12 August 2025

New Zealand Infrastructure Commission, Te Waihanga
Level 7, The Todd Building
95 Customhouse Quay
Wellington 6011

Tēnā koe,

South Island Regional Transport Committee Chairs Group submission:
New Zealand Infrastructure Commission, Te Waihanga draft National Infrastructure Plan

Thank you for the opportunity to provide feedback on the New Zealand Infrastructure Commission, Te Waihanga draft National Infrastructure Plan. This letter forms the submission from the South Island Regional Transport Committee Chairs Group (the Chairs Group), setting out the collective feedback of the Chairs from each of the Regional Transport Committees in the South Island.

The Chairs Group was formed in 2016 for the purpose of significantly improving transport outcomes to, from and within the South Island through stronger interregional collaboration and integration.

This approach has sought to ensure that the needs and aspirations of our South Island communities – including those of more than 1.2 million people – for our transport system are well recognised and understood. While each region in the South Island is unique, they also share many of the same transport priorities and challenges.

The Chairs Group wishes to express support for the individual submissions provided by South Island Regional Councils. This submission highlights and reinforces some of the shared views expressed by South Island Regional Transport Committees on the draft National Infrastructure Plan. Our key points are set out below.

General comments

We support the four principles of the draft Plan, however advocate to see further focus and priority given to the resilience of infrastructure throughout its lifetime and wish to raise the important link between flood protection and river maintenance and our transport infrastructure.

Adequate, long-term funding to enable regular maintenance of our transport infrastructure is critical. The disconnect between depreciation rates and renewal funding means many of our assets are not adequately supported for the long-term. As a result, key connecting infrastructure becomes more vulnerable to climate-related events, leading to costly emergency repairs or replacements that could have been avoided with better planning and funding.

We strongly support the pipeline of new infrastructure and urge the Government to match this with steady investment in maintenance and renewals of our existing infrastructure. Infrastructure must be planned for throughout its entire lifecycle, with consideration given to long-term commitments to fund and manage an asset.

We advocate for the Plan to recognise the important links between river control and flood management infrastructure and protection of our key transport routes. Some of our most high-value routes in the South Island follow and cross extensive rivers, we support a focus on nature-based solutions, green infrastructure and technological innovations for river infrastructure provision.

Our transport network is highly vulnerable to disruption from a range of natural hazards – earthquakes, flooding, landslides and coastal erosion. Unplanned disruption on our network has significant impacts on the efficiency and reliability of freight and people movements, which reduces productivity and potential economic output. This has been demonstrated during the 2021 floods in Canterbury and the recent flooding events in the Nelson, Tasman region.

We acknowledge the inclusion of Greater Christchurch Mass Rapid Transport system in the Infrastructure Pipeline and as an Infrastructure Priority Project. Greater Christchurch, Queenstown and parts of the Nelson Blenheim area are growing rapidly.

We advocate for investment that supports our growing populations access to transport choices, this includes public transport, walking and cycling networks and private travel where communities need it.

The Chairs Group is committed to encouraging integrated transport solutions and investment into the network that crosses intra-regional boundaries with shared goals towards improving mobility, reducing emissions, increasing social equity, and promoting economic development.

Closing remarks

We thank all those involved in preparing this draft National Infrastructure Plan and for the opportunity that has been afforded to provide feedback on it. The Chairs Group is focused on ensuring our transport infrastructure supports our growing population, provides adequate transport choices for our communities and ensuring our 7,730 bridges across the network are resilient and well-maintained.

Attached to this submission is the *South Island Transport Story*, which highlights the cross-regional strategic priorities facing our transport network and provides a case for collective action across local and central government in response.

We also attach the *South Island Transport Network Vulnerabilities* report. This report consolidates existing analysis and research to provide a comprehensive overview of the vulnerabilities facing the South Island's transport network due to natural hazards, infrastructure limitations, and the projected impacts of climate change.

We ask that you note that while the NZ Transport Agency is invited to attend the meetings of the Chairs Group, this submission does not reflect their views.

The Chairs Group's secretariat is available to clarify or answer any questions that you may have about our submission.

Please contact [redacted] at the Canterbury Regional Council on [redacted] if you have any questions or would like to discuss the submission further.

Yours sincerely,

[redacted]

[redacted]
Chair of the South Island Regional Transport Committee Chairs Group

South Island **Regional Transport Committee Chairs Group**

South Island Transport Story

A case for collective action on strategic transport priorities shared across the motu

Contents

Cover image: Arthurs Pass | Inside cover: Road to Aoraki/Mt Cook

Timaru port and township

Introduction

A resilient and fit-for-purpose transport network is vital for the continued health, wellbeing and prosperity of the people and communities of Te Waiponamu, the South Island.

The South Island transport network provides the arteries and veins that bring communities to life. From Bluff in the south to Golden Bay in the north, it provides the connections communities need to not only function, but flourish. It ensures people and freight can travel safely and efficiently through our diverse landscapes, moving across Te Waipounamu and beyond, to the North Island and overseas destinations.

However our network is facing unprecedented challenges that increasingly impact our success and hauora (wellbeing) if not addressed.

We must respond and adapt to the changing climate and the need to reduce emissions, while adequately planning for the growth and changes in our population, visitor numbers and freight types and volumes.

These challenges are not unique to one region and are already being felt across Te Waipounamu.

The South Island Transport Story highlights the cross-regional strategic priorities facing our transport network and provides a case for collective action across local and central government in response. It is intended to shape the strategic direction for the South Island transport network, building on and supporting the development of South Island Regional Land Transport Plans.

The interdependencies between our infrastructure, services, markets, supply chains, and where people choose to live and work across the motu (island) are essential and must be recognised for integrated planning and investment. What happens in one place impacts another and effects our reliance on the transport network.

Ongoing investment is crucial for guaranteeing the maintenance and resilience of our existing infrastructure, and the continuation of key services.

Current investment levels are struggling to keep up with the required maintenance of aging infrastructure, while additional investment is desperately needed to improve our network and ensure it remains fit-for-purpose for future generations. Future planning and investment should prioritise outcomes-based approaches and strategic integration across South Island partners and ensure our transport networks are adaptive to the changing environment.

We outline three strategic priorities:

- Building network resilience with strengthened bridges and connections
- Boosting the economy with efficient freight networks
- Enabling people and communities to flourish with better travel options

Well-planned investment across Te Waipounamu has the potential to generate increased economic growth and productivity and continue to support the transport of goods that significantly contribute to the New Zealand economy.

The South Island regional councils have strong collaborative bonds and willingness to work in partnership with the Government to achieve our shared transport goals.

South Island Regional Transport Committee Chairs Group

The South Island Regional Transport Committee Chairs Group was formed to enhance transport outcomes across the South Island through stronger inter-regional collaboration and integration.

Our objective is integrated transport planning (air, rail, shipping, roads) that enables the efficient movement of people and freight; improves social connectedness and wellbeing; supports regional visitor strategies; and improves overall road safety.

We want to advocate with one voice and work towards shared goals. We are focused on ensuring that the needs and aspirations of communities across the motu are recognised and understood, particularly by central government.

The Group's membership comprises the Chair and/or Deputy Chair from each of the South Island Regional Transport Committees – Southland, Otago, Canterbury, West Coast, Nelson-Tasman and Marlborough. Representatives from the NZ Transport Agency Waka Kotahi (NZTA) and KiwiRail provide support to the work of the Group.

Te Waipounamu, the South Island

Te Waipounamu, the South Island is vast and characterised by its dramatic natural landscapes – rugged mountains, expansive plains, rolling hillsides, subtropical forest, lakes and rivers, glaciers, picturesque fiords, and many kilometres of exposed coastline.

Mountainous terrain occupies almost three-quarters of the South Island, with the Southern Alps forming the backbone of the motu. To the west of the mountain range is the narrow coastal strip of the Westland Plains; to the east is the rolling farmland of Otago and Southland, and the vast flat Canterbury Plains; and to the north is a diverse geography with varied landscapes.

While spectacular, Te Waipounamu's geography places a significant reliance on a few key routes to connect people, freight and places across the motu. These routes are highly vulnerable to disruption from natural hazards, including earthquakes, flooding, landslides and coastal erosion. Extreme weather events in Marlborough (2021), Fiordland (2020) and the West Coast (2019) are just a few recent examples of climate change impacting our transport network, while major earthquakes in Canterbury in 2010, 2011 and 2016 also caused widespread devastation.

The resilience of our transport network is a significant challenge. Climate change is increasing the likelihood of extreme weather events, and there is substantial risk of the Alpine and Hikurangi faults rupturing in the near future. It is not a matter of if, but when major natural hazard events impact our transport network. We need to be ready and adapt to this new context.

The South Island is sparsely populated. While it makes up 56% of New Zealand's land area, there are only around 8 people per square kilometre in the South Island, which is much lower than the 35 people per square kilometre in the North Island.

One out of five people living in the South Island reside in a rural area. Our rural communities have different accessibility, and connectivity needs when compared with our urban communities – all of which must be provided for by our transport network.

Most of the 1.2 million people that call the South Island home live in urban centres. The largest urban centres are Greater Christchurch, Dunedin, Nelson and Invercargill. Greater Christchurch is the second most populous urban centre in New Zealand and continues to grow. Other parts of the South Island are among the fastest growing in the country, with Selwyn being the fastest growing district in the country. Queenstown-Lakes and Central Otago are experiencing particularly high levels of population growth in recent years.

Each region of the South Island has its own unique social and economic characteristics, and present opportunities for higher economic growth and productivity. The South Island economy has had major economic increase in recent years and continues to contribute significantly to Aotearoa's economy.

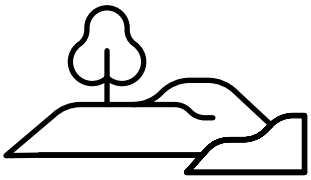
Agriculture, forestry, fishing, construction, manufacturing and professional services are the key primary industries contributing to the South Island GDP. Efficiently moving goods to domestic and international markets remains of critical importance to our economy.

Te Waipounamu remains a top destination for both local and foreign travellers, who travel across our transport network to experience the conservation land, recreational opportunities, and unique towns and cities on offer in different parts of the motu.

Tourism has surged in the South Island following the COVID-19 pandemic. Between 2023 and 2024 tourism expenditure has increased 6.39%, $11 billion dollars was injected into our South Island economy during 2024 alone.

The South Island is an expansive geographic area with a dispersed population and challenging terrain. This creates a number of transport challenges. We must have a resilient and fit-for-purpose transport network to overcome these challenges, as well as support the ongoing growth and prosperity of the people and places that make-up the motu. The success of Te Waipounamu is critical to the success of the Aotearoa, New Zealand.

By the numbers



LAND

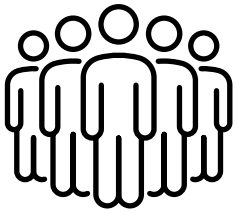
Over **150,000** square kilometres of land area – 12th largest island in the world

56% of New Zealand's land area

8 mountain peaks of more than **3,000** metres

More than **5,800km** of coastline

7 regions, **19** districts



POPULATION

More than **1.2 million** people

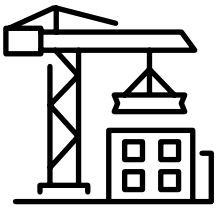
1 of 5 people live in rural areas

Average annual growth of **1.6%**

(compared with **1.3%** in the North Island)

Some of the **fastest** growing districts in the country

Population projected to grow by **20%** from 2018 to 2048

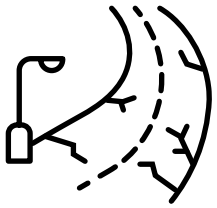


ECONOMY

$93.7 billion of GDP – **22%** of New Zealand's GDP

30% growth in GDP from 2018 to 2023

$74,000 GDP per capita (compared with **$79,000** in the North Island)



NATURAL HAZARDS

4 of the top 5 **'at-risk'** regions in New Zealand by number of natural hazards

Top 4 regions by criticality of natural hazards

Nelson port

Our transport network

The South Island transport network has low levels of network resilience and high levels of economic reliance on vulnerable routes. Our population is also growing – we need a transport network that provides more people with increased travel options. This challenging context requires us to think differently about how we invest in our network, to ensure we can continue to adapt to climate change and can cater for growth and changes in our population and economy.

36,500 km
of local roads and 5,000 km of state highways – one of the highest kilometres of road length per person in the world

1,500 km
of railway lines, consisting of two main lines, two secondary lines and several branch lines

7,730
bridges across the roading network, including 1,910 on the state highway network alone – the ages and conditions of bridges varies across our network, commonly, many are in vulnerable conditions

One long-distance international airport at Christchurch, two short-haul international airports at Dunedin and Queenstown, and nine domestic airports across the motu (Tākaka, Nelson, Blenheim, Picton, Hokitika, Westport Timaru, Wānaka and Invercargill)

Two container ports at Lyttelton, Christchurch and Port Chalmers, Dunedin, and six regional ports at Nelson, Picton, Westport, Greymouth, Timaru and Bluff.

Inland ports are located at Rolleston, in the Selwyn District, Woolston in Christchurch City and Port Chalmers in Dunedin.

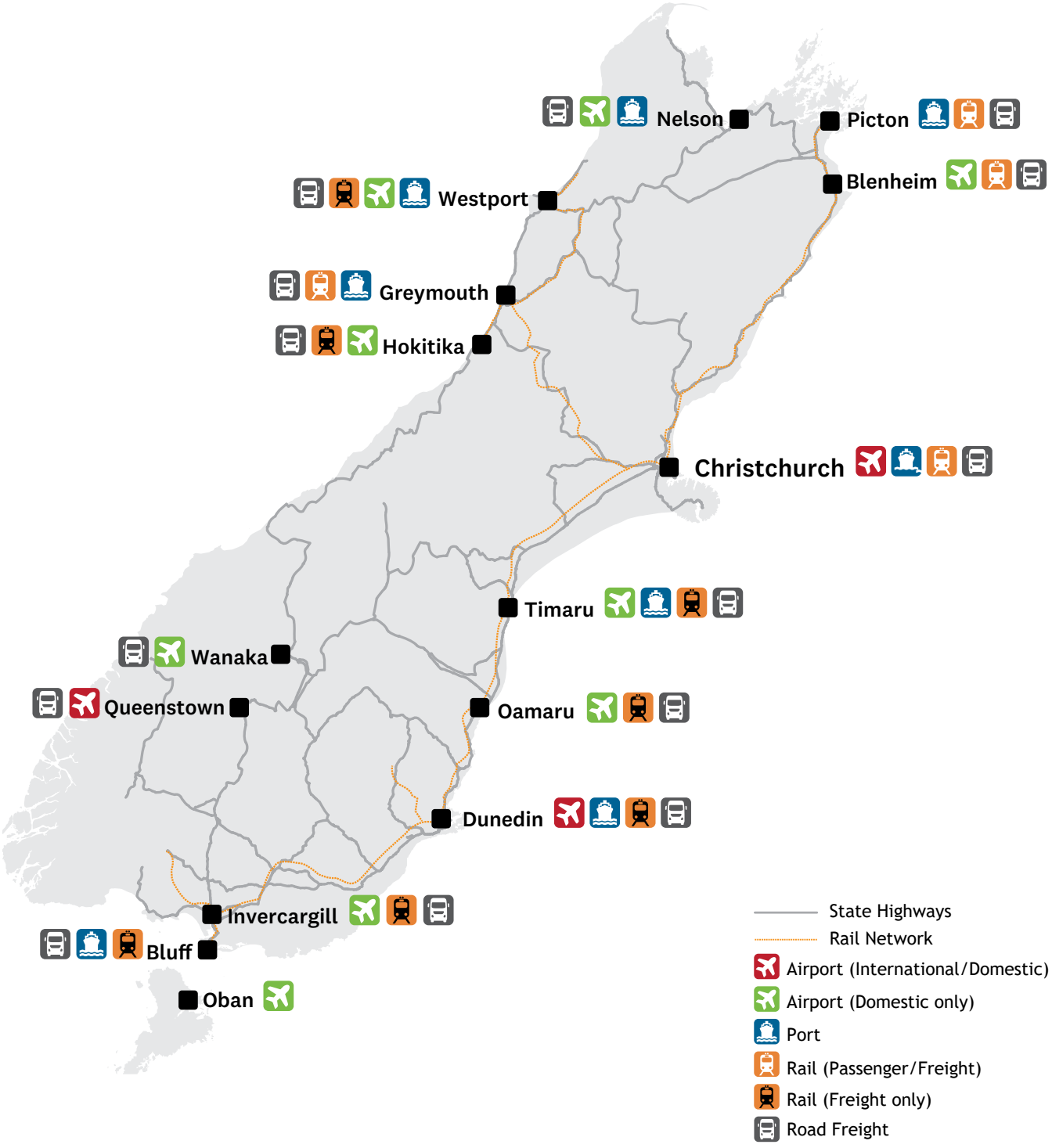
A vital link to the North Island is maintained through coastal shipping and road and rail-enabled ferries operating between Picton and Wellington. Additionally, direct vessel calls to Australia, Asia, North America, and Europe provide crucial access to international markets.

Public transport plays a crucial role in shaping and supporting our key urban centres across the motu by providing efficient, accessible, and sustainable mobility. Efficient public transport supported by the transport network reduces traffic congestion, lowers carbon emissions, and ensures that people can easily access jobs, education, healthcare, and recreational areas.

Well-designed public transport systems encourage economic development by enhancing connectivity and fostering the growth of communities and businesses. When considering transport resilience and security, public transport must also be at the forefront of strategic planning.

It is important to note that public transport looks different across the motu, smaller communities rely on total mobility schemes, while interregional coach services, driven by transport providers and rail tours provide connections for visiting tourists, and priced accordingly.

Road and rail services along the coast and through mountain passes face imminent threats and associated resilience issues.



