally flows over the road. The road could be built up to the same height as the bridge adjacent to it. Currently the surrounding houses and community are under water, they effectively dam the water causing it to significantly back up, therefore significant stormwater management would be needed.	4L	4VL	No	Physical works ($$)	Raise the section of the road to the east of the bridge. However, the flood waters need to cross the road corridor or the Whangaehu town will get flooded. The options are a bridge or several very large culverts. A raised embankment will not work.	Yes	2	2	3	0	3	3	3	3

A1.6 Milford Road regional risk catalogue

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
MR1	94	Along Lake Te Anau	Road	Tsunami	Significant risk of landslide induced tsunami which could be triggered in a significant earthquake event such as the Alpine Fault.	4L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Emergency response planning only	No	1	3	3	0	3	3	-	-
MR2	94	Cleddau River	Road	Flooding	Cleddau River - flood risk. There are regular flooding events which inundate the road and damage structures.	4VL	4VL	No	Unknown. Pending further investigations	Difficult to address. Further work required. Address through integrated route strategy with MR3, MR5 and MR11	Unsure	3	3	3	0	3	3	3	3
MR3	94	Eglington River	Road	Flooding	There are regular flooding events which inundate the road and damage structures. The river is a wide braided river which aggrades. There are current operating flood protection structures. Each year material is removed from under the bridge as it builds up.	4L	4VL	No	Unknown. Pending further investigations	Difficult to address. Further work required. Address through integrated route strategy with MR2, MR5 and MR11	Unsure	3	1	3	0	3	3	3	3
MR4	94	Hollyford Rd to Chasm	Road	Avalanche	Avalanche risk for the winter season is the major focus which drives most of the work throughout winter (April/May-October/November). Twice a day there is an avalanche hazard forecast put out which drives public access, restrictions and control work. Climate trends: winter is arriving later but staying longer. This affects tourism. Increased precipitation and snow – however more rain on snow increases the risk. Risk level is rising with annual increasing traffic volumes.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing prevention	Unsure	3	2	3	0	3	3	3	3
MR5	94	Hollyford River	Road	Flooding	Flood risk on the Hollyford River. There are regular flooding events which inundate the road and damage structures.	4L	4VL	No	Unknown. Pending further investigations	Difficult to address. Further work required. Address through integrated route strategy with MR2, MR3 and MR11	Unsure	3	2	3	0	3	3	3	3

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
MR6	94	Homer Tunnel	Tunnel	Earthquake / liquefaction	Reinvestment issues for tunnel. There is a BC being developed for replacement portal/protection structures to build resilience for future earthquake, rockfall and avalanche events. The structure is ageing and will soon become a historic site, this will limit the works that can occur on the tunnel. A heritage assessment is currently in draft but recommends some very intensive improvement and maintenance works to protect the nature of the site.	4L	-	No	Physical works ($$$)	A smart design for replacement of the tunnel portals could deal with strengthening and upgrading, aiding avalanche and rockfall risks at the same time. In short term, Rockfall prevention measures e.g. scaling, fences and bunds. But has cross over with avalanche zone - avalanches will destroy rockfall structures. Longer term needs to reinforce and upgrade the portals/tunnel before it is designated as a historical site. A smart design for replacement of the tunnel portals could deal with strengthening and upgrading, aiding avalanche and rockfall risks at the same time. Portals are under the largest avalanche zones. In addition, remote control avalanche systems could be employed. This is a significant tourism route and also safety issues.	Yes	1	3	3	0	3	3	-	-
MR17	94	Homer Tunnel	Tunnel	Avalanche	Significant reinvestment issues for tunnel and portals but there is a BC being developed for replacement portal/protection structures. Resilience for future EQ/Rockfall. The structure is ageing, soon to be a historic site – heritage assessment currently in draft but recommends some very intensive improvement and maintenance works to protect nature of the site.	4L	4VL	No	Physical works ($$$$)		Yes	3	2	3	0	3	3	3	3
MR16	94	Homer Tunnel	Tunnel	Rockfall	Reinvestment issues for tunnel and portals but there is a BC being developed for replacement portal/protection structures. Resilience for future EQ/Rockfall. The structure is ageing, soon to be a historic site – heritage assessment currently in draft but recommends some very intensive improvement and maintenance works to protect nature of the site.	4VL	-	No	Physical works ($$$)		Yes	3	3	3	0	3	3	-	-
MR13	94	Milford Rd - Te Anau to Park boundary	Road	Wildfire	Fires affecting SH94 from adjacent farmland and/or DOC lands (2 in 10 years)	4UL	4L	Yes	Enhanced proactive maintenance	Help advise park users of fire risks & have response available e.g. VMS and stopping points	No	2	1	3	0	3	3	3	2
MR15	94	Milford Rd - Te Anau Downs to Milford	Road	Landslip	Landslides and under slip risk in a number of locations.	4VL	-	No	Enhanced proactive maintenance	Preventative works and repairs	No	3	3	3	0	3	3	-	-

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
MR14	94	Milford Road	Road	Earthquake / liquefaction	Significant earthquake risk across entire length of Milford road.	4L	-	Yes	Enhanced proactive maintenance	Monitoring and response procedures	No	1	3	3	0	3	3	-	-
MR10	94	Milford Road	Road	Extreme Weather	Tree fall due to extreme weather is a significant risk that is partly managed through an extensive tree removal programme however this is still resulting in significant residual risk which is likely to increase due to climate change. Tree fall hazard has led to fatalities in the last 5 years. The tree fall risk strategy in place primarily focuses on investment over time for managing (>3000 at present) and removing trees from along the roadside.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	Unsure	3	1	3	0	3	3	3	3
MR7	94	Milford Road Bridges	Bridge	Flooding	In addition to the individually listed bridges, there are a number of 1-way truss and concrete bridges that are at risk to flooding. Greater than 30 bridges experience 8-9m of rain every year. Currently the alliance handles this well, however a single failure will break the entire network. A number of the bridges require ongoing work however, a reduction in bridge maintenance funds by NZTA will limit the amount of work that can be completed.	4L	4VL	No	Enhanced proactive maintenance	Enhanced maintenance	Yes	2	3	3	0	3	3	3	3
MR9	94	Milford Township	Road	Flooding	Flood risk. Currently there are a number of flood protection works being carried out to protect property. However, there is residual risk, but this is less of a highway risk. DOC have some ongoing work that involves increasing the ground level of Milford by 0.5-1m, as a significant portion of Milford is on reclaimed land and flood plain/fan. To provide slightly more protection for SLR and tsunami.	4L	4VL	No	Physical works ($$)	Raise village height and build higher stop banks. Some work is already underway	Yes	3	2	3	0	3	3	3	3

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
MR8	94	Milford Township	Road	Tsunami	Significant risk of landslide induced tsunami which could be triggered in a significant earthquake event such as the Alpine Fault. Also, tsunami waves at Milford Township from offshore sources.	4L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Emergency response planning only	No	1	3	3	0	3	3	-	-
MR11	94	Upukerora River	Road	Flooding	There are semi regular flooding events that inundate the road and damage structures.	4L	4VL	No	Unknown. Pending further investigations	Difficult to address. Further work required. Address through integrated route strategy with MR2, MR3 and MR5	Unsure	2	3	3	0	3	3	3	3

A1.7 Northland regional risk catalogue

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
N36	1	Awanui	Road	Flooding	Lack of catchment, no catchment clearance, forestry roads, slow land movement, issues with geology, no detour for SH 1 in the north, beach road a "worry" CDEM decision	3L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Unsealed roads that could be sealed, no local roads that loop only option is forestry	Yes	1	3	2	0	2	3	-	-
N2	12	Between Ruawai and Paparoa	Road	Flooding	Culverts being damaged and popping up the road. There is a test design underway to ensure that there is something in place to be able to respond	3L	-	No	Physical works ($$)	Further investigations needed	Yes	2	3	2	1	3	2	-	-
N1	1	Brynderwyn to Ruakaka	Road	Landslip	Landslip risk on Brynderwyn hills, and limited detour HPMV incapable. No HMPV both ways. Detour route has a number of 1-way bridges. If the Brynderwyn route is out, the whole upper north is out. Currently working on the major detour route to address the risk to Brynderwyn. There are also a lot of outages because of accidents and breakdowns etc. Southern side has more issues. Traffic going south goes through Mangawhai and north goes through Paparoa.	4VL	-	No	Physical works ($$$$)	Short term solution is to upgrade alternate routes. Costs for this will likely be less than construction of a new alignment. There is a wider PBC under way to look at a range of options.	Unsure	3	3	4	0	4	3	-	-
N38	10	Cable Bay	Road	Coastal Inundation / SLR	Coastal erosion and slips	2L	2VL	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	2	2	0	2	2	3	3
N46	1	Dome valley	Road	Landslip	More accident related	3L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	1	5	0	5	1	-	-
N42	15	Entire length of SH15	Road	Flooding	Flooding all along SH15.	2L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	2	2	0	2	2	-	-
N3	16	Entire length of SH16	Road	Flooding	Flood risk to route. It is the only alternate route for SH1, but it is not a high-quality section of road. During the holiday season they strongly advise people to take SH16. Due to it being a key alternate route it should be higher than a primary collector. The ONF will look to address this.	4L	-	No	Unknown. Pending further investigations	Requires a detailed study	Unsure	3	2	2	1	3	3	-	-

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N5	1	Hikurangi Swamp	Road	Flooding	SH15 and 14 are generally a result of SH1 flooding.	3L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	2	4	0	4	2	-	-
N43	14	Hikurangi Swamp - Whole river catchment down to the Western inlet which takes out all roads across Sh1, SH15 and SH12.	Road	Flooding	All flooding occurs around the swamp and takes out all roads. 1 in 5 years. Rail has been built	2L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	2	2	0	2	2	-	-
N40	14	Hikurangi Swamp Flooding	Road	Flooding	Flooding between Dargaville and Whangarei	2L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	2	2	0	2	2	-	-
N22	11	Hururu Falls to Ridglen Road	Road	Coastal Inundation / SLR	Coastal inundation occurs over the road for approximately 8 hours over high tide.	1UL	1L	No	BAU / Ongoing maintenance / Reactive	Could raise the road	Yes	1	2	2	0	2	1	2	3
N6	12	Inlet in Opononi	Road	Coastal Inundation / SLR	SLR and coastal inundation	3L	3VL	No	Physical works ($$$)	Short fix strengthening, midterm fix, existing works stopped the erosion, but still an issue. Raise the road? Need to raise land as well.	Yes	3	2	2	1	3	2	3	3
N26	10	Kaeo	Road	Flooding	Frequent flood area that is being partially addressed through current works. However likely to remain a flood issue in the future.	2VL	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	3	2	0	2	2	-	-
N7	15	Kaikohe to Pakotai	Road	Landslip	Fastest route to port, relevant for logging (ONRC increase)	3L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	2	3	2	1	3	2	-	-
N31	11	Kawakawa	Road	Flooding	Significant flooding especially with tides	2L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	1	2	0	2	2	-	-
N39	10	Kerikeri	Road	Flooding	Urban development, lack of storm water facilities	2L	-	No	Enhanced proactive maintenance	No meetings with local authorities, need more connected “convos”, systematic issue - strategic road network plan (storm water)	Yes	3	2	2	0	2	2	-	-
N8	12	Length of SH12 north of Dargaville	Road	Flooding	Culverts blocked	3L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	2	2	1	3	2	-	-
N9	16	Lookout slip	Road	Landslip	Significant landslip risk - Slip has occurred, there is a solution, but it has not been funded.	4L	-	No	Physical works ($)	Realign road as it could be a significant issues. Low cost low risk. Already designed.	Yes	2	3	2	1	3	3	-	-
N33	1	Mangamuka to Okaihau	Bridge	Flooding	Flood risk along SH1 where the Mangamuka and Waihou Rivers come close to the road.	2L	-	No	Enhanced proactive maintenance	There is funding for Mangamuka River but no funding for Waihou River. Could be solved by improving the catchment management (drainage)	Yes	3	1	2	0	2	2	-	-

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N37	10	Matauri Bay Road to Taupo Bay Road	Road	Landslip	Detour for SH 1	2L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	2	3	2	0	2	2	-	-
N28	1	Maungataniwha Range	Road	Landslip	Landslips due to heavy rainfall occur through the Maungataniwha ranges. There are currently no VMS boards to be able to inform road users of closures.	2L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Emergency response planning only	Unsure	1	3	2	0	2	2	-	-
N12	1	Oakley and Mata Flooding	Road	Flooding	Combined coastal inundation and river flooding risk. Key freight route. Used to occur every 5 years. Has been blocked twice in less than 10 years. Catchment boards involved in flood risk management were lost in the amalgamation of councils.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study	Unsure	3	2	4	0	4	3	3	3
N23	15	Otaika Valley	Road	Flooding	Typically, short term surface flooding which clears quickly.	1L	-	No	BAU / Ongoing maintenance / Reactive	Further investigations needed	Unsure	3	1	2	0	2	1	-	-
N29	10	Pakaraka to Awanui	Road	Landslip	Landslip risk across SH10 from Pakaraka to Awanui which causes disruption. This is also the main detour route for SH1.	1L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	2	3	2	0	2	1	-	-
N4	1	Ruakaka and Whangarei	Road	Flooding	Flood risk between Ruakaka and Whangarei. Both river and tidal flooding during king tides. Typically, when there are issues on the SH there are issues on the local roads so there are no alternate options.	5L	5VL	No	Unknown. Pending further investigations	Requires further detailed study.	Unsure	3	2	5	0	5	3	3	3
N14	12	Ruawai	Road	Flooding	Almost identical to SH14 flooding. Massive tidal surge. Prominent tourist route	3L	3VL	No	Enhanced proactive maintenance	Lifting the road, better drain management currently but with SLR then potentially raising the road.	Yes	3	2	2	1	3	2	3	3
N41	12	Ruawai to Brynderwyn	Road	Landslip	Slips and flooding between Ruawai and Brynderwyn. 5-10 years like to get worse with CC	3L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	1	2	1	3	2	-	-
N32	1	Schedways	Road	Landslip	Constantly moving but P2W will bypass	2L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	1	4	0	4	1	-	-
N15	1	South of Kawakawa	Road	Landslip	Landslip risk. Lack of detour unless travellers go onto SH 15 (> 4 hours detour), detour would cause issues for trucks.	4L	-	No	Unknown. Pending further investigations	Requires a detailed study	Yes	2	3	3	0	3	3	-	-
N44	15	South of twin bridges	Road	Landslip	Landslips occur along the road adjacent to the river south of the twin bridges.	2L	-	No	Enhanced proactive maintenance	Further investigations needed	Yes	3	2	2	0	2	2	-	-

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N34	12	Te Pouahi to Waiotemarama	Road	Landslip	No detour, relevant for tourism (ONRC increase)	4L	-	No	Unknown. Pending further investigations	Requires a detailed study	Unsure	2	3	2	1	3	3	-	-
N27	1	Tehana Bridge	Bridge	Flooding	Critical rail and road bridge. Look to upgrade the detour - waybe valley road floods, tidal flooding which could get worse with CC.	2L	2VL	No	Unknown. Pending further investigations	Work with AT, they have identified it as a key route. Potentially try and address flooding	Yes	3	1	4	0	4	1	3	3
N16	12	Tokatoka Bluff	Road	Rockfall	Highest priority in risk register	3L	-	No	Physical works ($$$)	Potentially realign the road because it would also address the coastal erosion.	Yes	2	3	2	1	3	2	-	-
N17	1	Turntable hill	Bridge	Flooding	Flooding of approaches at Turntable hill bridge	3L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	2	3	2	0	2	3	-	-
N13	Twin Coast Discovery Road	Twin Coast Discovery Road - Herekino Forest	Road	Landslip	Largest area of slips/geological movement in the area, probably most exposed area.	3VL	-	No	Physical works ($$$)	BC developed, multi hazard area needs thought.	Yes	3	3	2	0	2	3	-	-
N18	12	Waipoa Forest	Road	Flooding	Removing trees due to Kauri Die back has increased flooding issues along SH12 through Waipoa Forest. $1.5M has already been spent to repair roads from damage caused by excavating trees.	4L	-	No	Unknown. Pending further investigations	Requires further detailed study.	Unsure	3	2	3	2	5	2	-	-
N19	12	Waipoa Forest	Road	Landslip	Land stability issues along the stretch of SH12 through Waipoa forest	3L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	2	2	1	3	2	-	-
N10	1	Wayby Road on SH1	Road	Landslip	Existing landslip, however, there has been no work done to understand the landslip risk. Ongoing land movement.	4VL	-	No	Unknown. Pending further investigations	Requires further detailed study.	Unsure	3	3	4	0	4	3	-	-
N24	Wayby Valley Road	Wayby Valley Road Detour route	Road	Flooding	Flooding along Wayby Valley Rd which is a key detour route.	1L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	1	2	0	2	1	-	-
N45	16	Wellsford to Punganui	Road	Landslip	Landslip risk from Wellsford to Punganui	3L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	2	2	2	1	3	2	-	-

A1.8 Otago regional risk catalogue

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
O1	8	Alexandra to Clarkes Junction (Milton)	Road	Ice / Snow	Risk from snow and ice.	4L	-	No	Physical works ($$)	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Yes	3	2	3	0	3	3	-	-
O3	8	Alexandra to Clarkes Junction (Milton)	Road	Landslip	Shingle Creek landslip feature. Manuka Gorge, tight narrow alignment through a gorge with lots of rock bluffs and areas of fill.	3L	-	No	Physical works ($$$)	Retaining walls and drainage	Yes	3	2	3	0	3	2	-	-
O2	8	Alexandra to Clarkes Junction (Milton)	Road	Rockfall	Isolated areas of rockfall. Unlikely to warrant capital intervention at this stage.	3L	-	No	BAU / Ongoing maintenance / Reactive	Minor rockfall and can be addressed through Emergency Works if required	Yes	3	1	3	0	3	2	-	-
O23	86	Allanton to Dunedin Airport	Road	Flooding	Airport is at or just below SL, protected by stop banks but has flooded a couple of times. Pump system could potentially work however you get lower and lower ground level as you head towards the airport.	2UL	2L	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance to ensure SWC and culverts are clear pre-event	No	2	1	3	0	3	1	3	1
O4	1	Balclutha Bridge	Bridge	Flooding	Flooding of the Balclutha river has potential to impact / compromise the Balclutha Bridge. This is the only bridge and detour routes are significant.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study	Unsure	2	2	3	0	3	3	3	3
O15	1	Big Kuri River	Road	Flooding	Big Kuri River north of Hampden deposits a large amount of gravels which causes water to flow over the bridge. 4-5-hour detour.	4L	4VL	No	Physical works ($$$)	The plan is to wait for the bridge to get to the end of its life then construct a new bridge with improved freeboard.	Yes	3	2	4	0	4	3	3	3
O46	8	Cromwell to Alexandra	Road	Landslip	Cromwell Gorge landslip risk. Numerous active landslips throughout the man-made Cromwell Gorge (part of the Clyde Dam construction). Actively dewatered on an ongoing basis to maintain slope stability.	4L	-	No	Physical works ($)	Corridor investigation to determine vulnerable areas and possible solutions to mitigate	Unsure	2	3	3	0	3	3	-	-
O5	8	Cromwell to Alexandra	Road	Rockfall	Cromwell Gorge and Clyde Dam, current LCLR investigation project. A low number of rockfalls have occurred in the past, however there is potential for future rock fall. Relaxed and partially cracked benches which have accumulated debris and pose future risks.	4L	-	Yes	Physical works ($$)	Scaling, stabilisation and catch fences/structures	Yes	2	3	3	0	3	3	-	-