Strategic priorities

The state of our current transport network and its shape in the coming decades will demand assertive partnership. Together, we must plan for and invest in our transport network to ensure it is resilient and fit-for-purpose for generations to come. We require bold and decisive leadership and action across local and central government to confront the challenges facing transport. The South Island Regional Transport Committee Chairs Group and partners are well positioned to work in partnership with the government on these challenges.

The transport system plays a pivotal role in shaping the South Island and supporting our economy and lifestyles. By the late 2040s, we have the opportunity to embrace real-time data, and new digital and advanced technologies which will not only improve our quality of life but also increase economic output and reduce our climate footprint.

To ensure our transport network meets both current and future needs, three strategic priority areas have been identified. These priorities are relevant across all regions of the South Island and are considered critical to the success of our motu.

Our identified strategic priorities are intrinsically linked, cannot work alone and investment and action in one area subsequently lifts another.

Key to progressing the priorities will be investigating and implementing a range of new funding and financing mechanisms. While significant, capital funding of new transport infrastructure is only part of the consideration.

These strategic priorities are:

- Building network resilience with strengthened bridges and connections
- Boosting the economy with efficient freight networks
- Enabling people and communities to flourish with better travel options.

The South Island Regional Transport Committee Chairs Group recognises the need to align efforts to achieve an integrated, resilient, sustainable and economically viable transport network. Collective action on the strategic priorities outlined in this Transport Story is a starting point for greater collaboration and partnership.

The costs of maintaining existing and new infrastructure, and providing public transport services to our communities, is another consideration. Underinvestment in transport infrastructure increases the risk of asset failure, this will be compounded by the impacts of climate change. Appropriate levels of investment into transport infrastructure and services in the short, medium and long term across the South Island, from both local and central government is critical.

Key to the future success of Te Waipounamu will be to investigate various transport funding mechanisms, including private sector investment.

We must ensure that development within existing urban areas is effectively supported by investment in infrastructure, services, and local amenities. This includes exploring collaborative infrastructure solutions and partnering with other sectors to deliver integrated outcomes.

Christchurch City

The capital funding of new infrastructure is only part of the picture when considering our transport network. The operational costs of providing services (e.g. public transport) and maintaining existing and new infrastructure are substantial, with these costs currently falling on councils and ratepayers.

Ensuring Road Controlling Authorities are supported enough to reinvest in their assets that are annually depreciating is key. It is well known that underinvestment in transport networks increases the risk of asset failure, without factoring in climate and resilience impacts.

Renewals in roading infrastructure declined to 69% in 2022/23.

The South Island Regional Transport Committee Chairs Group recognises and identifies the need to align our transport priorities to achieve an integrated, economically viable, sustainable transport system.

This story plans to build on priorities identified in Regional Land Transport Plans (RLTP) and ensure investment is long term throughout all aspects of the transport network.

This is a time when without delay, bold, decisive leadership and action is required. Below, we outline our key strategic priorities in further detail. This reflects the most effective and cost-efficient path forward; one that delivers the best value for money while lifting the resilience of our regions, with additional benefits of economic growth, productivity, and improved quality of life across New Zealand.

Collective effort on these priorities will increase the resilience of our regions, catalyse economic growth and productivity, reduce our climate footprint, and improve our overall quality of life. A joined-up approach across local and central government will support an effective path forward that delivers efficient value for money.

Building network resilience with strengthened bridges and connections

We're actively planning and investing in network resilience as a key priority for our transport network, it secures transport mobility options and economic prosperity. The South Island transport network is vast and varied, which in turn requires a higher amount of investment to keep the network at an acceptable service level.

Bridges across the South Island are a key transport network resilience issue and one that is rapidly reaching a critical point. Through the collaboration of the Chairs Group, we have developed a comprehensive case for investment into major bridges as key connectivity infrastructure, to ensure freight and communities can continue to move around in a significant event.

Bridges in the South Island are aging, 73% of those on the national State Highway network were built before 1980 and potentially due for renewal.

Whilst it is more difficult to get specific data on local road bridges, we do know there are around 5,816 bridges on the local transport network, with many of them included on the National Resilience Programme Business Case as most at risk to be exposed to significant natural hazards.

With such critical transport infrastructure being built nearly half a century ago, there is a substantial risk that infrastructure is no longer fit for purpose, sustainable, or economic to continue maintaining. Ensuring that transport assets are well maintained is key to resilience and efficient investments.

The increase of severe weather events due to climate change makes a clear case for revisioning the build location and specifics of our bridges in the South Island. Early resilience investment reduces the need for significant external emergency grant funding to support recovery from severe weather events.

It is critical that we begin considering bridge upgrades in conjunction with resilience upgrades and significant road developments. This will ensure works are done together in a timely and efficient manner and make certain that bridging infrastructure is upgraded accordingly with the network.

Waihopai Bridge, Marlborough

Kaikōura Coast/ State Highway 1

Boosting the economy with efficient freight networks

The economic contribution of specific transport routes in Te Waiponamu are specific. It is vital to identify and protect these key routes to ensure goods and people can continue to move freely in the event of a disaster. The South Island Regional Transport Committee Chairs Groups are committed to working together with local government and NZTA to protect these high value key routes, ensuring maintenance and renewals are well funded and enduring.

Ensuring that freight can travel freely and reliably through the South Island is key to unlocking further economic prosperity. The future state of the South Island Freight network will be data driven and an efficient mix of modes to see goods delivered in a timely, efficient and climate conscious manner. This will help us achieve maximum value from our network and appropriate levels of service.

We value supporting industry to transition to rail where practicable across the South Island as an alternative to long distance, non-time critical freight movement.

Over 40 million tonnes of freight are transported annually from the Canterbury region alone. In 2017 the total freight movements impacting on the South Island (to, from and within) are estimated to be 81.1m tonnes.

There are significant opportunities to work together with industry, local Road Controlling Authorities, regional government and the Government through NZTA to consciously plan and invest in freight hubs on transport routes that are protected in severe weather events, have well maintained supporting infrastructure and are safe for all users.

The South Island Regional Transport Committee Chairs Group is committed to strategic freight infrastructure across the motu such as freight hubs, key corridors and, rail. These connections will support economic prosperity and encourage thriving businesses in our communities. There are significant opportunities to collaborate with industry to identify where private funds are being invested now, and in the future, to ensure strategic alignment between those business investments and our transport network.

Image supplied by Nelson City Council

Enabling people and communities to flourish with better travel options

As the population of Te Waipounamu continues to grow, there will be a demand for new infrastructure together with the on-going need to maintain existing infrastructure, networks and services. A resilient well maintained transport network will ensure appropriate, growth and accessibility for our communities.

Planning across the region

We are committed to encouraging integrated transport solutions and investment into the network that crosses intra-regional boundaries with shared goals towards improving mobility, reducing emissions, increasing social equity, and promoting economic development. Our transport infrastructure will support the efficient and sustainable movement of goods and people with integrated planning between existing transport networks and new transport solutions coupled with considered urban planning. This will enable our transport networks to respond to population growth demands, ensuring appropriate and sustainable transport outcomes.

Collaborative planning of the transport system to support growth and accessibility can ensure our network is adaptable to future demands, by considering factors like population growth, climate change, and evolving technologies. Connected urban growth and form will prioritise transport infrastructure and associate land use change to capitalise on opportunities to promote transport options that make the most of our existing network.

Reporting and monitoring

Improving the reporting and monitoring of dollar investment in the South Island transport network is key to facilitating resilient growth and accessibility. This will enable us to have consistent and comparable data in the 2027 Regional Land Transport Plans from the South Island.

There is significant uncertainty around forecasting location and timing required of infrastructure to support the growth that is expected to occur over the next 25 years, whilst reducing emissions, adapting to natural hazards and increasing accessibility. These factors drive the need to reconsider where and how to invest in infrastructure for the most efficient spend.

Transport infrastructure is expensive and takes a significant amount of time to plan and implement, Councils are planning to invest $8.1 billion on transport over the next RLTP period with central government contributions never guaranteed.

The future state of funding will see local and regional government working collaboratively with the private sector to mitigate investment risks to increase dollar investment made.

The South Island Regional Transport Committee Chairs Group and our communities will continue to advocate for increased investment in the South Island to witness significant shifts in our transport system towards a desired future state.

Closing remarks

The South Island Regional Transport Committee Chairs Group have identified key strategic priorities for the South Island transport system that are intrinsically linked to one another and are the values held by local government and community alike. This South Island Story links the strategic direction across the motu through to each region's Land Transport Plan which includes investment priorities and directive to keep Te Waipounamu moving.

The transport system has significant interdependencies with urban development, environmental and climate mitigation planning and community organisation. We are advocating for cross-regional strategic priorities and associated funding from strong collaborative regional relationships.

Weld Pass, Marlborough

South Island Transport Network Vulnerabilities

A summary of the risks and resilience challenges facing the South Island transport network from natural hazards

May 2025

Nelson City Council Te Kaunihera o Whakatū
Marlborough District Council
Environment Canterbury Regional Council Kaunihera Taiao ki Waitaha
Otago Regional Council
environment Southland Regional Council Te Taiao Tonga
Waka Kotahi NZ Transport Agency
West Coast Regional Council
tasman district council

South Island Regional Transport Committee Chairs Group

Executive Summary

This report consolidates existing analysis and research to provide a comprehensive overview of the vulnerabilities facing the South Island's transport network due to natural hazards, infrastructure limitations, and the projected impacts of climate change. The focus is on critical transport routes, regional lifelines, and the challenges posed by natural hazards, including seismic activity, flooding, coastal erosion, and extreme weather events.

This report outlines a fragile and linear transport network. Seismic events, climate change, and geographic isolation all pose significant risks.

In Arataki, the NZ Transport Agency's 30-year plan, criticality is determined by the level to which transport corridors are "*supporting the most essential movements of people and freight across all modes*".[1] This definition has been applied in this report, given that Arataki was developed as a shared-sector project to deliver a vision for the entire motu. A common definition of criticality supports report consistency, acknowledging that what is critical will differ significantly on an individual basis.

The South Island's critical transport network plays a pivotal role in connecting population centres, import/export opportunities, and facilitating general movement of freight and persons. This network is composed primarily of key state highways (SH) (notably SH1, SH6, SH7, SH8 and SH73) and the Main North, South and Midland rail lines.

SH1, which runs along the east coast from Picton to Dunedin, is the backbone of this network. This is supported by critical inland routes, such as SH6, which runs from Blenheim to Invercargill via the West Coast. This route also plays a role in connecting to Queenstown, a key tourist destination.

Another critical inland route is SH73, which connects the West Coast to Canterbury via Arthur's Pass. The network is vulnerable due to its dependency on a few key routes, many of which lack redundancy or alternative options, particularly in regions like the West Coast and Canterbury where rugged terrain and geographic isolation increase the risks. For example, there are limited alternatives to SH73. While freight could be moved via SH7 this would be a significant, and costly, detour.

The South Island's transport corridors are often exposed to significant hazards. An AF8 (Alpine Fault magnitude 8) scenario is a major risk, particularly to stretches of routes located in the West Coast, like SH6 and SH73, which could face prolonged closures due to landslides. Research indicates there is a 75% probability of an Alpine Fault earthquake greater than magnitude 7 over the next 50 years, with an 80% chance that this is a magnitude 8+ event.[2]

Coastal highways, such as SH1 in Marlborough, Canterbury and Otago, are increasingly vulnerable to sea-level rise and storm surges. On the other hand, inland routes such as SH8 through Central Otago, face risks from heavy snowfall and landslides, particularly in alpine regions. Several key inland routes, particularly those on low-lying land, face the additional challenge of flooding. With limited redundancy and alternative routes in many areas, these hazards threaten to disrupt connectivity across the South Island unless resilience investments are prioritised.

The only natural hazard which the South Island is not particularly exposed to is volcanic eruption.

The condition of the transport network's bridges, rail lines, and ports is a pressing concern, especially with many structures nearing the end of their useful life. This sentiment is shared by the majority of regions and road-controlling authorities.

There is a limited understanding of the important role of local roads as part of the network, though there are several recognised in this report at varying levels of importance. These routes tend to feed into state highways, promote access to critical utilities, or provide alternative routes.

Local roads are often overshadowed by the strategic significance of state highways and rail lines, given local networks may have more suitable alternate routes and tend to carry lower movement volumes. These roads still play a significant role in supporting the movement of people and goods to and from smaller towns, rural communities, and agricultural areas, feeding into the major transport corridors. In areas such as the West Coast and Marlborough, local roads are often the only access routes to isolated communities, making their resilience essential for maintaining access to essential services.

Often, local roads in the vicinity of state highways are considered vulnerable to the same general hazards. For example, the Crown Range Road between Wanaka and Queenstown is anticipated to experience natural hazards similar to those on the nearby stretches of SH6 and SH8, as the road shares comparable conditions and traverses similar terrain.

In areas like Central Otago, local roads are frequently impacted by snowfall and landslides, while on the West Coast, narrow, winding local roads are prone to landslips and flooding. Local roads are more likely to be unsealed, or in worse condition than the state highway network, resulting in more severe impacts from hazards. The lack of redundancies on many local roads means that even minor disruptions can have outsized consequences, isolating communities and local economies.

The South Island's rail network is made up of three primary rail lines: the Main North Line (MNL), Main South Line (MSL) and Midland Line. These lines are vulnerable to a number of hazards on specific sections of track. For example, stretches of the MSL through the Taieri Plains are exposed to frequent flooding events, whereas this may not be a risk for other sections of the line.

The South Island's ports and airports exhibit varying levels of resilience. Many ports are exposed to sea-level rise and associated coastal hazards (e.g. erosion). Inland ports provide additional redundancy to the freight sector, though connections to these facilities via road may themselves be vulnerable.

Climate change is exacerbating existing vulnerabilities, with rising sea levels, increased storm frequency and shifting rainfall patterns threatening transport infrastructure. Coastal highways, such as SH1 near Port Chalmers, and bridges over braided rivers in Canterbury are particularly at risk. Frequent flooding and coastal erosion will likely lead to significant disruptions in connectivity across the island. The rupture of a major fault line, such as the Alpine or Hikurangi Subduction Zone, remains one of the most consequential hazards, if not the most, to the South Island despite climate change having relatively lower impact on the size, scale or likelihood of this scenario.

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Tables

The Strategic Transport Network

1. The Strategic Transport Network

1.1 Criticality

This report frequently discusses the concept of criticality. It is important to acknowledge that what is considered critical can vary significantly depending on perspective. For instance, what is critical for someone involved in the lifelines industry is likely to be notably different than that for an everyday citizen, engineer, farmer, politician, etc.

For the purposes of this report, readers should interpret criticality through the lens of the Arataki framework (Arataki is the NZ Transport Agency's (NZTA's) 30-year plan), which defines a critical route as one "*supporting the most essential movements of people and freight across all modes*".[3]

While strategic assessments of the transport network often emphasize state highways and the main rail lines, this should not diminish the role of local roads. Local roads remain critical to their users and play a fundamental role in supporting transport outcomes despite carrying relatively lower volumes of traffic.

In some cases, the word critical is used more broadly to mean important, significant, etc. In these cases, the context should make the intended meaning clear to the reader. This is not to be confused with criticality as referring to the level of consequence should an asset fail or no longer be available for use.

1.2 Strategic Network

The strategic network comprises the most critical parts of New Zealand's land transport network, acting as the backbone for essential movements of people and freight across all modes.[4] A range of projects, including Arataki, the South Island AF8 Priority Routes Project, and the One Network Framework (previously the One Network Road Classification (ONRC) Framework), provide valuable perspectives on what constitutes the most critical routes across the South Island.

While these projects consider criticality through various perspectives – such as transport outcomes, post-earthquake recovery, or traffic volumes and access – they all identify the east coast transport corridor as the highest priority in the South Island. This is likely due to the corridor's role in connecting key urban hubs with significant population density, primarily through SH1, connecting routes like SH6, and KiwiRail's Main North and South Lines, which run parallel along the coast.

Figure 1 outlines the South Island's strategic transport network as identified by Arataki. For a road to be considered nationally strategic, it must, to varying degrees, provide important primary connections between population centres, ports and urban areas, perform national level functions, link major freight hubs to cities, support in-region and interregional travel, and have high volume, high value trips.

Alternatively, for a road to be considered regionally strategic, it should provide interregional connections, connect areas to the spine of the network, provide a lifeline for areas with a single connection, and provide alternate routes in the event of disruption or closures.

These criteria align strongly to the previously provided definition of criticality.

KiwiRail's Rail Network Investment Programme (RNIP) classifies the Main North Line (MNL), Midland Line, and Main South Line (MSL) as the South Island's Priority Lines. These form the current strategic rail network.