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O8	6	Cromwell to Frankton	Road	Landslip	Landslip risk throughout the Kawarau Gorge. Some LCLR investigation work underway.	4VL	4VL	No	Physical works ($$$)	Retaining walls and drainage improvements	Yes	3	3	3	0	3	3	3	3
O6	6	Cromwell to Frankton	Road	Ice / Snow	Risk from snow and ice.	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter maintenance LOS and improved communication. Additional VMS required at selected locations along route where alternative routes exist	Yes	3	2	3	0	3	3	-	-
O7	6	Cromwell to Frankton	Road	Rockfall	Sites at risk to rockfall throughout the Kawarau Gorge.	4VL	-	No	Physical works ($$$)	Scaling, stabilisation and catch fences/structures	Yes	3	3	3	0	3	3	-	-
O37	1	Dunedin to Mosgiel	Road	Ice / Snow	Snow & Ice	3L	-	No	Enhanced proactive maintenance	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Yes	3	1	4	0	4	2	-	-
O53	88	Dunedin to Port Chalmers	Road	Coastal Inundation / SLR	Multiple low-lying areas and therefore potential to be exposed to coastal inundation in the future	3UL	3VL	No	Unknown. Pending further investigations	Further investigations needed	Unsure	1	1	4	0	4	2	3	3
O45	88	Dunedin to Port Chalmers	Road	Earthquake / liquefaction	Constructed as side cast fill – cut into the bank and the compacted the fill on the side so one good lane and one lane that is likely to slip in an earthquake. Rail would likely be knocked out as well as it is on fill and therefore would rely on shallower draft ships to drop off goods into Dunedin. Rail is part of the South Island main trunk line from Christchurch to Bluff. Event would be significant to take out the highway and the rail – significant or local EQ.	3L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Corridor investigation to determine vulnerable areas and possible solutions to mitigate	Unsure	1	3	4	0	4	2	-	-

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
O9	88	Dunedin to Port Chalmers	Road	Landslip	Constructed as side cast fill – cut into the bank and the compacted the fill on the side so one good lane and one lane that is likely to slip in an EQ. Corridor which probably needs a holistic view across its whole length. Freight and rail would likely be knocked out as well as it is on fill and therefore would rely on shallower draft ships to drop off goods. This is the main trunk line from CHCH to Bluff. Slips occur during storm events as a result of water coming down from hillsides. Small washouts of roadside barriers also occur.	3VL	3VL	Yes	Physical works ($$$)	Retaining walls and drainage in the short term, with wider investigation required for the longer term	Yes	3	3	4	0	4	2	3	3
O40	88	Dunedin to Port Chalmers	Road	Ice / Snow	Snow & Ice	3L	-	No	Enhanced proactive maintenance	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Yes	3	1	4	0	4	2	-	-
O34	6	Frankton to Kingston	Road	Ice / Snow	Risk from snow and ice.	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Yes	3	1	3	0	3	3	-	-
O48	6	Frankton to Kingston	Road	Landslip	Landslips along the side of Lake Wakatipu.	4VL	-	No	Unknown. Pending further investigations	Corridor investigation to determine vulnerable areas and possible solutions to mitigate	Unsure	3	3	3	0	3	3	-	-
O42	6A	Frankton to Queenstown	Road	Ice / Snow	Snow & Ice	3L	-	No	Enhanced proactive maintenance	Winter maintenance LOS and improved communication. Small urban style VMS required at each end of route where alternative routes exist	Yes	3	1	3	1	4	2	-	-
O10	6a	Frankton to Queenstown	Road	Landslip	Only route that links Queenstown and airport; alternate route would take an extra hour, however, is complicated by the single lane Edith Cavell bridge. SH6a is built on landslides, is the key route between Qtown and airport. Several known active and monitored slips	3L	3VL	No	Physical works ($$$$)	Retaining walls and drainage	Unsure	2	3	3	0	3	2	3	3
O11	6	Haast Pass to Lake Hawea	Road	Ice / Snow	Risk from ice and heavy snow. Passes through a national park with overhanging trees, prone to falling.	4L	-	Yes	Enhanced proactive maintenance	Winter maintenance LOS and improved communication	Yes	3	2	3	0	3	3	-	-

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O50	6	Haast to Hawea	Road	Rockfall	Numerous large scale rockfall locations along the corridor. Improved funding would be a starting point to improve resilience but not resolve the issue in its entirety. Funding currently allocated through the National Rockfall programme to address isolated high priority sites with a supporting Rockfall Hazard Rating System (RHRS) score.	4VL	-	No	Physical works ($$$)	Scaling, stabilisation and catch fences/structures	Unsure	3	3	3	0	3	3	-	-
O41	6	Hawea to Cromwell	Road	Ice / Snow	Snow & Ice	3L	-	No	Enhanced proactive maintenance	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Yes	3	1	3	0	3	2	-	-
O12	1	Katiki Coast	Road	Coastal Erosion	Both bottom up and top down erosion along the coast. Some coastal erosion funding has been provided. If coastal route is gone there is a light vehicle detour but heavy's will be 4-5 hours. Mini Kaikoura as KiwiRail is located directly next to the road. The only coastal section of SH1 and vulnerable to high seas and erosion.	3VL	3VL	No	Physical works ($$$)	Continuation of rock revetment. Assessment and development of overland flow measures to prevent top down erosion.	Yes	3	3	4	0	4	2	3	3
O13	1	Katiki Coast	Road	Coastal Inundation / SLR	Only coastal section of SH1 and vulnerable to high seas and inundation. Some bridges are within 2m of high tide level	3VL	3VL	No	Physical works ($$$)	Requires continuation of rock revetment.	Yes	3	3	4	0	4	2	3	3
O14	1	Katiki Coast	Road	Tsunami	Coastal section exposed to tsunami.	3L	-	Yes	Physical works ($$$)	Partially funded Further funding will be required to continue rock revetment to armour toe of the slope against SLR and tsunami impact	Yes	1	3	4	0	4	2	-	-
O38	83	Kurow to Omarama	Road	Ice / Snow	Snow & Ice	2L	-	No	Enhanced proactive maintenance	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Yes	3	1	2	0	2	2	-	-
O47	6	Lake Hawea and Lake Wanaka	Road	Landslip	Landslips along the side of lakes Wanaka & Hawea. This links to risk Id WC9 which identifies landslip issues along Haast Pass.	4VL	-	No	Unknown. Pending further investigations	Corridor investigation to determine vulnerable areas and possible solutions to mitigate	Unsure	3	3	3	0	3	3	-	-

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O15	1	Maheno	Bridge	Flooding	Flooding issues within a number of river catchments. Options have been scoped. Overland flow path floods the road between Clarks Mill and where the road crosses the railway. There is a plan to put culverts in to allow water to run from one side of the road to the other to stop flooding. When this floods the bridge also floods and the detour is ~ 4-5 hours.	4L	4VL	No	Physical works ($$)	Upgrade culverts and overland flow paths.	Yes	3	2	4	0	4	3	3	3
O31	87	Mosgiel	Road	Flooding	Heavy rainfall results in surface flooding through Mosgiel on SH97. Often the first 2km of the road gets closed to protect the local businesses to stop water washing into buildings when cars drive by.	2L	2VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance to ensure drainage structures are clear pre-event	No	3	1	2	1	3	1	3	3
O44	1	Mosgiel to Gore	Road	Ice / Snow	Snow & Ice	3L	-	No	Enhanced proactive maintenance	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Yes	3	2	3	0	3	2	-	-
O30	87	Mosgiel to Kyeburn	Road	Rockfall	There are isolated areas of minor rockfall along SH87 from Mosgiel to Kyeburn however it is thought to not be a significant enough issue for capital intervention.	2L	-	No	BAU / Ongoing maintenance / Reactive	Minor rockfall and can be addressed through EW if required	Yes	3	1	2	0	2	2	-	-
O51	6	Nevis Bluff	Road	Rockfall	Nevis Bluff is a significant unstable feature between Cromwell and Queenstown. Proactive monthly inspections are undertaken and programmed rock scaling pre & post winter to remove fractured material is funded and managed through the NOC. Regular additional funding is required to address high other priority/urgent unstable features in the order of $1M-$5M per intervention. Alternate long-term options could be investigated such as a tunnel.	4VL	-	No	Enhanced proactive maintenance	More detailed investigation required which would assess all possible options. Continued proactive monitoring and maintenance intervention	Unsure	3	3	3	0	3	3	-	-

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O16	8	Omarama to Tarras	Road	Ice / Snow	Continuous snow in winter. Winter events affect both sides of Lindis Pass. This is within the corridor management plan from Christchurch to Queenstown.	4L	-	Yes	Enhanced proactive maintenance	Winter maintenance LOS and improved communication	Yes	3	2	3	0	3	3	-	-
O49	8	Omarama to Tarras	Road	Landslip	Land instability around Cluden Hills area north of Tarras	3L	-	No	Physical works ($)	Retaining wall and drainage	Yes	2	2	3	0	3	2	-	-
O17	8	Omarama to Tarras	Road	Rockfall	Rockfall risk predominantly to the south of Lindis Pass (Central Otago side).	4L	-	No	Physical works ($$)	Scaling, stabilisation and catch fences/structures. Detail in the corridor management plan.	Yes	3	2	3	0	3	3	-	-
O35	87	Outram to Kyeburn	Road	Ice / Snow	Snow & Ice	2VL	-	Yes	Enhanced proactive maintenance	Winter maintenance LOS and improved communication	Yes	3	3	2	0	2	2	-	-
O22	85	Palmerston to Alexandra	Road	Ice / Snow	Snow and ice, closed half a dozen times a year	3L	-	Yes	Enhanced proactive maintenance	Winter maintenance LOS and improved communication	Yes	3	2	2	0	2	3	-	-
O25	85	Palmerston to Alexandra	Road	Landslip	Dead Horse Pinch is a section of highway built on poor material. Monitored twice a year with a ground-based survey and gradually moving downhill. Repeat intervention to maintain ride quality and safety. Williamsons landslip near Lauder. Slow gradual movement with repeated intervention. Secondary collector route – would be wanting to put money into SH 8 first	2L	2VL	No	Physical works ($$)	Retaining wall and drainage	Yes	2	2	2	0	2	2	3	3
O29	85	Palmerston to Alexandra	Road	Rockfall	There are isolated areas of minor rockfall along SH85 from Palmerston to Alexandra however it is thought to not be a significant enough issue for capital intervention.	2L	-	No	BAU / Ongoing maintenance / Reactive	Minor rockfall and can be addressed through EW if required	Yes	3	1	2	0	2	2	-	-
O36	1	Palmerston to Dunedin	Road	Ice / Snow	Snow and ice risk.	4L	-	Yes	Enhanced proactive maintenance	Winter maintenance LOS and improved communication	Yes	3	2	4	0	4	3	-	-
O26	90	Pomahaka Bridge	Bridge	Flooding	There is regular flooding of the river where a significant amount of debris catches around bridge. This typically results in water spilling over and flooding the northern approach to bridge	1L	1VL	No	Physical works ($$$)	Raise the level of the northern approach, install culverts	Yes	3	2	2	0	2	1	3	3