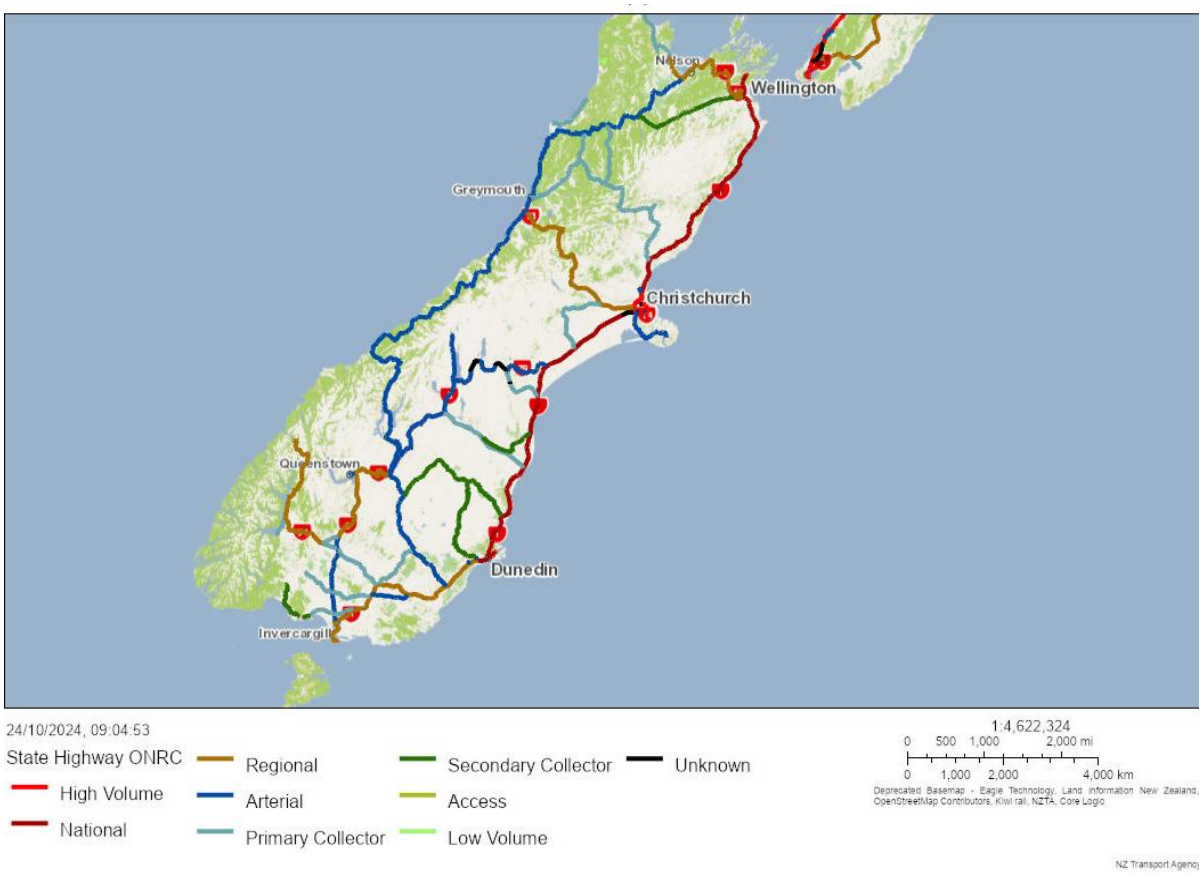
These routes largely run parallel to the state highway network, as illustrated in Figure 1.

Arataki's Strategic Road and Rail Network, Figure 1, broadly aligns with the ONRC Framework, presented as Figure 2. The ONRC Framework categorises New Zealand's roads based on volume of traffic, whether they connect to important destinations, or are the only available route.

Arataki identifies SH1 as a nationally strategic state highway, with stretches of SH8, 73 and 6 identified as regionally strategic state highways. Comparatively, the ONRC Framework identifies SH1 as a national route, along with sections of SH76 and 74 connecting to Lyttelton Port in Christchurch.

Figure 1: Arataki Strategic Road and Rail Network

Figure 2: ONRC Classification, South Island State Highway Network



Sections of SH6, 62, 60, 73, 6 and 94 are all assessed as regional routes within the ONRC Framework.

Despite these differences both frameworks are relatively similar, clearly signalling the importance of SH1 as the backbone of the South Island's transport network, with key horizontal connectors.[5]

During engagement for this report, concerns were raised regarding inadequate recognition of inland routes from Christchurch to Queenstown and Picton. While these routes are regarded as significant by several stakeholders, they are not currently represented in Arataki. As Arataki is being refreshed in the near future, it is anticipated that the strategic network will likely be amended to reflect these considerations.

Similarly, there are concerns that the ONRC Framework does not appropriately capture access to lifeline facilities or essential services, meaning some routes may be over/under ranked. NZTA have recently undertaken work to refresh the strategic freight network previously identified in 2018 using freight vehicle telemetry data.[6] This project analysed real-time electronic Road User Charges (eRUC) data to track freight movements from ignition to shut down. It is important to note that volume alone does not determine a route's strategic significance – factors such as resilience and route security are also critical considerations.

The project provides further evidence for the importance of SH1 and its horizontal connections and supports potential amendments recognising the strategic inland

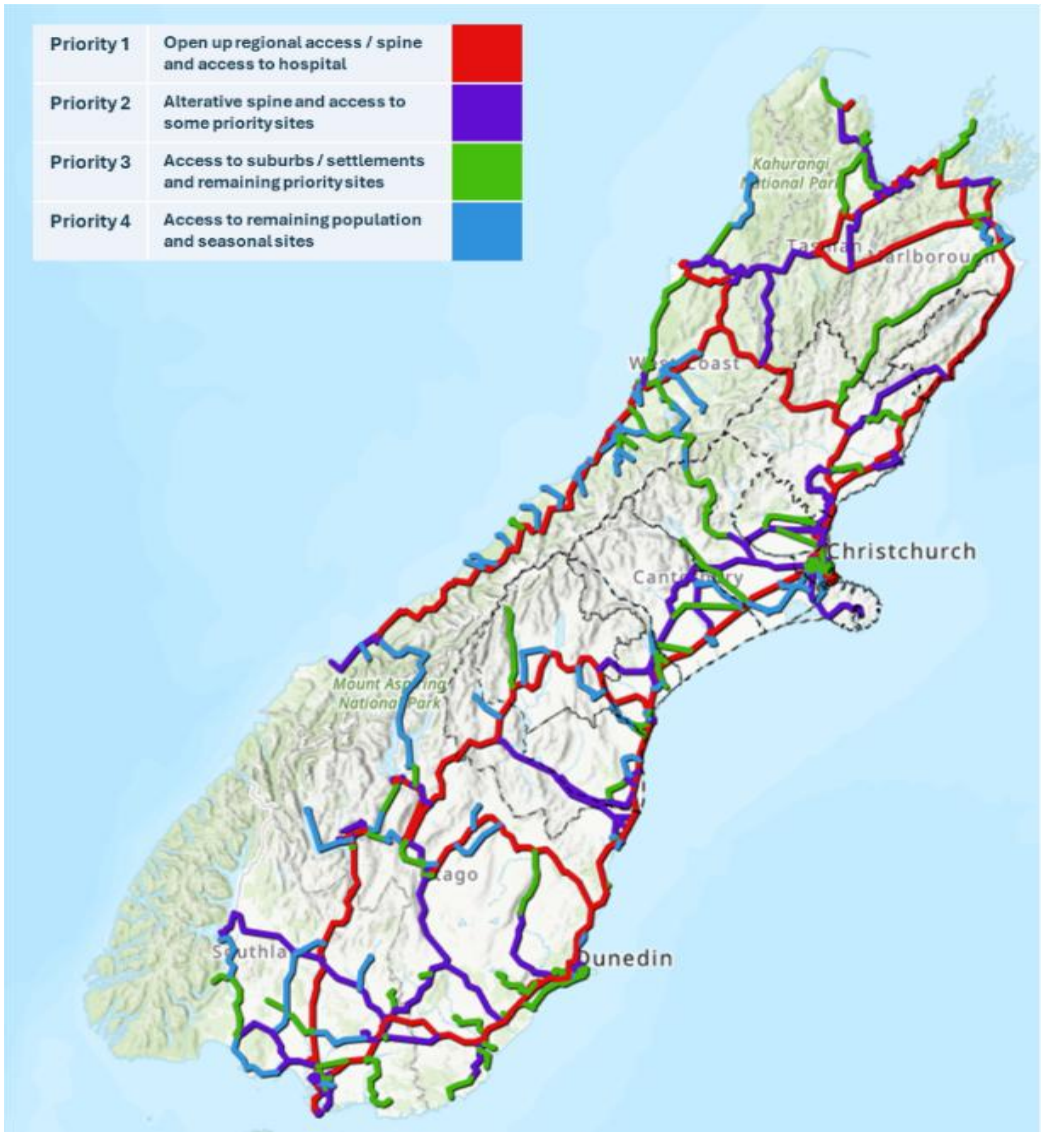
connections from Christchurch to Queenstown along SH8 and Christchurch to Picton via SH7, 65 and 6.

Figure 3 shows the strategic network that was produced by the AF8 Priority Routes Project.

This project assessed priorities for the restoration of roading networks based on the relative priority of sites and freight corridors requiring access. This was achieved by applying the results of University of Auckland vulnerability modelling for both local roads and state highway networks to an AF8 event.

Priority was determined through workshops with key stakeholders in each region. It is not unreasonable to take the identified Priority One routes as being of most strategic importance to consulted stakeholders, moving beyond a volume-focussed approach to a more holistic understanding of the transport network.

Figure 3: South Island Priority Routes, AF8 Priority Routes Project



All three presented strategic road networks highlight routes connecting to major ports and airports, typically via the state highway network. These facilities are critical in facilitating movement of people and goods, particularly following disasters which may leave the road network inoperable. For example, following the Kaikōura earthquakes, KiwiRail initiated the NZ Connect coastal freight shipping service into Lyttelton Port to ensure freight was able to move into the South Island. This resulted in a doubling of coastal shipping trade out of Auckland, underscoring the importance of alternative modes of transport within any strategic network.[7]

1.2.1 South – North Connection

The Interislander ferry is one of the most integral non-road based transport modes, bridging the Cook Strait between the South and North Island. This service is critical to the wider New Zealand supply chain. On average each year, the Interislander operates approximately 3,800 services to transport about 850,000 passengers, 250,000 cars and up to $14 billion worth of freight, making the Interislander service a core contributor to national GDP growth.[8]

Importantly, there is no viable alternative to CentrePort Wellington and Port Marlborough terminals for operating a ferry service between the South and North Islands.[9]

Without a functioning inter-island connection, there are likely to be significant consequences to local and national economic outcomes, resilience and wellbeing.

The Islander rail fleet currently provides a roll-on roll-off link between the South and North Island rail networks, connecting to local ports and freight hubs. Lyttelton Port dominates the South Island's container trade, handling 13% of New Zealand's total Twenty-foot Equivalent Unit (TEU) container traffic. It is followed by Port Otago (6%), South Port (2%), Port Nelson (2%), and PrimePort Timaru (1%).[10]

Complementing sea and rail-based transport is the South Island's network of airports. Christchurch Airport served approximately 5.69 million passengers in the 2023 financial year, establishing it as the South Island's most critical airport for both travel demand and freight movement.[11] Additionally, Queenstown Airport experiences significant traffic, with 2.41 million passengers in 2023, reflecting its status as a key tourist destination.[12]

1.3 Critical Infrastructure

1.3.1 Bridges

Bridges play an important role in ensuring the ongoing function of the transport network by supporting movements over the South Island's many rivers, streams and crossings. This report highlights critical bridge infrastructure in each region and the associated risks they face.

Across the NZTA managed state highway network, there are 1,914 bridges and major culverts. Of the 1,845 bridges with a known construction year, 72.3% of them were built before 1980 and could be coming up to being over 50 years old. These bridges may therefore be at greater risk of being compromised by a natural disaster due to dated design features (e.g. pile depth, scour protection), or simply failing due to hidden defects.

In total there are about 7,730 bridges across state highways and local roads in the South Island. KiwiRail also operates an estimated 700 bridges in the South Island, each with varying condition and age profiles.

Bridges are vulnerable to both first and second-order impacts of seismic events, which include ground movement, sediment generation washing beneath them, swollen rivers, violent currents during floods and storms, and the increasing stress imposed by network users on aging or unsuitable infrastructure (e.g. High Productivity Motor Vehicle (HPVM) restricted, including 50MAX).

Bridges identified within the National Resilience Programme Business Case (PBC) are outlined in Table 1. Further information regarding detailed hazard description, location, risk rating and suggested response can be found within the PBC itself.

Besides the higher-volume bridges listed in

Table 1, there are growing strategic challenges regarding the ownership of infrastructure connecting to isolated settlements, rural communities, and privately owned land. While this report does not offer an answer, questions will need to be asked about who is best positioned to own and maintain these assets (of which stakeholders typically hold very little information). Faced with the requirement to potentially step-back from some of these structures, some councils have begun investigating solutions, such as large-scale ownership transfer schemes.

Table 1: State Highway Bridges Known to be Exposed to Significant Natural Hazards

Asset name	Hazard
Bealey Bridge (SH73)	Earthquake / liquefaction
Clarence Bridge (SH1)	Flooding
Hurunui River Bridge (SH1)	Earthquake / liquefaction
Rangitata Bridge (SH1)	Flooding
Arundel Bridge (SH1)	Flooding
Waiau Ferry Bridge (SH7A)	Rockfall
Milford Road Bridges (SH94)	Flooding
Balclutha Bridge (SH1)	Flooding
Maheno (SH1)	Flooding
Griffiths Bridge (SH73)	Erosion
Taipo Bridge (SH73)	Flooding
Wainihinini Bridge (SH73)	Flooding

1.3.2 Lifeline Utilities

Lifeline utilities are entities that provide essential infrastructure services to the community, supporting communities, enabling business, and underpinning the provision of public services. Facilitating continued access to these utilities, particularly during an emergency, is a critical role of the transport network. Therefore, the transport network tends to be restored first.

Lifeline utilities all face varying levels of vulnerability to hazards, depending on location, scale, and type of hazard. Lifeline utilities can be loosely grouped as follows:[13]

- Transport – roading, rail, ports, airports
- Telecommunications and broadcasting
- Energy – electric power and fuel
- Protection – river and coastal protection works
- Water and wastewater

Discussion on strategic networks often considers access to lifeline utilities as part of identifying what constitutes strategic or critical. Following an emergency, nearly all lifeline utilities are dependent on a functioning transport network. Without access to these utilities to ensure they remain operable many communities would suffer significant consequences. The interdependencies between transport and lifeline utilities is visualised and discussed further within NZTA's Research Report 671.[14]

Lifeline utilities are a key consideration of the AF8 Priority Routes Project, reflected in multiple GIS layers allowing users to overlay locations of sites including electricity, fuel, telecommunications, transport, correction facilities, emergency services, supermarkets and hospitals. The communication of simultaneously overlaid indicators in static images is challenging, and so it is recommended that interested parties access the GIS tool directly rather than relying on this report for illustrative images.[15] A GIS application was developed as part of Arataki, featuring additional details such as the location of marae, health centres, schools and ports. While this does not include hazard layers, a layer outlining Arataki's strategic network (national or regional) is able to be applied.[16]

In addition to the development of GIS tools, other research efforts have sought to understand the connections between lifeline utilities and the transport network. The New Zealand Infrastructure Vulnerability Assessment provides a comprehensive analysis of each lifeline sector and the expected impacts from various hazards.[17]

Risk and Resilience

2. Risk and Resilience

In addition to understanding that definitions of criticality may vary across perspectives; it is fundamental to understand that risk and resilience are separate concepts. Risk relates to the likelihood and consequence of a specific outcome, while resilience is focused on the ability to absorb an event at any given moment, assuming that we are unable to predict all that may happen.

This report explores risk and resilience for each region in the South Island. Regarding risk, the report outlines the unique and diverse natural environments across the South Island, and how this may lead to certain natural hazards. It explores critical aspects of local and interregional transport networks, including built infrastructure beyond roads.

Regarding resilience, the report assesses the reliability of specific aspects of the transport network at any given time and explores potential alternatives.

This section briefly outlines resilience challenges for critical national transport corridors, before summarising the key risk and resilience themes repeated or shared between regions in the South Island.

Transport Resilience Overview

The New Zealand Lifelines Council's list of nationally significant roads identified in regional lifelines projects is presented in Table 2, noting the list is not intended to be exhaustive. This is useful as a high-level indicator of the types of risks that parts of the South Island's strategic network may be vulnerable to.

Table 2: Nationally Significant Roads with Hazard Exposure[18]

Location	Hazards	Comments
SH1 Kaikōura Corridor	Landslips (rain and earthquake)	Road and rail in narrow corridor. Major mitigation work following 2016 quake.
Lyttelton Tunnel and access roads	Seismic	Access to Lyttelton, port facilities and fuel.
SH1, 6 and 8 in Otago	Seismic, alluvial activity and flooding	Long detour routes. SH1 near Oamaru flooded for a few days in 2019.
SH6 Kawarau Gorge	Seismic, flooding and slope instability	Key route into Queenstown – alternate route adds 4 hours.
SH6 Hokitika-Haast Pass and SH94 Milford Sounds	Seismic and weather (flooding, snow/ice)	Important tourist routes.
SH6, 7 and 73, West Coast	Seismic and weather (flooding, snow/ice)	Only links to the West Coast – potential isolation in a major alpine fault. Coastal erosion and flooding near Punakaiki.
SH88, Dunedin	Tsunami and coastal flooding	Link to Port Chalmers.

Figure 4, developed as part of Arataki, illustrates key state highway and rail system corridors – highlighting corridors with extreme resilience risks and journey reliability deficiencies, both now and into the future.

This figure highlights the significant threats faced by the state highway network operating along the West Coast, including the connecting routes to the region. Similarly, many of the routes in and out of the top of the South Island are threatened, which is significant given this is where the connection between the South and North Islands is strongest.

Sections of SH1 face resilience risks, both now and into the future, though less so than other routes, such as SH6 and 7. There is a large reliability deficiency in South Canterbury, likely due to the reliance of the road network on pinch-points to cross the region's rivers network, such as the Ashburton Bridge.

Figure 4: Map of Network Deficiencies, Arataki

2.1 Key Themes

2.1.1 Seismic Vulnerability

The South Island's seismic vulnerability is one of its most pressing risks. Research indicates there is a 75% probability of an Alpine Fault earthquake greater than magnitude 7 over the next 50 years, with an 80% chance that this is a magnitude 8+ event.[19] This fault runs through several regions and a significant earthquake could lead to widespread infrastructure damage. For instance, the West Coast's mountainous terrain and narrow corridors make it especially prone to rockfall and landslides, which could sever key transport routes like Arthur's and Haast Passes. These areas are expected to face months of isolation in the event of a severe earthquake due to alternate routes likely being equally compromised, making recovery efforts slow and complex, as illustrated in Appendix 2.