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O33	83	Pukeuri to Omarama	Road	Flooding	SH83 from Pukeuri to Omarama is subject to flooding. There are effectively two separate climates across the stretch of road the coastal section and the dryer inland section where flooding is induced by two different mechanisms. Increased dairy farming which has therefore increased the amount of irrigation has reduced the lands ability to absorb heavy rainfall along the coastal section of the route. Farmers have also closed over the old overflow / flood pathways and which result in flooding of the highway instead. Inland is barren and dry and therefore slightly different issues. There are also a number of culverts which block in very large rainfall events due to heavy rainfall on gravely slopes.	2L	-	No	Enhanced proactive maintenance	Ongoing maintenance to ensure drainage structures are clear pre-event. Working through minor drainage improvements as part of annual plan funding	Yes	3	2	2	0	2	2	-	-
O19	6	Queenstown to Frankton	Road	Landslip	Highly vulnerable to rainfall induced landslips.	4L	4VL	No	Physical works ($$$)	Retaining walls and improving lakeside stability to minimise under slips	Yes	3	2	3	0	3	3	3	3
O18	6	Queenstown to Kingston	Road	Rockfall	Highly vulnerable to rockfall.	4L	-	No	Physical works ($$$)	Scaling, stabilisation and catch fences/structures	Yes	3	2	3	0	3	3	-	-
O24	90	Raes Junction	Road	Flooding	Regular flooding at the junction of SH90 & SH8	2L	2VL	No	Physical works ($)	Routine debris removal, creek bed training, rock armouring and site concrete to prevent scour	Yes	3	2	2	0	2	2	3	3
O39	90	Raes Junction to McNab	Road	Ice / Snow	Snow & Ice	2L	-	No	Enhanced proactive maintenance	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Yes	3	2	2	0	2	2	-	-

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O20	8	Roxburgh	Road	Flooding	Flooding in Roxburgh which affects all assets not just road due to climate and topography of the mountains and predominant in spring due to heat inversion, 'thunder plumps / cloud bursts' generally develop on a hot sunny day. At least once a year for the last 3 years with significant flooding. Low cos Low risk project is currently underway to address some of the issues as well as a catchment study done by the regional council. Started to design the upsizing of 3 highway culverts. When it does rain heavily it brings down a massive amount or debris and block up culverts and wash out abutments. Almost debris flow like.	3L	3VL	Yes	Physical works ($$)	New increased capacity culverts under SH8. Currently being addressed under LCLR. Main link from Central Otago to Dunedin.	Yes	3	2	3	0	3	2	3	3
O32	86	SH1 to Dunedin Airport	Bridge	Earthquake / liquefaction	Bridge located on SH86 between SH1 and Dunedin airport is potentially vulnerable to liquefaction.	2L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Re-engineer piles. Alternate routes exist however all use bridges to cross the same river	No	1	3	3	1	4	1	-	-
O43	8	Tarras to Alexandra	Road	Ice / Snow	Snow & Ice	3L	-	No	Enhanced proactive maintenance	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Yes	3	1	3	0	3	2	-	-
O15	1	Waikouati River	Road	Flooding	Waikouati River floods the highway.	4L	4VL	No	Physical works ($$)	Raise level of road to clear flood level	Yes	3	2	4	0	4	3	3	3
O27	1	Waitaki Bridge	Bridge	Flooding	Waitaki bridge through to Oamaru – regular flooding. Recent seismic strengthening but a few vulnerabilities, braided river. A lot of river protection works and erosion on the north bank. Vegetation management in Longest structure in Otago. Detour adds about an hour and a half should the Waitaki Bridge get taken out. Doesn't need massive capital investment.	3L	3VL	Yes	BAU / Ongoing maintenance / Reactive	Ongoing maintenance through structures contract	Yes	3	1	4	0	4	2	3	3

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O33	1	Waitaki Bridge to Oamaru	Road	Flooding	Hilderthorpe straight south of the Waitaki Bridge to Pukeuri is flood prone. Currently looking to address in LCLR working with KiwiRail, WDC & ORC. Some unmaintained flood channels and undersized culverts. The channels don't reach the ocean and sometimes back up and flood the area approx. one every three years. Detour route is subject to flooding in the same event so not always viable	3L	-	No	Physical works ($$)	Ditching, culvert upgrades where required, ongoing maintenance of flood channels by responsible parties (ORC)	Yes	3	2	4	0	4	2	-	-
O52	1	Waitati to Dunedin	Road	Ice / Snow	Ice and snow issues from Waitati as you pass over the hill into Dunedin	3L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	1	4	0	4	2	-	-
O21	1	Wakouaiti to Evansdale	Road	Landslip	The Kilmog is a very unstable length of road. Grout columns have been installed through sections of highway but are now protruding through the road surface. Haven't considered options in depth due to multimillion-dollar need. Extremely slip prone ground. National Criticality. Light traffic can use Coast Road as a detour. There are a couple of sites with options which could greatly enhance or remove the issues with the right solution.	3VL	3VL	No	Physical works ($$$)	Piling works to retain active slopes. Drainage improvements and ongoing pavement and surfacing intervention to maintain LOS	Yes	3	3	4	0	4	2	3	3

A1.9 Southland regional risk catalogue

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
S1	1	Entire coastal section at Ocean view north of Bluff	Road	Coastal Inundation / SLR	Ocean view route to the port - risk to coastal inundation that will need to be addressed within the next 10 years. Combination of coastal and rainfall flooding at high tide resulting in traffic lanes being submerged over a length of approximately ~70m. This is the key route to the port, with no detour. Compounding issue is that the lagoon doesn't drain.	4L	4VL	No	Physical works ($$)	Raise the road for around 70m	Yes	3	1	3	0	3	3	3	3
S2	94	Gorge Hill	Road	Landslip	Landslip risk at Gorge Hill. Slip has failed previously, completely damaging the road. Currently no detour, however a subsidiary road could be built through farmers land. Has been stable, with preventative maintenance undertaken. Slumping is topped up approximately monthly. Annual visits to survey the movement. Low volume but strategic for tourist reasons. 4-hour detour.	4L	4VL	No	Emergency response and preparedness planning only (typically HI/LF)	Pre buy section in advance to be able to build an alternate/backup road.	No	1	3	3	0	3	3	3	3
S7	96	Hedgehope	Road	Flooding	Flooding from the Makarewa River - similar to Makarewa Junction	2UL	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	2	1	2	0	2	2	-	-
S8	6	Makarewa Junction	Road	Flooding	Flooding from the Makarewa River - similar to Hedgehope	2UL	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	2	1	3	0	3	1	-	-
S10	90	Mataura River	Bridge	Earthquake / liquefaction	Mataura river bridge is the most vulnerable to seismic hazard in the southland region and has no funding allocated for any maintenance works under LC/LR.	2L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Emergency response planning only	No	1	3	3	0	3	1	-	-
S4	99	McCracken's Rest	Road	Landslip	McCracken's rest land stability. visited site once in 11 years. there is a detour for small vehicles but minimal for heavies.	2L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	2	2	2	0	2	2	-	-
S6	90	Old Coach Road	Road	Rockfall	Old coach road - minor rockfall	3UL	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	1	1	3	0	3	2	-	-

A1.10 Taranaki regional risk catalogue

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T2	3	Awakino gorge	Road	Rockfall	Rockfall risk, erosion drop out, over and under slips and severe weather (>2m rainfall a year). This is a priority for significant rockfall and vegetation removal (due to rockfall). Currently Awakino Gorge tunnel only bypasses ~500m of the gorge. Difficult to predict where rockfall will occur next, therefore difficult to plan for unless the entire 8km was realigned. High risk gorge environment with no viable detour.	4L	-	No	Physical works ($$$)	Rockfall protection, mesh, clearing material and retaining walls.	Yes	3	2	3	0	3	3	-	-
T14	3	Awakino Village	Road	Coastal Erosion	Awakino Village at risk of coastal erosion.	4L	4VL	No	Physical works ($$)	In the short term continue rock fencing. Realignment and smoothing the corner and cut into the bluff is the long-term solution. ~60-70m bluff.	Yes	2	2	3	0	3	3	3	3
T3	3	Entire length of SH3 north of New Plymouth	Road	Landslip	Landslip risk to strategic highway on Taranaki network. Lack of viable alternative route with the nearest detour being SH4, adding a large amount of time and distance. Substantial geotechnical structures for slope instability along the road south of Piopio (in the gorges). Some structures are very old.	4L	4VL	No	Physical works ($$)	Requires a detailed study	Unsure	3	2	3	0	3	3	3	3
T4	3	Entire length of SH3 north of New Plymouth	Road	Rockfall	Significant rockfall risk.	4L	-	No	Physical works ($$)	Requires a detailed study	Unsure	3	2	3	0	3	3	-	-

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T5	43	Entire length of SH43	Road	Extreme Weather	Severe weather events, under and over slips, flooding the entire length of SH43 ~ 150km. No detour routes, it is not a suitable detour route for SH3 because its already down to 1 lane due to slips and dropouts and not suitable as a detour due to its low resilience. Project would be transmission gulley to solve the issues. A few structures which are currently being maintained but in terms of upgrading its not seen as viable. In terms of tourism it is seen as a key highway.	3L	-	No	Unknown. Pending further investigations	Massive realignment of road	Yes	3	2	2	0	2	3	-	-
T6	43	Entire length of SH43	Road	Landslip	Severe weather events, under and over slips, flooding the entire length of SH43 ~ 150km. No detour routes, it is not a suitable detour route for SH3 because its already down to 1 lane due to slips and dropouts and not suitable as a detour due to its low resilience. Project would be transmission gulley to solve the issues. A few structures which are currently being maintained but in terms of upgrading its not seen as viable. In terms of tourism it is seen as a key highway.	3L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	2	2	0	2	3	-	-
T8	3	Mangaotaki gorge	Road	Landslip	Mangaotaki Gorge is at risk of landslip. Currently has no geotechnical barriers.	4L	4VL	No	Physical works ($$$)	Active/priority sites have been funded but the whole corridor has a resilience issues. Retaining walls.	Yes	3	2	3	0	3	3	3	3
T9	4	Mapara North road through to Ohura road	Road	Flooding	Occurs from approximately 12km in Mapara North road through to Ohura road - over slip, under slip and localised flooding during extreme weather. Requires preventative maintenance works. Waterfall Hills - reasonable geotechnical remediation being put in place to address under slip and bluff rock fall.	3VL	3VL	No	Physical works ($$)	Further investigations needed	Unsure	3	3	2	0	2	3	3	3

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T10	3	Mohakatino and Tongaporutu estuaries	Road	Coastal Inundation / SLR	Mohakatino and Tongaporutu estuaries could potentially have coastal inundation and erosion issues.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study	Unsure	2	2	3	0	3	3	3	3
T12	3	Mohakatino Bridge	Road	Coastal Erosion	Potential for erosion risk due to it being low lying and in an estuary. The causeway is very narrow and vulnerable to erosion due to wave action. Currently a low cost, low risk project to provide rock armour. One side of the wall had rock armour which has been washed out. Could have coastal inundation issues in the future, however the geomorphology of the estuary could change this.	4L	4VL	No	Physical works ($$)	Rock armour improvements in the short term, but needs a long-term plan	Yes	2	2	3	0	3	3	3	3
T13	3	Mokau Bluff	Road	Erosion	Mokau Bluff, at risk of coastal erosion.	4L	4VL	No	Physical works ($$)	In the short term continue rock fencing. Realignment and smoothing the corner and cut into the bluff is the long-term solution. ~60-70m bluff.	Yes	2	2	3	0	3	3	3	3
T15	3	Mt Messenger	Road	Landslip	South of Mt Messenger is at risk of landslip- Uruti Valley has a number of cuttings prone to slipping.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study	Unsure	3	2	3	0	3	3	3	3
T16	3	Patea Bridge	Bridge	Erosion	Bridge built between 60's-70's at risk to erosion.	4L	4VL	No	Physical works ($$)	Strengthening or realignment of the bridge would be a more beneficial outcome in comparison to a new route.	Yes	2	2	3	0	3	3	3	3
T17	45	Ratahei to Whanganui	Road	Landslip	Raetihi to Whanganui major landslip which occurred in 2019. This already has a PBC underway.	3VL	3VL	Yes	Physical works ($$$$)	PBC already underway	Yes	3	3	2	0	2	3	3	3
T19	3	SH3 Midhurst rail overbridge	Road	Erosion	SH3 Midhurst rail overbridge has the potential for erosion and scour - which may in turn affect the road below. The detour route is also very long and is not ideal for HPMV.	4L	4VL	No	Unknown. Pending further investigations	There is no specific risk at the moment, but the solution should be similar to what occurred in Normandy, bridge realignment and creation of a viable detour. Main pinch points are all bridges with no detour routes.	Yes	3	2	3	0	3	3	3	3

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
T18	3	SH3 Midhurst rail overbridge	Road	Flooding	SH3 Midhurst rail overbridge has the potential for flooding. The rail and river bridge are back to back with detours that are not ideal for HPMV. The detour route is also very long. There is no specific hazard at the moment, but the solution should be similar to what occurred in Normandy, bridge realignment and creation of a viable detour. Main pinch points are all bridges with no detour routes.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study	Unsure	3	2	3	0	3	3	3	3
T20	3	South of Mt Messenger	Road	Erosion	Erosion risk where river runs adjacent to SH3 South of Mt Messenger	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Requires ongoing monitoring and potential stabilisation	Yes	3	2	3	0	3	3	3	3
T21	45	Tataraimaka	Road	Flooding	Tataraimaka - 'z' shaped alignment, flooding issues and previously a culvert has washed out the whole road with no detour around the area at all and there is increasing development in the area to connect to new Plymouth, Bridge alignment is not ideal, re alignment would be the best option to straighten up the road. lower priority than SH3 - some sections of 45 have the highest volumes on the network.	3L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	2	2	0	2	3	-	-
T22	3	Tongahoe	Bridge	Erosion	Bridge built between the 60's-70's and is at risk to erosion. Tongahoe should be a high priority as it has a bluff and the river.	4L	4VL	No	Physical works ($$)	Strengthening or realignment of the bridge would be a more beneficial outcome in comparison to a new route.	Yes	2	3	3	0	3	3	3	3
T23	3	Tongaporutu estuary	Road	Coastal Erosion	Route has coastal erosion risk due to the estuary and also has potential to be at risk from coastal inundation.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Requires ongoing monitoring and potential stabilisation	Yes	1	3	3	0	3	3	3	3
T24	3	Waitotara bridges	Bridge	Erosion	Erosion risk to the bridge. Built between 60's-70's.	4L	4VL	No	Physical works ($$)	Strengthening or realignment would be of more value than creating a new route,	Yes	2	2	3	0	3	3	3	3

A1.11 Top of the South regional risk catalogue

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
TS5	6	Atawhai	Road	Landslip	Slow moving landslips	3L	-	No	Physical works ($$$)	realign road	Yes	3	2	3	0	3	2	-	-
TS49	6	Atawhai through to Nelson	Road	Coastal Inundation / SLR	Low lying and water over the road. Does coincide with spring tides and so likely get more frequent	3UL	3L	No	Physical works ($$)	raise road	Yes	2	1	3	0	3	2	3	2
TS35	6	Atawhai through to Nelson	Road	Flooding	Low lying and water over the road. Does coincide with spring tides	3L	3VL	No	Physical works ($$)	Raise road	Yes	3	1	3	0	3	2	3	3
TS36	6	Atawhai through to Richmond	Road	Tsunami	Tsunami Risk along Rocks Road.	3L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Emergency response planning only	No	1	3	3	1	4	2	-	-
TS52	6	Brightwater Bridge	Bridge	Flooding	Flooding of approaches	2L	-	No	Physical works ($$)	raise approaches	Yes	3	1	3	1	4	1	-	-
TS54	60	Bronte	Road	Coastal Inundation / SLR	SLR in the future with 0.5m SLR will complicate. moving from low frequency and outage to high and medium	3UL	3L	No	Physical works ($$$)	Raising the road	Yes	2	1	3	0	3	2	2	2
TS6	6	Canvastown along Pelorus River	Road	Flooding	River floods and inundates the road	4VL	4VL	No	Physical works ($$$)	Raise the road	Yes	3	3	3	0	3	3	3	3
TS48	6	Collins Valley	Road	Flooding	Collins valley slips and flooding	3UL	3L	No	Physical works ($$)	River protection	Yes	2	1	3	0	3	2	3	2
TS34	6	Collins Valley	Road	Landslip	Under slip	3L	-	No	Physical works ($$$$)	Realignment	Yes	2	2	3	0	3	2	-	-
TS22	63	Connors Bend along Wairau River	Road	Flooding	Flooding risk where land drains river.	4L	4VL	No	Physical works ($$)	Better drainage required	Yes	3	1	2	1	3	3	3	3
TS7	6	Dallows Bluff	Road	Rockfall	Frequent rockfall on SH6 stretch between intersections with SH65 and SH63. High priority for the Top of the South	4VL	-	No	Physical works ($$)	Requires netting.	Yes	3	3	3	1	4	3	-	-
TS27	65	Deadman's Slip	Road	Landslip	Undercutting of the road caused by the river	3VL	3VL	No	Physical works ($$)	Requires armouring and protection.	Yes	3	3	2	1	3	2	3	3
TS46	1	Delegats	Road	Flooding	Surface runoff	3L	-	No	Physical works ($$)	Culvert upgrade	Yes	3	1	4	0	4	2	-	-
TS8	6	Entire Region	Road	Wildfire	Wildfire risk to wooden structures such as bridges and retaining walls which exist across the entire region.	4L	4VL	No	Enhanced proactive maintenance	Preparedness	Unsure	2	3	3	0	3	3	3	3
T65	6	Glenhope to Murchison	Road	Ice / Snow	Ice and snow risk through hills from Glenhope to Murchison	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Unsure	3	2	3	1	4	3	-	-

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
TS9	6	Granity Rockfall	Road	Rockfall	Frequent rockfall on SH6 stretch between intersections with SH63 and WC boundary. High priority for the Top of the South	4VL	-	No	Physical works ($$)	Requires netting.	Yes	3	3	3	1	4	3	-	-
TS47	6	Havelock to Renwick	Road	Flooding	Surface flooding	3L	-	No	Enhanced proactive maintenance	Improve land drainage	Yes	3	1	3	0	3	2	-	-
TS28	65	Higgins Bluff	Road	Rockfall	Rockfall risk along the bluff.	4VL	-	No	Physical works ($$)	Requires netting	Yes	3	3	2	1	3	3	-	-
TS40	6	Hope	Road	Flooding	Surface flooding occurs along SH6 from Brightwater to Richmond.	2L	-	No	Physical works ($$$)	Improve drainage	Yes	3	2	3	1	4	1	-	-
TS10	6	Hope saddle	Road	Landslip	Ongoing landslip risk	4VL	4VL	No	Physical works ($$)	Requires netting.	Yes	3	3	3	1	4	3	3	3
TS53	63	Howard Junction	Road	Erosion	River erosion	3UL	-	No	Physical works ($$)	River protection	Yes	2	1	2	0	2	3	-	-
TS23	63	Howard Narrows	Road	Rockfall	Rockfall hazard for ~3km	3L	-	No	Physical works ($$$)	netting	Yes	3	2	2	0	2	3	-	-
TS11	6	Kawatiri to Owen	Road	Erosion	At risk to river erosion and drop out.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	No	2	3	3	1	4	3	3	3
TS42	6	Kohatu Bridge	Road	Erosion	Scour	2L	-	No	Physical works ($$)	scour protection and raise approaches	Yes	2	3	3	1	4	1	-	-
TS43	6	Kohatu Bridge	Road	Flooding	Flooding of bridge approaches	2L	-	No	Physical works ($$)	raise approaches	Yes	2	3	3	1	4	1	-	-
TS56	1	Lake Grassmere	Road	Coastal Inundation / SLR	Sea level rise has potential to inundate the road	3UL	3L	No	Physical works ($$$)	Raise road. co-fund through annual plans and renewals	Yes	2	1	4	0	4	2	3	2
TS55	60	Mariri	Road	Coastal Inundation / SLR	moving from low frequency and outage to high and medium	3UL	3L	No	Physical works ($$$)	raise road	Yes	2	1	3	0	3	2	3	2
TS30	65	Mauria River	Road	Erosion	Surface flooding and undercutting / erosion where river is next to the road.	4VL	4VL	No	Physical works ($$$)	Rock protection along river to protect road	Yes	3	3	2	1	3	3	3	3
TS29	65	Mauria river	Road	Flooding	Surface flooding and undercutting / erosion where river is next to the road	3VL	3VL	No	Physical works ($$$)	Rock protection	Yes	3	3	2	1	3	2	3	3
TS64	60	Milnthorpe	Road	Coastal Inundation / SLR	Coastal inundation and sea level rise risk. Moving from low frequency and outage to high and medium	2UL	2L	No	Unknown. Pending further investigations	Further investigations needed	No	2	1	2	0	2	2	3	2
TS12	6	O'Sullivans Bluff	Road	Rockfall	Frequent rockfall on SH6 stretch between intersections with SH65 and SH63. High priority for the Top of the South	4VL	-	No	Physical works ($$)	Requires netting.	Yes	3	3	3	1	4	3	-	-
TS37	6	Port / QEII Drive	Road	Earthquake / liquefaction	Liquefaction on reclaimed land.	3L	-	No	BAU / Ongoing maintenance / Reactive	Emergency response planning only	No	1	3	3	1	4	2	-	-