Canterbury is also at high risk in an AF8 scenario due to its dependence on bridges to cross the region's seven major braided rivers. Many of these bridges could become unusable due to ground shaking, and with limited alternative routes, significant parts of the region could be isolated. The region's transport lifelines, including SH1 and the rail network, which run parallel in many sections, would be heavily impacted by seismic events, amplifying the disruption to freight and passenger movements across the South Island.

In Marlborough and Tasman, seismic risks have an outsized impact on resilience given the region's reliance on vital infrastructure like Port Marlborough, which plays a crucial role in connecting the South and North Islands. If the port was severely damaged by an earthquake, it would cause nationwide disruptions to supply chains. With both Marlborough and Nelson ports identified as being subject to medium seismic demand, and with no feasible alternative to Port Marlborough as a key inter-island connection, maintaining their operability is critical for the broader South Island economy.

Work undertaken by the Canterbury Civil Defence Emergency Management (CDEM) Group, in collaboration with stakeholders across the South Island, to better understand the impacts of an AF8 scenario earthquake has produced **Error! Reference source not found.** – an indicative downtime matrix. The matrix illustrates the significant detours transport network users could expect following an AF8 scenario.

Other matrices are included as part of the Canterbury AF8 Risk Profiles Summary Report, developed by QuakeCore. This report provides a summary of relevant studies and research undertaken by the group. This includes analysis from the Te Ripahapa, CDEM-led, scenario testing exercise.

The Te Ripahapa exercise explored a scenario in which a magnitude 8 earthquake occurred on the Alpine Fault with an epicentre in the Fox Glacier region. Four aftershocks with magnitude greater than 5.5 followed within the next 18 hours. Other studies have produced restoration estimates and projections of infrastructure failures arising from an Alpine Fault earthquake based on Measuring the Economics of Resilient Infrastructure (MERIT) modelling, aftershock likelihood modelling, landsliding estimates and tsunami estimates. A variety of maps, tables and figures are available in the AF8 Risk Profiles Summary Report, which are valuable for considering an Alpine Fault event and how it may impact the South Island's transport network.[20,21]

In terms of lifeline utilities, the New Zealand Infrastructure Vulnerability Assessment outlines that in an AF8 scenario, there are likely to be electricity blackouts within at least 150 km of the Alpine Fault and intermittent supply in areas considerably distant. Most hydro generation plants will shut down, with some damage expected and many substations heavily damaged. The three-waters network throughout the South Island is likely to be damaged, with the West Coast and Queenstown the hardest hit and requiring months to years of restoration (which would be heavily reliant on continued road access). Communities are also likely to be isolated from commercial fuel supply points, particularly if Lyttelton, Dunedin and Bluff port infrastructure are damaged, as expected.[22]

Road access to lifeline infrastructure is critical in supporting resilience in the South Island, highlighting the risk of seismic activities impacting these routes.

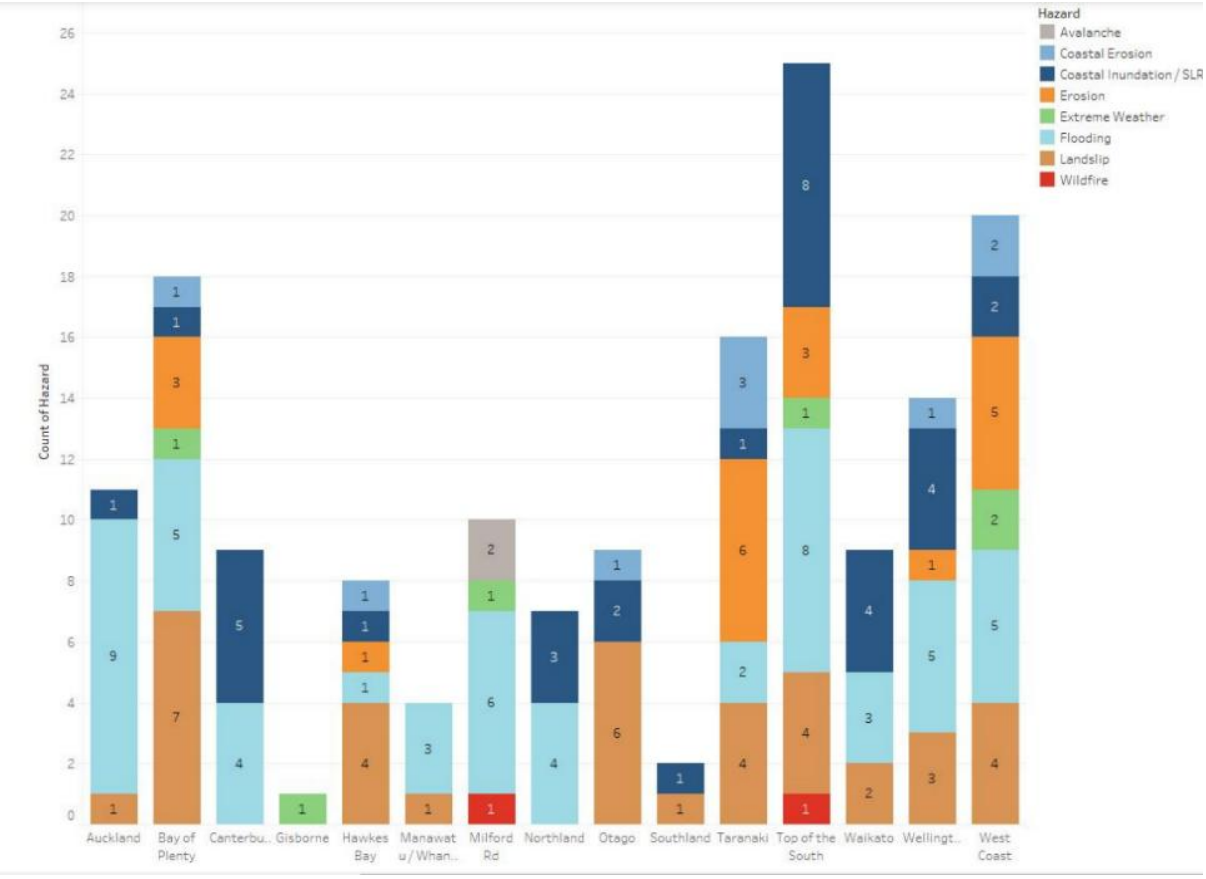
2.1.2 Coastal and Flood Risks

Flooding and coastal erosion pose significant risks to several South Island regions, particularly as climate change intensifies these hazards. The National Resilience PBC identified 160 climate change related risks throughout the country, many of which primarily relate to coastal inundation, sea level rise and flooding.[23] This is visualised in Figure 5.

Throughout this report, coastal and flooding risks are frequently identified as being high in number and in potential consequence. This sentiment is echoed in the National Resilience PBC, with the top of the South and the West Coast having the highest number of identified climate risks.

Canterbury, with its extensive network of braided rivers, is highly vulnerable to flooding. Many of the region's key roads and bridges are located near these rivers, and during major flood events, these crossings can

Figure 5: National Climate-Related Risks Summary



become impassable. For instance, when the Ashburton Bridge was temporarily closed due to floodwater scour, it forced detours of up to 14 hours, severely disrupting regional connectivity.

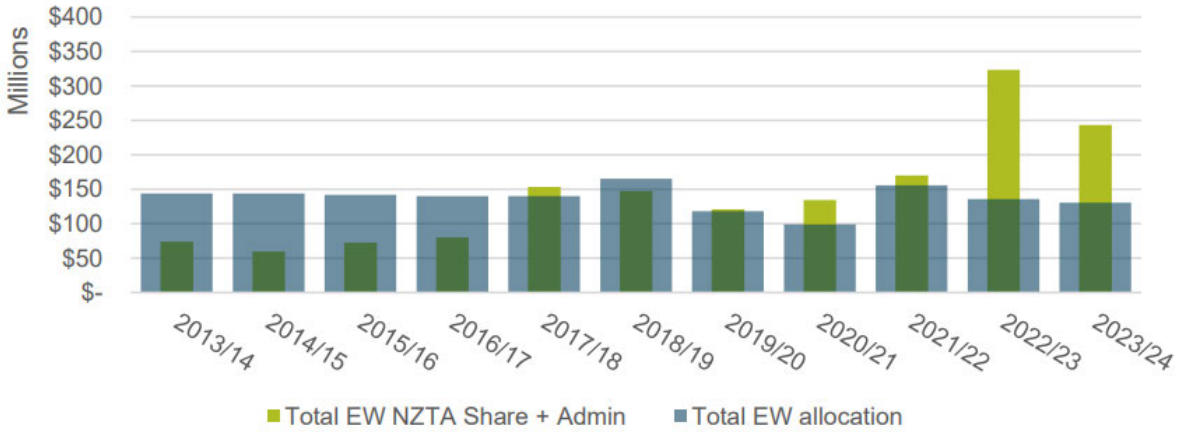
Rising sea levels is also a critical concern, especially in low-lying coastal areas of which the South Island has many. For example, research by NIWA highlights that 84 km of road and 9 km of railway in the Marlborough-Tasman region are at risk from sea level rise, which would compound the impacts of frequent flooding events.

The vulnerability of the coastal routes which connect the South Island makes it increasingly challenging to maintain reliable connections between urban centres and freight hubs. A 2009 report found 2.5% (122 km) of the South Island state highway network is located on low-lying coastal lands – a number which is unlikely to have improved since the report was undertaken.[24] Examples include specific sections of SH1 near Katiki and Evansdale, and SH88 to Port Chalmers, being particularly vulnerable to flooding and erosion, or on the east coast with SH1 running parallel to the ocean.

2.1.3 Impacts of Climate Change

Climate change is intensifying natural hazards and risks across the South Island, which is already significantly impacting infrastructure resilience and will continue to do so. Rising sea levels, more frequent and intense storms, and shifting rainfall patterns are exacerbating the risks of flooding, coastal erosion, and landslides.

Figure 6: Allocation and Spend on Emergency Works (State Highways and Local Roads), excluding Earthquake and North Island Weather Events



This is reflected in the rising emergency works expenditure, as visualised in Figure 6.[25]

It is important to note that the impacts of climate change will be felt differently across the South Island, and even within regions. For instance, some areas of Southland may experience increased levels of rainfall while others should prepare for increasing periods of drought. Low-lying coastal areas found throughout the South Island, such as in Canterbury, Blenheim and Nelson, will face accelerating rates of sea level rise impacts.

While the exact form of climate change is not shared between regions, through their respective plans, policies and strategies, all regions openly acknowledge the threat that this phenomenon poses to their transport networks. Climate change is expected to continue to drive an increased need for maintenance and renewals expenditure, emphasising the importance of future-focussed network management in all regions.

2.1.4 Transport Network Fragility and Redundancy

The South Island's transport network is fragile, with many regions relying on a few critical routes, and lacking alternative connections in the event of disruption. The state highway network is therefore highly susceptible to blockages, particularly in areas crossing the Southern Alps where natural hazard risk is heightened. The single biggest risk to the resilience of the state highway network crossing the Alps is earthquakes.

This theme applies to all regions across the South Island and has significant consequence to the resilience of interregional transport networks. These routes are often state highways and have either few (or no) detours, or available detours are either time-consuming or unsuitable for all traffic (such as HPMVs due to weight restrictions on smaller bridges, unsealed roads, narrow passages, etc.).

SH1 and SH6, for example, serve as the primary lifelines for both freight and passenger transport across the island, but their vulnerability to natural hazards makes the entire network susceptible to breakdowns. Marlborough's SH60, which is the only land connection for some communities, further exemplifies this lack of redundancy. A closure on this road, particularly in the event of flooding or landslides, could isolate entire towns, making

it difficult to maintain access to essential services and supplies.

On the West Coast, the reliance on SH6 is particularly concerning given its exposure to landslides and extreme weather events. It is the most exposed state highway to an Alpine Fault rupture, which would cause all towns to become completely isolated from each other and the rest of the island. The region's sparse population and mountainous terrain mean there are few alternative routes, increasing the risk of prolonged isolation during major natural disasters. Even short-term closures can have serious impacts, as seen after the 2016 Kaikōura earthquake, when parts of SH1 (e.g. between Clarence and Mangamaunu) were closed for an extended period, forcing traffic onto lengthy detours and highlighting the need for more resilient transport networks.

Alternate transport arrangements, primarily via coastal shipping and air freight, were critical in supplying communities with goods and services to aid recovery efforts following this disaster, as well as providing evacuation support.

2.1.5 Economic Reliance on Vulnerable Routes

The South Island's economy, particularly in sectors like tourism, agriculture and forestry, heavily depends on the operability of its transport network, highlighting low system resilience. State highway routes are particularly important in connecting the regions, especially given there are often significant detours in the instance of an inoperable state highway.

The South Island's most important corridor is SH1, which supports key economic activities, including freight movement between regions and to ports for export. Marlborough and Tasman, for instance, are reliant on SH1 to maintain their viticulture and aquaculture exports, which are major economic drivers. This route is also vulnerable to numerous hazards. Any disruption to SH1, such as those caused by the 2016 Kaikōura earthquake, can result in significant economic losses, as the detours add time and cost to transport.

A useful GIS tool which explores the resilience of the state highway network to earthquakes, storms, volcanos and tsunamis has been developed by NZTA. This tool combines a route indicator, which outlines the level a road would be able to operate to, with an outage indicator, which outlines the expected duration the road would operate at the identified availability level to create a disruption score.

This can be used to better understand how resilient the network is, and therefore the risks transport network users face if relying primarily on movement via the state highway system. This tool illustrates that the network faces a significant number of earthquake risks throughout the South Island, while storm and tsunami risk cause the most disruption at the top of the South Island.

Regional Analysis

3. Te Tau Ihu, Nelson, Tasman and Marlborough

Te Tau Ihu represents the northern tip of the South Island and has a resident population of approximately 160,000.[26] The main urban hubs are Nelson and Blenheim. Nelson City hosts Te Tau Ihu's primary airport, port, hospital and the main campus of the Nelson Marlborough Institute of Technology. Te Tau Ihu includes the Tasman, Nelson City and Marlborough communities, whose main economic activities include agriculture, forestry and manufacturing. Also known for the natural beauty of its landscape, this region is a landmark destination for domestic and international travellers.

The region is susceptible to a wide range of natural hazards, including sea level rise, heavy rainfall and flooding events, droughts and high temperatures. Seismic risks associated with the Alpine, Waimea and Wairau Faults are significant. The communities and transport networks of Te Tau Ihu are expected to be impacted by more frequent and severe weather patterns, particularly in coastal and hilly areas, as these are exacerbated by climate change.

Te Tau Ihu is a crucial link between the South and North Islands, with Port Marlborough providing the southern end of the inter-island connection. As the only South Island port equipped with linkspans accommodating the ferries crossing the Cook Strait, Port Marlborough's resilience is paramount to the transport network of both the region and wider New Zealand. Disruption to this connection would significantly impact national supply chains.

Port Nelson also plays a key role as Australasia's largest fishing port and the primary fuel supplier for Te Tau Ihu. Shakespeare Bay in Picton is home to New Zealand's deepest export shipping berth at Waimahara Wharf, supporting the tourism industry by accommodating the world's largest cruise vessels. Additionally, the smaller ports of Havelock and Waikawa support local industry and recreational activities.[27]

An inland cargo site is being built at Riverlands near Blenheim, which links to Port Marlborough in Picton by both road and rail. The hub is designed to provide a resilient, reliable and competitive option for exporters to get their products to market. Construction is planned to be completed in 2024.

SH1, 6, 60, 63 and 65 are all assessed as regionally significant in the Nelson-Tasman Regional Land Transport Plan (RLTP), serving as major connectors and alternative routes to the South Island's main trunk line and SH1. Marlborough's 2024 RLTP highlights SH6, 62 and 63 for their importance in inter-regional connectivity and their role in linking settlements within Marlborough. SH1 stands out as the region's most critical route, supported by findings from Arataki and the AF8 Priority Routes Project. This route facilitates essential freight, and tourism flows between Picton (and by extension the North Island) and Christchurch.

Other key stretches of the state highway network identified within Arataki include SH60 between Waimea and Motueka, SH6 between Whakatū (Nelson) and Waihareakeke (Blenheim), and SH6 to the West Coast.[28]

Local roads (Main Road Stoke, Moutere Highway and Motueka Valley Highway) connect the state highway network with local destinations. Anecdotal evidence indicates that these routes are often used by heavy

vehicles, subjecting them to additional strain and underscoring their criticality.[29] Weather and seismic events which may affect state highways are also likely to affect many of the local road detour routes.