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
TS50	6	QEII Bridge	Bridge	Coastal Inundation / SLR	Approaches currently Low now but this is moving up to more frequent. If SH6 is closed, then Waimea road is at capacity	3UL	3L	No	Unknown. Pending further investigations	Further investigations needed	Unsure	1	2	3	1	4	2	2	3
TS1	1	Redwood Pass	Road	Rockfall	Rockfall risk through Redwood Pass.	4L	-	No	Physical works ($$)	rockfall protection	Yes	3	1	4	1	5	2	-	-
TS45	63	Renwick creek	Road	Flooding	annual flooding	2L	-	No	Physical works ($$)	Better drainage and stormwater management	Yes	3	2	2	1	3	1	-	-
TS39	6	Richmond to Nelson	Road	Earthquake / liquefaction	Earthquake and liquefaction risk from Richmond to Nelson.	3L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Emergency response planning only	No	1	3	3	1	4	2	-	-
TS19	60	Richmond to O'Connor's bridge	Road	Flooding	Surface flooding	3L	-	No	Physical works ($$$)	Further investigations needed	Yes	3	2	3	0	3	2	-	-
TS44	60	Riwaka River	Road	Flooding	Flooding of road adjacent to Riwaka river	2L	-	No	Physical works ($$)	Could have upgrade of drainage and culverts	Yes	3	2	2	0	2	2	-	-
TS51	6	Rocks Road	Road	Coastal Inundation / SLR	Aged sea wall moving towards a medium to high outage. Detour is low but the ONRC should be increased. Detour is over Waimea which is at capacity	2L	2VL	No	Physical works ($$$)	Further investigations needed	Yes	3	1	3	1	4	1	3	3
TS38	6	Rocks Road	Road	Rockfall	Rockfall Risk from Atawhai through to Richmond as the road runs adjacent to a number of bluffs and rock faces.	3L	-	No	Physical works ($$)	Further investigations needed	Yes	3	1	3	1	4	2	-	-
TS24	63	Salt Lake	Road	Flooding	Runoff leads to flooding of road	4L	4VL	No	Physical works ($$)	Box culverts and raise road.	Yes	3	1	2	1	3	3	3	3
TS31	65	Shenandoah Bridge	Bridge	Erosion	Rockfall and erosion	3L	-	No	Physical works ($$)	River training	Yes	3	2	2	1	3	2	-	-
TS41	6	Spooners	Road	Rockfall	Rockfall	2VL	-	No	Physical works ($$)	netting	Yes	3	3	3	1	4	1	-	-
TS59	6	Tahunanui to Richmond.	Road	Coastal Inundation / SLR	Coastal inundation and sea level rise risk. Moving from low frequency and outage to high and medium	2UL	2L	No	Physical works ($$$)	raise road	Yes	2	1	3	1	4	1	2	2
TS20	60	Takaka Hill	Road	Landslip	Landslip risk with both under and over slips. Mainly on the Nelson side. Occurs at least once a year. There are also a number of drainage issues.	4VL	4VL	No	Physical works ($$$)	Realignment improve drainage and catchment management. Even with improvements, there would still be ongoing issues, requiring response and BAU maintenance.	Unsure	3	3	2	1	3	3	3	3
TS21	60	Takaka Hill to Puramhoi	Road	Flooding	Flooding which could increase with climate change	3L	-	No	Unknown. Pending further investigations	Further investigations needed	No	3	2	2	0	2	3	-	-
TS25	63	The wash	Road	Flooding	Flooding risk through the Wairau Valley as road follows river in floodplains.	4L	4VL	No	Physical works ($$)	Raise road and provide river protection	Yes	3	2	2	1	3	3	3	3

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TS2	1	Tuamarina to Picton	Road	Flooding	Surface flooding risk from adjacent catchment runoff.	4L	4VL	No	Unknown. Pending further investigations	Requires a detailed study	Unsure	3	2	4	1	5	2	3	3
TS16	6	Upper Buller Gorge	Road	Erosion	Erosion risk along the Buller Gorge in both Top of South and West Coast.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	No	2	3	3	1	4	3	3	3
TS13	6	Upper Buller gorge	Road	Extreme Weather	Extreme weather risk with strong winds resulting in tree fall.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	No	3	2	3	1	4	3	3	3
TS14	6	Upper Buller gorge	Road	Landslip	At risk to landslips both over and under slips.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	No	2	3	3	1	4	3	3	3
TS15	6	Upper Buller Gorge	Road	Rockfall	Rockfall risk with rockfall occurring along the Buller Gorge in both Top of South and West Coast.	4L	-	No	BAU / Ongoing maintenance / Reactive	Ongoing maintenance	No	2	3	3	1	4	3	-	-
TS33	65	Warwick	Road	Erosion	Erosion and flooding along river	3L	-	No	Physical works ($$)	rock protection works	Yes	3	2	2	1	3	2	-	-
TS32	65	Warwick	Road	Flooding	Flooding and erosion	3L	-	No	Physical works ($$)	rock protection	Yes	3	2	2	1	3	2	-	-
TS4	1	Welds Pass	Road	Landslip	rockfall and over / underlips	3L	-	No	Physical works ($$$)	realignment	Yes	2	3	4	0	4	2	-	-
TS3	1	Welds pass	Road	Rockfall	rockfall and over under slips	3L	-	No	Physical works ($$$)	realignment	Yes	2	3	4	0	4	2	-	-
TS18	6	Whangamoas	Road	Landslip	Slips and rockfall	3L	-	No	Enhanced proactive maintenance	an alternate route has been designed. a number of sites where you could do different things. There is a realignment option and could be better bang for your buck with the number of sites	Yes	3	2	3	0	3	2	-	-
TS17	6	Whangamoas	Road	Rockfall	Same as Landslip results	3L	-	No	Physical works ($$$$)	realignment	Yes	3	2	3	0	3	2	-	-
TS26	63	Windy Point	Road	Rockfall	Constant Rockfall on the beginning stretch of SH63	3VL	-	No	Physical works ($$)	Requires netting.	Yes	3	3	2	0	2	3	-	-

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Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
WK1	1	Along Lake Karapiro	Road	Erosion	Erosion of riverbank can undermine road. There are significant detour issues along this road if it were out of service.	5L	-	No	Physical works ($$$)	Realignment, new bridge or possible retaining wall. Also invest in upgrades to Maungatautari Road through strengthening of structures to carry HMPV's. Realignment, bridge or possible retaining wall.	Yes	2	3	5	0	5	3	-	-
WK7	1	Bulli Point	Road	Landslip	Bulli point drop out combined with narrow carriage way significantly lowers the resilience. Typically to repair you need to close both sides of the road. Even for repairs you need to close the road.	4L	-	No	Physical works ($$$)	Build retaining wall(s) on Lakeside and/or cut into adjacent rock face. Ultimate solution is to construct the proposed Hatepe to Motuoapa realignment project.	Yes	2	3	4	0	4	3	-	-
WK22	1	Desert Road	Road	Volcanic	Volcanic hazard risk along the desert road, this may include ashfall disruption or damage from hazards including lahar and ballistics.	3L	-	No	Emergency response and preparedness planning only (typically HI/LF)	Emergency response planning only	No	1	3	4	0	4	2	-	-
WK3	25	Entire Coromandel Peninsula	Road	Coastal Inundation / SLR	Flooding around entire coromandel peninsula. Likely the alpine route and coromandel have the most closures in the Waikato region.	3L	3VL	No	Physical works ($$$$)	PBC has been written for 25 and 25A loop	Unsure	3	2	2	0	2	3	3	3
WK2	25a	Entire Coromandel Peninsula	Road	Flooding	Flooding around entire coromandel peninsula. Likely the alpine route and coromandel have the most closures in the Waikato region.	3L	3VL	No	Physical works ($$$)	PBC has been written for 25 and 25a loop	Yes	3	2	3	0	3	2	3	3
WK6	25	Entire Coromandel Peninsula	Road	Landslip	Landslip risk occurs along the entire coromandel 'loop route' this can be induced by rainfall and earthquake shaking.	3L	3VL	No	Physical works ($$$)	PBC has been written for 25 and 25a loop	Yes	3	2	2	0	2	3	3	3
WK4	3	Entire stretch of SH3	Road	Landslip	Landslip risk with road instability. Key route for LPG to get trucked from New Plymouth to Auckland.	4L	4VL	No	Unknown. Pending further investigations	Business Case required	No	3	2	3	1	4	3	3	3
WK13	46	Entire stretch of SH46	Road	Flooding	Flooding issues along SH	2L	-	No	Physical works ($$)	Increase culvert sizes along vulnerable route.	Unsure	3	2	3	0	3	1	-	-
WK14	46	Entire stretch of SH46	Road	Volcanic	ashfall in the water course is still causing significant scour issues along the road, lifts the road surface from 2012 eruption event	2L	-	No	Physical works ($)	Install large box culvert under SH46 to allow for the large amount of ash to flow to the other side of the SH.	Yes	3	2	3	0	3	1	-	-