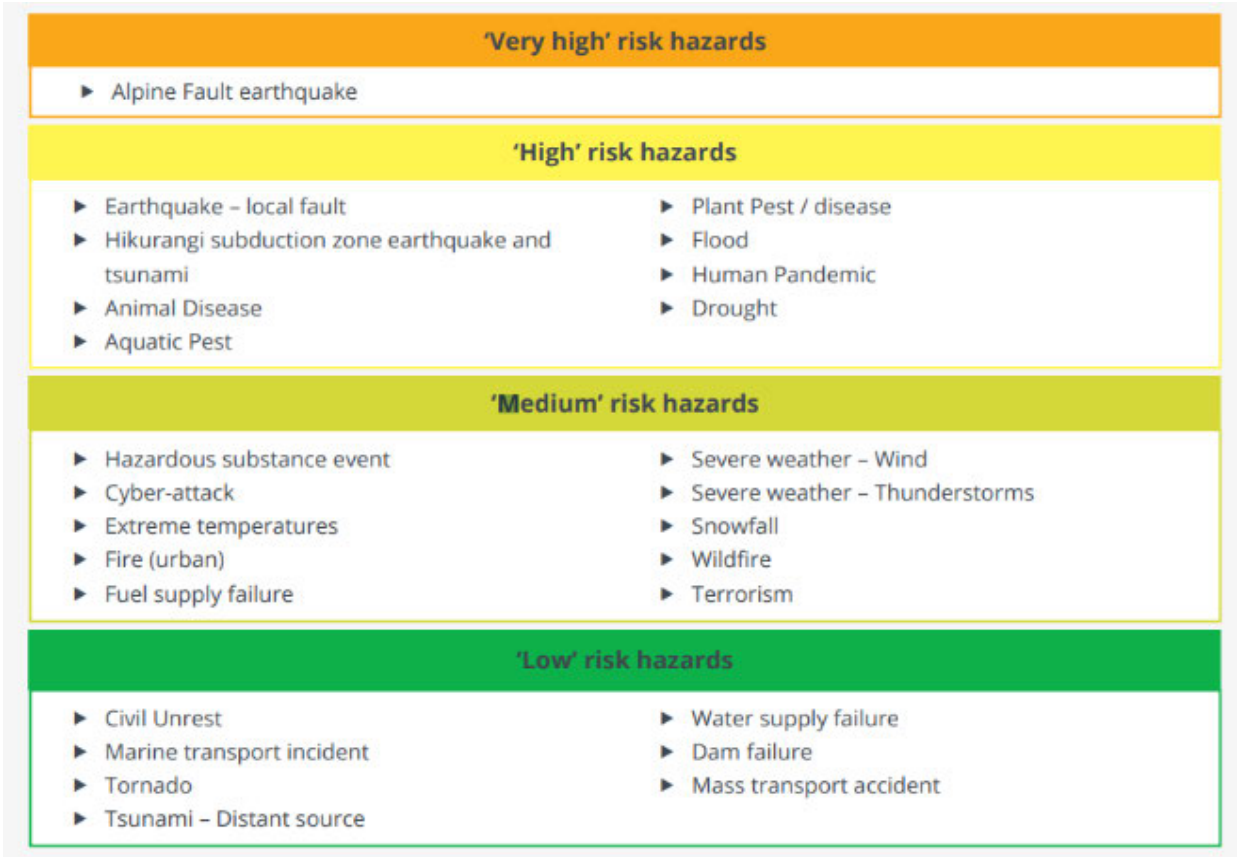
3.1 Resilience Challenges

NZTA's National Resilience PBC identifies flooding as the most frequent risk to the region's state highway network, identifying 23 major and extreme risks to the state highway network, many related to the potential landslips on SH6 and 65.[30] These risks are expected to worsen with climate change.

Figure 7, developed as part of the Marlborough Regional Resilience Analysis, outlines Marlborough's risk hazards in further detail.

An Alpine Fault earthquake is assessed as a very high-risk hazard, with local faults like White Creek and Waimea/Flaxmore classified as high risk hazards.[31] Earthquakes may trigger tsunamis, with warning times varying based on the source. Distant sources offer more time to prepare, while closer ones, like the Hikurangi Trough or Kermadec Trench, provide less.

Figure 7: Marlborough Regional Resilience Analysis



Slope instability resulting from flooding and seismic hazards (high risk hazards) is a significant challenge for the road network, which traverses mountainous terrain historically affected by earthquake-induced slips.[32] The region's geology, soils, topography and climate exacerbate vulnerability to landslips. Narrow and rural roading networks throughout the Marlborough Sounds are critical, but difficult to maintain and reach on an ongoing basis. The 2021 Marlborough Roading Asset Management Plan (pages 29-32) includes maps that illustrate the challenges posed by landslips and flooding.[33]

Te Tau Ihu has a significant proportion of urban infrastructure which is coastal or low lying.[34] Research from NIWA for The Deep South Challenge shows that the region has one of the highest estimated values of roading infrastructure at risk from sea level rise, including 84 km of road and 9 km of railway currently exposed.[35]

In addition to natural hazard risks, the Marlborough Regional Resilience Analysis highlights several vulnerabilities that could exacerbate challenges during such events. These include the concentration of medical facilities primarily in Blenheim, a dispersed population, a high proportion of elderly residents, and significant numbers of tourists and migrant workers. Further, multiple emergency service facilities are situated within flood and tsunami hazard zones. These factors are likely to augment challenges arising from natural hazard events and the required recovery effort.

3.2 Critical Infrastructure

3.2.1 Roads

The Marlborough Regional Resilience Analysis identified SH1 and SH6 as being the most critical transport links within the Marlborough region. SH1 is a lifeline route considering its use for fuel supply and fast-moving consumer goods, among other freight. All large heavy vehicle freight movements must use SH1 between Picton and Blenheim due to permanent length restrictions on the alternative Queen Charlotte Drive route.[36] This reliance underscores the route's significance in maintaining regional supply chains and supporting economic activity.

SH6 is crucial for aquaculture, viticulture exports, and fuel transport to the port. The Nelson-Tasman Joint CDEM Group report highlights a section of SH6 along Atawhai Drive as a critical hotspot for the region's lifelines, as it accommodates a major telecommunications fibre cable and the rising main for Nelson’s wastewater treatment plant.[37] Additionally, SH60, which traverses Takaka Hill, is essential for maintaining telecommunications and electricity services to Golden Bay, the population of which tends to increase drastically over summer from a baseline of approximately 2,500.[38] The intersection of transport routes with lifelines infrastructure is likely to further delay any repairs following a hazardous event.

SH1 is particularly vulnerable to landslides and rockfall, with extreme impacts to the roading network expected following an AF8 scenario. Additionally, residents have raised concerns regarding the frequent threat of floods to this route, threatening to disrupt connections between smaller towns.[39]

Similarly, SH6 faces challenges from frequent rockfalls between SH65 and SH63 (Murchison to St Arnaud), making this a top priority for the region.[40] Additionally, sections of SH6 are under significant threat from rising sea levels, with only a 0.5 m sea level rise required to impact access to Nelson Port via SH6.[41]

The only alternative is a long detour (approximately 1.5 hours in additional travel time) via SH63.

The 2015 NZTA State Highway Resilience Assessment also identified SH6 as vulnerable to flooding and slips, while SH65 (Murchison to Lewis Pass) is vulnerable to snow, ice and slips. Both SH1 and SH60 (Riwaka to Takaka) were noted as constrained routes with limited detour options, with a medium likelihood of facing road closures of up to three months.

SH1, 6, 60, 63 and 65 have all been classified as Priority 1 (P1) or Priority 2 (P2) in the AF8 Priority Routes Project along with several local roads that connect these critical routes. Abel Tasman Drive is identified as a key local road, designated P1. A further range of local roads are identified as P2 including the Korere-Tophouse Road – Stock Road corridor, Queen Charlotte Drive, Waimea West Road, Alabama Road and Murphys Road. These routes all act as alternative spines to the network or provide access to priority sites.

A close-up view of the region's main urban hubs is provided as Figure 8 and Figure 9.

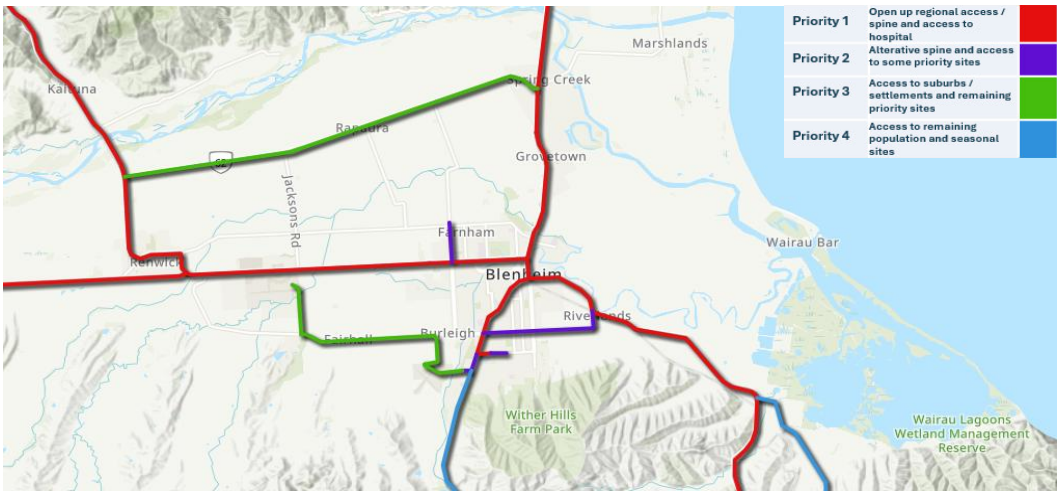


Figure 8: AF8 Priority Routes, Blenheim Snapshot

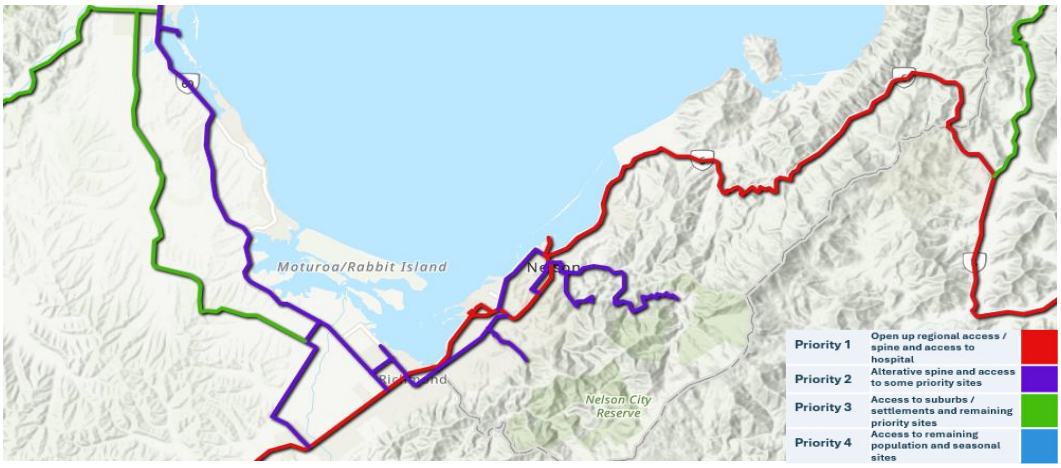


Figure 9: AF8 Priority Routes, Nelson Snapshot

Local road networks tend to feature several alternate routes due to typical grid-like systems which connect households and businesses. While this might increase network resilience, many of these roads remain vulnerable to a range of hazards. For instance, much of Nelson City's urban network is exposed to flooding, tsunamis and coastal erosion; this is able to be considered using tools from Nelson City Council which detail a range of natural hazards, including future flood scenarios.[42] Similarly, much of Blenheim's land transport network is vulnerable to liquefaction and some to flooding. Coastal areas are exposed to tsunami risk, including minor sections of SH1 which sit within the "yellow zone" indicating a greater than 5 metre threat level warning in a 2,500-year return period.[43]

Outside of the region's urban hubs, the Marlborough Future Access PBC highlights numerous further challenges in Marlborough, including:[44]

- 83% of roads in the Marlborough Sounds area have no alternative route, meaning any road closure can significantly impact access across the entire network. Some small communities in the outer Sounds rely on water transport as well as roading networks.
- 73% of roads are highly susceptible to slope instability following man-made adaptations, such as building roads, and 13% are highly susceptible to natural slope instability.
- Port Underwood Road and Tumbledown Bay Road are strategically important, providing access to lifeline infrastructure – the Cook Strait electricity cable, which supplies electricity to the North Island.

3.2.2 Rail

The MNL, part of the Main Trunk Railway, runs along the east coast from Christchurch to Picton, passing through Blenheim. Classified as "very high" criticality in KiwiRail's Asset Management Plan, the line often parallels SH1, making it vulnerable to similar hazards. This vulnerability was highlighted by the 2016 Kaikōura earthquake, which caused significant damage to both the road and rail networks along the eastern corridor of Canterbury leading to Blenheim. While the road network recovered quickly due to available alternate routes, the rail line remained inoperable for an extended duration.

This interconnectedness is crucial, as rail freight along the MNL is transferred to trucks at KiwiRail's Spring Creek freight hub for distribution across the top of the South Island. As a result, freight typically reaches Port Nelson via road transport, meaning any disruption to road transport can have significant repercussions for the supply chain.

An analysis of data from the Civil Engineering Risk Registers assessed the risk profile of various rail network sections. The study, aligned with KiwiRail's Safety, Health and Environment (SHE) Risk Management Standard, evaluated the impact of severe weather events on network disruptions. The findings indicate two sections of the MNL, located south of Blenheim, are at medium risk of slope failure, while two additional sections are susceptible to flooding. However, the line is well protected from coastal erosion due to its inland location, resulting in minimal risk of scour to built structures and rail lines. Risks along the section operating from Blenheim to Picton are assessed as low.[45]

3.2.3 Bridges

Unlike the majority of the South Island, most bridges within Te Tau Ihu are not due for renewal within the next 30 years. The slow deterioration of these assets in combination with little growth means general bridge condition is good for the ageing asset base.[46,47] Only three state highway bridges are identified within the National Resilience PBC; Brightwater (SH6), QEII (SH6) and Shenandoah (SH65), which are at risk of flooding, coastal inundation and erosion (respectively).[48] There are a variety of smaller wooden structures across Te Tau Ihu, such as bridges and retaining walls, built after the Second World War, which are exposed to wildfire hazards. While speed and weight restrictions have extended their useful lives, the Nelson-Tasman RLTP notes that a planned renewal programme is required.[49,50]

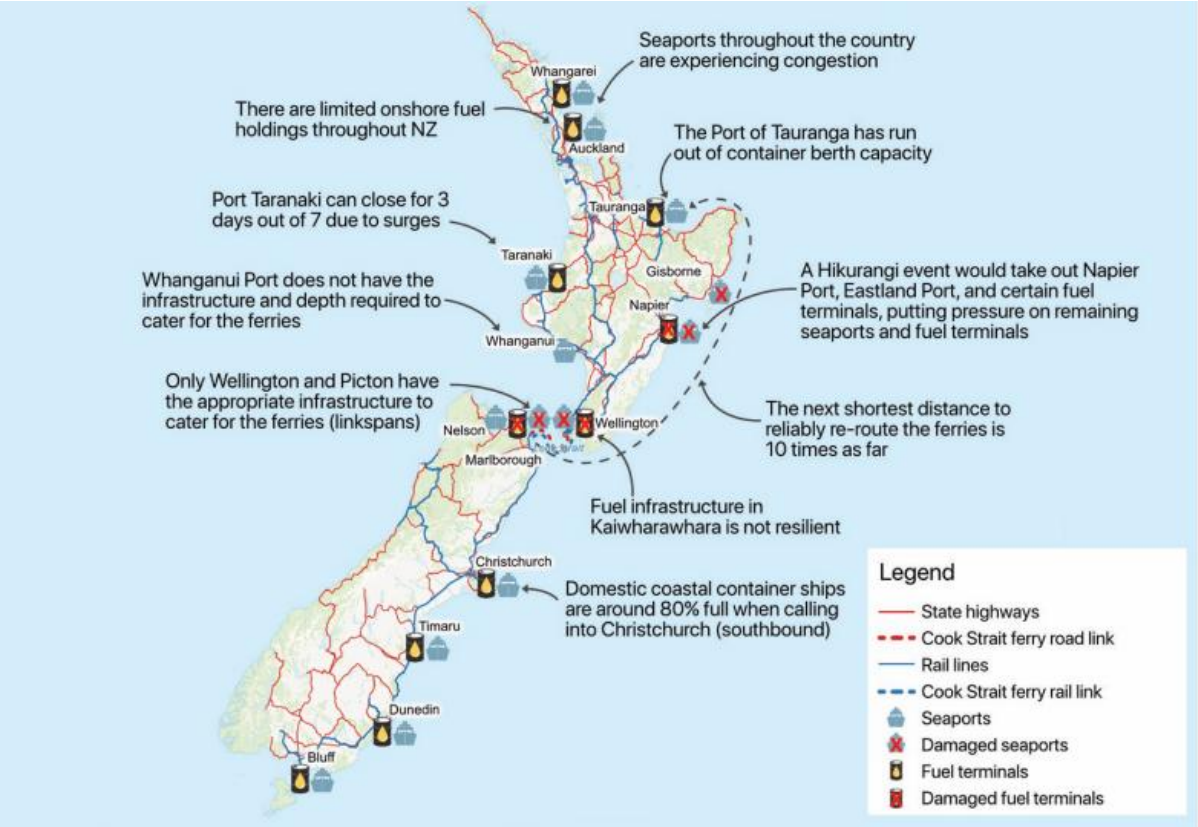
3.2.4 Other Infrastructure

New Zealand's domestic freight system is reliant on the continued operation of the ferry terminals at CentrePort Wellington and Port Marlborough. If Port Marlborough was to suffer from an extended terminal outage, the options to keep goods moving between the South and North Islands are severely limited. This is primarily due to other ports having insufficient infrastructure to support the ferries and the limited capacity of coastal shipping in New Zealand (based on number of containers, number of vessels, qualified workers, fuel constraints).[51] Port Marlborough has been identified as being subject to medium seismic risk and is likely to suffer significant damage following an earthquake from the Hikurangi subduction zone, further exacerbating the already limited alternatives for maintaining inter-island transport.[52]

While Port Marlborough remains vulnerable to seismic risks, the likelihood of disruption from other hazards is reduced for the main route to Marlborough, as it is elevated above the coastline and free from sections vulnerable to sea level rise (SLR).[53] Additionally, Port Nelson has recently invested in resilience measures to futureproof its operations against the ongoing threat of SLR, with a SLR of 0.5 m predicted to exceed Rocks Road 11 days per year.[54]

Constraints to the freight network are visualised in Figure 10, highlighting the key role of Picton in the national supply chain.

Figure 10: Key Shipping Constraints



Nelson Airport faces significant risk from even minor sea level rise, with access becoming restricted under a 0.3 m rise and conditions worsening with larger sea-level increases.[55] For instance in 2018, stormy weather and a king tide meant Jenkin's Creek flooded the airport's car park, prompting decision-makers to reassess resilience plans.[56] This has been accelerated due to new data revealing sea level rise is occurring at approximately 5 mm per year.[57]

Lifeline utilities in the region also contend with challenges from the demanding natural environment. The electricity network has low resilience between Havelock and Rai Valley, while local sewage systems are particularly vulnerable to land movement, and critical water infrastructure faces heightened risk due to limited alternative access routes in emergencies.