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WK11	49	Entire stretch of SH47	Road	Flooding	Flooding issues along SH	3L	-	No	Unknown. Pending further investigations	Build the carriageway up out of flood level. Increase culvert sizes along vulnerable route.	Unsure	3	2	3	0	3	2	-	-
WK20	1	Flooding just north of Turangi	Road	Flooding	Surface flooding issues along SH 1 through Waiotaka Straight (within Waiotaka Valley). This is a low-lying wetland area (South Taupo Wetlands) which is prone to flooding.	4L	4VL	No	Unknown. Pending further investigations	Business Case required	Unsure	3	2	4	0	4	3	3	3
WK8	5	Kaweka Ranges	Road	Ice / Snow	Major snow event caused power lines to drop and this blocked the road, preventing snow removal. This led to a significant event. Potential for undergrounding of the lines to stop the road from going out. Poor to no cell phone connection means if there are any issues its very hard to call any emergency services.	4L	-	No	Physical works ($$$)	Underground overhead lines and improve telecommunications/cell phone reception	Yes	3	2	3	0	3	3	-	-
WK10	47	National Park end of SH47	Road	Flooding	Flooding along SH47 towards National Park	3L	-	No	Physical works ($$)	Build the carriageway up out of flood level. Increase culvert sizes along vulnerable route.	Unsure	3	2	3	0	3	2	-	-
WK21	47	National Park end of SH47	Road	Landslip	Landslip issues along SH4 towards national park over the saddle.	3L	-	No	Unknown. Pending further investigations	Further investigations needed	Unsure	3	2	3	0	3	2	-	-
WK5	26	North of Te Aroha Township	Road	Flooding	Flooding between Te Aroha and Paeroa	3L	3VL	No	Physical works ($$)	Culvert and Drainage System Upgrade.	Yes	3	2	3	0	3	2	3	3
WK25	31	Puti Bridge to Waipapa Marae	Road	Coastal Inundation / SLR	Low-lying areas potentially exposed to coastal inundation in the future	3UL	3VL	No	Unknown. Pending further investigations	Further investigations needed	Unsure	1	1	2	0	2	3	3	3
WK15	41	SH 41 to Taumaranui	Road	Landslip	Land instability issues through	2L	-	No	Physical works ($$)	Build retaining walls at unstable locations where there's visible subsidence.	Unsure	3	2	2	0	2	2	-	-
WK23	25	Tairua along Pauanui Inlet	Road	Coastal Inundation / SLR	Low-lying areas potentially exposed to coastal inundation in the future	3UL	3VL	No	Unknown. Pending further investigations	Further investigations needed	Unsure	1	1	2	0	2	3	3	3
WK17	32	Tokoroa to Whakamaru	Road	Flooding	Flooding due to deforestation which is causing more run off and therefore more flooding.	2L	-	No	Physical works ($$)	Construct deep water tables and/or retaining ponds. Change the District Plan to enforce adjacent landowners to hold/retain stormwater runoff.	Unsure	3	1	2	0	2	2	-	-
WK12	41	Waihi Hill	Road	Landslip	Ongoing mass movement	3L	-	No	Physical works ($$)	Build retaining walls at unstable locations where there's visible subsidence.	Unsure	2	3	2	0	2	3	-	-

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WK16	1	Waihononu Bridge	Road	Ice / Snow	Snow and Ice, snow closes the road however black ice has a bigger impact to drivers. The three tight curves of the northern end of the desert road are the ice issues the only way to be able to deal with ice is build a new road that doesn't go into the icy areas. CMA only works for a certain temperature range and if there is too much water it washes out and dilutes. Waihononu bridge shipping container has temperature gages which automatically sprays CMA	2L	-	No	Physical works ($$)	Heat road, using geothermal energy	Unsure	3	1	4	0	4	1	-	-
WK9	1	Waiouru	Road	Ice / Snow	Waiouru - snow and ice which closes the road, alternative route is 49 / 4, significant snow does get as far south as Taihape, can't prevent it but can manage it.	3L	-	No	Physical works ($$)	Heated road, using geothermal energy	Unsure	3	2	4	0	4	2	-	-
WK24	25	Whitianga Inlet	Road	Coastal Inundation / SLR	Multiple low-lying areas and therefore potentially exposed to coastal inundation in the future	3UL	3VL	No	Unknown. Pending further investigations	Further investigations needed	Unsure	1	1	2	0	2	3	3	3

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Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
W20	58	Along Pauatahanui Inlet	Road	Coastal Inundation / SLR	Low-lying areas potentially exposed to coastal inundation in the future	3UL	3VL	No	Physical works ($$$)	Various high-risk areas across the region that require slope stabilisation	Unsure	1	1	3	0	3	2	3	3
W21	1	Along Porirua Harbour	Road	Coastal Inundation / SLR	KiwiRail and road has the potential to be subject to coastal inundation in the future	4UL	4VL	No	Physical works ($$$)	Various high-risk areas across the region that require slope stabilisation	Unsure	1	1	5	0	5	2	3	3
W14	1	Aotea	Road	Earthquake / liquefaction	Seismic risk to Aotea off-ramp as it is thought that the Wellington fault is located underneath it.	4L	-	No	Physical works ($$$$)	Requires interface with various asset owners - WCC, KiwiRail & The Port Authority to agree full mitigation option	Yes	1	3	5	0	5	2	-	-
W8	1	CBD	Road	Earthquake / liquefaction	Liquefaction will impact such a significant length of the highway. We need to understand what our expected level or service after an event. You can spend a lot of time on building resilience; however, do you just accept that something is going to happen, hunker down and then go back to normal levels in 12 hours.	3L	-	No	Physical works ($$$$)	Full impacts difficult to quantify	Unsure	1	3	5	0	5	1	-	-
W13	1	CBD	Road	Flooding	Kilbirnie flood modelling and sea level rise. There is good understanding of the historic flood areas, but future flooding is not well understood. There is nothing finalised in terms of what to actually do about the flooding due to the low-lying nature or the land - needs to be more operational response to flood such as partnering with wellington water etc. There are future flooding risks that are not well understood. We need to understand what our expected level or service after an event. You can spend a lot of time on building resilience; however, do you just accept that something is going to happen, hunker down and then go back to normal levels in 12 hours.	3L	3VL	No	Physical works ($$$)	Would require joint project with Wellington City Council	Unsure	3	2	5	0	5	1	3	3

Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
W15	1	CBD to Ngauranga	Road	Earthquake / liquefaction	A number of critical road and rail bridges, structures, utilities etc located in this corridor and within a high earthquake zone.	4L	-	No	Physical works ($$$$)	Would require a prioritised list and mitigation option for each structure	Unsure	1	3	5	0	5	2	-	-
W10	58	Haywood's	Road	Landslip	Some water, power and gas utilities along SH 58 - The Haywards.	3L	3VL	No	Physical works ($$$$)	Further slope stabilisation works required	Yes	2	3	3	0	3	2	3	3
W18	58	Haywood's	Road	Landslip	GNS are doing a landslide assessment along SH58.	3L	3UL	No	Physical works ($$$)	Linked to SH 58 Haywards	Yes	3	2	3	0	3	2	1	2
W16	2	Korokoro Stream	Road	Flooding	Korokoro Stream: Petone 1 in 5-year ARI culverts, significant issues to build ourselves out. They have monitoring in place, the best you can do is let people know and be able to respond to close the road and keep people moving however there isn't anything you can do in the next 10 years to deal with that. Will likely be $100M but is being addressed in the Petone to Grenada piece of work.	3L	3VL	No	Physical works ($$$$)	Linked to proposed interchange at SH 2 Petone on//off ramp - include building relocation and interface with KiwiRail assets - has current flood monitoring system, but only as early warning device	Yes	3	2	4	0	4	2	3	3
W5	1	SH1 Centennial Highway	Road	Coastal Erosion	Sea level rise, storm events, high seas causing damage to seawall.	5L	5VL	No	Physical works ($$$)	Ongoing armouring. More work required to determine appropriate solutions	Yes	3	2	5	0	5	3	3	3
W4	1	SH1 Centennial Highway	Road	Coastal Inundation / SLR	Coastal inundation and SLR risk with water over topping the road in larger events. Currently reactive maintenance is prioritised as opposed to proactive. Culvert near Paekakariki blocks frequently due to lose material causing flooding in the town. Catchments flood in short duration events causing slips and debris/blockages. KiwiRail assets are adjacent (up-catchment) and also are affected. Even with completion of Transmission Gully, access will still be required for the rail line.	5L	5VL	No	Physical works ($$$)	Will continue to flood in the long term but will require ongoing repair and maintenance. More work required to determine appropriate solutions.	Unsure	2	2	5	0	5	3	3	3
W3	1	SH1 Centennial Highway	Road	Rockfall	Rock, debris comes down off the steep slopes and covers the road and rail network. NZTA are trying to get KiwiRail to input into funding. Risk will be reduced once Transmission Gulley is open.	5L	-	No	Physical works ($$$)	Ongoing slope stabilisation works required.	Yes	3	2	5	0	5	3	-	-

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W6	1	SH1 Kuku	Road	Flooding	Flooding occurs frequently in low lying area - caused by a land drainage issue where water builds up on the highway approx. once a year. Flooding can often reduce traffic down to one lane and has affected both lanes for a couple of hours. With help from Council it could be improved. Risk could also be reduced if Otaki to Levin is confirmed.	5L	5VL	No	Physical works ($$)	Requires Council to address adjacent land drainage and runoff - less of an issue once O2NL is constructed could significantly improve the flood issue - especially considering the detour is extensive.	Yes	3	1	5	0	5	3	3	3
W19	1	SH1 Ngauranga Gorge	Road	Landslip	Rockfall risk and landslides - targeting low cost, low risk funding. Multiple users including cyclists. Debris screen is a hard structure and the footpath has become a combined pathway with no room left for construction. Low cost, low risk would address most of these.	4L	4VL	No	Physical works ($$$)	Some minor works planned, but would require significant infrastructure to fully mitigate	Yes	3	1	5	0	5	2	3	3
W2	1	SH1 Porirua	Road	Flooding	Some flooding. The roads go through wetland like material, some of the culverts and streams are full of gravel and upper reaches of streams need clearing and maintaining. NZTA ends up with the problem but they have very little control of what happens up or down stream of the road.	4L	4VL	No	Physical works ($$$)	Ongoing improvements to manage high intensity rainfall events - will require Council to improve stormwater catchment	No	3	2	5	0	5	2	3	3
W1	2	SH2 Petone to SH1	Road	Coastal Inundation / SLR	Coastal inundation and SLR are the biggest issue for this area. Regular events over recent years have caused outages and damage.	4VL	4VL	Yes	Physical works ($$$$)	There is a proposed seawall/cycleway which will help mitigate this risk.	Yes	3	3	4	0	4	3	3	3
W17	2	SH2 Remutaka Hill	Road	Earthquake / liquefaction	Whole SH 2 Remutaka Hill (13km) is at risk to earthquake shaking. If there is an EQ it will be out of service due to many risks. Focus should be on SH1 first to get a route open to the north before addressing SH2.	4L	-	No	BAU / Ongoing maintenance / Reactive	Requires ongoing investment to improve resilience, but likely to always be a risk in large earthquakes	No	1	3	4	0	4	3	-	-

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W12	1	Southern Rail over bridge	Road	Earthquake / liquefaction	Southern Rail over bridge - box bridge liquefaction piles will fail in a large event. Thordon overbridge - if this goes likely so much else will go so not much you can do.	3L	-	No	Physical works ($$$)	Current twin box culvert would require significant retrofit to fully mitigate this risk	Yes	1	3	4	0	4	2	-	-
W11	53	Waihina Bridge	Bridge	Flooding	Waihina Bridge often gets closed due to high river levels but well managed. Occasionally Martinborough gets cut off for a max 12 hours as the 2 detour routes can sometimes be closed as well as the bridge. No point to spend $12m to upgrade the bridge. Much more bang for your buck is to upgrade a road in and out of Martinborough. small number of vehicles in and out a day not sure that is worth $12m on a single bridge. Should be in there but not high priority (altern. route around Martinborough)	3L	3VL	No	Physical works ($$$)	new bridge but not worth it	Yes	3	1	2	0	2	3	3	3
W9	58	Wellington regionwide	Road	Erosion	some vulnerability and a safety project with bank stabilisation but potentially high.	3L	3VL	No	Physical works ($$$)	Various high-risk areas across the region that require slope stabilisation	Yes	3	1	3	0	3	2	3	3

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Risk ID	SH No	Location Name	Asset type	Hazard	Description of hazard	Current Risk Rating	2050 Risk Rating	Already funded?	Suggested Response Category	Suggested solution	Solvable	Current Hazard Likelihood	Current Outage	ONRC Category	Increase ONRC	ONRC + inc	Detour issues	2050 Hazard Likelihood	2050 Outage
WC1	7	Black Point	Road	Erosion	A few river erosion sites near Reefton river. Ongoing rock armouring.	4L	4VL	No	Enhanced proactive maintenance	Rock protection	Unsure	2	2	2	1	3	3	3	3
WC2	6	Bruce Bay	Road	Coastal Erosion	Route at risk from erosion. Rock protection measures are starting to be implemented through emergency works funding following Cyclone Fehi (2018). However, if there was another cyclone a large section of the road has the potential to be lost regardless of current resilience work.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Rock protection, however, will still be residual risk	Unsure	2	3	3	0	3	3	3	3

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WC3	6	Buller Gorge	Road	Extreme Weather	Extreme weather risk with tree fall along gorge.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Regular maintenance in tree cutting	Unsure	3	2	3	0	3	3	3	3
WC4	6	Buller Gorge	Road	Rockfall	Rockfall along steep slopes	3L	-	No	Enhanced proactive maintenance	Better ongoing maintenance to pull down loose material and lower rockfall	Yes	3	2	3	0	3	2	-	-
WC5	6	Fox River	Road	Coastal Inundation / SLR	Fox River - low lying with sea level rise risk.	4L	4VL	No	Enhanced proactive maintenance	Ongoing monitoring and maintenance	Unsure	2	2	3	0	3	3	3	3
WC25	6	Franz Josef to Fox Glacier	Road	Ice / Snow	Snow and ice over hill between Franz Josef and Fox Glacier	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter maintenance LOS and improved communication. VMS required at each end of route where alternative routes exist	Unsure	3	2	3	0	3	3	-	-
WC6	6	Greymouth to Westport	Road	Coastal Erosion	Coastal erosion during a cyclone has the potential to affect the whole region. Increased frequency to approx. once a year. Typically, still repairing from the previous event when then next one comes. Still recovering from Fehi 2018. All works are currently reactive. 4 sites where preventative works, these could be prioritised.	4VL	4VL	No	Enhanced proactive maintenance	Rock protection	Unsure	3	3	3	0	3	3	3	3
WC7	73	Griffiths Bridge	Bridge	Erosion	Erosion and scour risk around the bridge.	4L	4VL	No	Physical works ($$$)	New bridge	Yes	1	3	3	0	3	3	3	3
WC10	6	Haast Pass	Road	Erosion	Erosion risk along Haast River.	4L	4VL	No	Physical works ($$$$)	Expensive protection works	Unsure	2	3	3	0	3	3	3	3
WC9	6	Haast Pass	Road	Landslip	Route at risk from landslip. Currently all reactive works with proactive management on some sites, however there is still a risk of losing the whole road. A few landslip sites could potentially be more proactive some of it which would be less than $1m, however it is more like $5m altogether.	4VL	4VL	Yes	Enhanced proactive maintenance	Some areas could have more proactive work undertaken.	Unsure	3	3	3	0	3	3	3	3
WC8	6	Haast Pass	Road	Rockfall	Rockfall along the Haast River with only reactive works occurring.	4L	-	No	Enhanced proactive maintenance	could be more proactive	Yes	2	3	3	0	3	3	-	-
WC11	6	Junction of SH6 and SH69	Road	Landslip	At junction of SH6 and SH69 - large mass land movement slip into the Buller River.	3L	3VL	No	Physical works ($$$)	Rock toe at bottom of slip to stabilize	Yes	2	3	3	0	3	2	3	3
WC12	6	Knights Point	Road	Landslip	Most vulnerable piece of road to landslip in New Zealand and currently only	4VL	4VL	No	Enhanced proactive maintenance	Also, would require further investigation	Unsure	3	3	3	0	3	3	3	3

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					has reactive work underway.														
WC15	7	Lewis Pass	Road	Flooding	Shingle fans depositing on the road, as well as surface flooding risk.	4L	4VL	No	Physical works ($$$)	Solvable with upgrade to double lane bridges and bridge realignment away from rockface.	Yes	3	1	2	1	3	3	3	3
WC13	7	Lewis Pass	Road	Ice / Snow	Ice and snow risk at summit.	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter operations	No	3	2	2	1	3	3	-	-
WC25	7	Maruia Flats	Road	Flooding	Flooding - River is at the same height as road.	3L	-	No	Physical works ($$$)	Stop banking river	Yes	2	2	2	1	3	2	-	-
WC16	6	Newman's Slip	Road	Landslip	Upper Buller Gorge, right on the boundary of Canterbury and West Coast. A number of studies potentially would put road out for 6 - 12 months. Monthly monitoring of landslip being undertaken.	3L	3VL	No	Enhanced proactive maintenance	Little can be achieved without spending millions and currently not worth doing it due to cost. Options to use remote sensing and drone monitoring across a number of slips would help with more proactive maintenance.	Unsure	2	3	3	0	3	2	3	3
WC28	67	Orawati Bridge	Bridge	Earthquake / liquefaction	Approaches to the Orawati bridge are in liquefiable/lose material which could result in damage during a significant earthquake.	1L	-	No	Physical works ($$)	Strengthen and raise approach to bridge	Yes	1	3	2	0	2	1	-	-
WC17	73	Otira River at Otira	Road	Erosion	River erosion risk. Already funded but has ongoing issues in other areas as well.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Monitor and reactive maintenance	No	2	2	3	0	3	3	3	3
WC19	7	Rahu Saddle	Road	Extreme Weather	Extreme weather risk with trees falling from high winds.	4L	4VL	No	BAU / Ongoing maintenance / Reactive	Annual inspections and selective removals where risk identified	Yes	3	1	2	1	3	3	3	3
WC18	7	Rahu Saddle	Road	Ice / Snow	Snowfall and ice risk.	4L	-	No	BAU / Ongoing maintenance / Reactive	Winter operations	No	3	1	2	1	3	3	-	-
WC20	6	Scout Lodge Straight	Road	Erosion	Significant river erosion risk.	4VL	4VL	No	Physical works ($$$)	River protection works (groynes) to train river and realign road	Yes	3	3	3	0	3	3	3	3
WC21	6	South of Ross to Haast Pass	Road	Flooding	All rivers south of Ross (~15 rivers) need training/stop banking and active management to reduce flood risk.	4VL	4VL	No	Enhanced proactive maintenance	Ongoing training works and management	Yes	3	3	3	0	3	3	3	3
WC22	6	Southern side of Punakaiki	Road	Coastal Inundation / SLR	Low lying and vulnerable to sea level rise.	4L	4VL	No	Physical works ($$$)	Rock protection	Unsure	2	2	3	0	3	3	3	3
WC26	7	Springs Junction	Road	Flooding	Flooding of road during heavy rainfall	4UL	4L	No	BAU / Ongoing maintenance / Reactive	Monitor and reactive maintenance	Unsure	2	1	2	1	3	3	3	2
WC23	73	Taipo Bridge	Bridge	Flooding	Flood risk along one lane bridge.	4L	4VL	No	Physical works ($$$$)	replace whole bridge and double lane	Yes	1	3	3	0	3	3	3	3

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WC24	73	Wainihinini Bridge	Bridge	Flooding	Flood risk to bridge. Bridge replacement is critical from a HMPV point of view. Currently reaching end of life.	4L	4VL	No	Physical works ($$$)	Replace bridge.	Yes	2	3	3	0	3	3	3	3

Appendix B: Regional major and extreme risk location maps

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