4. Te Tai o Poutini, West Coast

The West Coast faces heightened vulnerability to natural disasters, attributed to both its geology and location. Earthquakes, storm events and the widely dispersed nature of its sparsely populated communities present significant risks to the transport network. Significant work has been undertaken to better understand the West Coast's infrastructure, lifelines and transport flows given the region's heightened exposure to natural hazards.

Spanning the greatest length of any region in New Zealand, the West Coast has a population of approximately 33,000, though this can fluctuate significantly with tourist numbers rising markedly over summer periods.[58] The location of primary sector industry (mining, agriculture and forestry) requires heavy vehicles to drive on low volume roads that are narrow, winding and often not designed with these vehicles in mind, with narrow lanes and few shoulders.

The Alpine Fault, which traverses directly through the West Coast, is likely to be the most damaging hazard for the region. In the event of a rupture, several transport pinch points are expected to be severed, isolating parts of the region. For example, based on the expected extent of landsliding, Arthur's and Haast Passes and the rail line could take more than six months to restore.[59] The region also frequently faces a host of minor events, such as small slips, snowfall and icy conditions, which can cause road closures, though the transport network tends to return to normal service within a short timeframe.[60]

The road network is heavily reliant on a core spine of state highway connections, stretching through mountainous and often treacherous terrain. SH6 serves as the region's primary arterial route, connecting the West Coast to neighbouring regions Tasman and Otago.[61] Other branches of the state highway network, particularly SH7 and 73, are critical in supporting the West Coast's primary economic drivers and connecting to Canterbury.[62] The state highway network is connected to a variety of smaller local roads which serve widely spread households and farms.

KiwiRail operates two railway lines in the West Coast which are of national and regional importance. These typically transport export goods from the mining and dairy industries north to Hokitika or east to Port Lyttleton. The region is home to four ports. The Port of Greymouth and WestPort are recognised as lifeline assets, and there is a port in Jackson Bay. All are exhibiting declining shares of export cargoes.[63] There is an additional inland port in Stillwater.

A passenger rail service connects Christchurch to Greymouth. This service is primarily considered a tourist attraction and is not used for everyday transport. Travel in and out of the West Coast tends to be road based given pricing constraints of rail and low flight demand leading to cancelled flights.

There are seven public airfields in the West Coast, which may also be considered critical assets following any natural disaster as they are better able to assist while some roads will remain shut for extended periods.[64] Hokitika and Greymouth Airports may be compromised in a seismic event, particularly an AF8 scenario, while smaller airfields will require inspection before they return to (likely) limited operations. The Westport and Greymouth Airports are additionally exposed to tsunami risk.[65]

4.1 Resilience Challenges

NZTA's National Resilience PBC identified a total of 21 major and extreme risks to SH6, 7 and 73 within the West Coast area relating to extreme weather, ice/snow, erosion, rockfall, landslip and flooding.[66] Climate change is expected to exacerbate these risks, with marked increases anticipated in average temperatures, rainfall frequency, and the occurrence of extremely windy days.[67]Hokitika and Reefton have experienced some of the largest increases in average rainfall already over the last thirty years.[68] Longer term impacts of climate change, such as coastal erosion, are already being felt in the region, particularly along SH6 and 67.[69]

The mountainous nature of the West Coast means there tends to be a heightened risk of landslides. The probability of a major earthquake on the West Coast due to slippage on the Alpine Fault within the next 50 years is 75%.[70]

The interaction of predominantly westerly winds with the high Southern Alps creates conditions conducive to major storm events. Further, the region's proximity to a coastal environment makes it highly susceptible to liquefaction due to typically higher ground saturation,[71] while also increasing the threat of sea level rise and tsunamis. These risks must be considered in light of the fact that most of the region's population and assets are situated on low-lying river delta mouths, heightening the potential consequences of any event.[72]

Analysis of the West Coast's coastal hazard areas has recently been refreshed and provides useful evidence broken down by risk area, assets at risk, hazard processes, priority assessment and hazard management. Finally, the region's alpine terrain increases the chance of snow, which can delay operations for short periods of time – particularly impactful due to the low number of alternate routes on critical corridors.

Resilience challenges in the West Coast extend beyond natural disasters and the region's unique geography. The transport system has little redundancy, particularly south of Hokitika and north of Westport, and the region's small base of ratepayers means it is a challenge to fund investments to improve resilience. Similarly, a lot of the downstream revenue from mining and tourism is captured by central government through levies and GST, while negative externalities, such as additional road wear, are borne by local government.

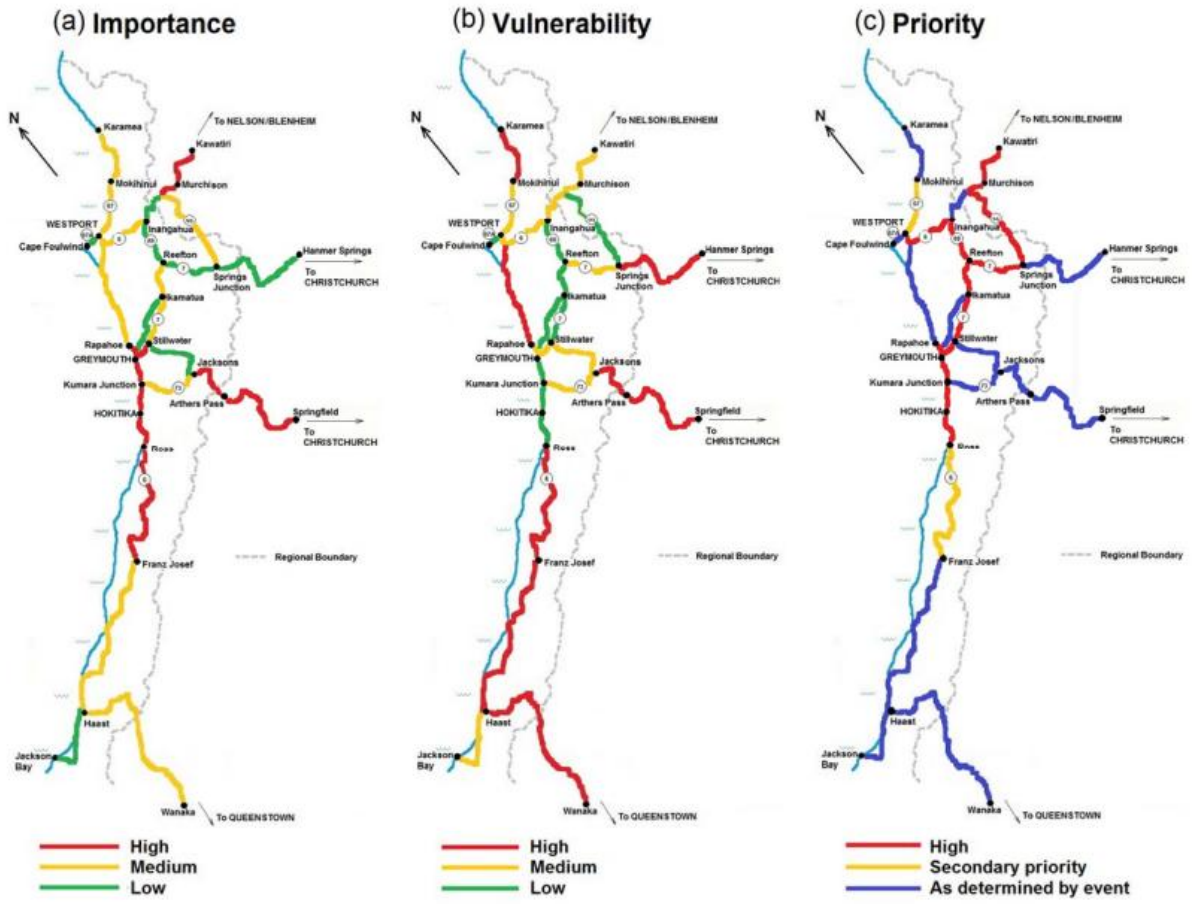
The lack of redundancy, combined with the widespread distribution of households, increases the region's vulnerability to hazards, limiting its capacity to absorb such shocks. The region is entirely dependent on trucked fuel, meaning any hazard which shuts a main road will have a significantly larger impact.[73]

4.2 Critical Infrastructure

4.2.1 Roads

The West Coast CDEM Group has undertaken extensive work to understand the importance, vulnerability and prioritisation of transport corridors following an earthquake, tsunami, or storm event. The intent of the work carried out by this group was to identify a spine of roads which were both less likely to be damaged in a major disaster and likely to be more easily repaired if they were damaged. The report produced by the West Coast CDEM Group highlights the importance of the state highway network following any emergency scenario, namely SH6, 7 and 73, which can be observed in the map provided below as Figure 11, or in tabular form as Appendix 1.

Figure 11: CDEM Analysis of West Coast Roading Network



This analysis also resulted in a breakdown of the region into 29 elements—areas, corridors, specific points, and facilities—assessed for their vulnerability and importance to various hazards. This table is included in the detailed report (referenced) and should be viewed alongside Figure 11 for additional context.

Work undertaken by the University of Auckland to understand post-disaster trip resilience highlights that, relative to the rest of the South Island, the majority of the West Coast network is expected to perform the worst in an AF8 scenario.[74] Appendix 2 offers a valuable visualisation of the expected state highway level of service across the South Island over various timeframes, illustrating that the West Coast is likely to experience the most downtime of any region.

The focus on the state highway network should not discount the value of the local roads network, of which important routes include Stillwater to Jacksons Road, the road on the west bank of the Grey River, and Special Purpose Roads such as the Karamea Highway, and the Haast–Jackson Bay Road at the south end of the region. These routes serve as critical alternatives to major state highways, are vital for connecting communities, and may be preferred as primary freight routes. For instance, the Stillwater to Ikamatua route and Stillwater to Jacksons route via Lake Brunner are both preferred to the state highway network due to directness and travel time saving.[75,76] Nearly all state highways in the region are constrained in some areas, meaning any alternate routes are critical to the network.

It is important to note that in the face of an AF8 or similarly devastating scenario which has rendered the (likely) more resilient state highway network inoperable, local roads are also likely to remain out of service for significant periods. Power and data cables tend to follow much of the state highway network, particularly SH6, making them equally vulnerable.[77]

4.2.2 Rail

KiwiRail services are critical to the West Coast mining industry, which relies on rail transport to Lyttleton. In an AF8 scenario[i], the Midland Line, which runs through Arthur's Pass, is expected to become inoperable for an extended period—at least six months. Other research expects that there would be no rail service on the East-West line for several years.

The Midland Line is highly susceptible to slope failure, with the entire line assessed at medium or higher risk for this vulnerability. Landslides are likely to affect the line as it runs through the Southern Alps, particularly through Cass, Waimakariri River to Otira Tunnel, Otira Tunnel to Otira Township, Otira Township to Taramakau River, Taramakau River, Lake Poerua and Lake Brunner.[78]

The Hokitika Line shares similar vulnerabilities to slope failure as the Midland Line, with considerable investment needed to bolster the life of its assets. In contrast, the Stillwater-Ngākawau Line is generally more resilient, with the exception of the section running through the Buller Gorge, which is at high risk to slope failure. Notably, the Tawhai Tunnel, south of Reefton, has been closed since June 2024 due to a partial collapse. This has caused significant disruption to local business, with reduced capacity to move goods (typically coal) out of the region.[79]

Several sections of the Midland Line along the Grey River are vulnerable to flooding, with significant risks in Canterbury along the Waimakariri posing a threat to the line's operability. Erosion of the Otira River continues to present ongoing risks to the Midland Line, while the Hokitika Line faces similar erosion threats in multiple sections before reaching Reefton.[80]

The rail network is likely to sustain similar damage as the road network following any significant hazard, particularly in areas where both share the same corridor. This may improve reinstatement timelines as reinstatement of road/rail services is likely to be a joint exercise.

4.2.3 Bridges

The resilience of bridges along the state highway spine is critical to the ongoing operability of the network, given their importance in supporting the West Coast economy and the absence of viable alternative routes. The deferred maintenance of bridges was identified in 2020 as a serious concern within the West Coast region, resulting in a worsening condition of bridges and posing a serious concern of asset failure risk. Ageing bridgesthroughout the region will require focussed investment over the next decade, with a total of 30 bridges identified as needing improvement or replacement over this period (11 in Buller, 14 in Grey and 5 in Westland).[81]

There are a considerable number of 50MAX restricted bridges in the region which creates further pressure on the continued function of

[i] Research related to this specific finding is based on a Mw8.0 Alpine Fault rupture with a central hypocentre and four aftershocks.

bridges in supporting the movement of the HPMV sub-section of the truck fleet.[82] Bridge restrictions may lead to unintended consequences. For example, while SH7 is the dedicated HPMV route between the West Coast and Canterbury, HPMV vehicles are sometimes travelling with reduced capacity via SH73 to reduce travel distance and time, particularly from the Grey and Westland Districts.

Bridges noted to be of particular importance in the report produced by the West Coast CDEM Group include the Inangahua River Bridge at Reefton, the Cobden Bridge, the SH6 Taramakau Bridge, and the Arahura Bridge. These act as key transport links, with few or no alternatives. For example, failure of the Arahura would cut off the whole of South Westland from the north. The SH6 Hokitika Bridge has also been previously identified as a key structure, noting however that there is an alternative river crossing at Kaniere which provides redundancy.[83] NZTA has approved investment to replace the SH6 Coal Creek Overbridge as it is at the end of its economic life.[84]

Besides supporting transport outcomes, many bridges also play a critical role in supporting lifeline utilities. For example, Cobden Bridge carries both a major road and a communication link, sewerage and water supply, and the power poles between the Mikonui River and Bold Head, which carry both 11 kV power and a fibre optic cable.

Buller Bridge is a similar hotspot, providing the only road access to Westport and the North Buller communities, while also supporting the supply of water to Carters Beach, power from the Westport substation to the BEL southern distribution, and provision of sewage services and fibre optic – which connects the Buller District to the rest of New Zealand.[85]

4.2.4 Other Infrastructure

While there are a limited number of airports and ports within the West Coast, these assets provide critical network redundancy given the vulnerability of the land-based means of transport to natural hazards. Coastal shipping and air transport will play key roles in recovery by allowing for the movement of emergency supplies into the region, which would otherwise be severed.

All of the region's traditional ports have been identified as likely to be flooded, and partially or totally destroyed following a tsunami, and become unsafe for use following an Alpine Fault earthquake. A storm is likely to have little impact on port structures.[86]

The supplementary papers to the West Coast Lifelines Vulnerability and Interdependency Assessment present a detailed analysis of each of the three district council's lifeline assets.

5. Waitaha/Canterbury

Waitaha/Canterbury is New Zealand's largest region and home to its second largest city. It is a key economic hub of the South Island that drives much of the South Island's economic and social activity. As of the year ended March 2023, Canterbury generated 12.3% of the national GDP and 56% of the South Island's GDP.[87] By comparison, Canterbury's estimated population of 653,000, as of June 2023, was around 12.8% of the national population and 54.5% of the South Island population.[88]

Canterbury's unique and active landscape creates resilience issues for its transport network. It has exposure to several risks, including flooding, earthquakes and coastal erosion. These events can all be particularly problematic in Canterbury given the regions heavy reliance on bridges, mostly on the state highway network, to cross the region's major braided rivers.

The transport network plays an important role in connecting the region's widespread communities whilst supporting the local economy, with primary production deriving heavily from dairy, sheep and beef farms, and manufacturing. SH1 serves as the backbone of the transport network in Canterbury, with the main interregional routes for Canterbury being SH1, 7, 8, 73 and 82.

In terms of local roads, Routes 70 and 72 are important inland alternatives to the state highway network. There are a number of other local roads (particularly within Christchurch as the main urban hub) which play an important role in feeding users on and off the state highway network. The dense, grid-like network of Christchurch city's local roads mean they are inherently more resilient than much of the South Island's local road networks, which tend to be more linear and with fewer alternate routes at any given point.

The main freight facilities include PrimePort in Timaru, Lyttleton Port in Christchurch and the MidlandPort freight hub in Rolleston. The international airport in Christchurch is a frequent destination for travellers across the entire South Island. Routes into these lifelines are fundamental to the ongoing function of the region's transport network. There are also a range of smaller airfields throughout the region which can play a significant role in responding to emergencies. For example, Kaikōura Aerodrome became an important asset following the 2016 Kaikōura earthquake for moving supplies and evacuating people.

5.1 Resilience Challenges

The flat plains of Canterbury, framed by alpine mountains, create an environment conducive to natural hazards. A winding network of braided rivers, which accounts for 60% of New Zealand's braided river systems, increases the potential isolation of significant sections of Canterbury following various disasters.[89] This is particularly noteworthy given there are only two road crossings over each of the region's three largest rivers.

This makes the region deeply reliant on bridges, the fragility of which has been highlighted through recent events. Examples include the Mid-Canterbury flood of 2021, which resulted in numerous disruptions to SH1 including alternate routes, and the Ashburton bridge; and the December 2019 Rangitata flood, which saw sections of SH1, the rail network, and Arundel bridge fail simultaneously. These events had significant impacts on freight moving through satellite

towns along the state highway network, and disrupted provision of lifeline utilities.

NZTA's National Resilience PBC identified 27 major and extreme risks related to state highways in the region. These relate to rockfall, landslip, ice and snow, flooding, coastal inundation/erosion, and earthquakes and liquefaction.

The most significant risks are associated with rockfalls and landslides, particularly along SH1 north of Kaikōura. This section of SH1 is deemed more critical than the southern portion due to its essential role in connecting to the north, is a vital freight route, and considering detour options involve a substantial deviation via SH63 and the Lewis Pass.[90] Other local roads in the Kaikōura district, such as Puhi Puhi, Blue Duck and the Waiau Toa/Clarence Southern Access Route, have precipitous sections where slips or dropouts could be extremely difficult and expensive to remedy, whilst roads such as Clarence Valley may be subject to severe erosion by very dynamic rivers.[91]

The region is relatively low-lying with an extended coastline traversed by SH1. Tonkin & Taylor's Interim Risk Screening Report on Canterbury Climate Change identified impacts from fluvial and pluvial flooding, sea level rise, and coastal erosion as being extreme to roads and bridges. Research has found that the region has the highest exposure of infrastructure assets to SLR in New Zealand, with 646 km of the road network exposed to a 3.0 m SLR,[92] and the most extensive built land area exposed to coastal flooding.[93] Christchurch city on its own faces a risk to 110 km of its road network, valued at $65.6M (2024), being inundated following a 1.0 m SLR. Inland sections of the transport network, such as near the Avon and Heathcote rivers, are also susceptible to flooding.[94]

As such, it is expected that climate change will have a significant impact on Canterbury. Rising sea levels will increase the level of risk for tsunami and coastal hazards such as storm surge and extreme waves, affecting coastal settlements and the wider road network. Inland, braided rivers are becoming increasingly active. There is also the potential for more cyclone events driving weather from the east, for example high intensity rainfall that could exacerbate flooding risk from low-land catchments.[95]

This is equally impactful for the long stretches of the rail network which lie on the coastline, often parallel to the state highway network. Increasing air temperatures may also place rail infrastructure at risk of buckling and heat stress, as already observed in Kaikōura.[96] For further information on the expected impacts of climate change, the Canterbury Regional Climate Change Risk Assessment provides an in-depth analysis of climate risks under various future scenarios.[97]

5.2 Critical Infrastructure

5.2.1 Roads

Roads within and adjoining Canterbury that have been identified as nationally significant and vulnerable include:[98]

- SH1 Kaikōura Corridor, where road and rail networks are laid in a narrow corridor vulnerable to both rain and earthquake induced slips.
- SH1, 6 and 8 in Otago, critical routes with a high risk of seismic/alluvial activity and severe weather events. These are key connecting routes into Canterbury.
- SH1, which is vulnerable to tsunami along several stretches.
- SH6, 7 and 73, which provide the only links to the West Coast. Damage to

one, or all of these, is highly likely in a major earthquake event – potentially isolating the West Coast completely.

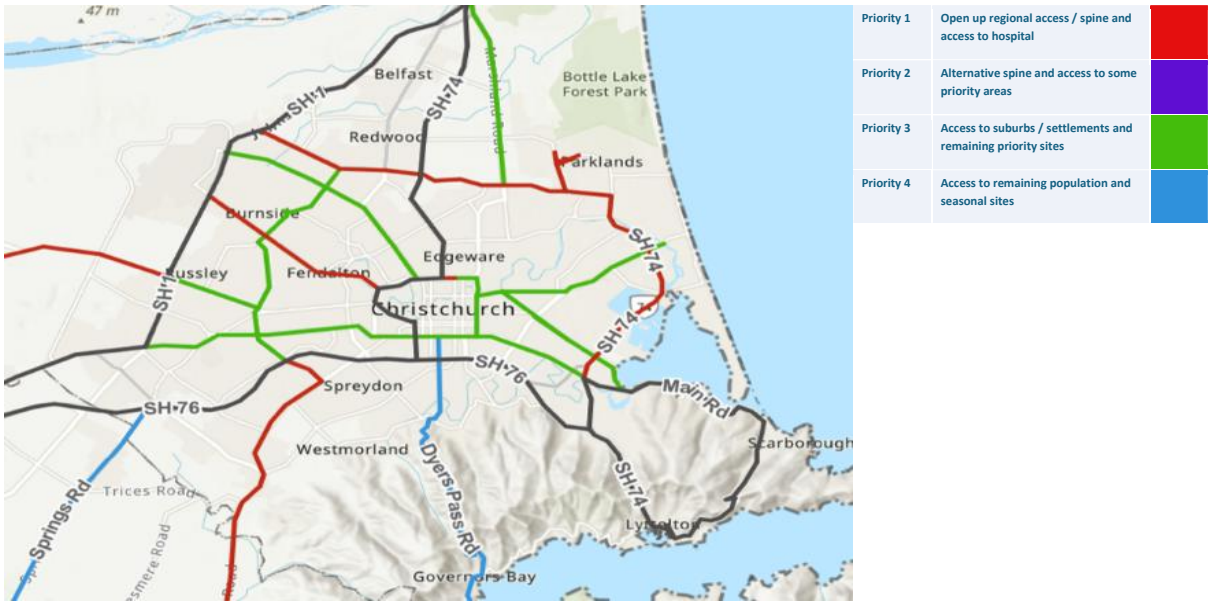
- Lyttelton Tunnel and associated access highways are critical in maintaining access to the South Island's international freight gateway, Lyttelton Port, handling the largest volume of TEU (Twenty-foot Equivalent Units) in the South Island. These routes are vulnerable to seismic hazards, with detours being relatively unsuitable for freight. It is important to note the Lyttelton Tunnel performed well in previous earthquakes.

For many of these roads, the alternate routes are also prone to the same hazards, or there are significant consequences for lifeline utilities if they are damaged. This is most easily observed along SH1, with KiwiRail and electricity lines also following parallel to the state highway, and no efficient alternate route for many stretches of the journey.

In fact, SH1 is the sole viable non-alpine route north of Kaikōura, and between Canterbury and the inter-island ferry port at Picton. It includes the main crossings of all the major braided rivers in Canterbury. Apart from the Waitaki River, which has three crossings, each of these rivers has only one other crossing point in its plain's section. If both routes are closed, road transport in the South Island is severed (with the exception of the West Coast roads, if they are open). For further information, the Canterbury CDEM Group Risk and Resilience Report contains a detailed assessment of the Canterbury state highway network and relevant vulnerabilities.

The AF8 Priority Routes Project emphasises the importance of the state highway network and access to Lyttelton Port. This is observed through the prioritisation of SH1, SH74 and SH76 as critical routes for restoration (Priority 1). The importance of local roads, which act as spokes connecting suburbs with Christchurch's CBD, is also highlighted in Figure 12.[99]

Figure 12: AF8 Priority Routes, Christchurch Snapshot



The preparation of asset and activity management plans, or district-commissioned reports, has led to a better understanding of resilience at the district-level. Through these reports we can see that there are numerous shared challenges across the region. Themes shared across the majority of asset management plans include the projected increased frequency of adverse weather events, discussion of natural hazards as a priority, lack of alternate routes, and restricted access to some areas of council networks – particularly in rural areas.[100]

Some districts have commissioned their own reports to further explore resilience, many of which echo the challenges noted at a regional level. For example, the Selwyn District Council commissioned a desktop study of critical roading infrastructure in 2015 with key findings as follows:[101]

- The network is generally redundant enough to provide alternative routes when a given route is affected by a specific issue.
- Alternate routes become less convenient where widespread events, such as floods, occur and the state highway network becomes the spine of the network when other limbs are impassable.
    - Fords are typically used as shortcuts – there are alternative routes using bridges available when rivers are high.
- Snow affects SH73 as well as local roads off the state highway. Appropriate arrangements to undertake combined snow clearing are in place; this may look like working in combination with the state highway managers. The key local roads requiring attention due to risks from snowfall are Coleridge Road and part of Homestead Road (to avoid risk to isolated residences at Lake Coleridge and the hydro station).
- The district's bridge programme has been refined to ensure there is adequate property access for heavy traffic (50MAX/HPMV).

5.2.2 Rail

KiwiRail has four lines in the Canterbury region, three of these providing services to neighbouring regions. As these lines are essentially single track, and therefore have a low capacity to absorb shocks, they are particularly vulnerable to operational and external disruption. The network is exposed to a range of hazards, including ground movement, liquefaction, landslides, extreme weather, coastal erosion and flooding.

The MNL faces significant exposure to slope failure along the Kaikōura coast and coastal erosion north of Oaro. Similarly, sections of the Midland Line are highly vulnerable to slope failure, as demonstrated by past events such as the July 2021 storm, which disrupted both rail and nearby state highways. The Midland Line is also vulnerable to flooding and erosion from the Waimakariri River, increasing the risk of scour to infrastructure.

Failure of any of the major bridges and tunnels which support the rail network would significantly impact movements of both people and freight via rail. Vulnerabilities of each of KiwiRail's four lines are being worked through by the Canterbury CDEM Group. Key findings are outlined in Table 3 below. Note that this table is not exhaustive, and work is ongoing to better understand the vulnerability of assets (e.g. other bridges), which may not be included below.[102]

Table 3: Rail Lines, Bridges and Tunnels, Major Vulnerabilities

Line / Bridge / Tunnel	Vulnerability
Christchurch to Picton, Main North Line	
Ashley River Rail Bridge	Earthquake and liquefaction – AF8 shaking expected to be MM8, old river sediments, isolated liquefaction possible, resulting in damage to bridge.
Track and corridor assets – Christchurch	Low level of vulnerability of structures to earthquake, having survived the 2010-11 earthquakes without significant damage. Potential liquefaction vulnerability but occurrence was minor in the 2010-11 earthquake on the railway route except for some settlement and track distortion on the embankment approach to the Waimakariri River bridge.
Track and corridor assets – North Canterbury	Much of the route has been rebuilt following 2016. A potential focal point for damage may be north of Rangiora where MM8 is possible. Localised potential for liquefaction. Extreme rainfall has the potential to cause washouts of tracks and/or minor culverts. There is potential for erosion affecting the line, due to large storms and wave action where the line is adjacent to gravel beaches found along the coast.
Christchurch to Lyttelton, Lyttelton Line	
Heathcote River Rail Bridge	Not expected to face significant issues to any hazard.
Martindales Road Rail Overpass	Not expected to face significant issues to any hazard.
Lyttelton Rail Tunnel and portals	Survived previous earthquakes and is expected to be resilient.
Track and corridor assets	While unlikely to be affected by flooding, given the elevation of track lines above the Heathcote, the track through Woolston and Heathcote is potentially vulnerable to large tsunami. The track's elevation is only 2m above mean sea level on either side of the SH74 overpass, rising to 4m to the west across the Heathcote River.
Christchurch to West Coast, Midland Line	
Otira Rail Tunnel	An AF8 scenario is expected to result in rockfall/landslides affecting tunnel portals, and potentially tunnel damage – closure expected for some time. Approaches to the tunnel could be damaged due to adjoining Bealey River flooding or landslides from above.
Track and corridor assets	Much of the route is through mountainous country where MM7 shaking is anticipated in an AF8 event. Low to very low likelihood potential, but with the possibility of isolated liquefaction. While the plains are not particularly susceptible to river breakout, the line could face flooding and associated damage once past Springfield.

Christchurch to Dunedin, Main South Line	
Track and corridor assets – Canterbury Plains to Waitaki River	MM6-7 shaking is expected for much of this route, with most powerful shaking predicted near Timaru – which also has the strongest suggestion of liquefaction due to the presence of major rivers and younger sediments. To the south of Timaru, much of the track through to Studholme is located in the orange or red evacuation zone and is potentially vulnerable to tsunami. The track is also potentially exposed to erosion and storm surge near Normanby due to being very close to gravel beaches where, despite being around 6m above MSL, it is within metres of the ocean. Flooding can be an issue where the line crosses the flood paths of the braided river network.
Track and corridor assets – Timaru	Assets are likely to face significant damage following an earthquake, particularly aged infrastructure. The line is located on low-lying land, prone to liquefaction, and is therefore relatively vulnerable to tsunami and coastal hazards (particularly between Saltwater Creek and the gravel beaches).

5.2.3 Bridges

The resilience of bridges, and the ramps leading up to them, is an ongoing risk for the Canterbury region given the braided river system which dominates its plains. The region's bridge stock is aged and represents a significant risk to the ongoing movement of people and goods throughout the region. Hidden defects risk (asset fatigue, wear and tear, etc) is one of NZTA's biggest risk to bridges.

The sometimes poor condition of bridges within Canterbury is particularly relevant given many of the region's bridges do not have nearby alternatives; their closure would result in significant detours. Of the routes with alternate structures nearby, many may not be suitable for the expected traffic flows or type, and alternate structures are likely to share similar vulnerabilities and so may also be inoperable following a natural hazard. One example is the network of four bridges in Oaro. While all four are located near one another, two are one-lane only and means that redirecting state highway traffic onto these structures is likely to cause significant delays – even if this represents a seemingly insignificant detour.

A national seismic screening programme of all state highway bridges was undertaken through the 1990s, and has been updated as recently as 2018 as detailed assessments and seismic retrofits have been completed. Of the then 416 state highway bridges in Canterbury, 49 were included in the list of "most earthquake vulnerable bridges" on a national basis. Some of these bridges require further detailed seismic assessment (e.g. Rakaia Gorge Bridge 2) or are on a scheduled replacement programme (e.g. Waimakariri River Bridge (SH1)). It is likely that the condition of some bridges not initially identified as at risk have worsened.

The Risk and Resilience Report produced by the Canterbury CDEM Group includes a detailed breakdown of bridges by district, along with associated risks and status.[103] Some of these are specifically called out in the Canterbury RLTP 2024-34, while others such as the Rangitata Bridge are acknowledged in the Risk and Resilience Report (where it is noted as being vulnerable to scour or washout of approaches due to high floodwater flow, and potential earthquake structural damage).

Bridges which are called out in the Canterbury RLTP, and their relevant details, include:

- Second Ashburton Urban Bridge: the current Ashburton Bridge is vulnerable to scour or washout of approaches due to high floodwater flow, and potential earthquake structural damage. When the bridge closes the detour can be up to 14 hours.
- Conway River Bridge: vulnerable to slips, landslides and overweight loading, with further seismic and scour assessments to be carried out. Not suitable for all HPMVs, resulting in freight moving inefficiently over alternative routes.
- Heaton Hayes Rail Crossing: strategically important crossing in the event of an alpine fault earthquake to ensure resilient port access.
- Pages Road Bridge: a critical lifeline route into and out of New Brighton, an urban environment lying on the east coast of Christchurch. This bridge will play a critical role in the recovery of the community following major hazard scenarios.

The physical condition of bridges themselves is not the only concern. It has been noted that at a regional level there are many rivers (and therefore crossings) that do not sit within a singular rating district for river management purposes. This has led to a lack of river maintenance and untrained river flows, meaning bridges only cross limited lengths of the waterway itself (e.g. a crossing point at School Road over Te Moana River, which lost an abutment due to lack of river works). A continued lack of investment is likely to exacerbate existing vulnerability challenges.[104]

5.2.4 Other Infrastructure

The Canterbury earthquakes have provided a valuable opportunity for the transport sector to improve the resilience of its assets, including airports and ports, as an important step in the recovery process. This extends to the wider lifelines sector, such as the rebuild of the water supply network, noting the grid-style network does not solely rely on one main trunk line and so is already relatively resilient.[105]

In Canterbury, the primary tunnel on SH74 linking Christchurch to Lyttelton plays a critical role in supporting the movement of freight from Lyttelton to inland freight facilities, or other parts of the network. There are also other minor tunnel structures on SH1 south of Kaikōura. These structures are considered robust to earthquakes, which was demonstrated during the Canterbury 2010-11 earthquake events where little damage occurred to the SH74 tunnel, and any damaged tunnels have since received seismic strengthening.

The region's port infrastructure has been substantially strengthened following the 2010-11 Canterbury earthquakes, which damaged 75% of Lyttleton Port's wharves – resulting in the opportunity for reconfiguration. An AF8 scenario is not expected to result in significant damage to the re-engineered port structures, nor induce liquefaction. There is an ongoing risk of slope failure, primarily impacting the roads leading to the port, though this was not noted as a major issue in the previous earthquakes. There are ongoing tsunami risks, which would be very damaging and disruptive to the port.

In Timaru, PrimePort Wharf 1 is exposed to potential seismic or tsunami risks, which may see the wharf "pull away" from the hardstand area. Wharf 2 is generally considered robust,

owing to sound seismic design and relatively new construction date of 2015.[106] Both PrimePort and Lyttleton Port are exposed to SLR and coastal hazards due to their locations.

Major airport expansions observed around New Zealand are being driven by growth in demand, rather than any specific resilience improvements, including plans for Christchurch's International Airport. There is low exposure of airports to coastal flooding and SLR; transport links in and out of airports are likely more vulnerable than airports themselves. Other climate change accelerated hazards, such as mean air temperature and extreme weather events, may require operational changes at these facilities, which are otherwise fairly constrained in their ability to adapt.

6. Ōtākou/Otago

Ōtākou/Otago covers approximately 31,185 km^2 and includes a vast natural environment of open coast, plains, rivers, valleys, basins, mountains and lakes. The region is predominantly rural, with key urban centres including Dunedin, the largest city, and Queenstown, a major tourist destination. Outside these centres, Otago consists of widely dispersed rural communities, reflected in strong agriculture, horticulture, forestry and meat-processing industries. These industries rely heavily on land transport infrastructure, particularly for connections from farm to export. Similarly, transport links in and out of Queenstown are important to maintaining tourism flows.

Much like the rest of the South Island, Otago is exposed to a wide range of natural hazards. Consequently, many of the routes in and out of the region are highly susceptible to periodic closure due to natural hazards.

SH1 plays a vital role in supporting the movement of both passengers and freight up and down the transport network, while SH6, 8 and 90 provide links between inland Otago, Southland, West Coast and Canterbury. SH6 and 8 over the Lindis Pass is particularly important as the only practical link in and out of Queenstown for both tourists and freight operators travelling to and from Canterbury and further north, with Cromwell serving as a freight hub.

Over 50% of the Otago region's roading network is unsealed.[107] This limits the availability of alternate routes in many areas, which can be indirect, resulting in excessively long diversions, or inappropriate for some vehicles, such as HPMVs. This is highlighted in NZTA's detour routes tool, with restrictions on many suggested detour routes in the region.[108]

The region is home to Port Chalmers, the second largest port operating in the South Island. Port Chalmers is connected to the transport network via SH88 and KiwiRail's MSL. Port facilities in Dunedin would be a critical supply point following an earthquake as road and rail links would likely be compromised. Additional key transport infrastructure includes two short haul international airports in Dunedin and Queenstown, and smaller regional airports.

6.1 Resilience Challenges

Significant efforts have been made to understand Otago's exposure and vulnerability to natural hazards. NZTA's National Resilience PBC identified 25 major and extreme risks to state highways within Otago, primarily related to rockfall, landslip, flooding and ice/snow along SH6, SH8 and SH88.

The region's geography makes certain hazards more common. Coastal Otago, with its subdued topography, variable geology and humid climate, has developed both floodwater-dominated and debris-style alluvial fans along hills and valleys.[109] Flooding and landslides may threaten to shift sediment held in these fans, threatening local infrastructure. Flooding along the Taieri River, one of the most recognised flood-prone areas, has been an ongoing issue for decades, significantly impacting transport and lifeline sectors.[110] There are approximately 160 km of local and state highway roads exposed to current day coastal flooding (1% Annual Exceedance Probability (AEP) event), of which greater than 60% are in Dunedin city and a

further 30% in the Clutha district. There is ongoing work to better understand these risks, particularly around larger bodies of water, such as the ongoing development of a flood hazard assessment for the Clutha Delta.[111]

Seaside routes, including stretches of SH1 near Evansdale and SH88 connecting to Port Chalmers, are also assessed as having moderate to extreme risk of tsunami.[112] A business case is being prepared to undertake level 3 tsunami zone mapping in coastal Otago, to better understand these risks.[113]

A Climate Change Risk Assessment was developed for the Otago Regional Council, outlined in Figure 13 and Figure 14 below.[114] These figures highlight the impact of climate change on present-day risks, with all risks worsening with time. A host of further research supports this trend, with specific analysis undertaken on the Otago transport network finding that *"Sensitivity of the road and rail network is projected to increase with increased temperatures and the frequency of drought events, with extreme heat causing rail lines to buckle and road asphalt to melt"*, among other impacts.[115]

Figure 13: Summary Risk Rating for Linear Transport Networks

Risk No.	Risk statement	Exposure			Vulnerability				Risk		
					Sensitivity			Adaptive Capacity			
		Present	2040	2090	Present	2040	2090	Constant	Present	2040	2090
B5.1	Risk to roads and bridges due to inland flooding.	M	H	E	M	H	H	L	M	E	E
B5.2	Risk to roads and bridges due to increasing landslides and soil erosion.	M	H	E	M	H	H	L	M	E	E
B5.3	Risk to rail due to coastal flooding.	L	M	H	M	H	H	L	L	H	E
B5.4	Risk to rail due to increasing coastal erosion.	L	M	H	M	M	H	L	L	M	E
B5.5	Risk to rail due to inland flooding.	L	M	H	M	M	H	L	L	M	E
B5.6	Risk to rail due to extreme weather events.	L	L	M	L	L	H	L	L	L	H

Figure 14: Summary Risk Rating for Airports and Ports

Risk No.	Risk statement	Exposure			Vulnerability				Risk		
					Sensitivity			Adaptive Capacity			
		Present	2040	2090	Present	2040	2090	Constant	Present	2040	2090
B6.1	Risk to airports due to coastal flooding.	M	H	H	M	H	H	L	M	E	E
B6.2	Risk to airports due to inland flooding.	M	H	H	M	H	H	L	M	E	E
B6.3	Risk to ports and wharf structures due to extreme weather events.	M	H	H	L	L	H	M	L	M	H

In relation to the headline risk of an AF8 scenario, tens of thousands of landslides are expected, isolating many areas by road, including Queenstown, Wānaka and surrounding settlements, and damaging most to all lifelines. Damage is primarily related to landslides and ground displacement. Liquefaction recurrence in Otago is low, excluding lake sediments in the Wānaka area,[116] and this is not expected to be a high impact outcome of any earthquake scenario.[117]

Appendix 2 illustrates that long-term, complete inoperability for the state highway network in an AF8 scenario is expected to be minimal. This is critical given there are several areas which remain geographically distant from their major sources of food and fuel and are totally dependent on trucked fuel, requiring use of the state highway network or alternative transport (e.g. airlifted fuel).[118]

Larger communities such as Queenstown are critically reliant on food being trucked into the district, leaving members vulnerable to both short and long-term shocks. Research highlighted that the Queenstown-Lakes district's food distribution system relies almost entirely on road freight via SH8 and the Lindis Pass, Kawarau Gorge, SH6 via the Devils Staircase, and somewhat the Haast Pass Highway. The research found that the region currently has 750 pallets of food brought in by the roading network in a day, which in the case of a major event cutting access to major roads, would require one Hercules aircraft to land every 21 minutes full of food to provision those in the district.[119]

Other known active faults in the region, such as the Nevis-Cardrona Fault Zone, the Grandview Fault and Pisa Fault are smaller than the Alpine Fault, but they are closer to Wānaka and Queenstown. These faults rupture less frequently but could still generate high intensity ground shaking, potentially causing ground deformation along the length of the rupture. Ruptures from these faults may produce more localised disruption. There are numerous pinch-points within the transport network, such as the Kawarau suspension bridge, where disruption from a local rupture would have significant impact on the Queenstown-Lakes district.[120]

A relatively unique factor to the Otago region is its highly transient, and in some locations, booming population. The Queenstown-Lakes district is a rapidly growing, world-renowned tourist hub. This growth requires infrastructure investment to keep pace to ensure ongoing redundancy capacity and resilience.[121] Furthermore, the tourism-driven fluctuation in population numbers means that the transport network must be prepared to support higher volume travel at any given point, especially by populations with an expectation that they will arrive in the area and leave again the same day or soon after. The highly seasonal road user volume may potentially place further stress in the response to a given emergency.

Several tools exploring and illustrating resilience risks in Otago have been developed, including the 2014 Otago Lifelines Project[122] and the Otago Natural Hazards Portal GIS application. These tools provide useful visual information to support effective communication of risks. A range of additional reports can be accessed from the Otago Natural Hazards Portal underneath the "Reports" tab.[123]

Table 4 overleaf details several key transport corridors in the region, each of which faces significant risks from natural hazards.

Table 4: Critical Transport Corridors, Otago Region

Corridor	Vulnerability	Description
SH8 – Roxburgh Dam	Landslides.	Alternative route adds another hour to the journey from Dunedin to Cromwell.
SH1 – Waitaki Bridge	Flooding from the Waitaki River, tsunami and liquefaction.	Clarries Transpower transmission lines, Chorus fiber cables and MSR. Alternative route to SH1 via Kurow adds 1.5 hours to the journey.
SH8 – Lindis Pass	Vulnerable to snow, flooding, landslides and alluvial fan activity.	Carries Chorus fiber cables and Transpower transmission lines.
SH6 – Haast Pass	Vulnerable to landslides.	A critical connecting route to the West Coast.
SH1 – Taieri Plains	Vulnerable to flooding, liquefaction, landslides and alluvial fan activity.	Carries important assets including KiwiRail's MSR, Transpower transmission lines and sub-stations (some of which connect Mahinerangi power generation assets to the grid).
SH86 – Taieri Plains	Vulnerable to flooding and liquefaction.	Primary access to Dunedin airport.
SH1 – Katike Strait	Vulnerable to coastal erosion, storm surge and tsunami. Vulnerability could worsen with future SLR.	Includes Transpower transmission lines and Chorus trunk telecommunications cable.
Three Mile Hill	Most susceptible to snowfall and ice.	A critical road into Dunedin from the south. Supports Transpower transmission lines and a substation supplying a significant portion of Dunedin's electricity.
Dunedin Northern Motorway	Vulnerable to landslides, snow and ice.	Critical transport route. Alternates may be unsuitable for larger vehicles and equally susceptible to liquefaction.
SH8 – Cromwell to Milton	Vulnerable to flooding, alluvial fan activity, landslides and earthquakes.	Critical transport route connecting Dunedin and Queenstown that is frequently used by tourists and to transport crops and livestock.
SH6, 97, 94: Queenstown to Milford Sound	Resilience issues relating to natural hazards (rockfall, avalanche), inclement weather, incident and preventative maintenance events.	There is no alternate route and limited communications (e.g. cell reception).

Source: Otago Regional Council Natural Hazards Database

6.2 Critical Infrastructure

6.2.1 Roads

The Arataki Strategic Network designates SH1 as the most critical transport route in Otago, essential for supporting regional connectivity and economic activity. SH6 is also highlighted for its importance in facilitating movement to Queenstown and to the West Coast.

Focusing on Dunedin, the AF8 Priority Routes Project identifies SH1 as the most critical route for restoration following an AF8 event, with SH88 classified as a second-tier priority, as shown in Figure 15 below.

Figure 16 highlights the importance of SH6 as a connecting route into Queenstown and Wānaka, with sections of SH8 also denoted as Priority 1 (P1). These routes both feed into critical tourist destinations as well as linking into adjacent regions.

There are several Priority 2 (P2) local roads, including McDonnell Rd, Berkshire St, Malaghans Rd, the Lake Esplanade, Fernhill Rd, Ardmore St, Sir Tim Wallis Drive and Mc Dougall St. These routes provide arterial connections through the urban centres or play a fundamental role in facilitating access to priority sites.

Figure 15: AF8 Priority Routes, Dunedin Snapshot

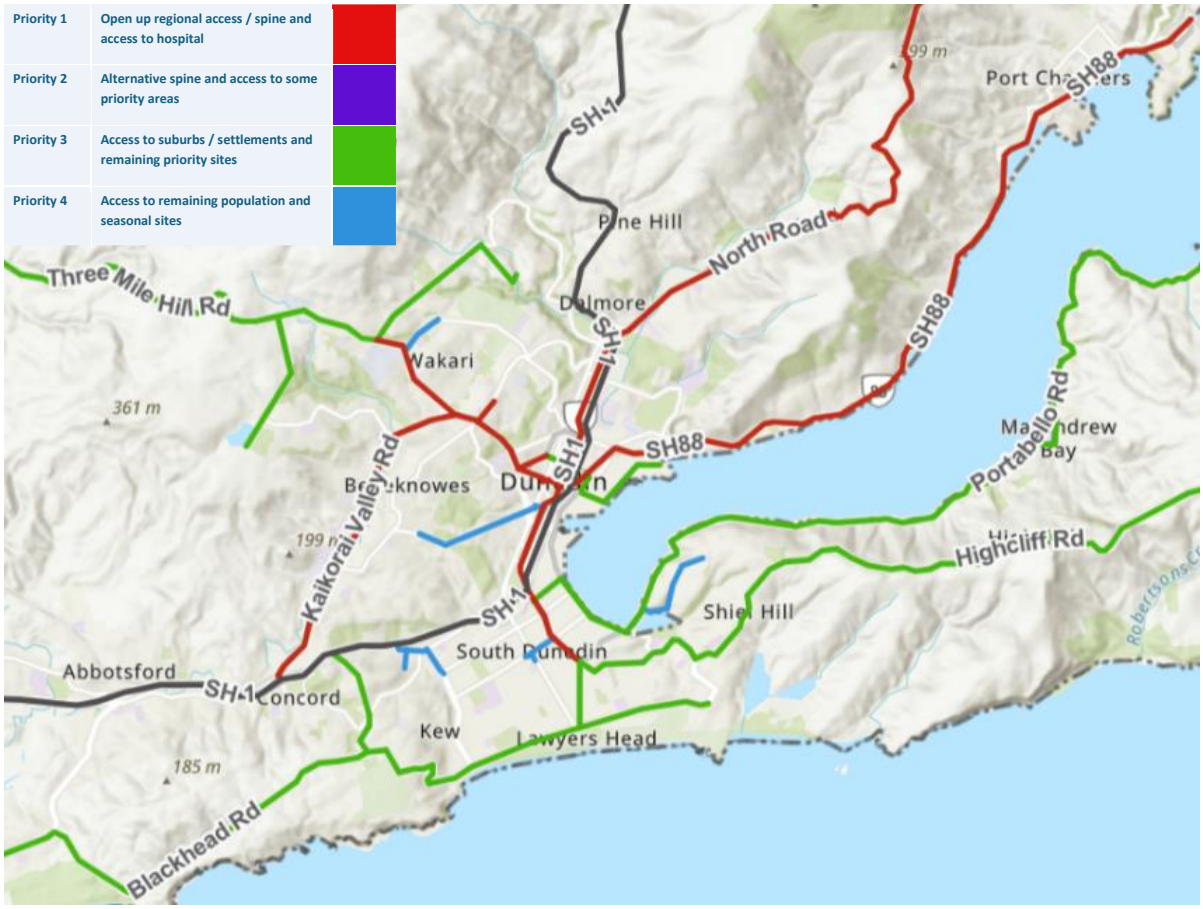
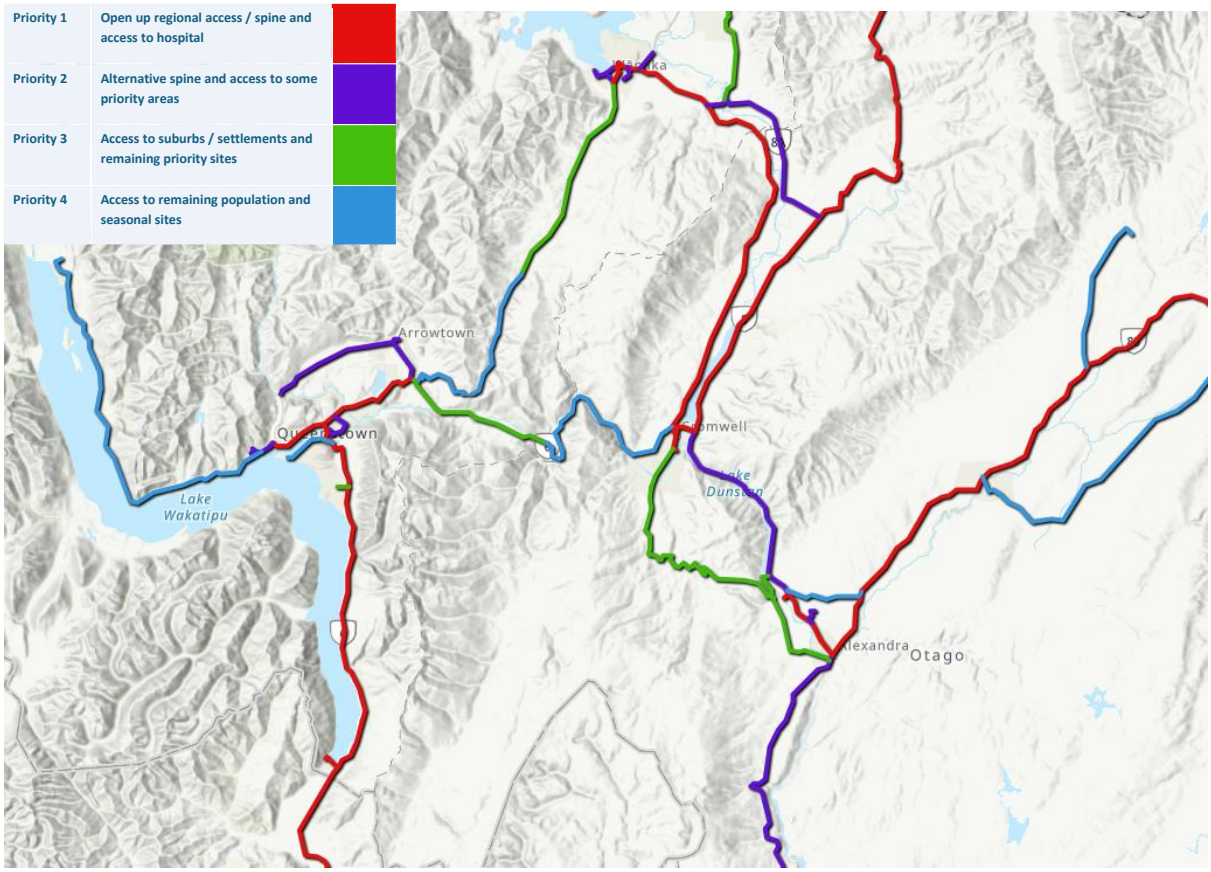


Figure 16: AF8 Priority Routes, Queenstown Snapshot



6.2.2 Rail

Otago hosts two railway lines, totalling 285 km of main trunk line and 65 km of branch line, the latter used primarily as tourist railways. There are over 150 rail bridges in Otago, approximately 10% of the national network.[124] The MSL is a key freight corridor, running south from Christchurch to Port Chalmers and then to South Port in Bluff.[125] The MSL facilitates the transfer of bulk and containerised freight between the region's two ports and northern destinations. Small branch lines also connect to the MSL in Southland and on the Taieri Plains.

The MSL is most vulnerable to slope failure between Oamaru and Dunedin, where although assessed as being low probability, the consequences would be significant. South of Dunedin, the risk of slope failure reduces, but flood risk increases to medium-to-high.

The Otago region has the highest rail exposure to present-day coastal flooding nationally, with 25 km currently exposed, increasing to 30 km with a 0.3 m sea level rise (expected within a mid-term timeframe, i.e. 2040). Rail assets located in the Taieri Plains are particularly susceptible to flooding and rely heavily on the flood protection and drainage schemes in this location. Local roads and state highway transport infrastructure which crosses through Milton, also face flood risks due to the area's geography.[126] Most assets have been mapped to be sufficiently positioned away from the alluvial fans and landslide-prone areas on the western slopes of the plains.

6.2.3 Bridges

The Otago CDEM Group Lifelines Project Report notes the following state highway bridges as being vulnerable to earthquakes, though it acknowledges that *"all significant state highway bridges meet seismic strengthening standards."*.[127]

- SH1: Waitaki bridge, Waiareka Creek bridge, Kakanui bridge, Waianakarua North River bridge, Waianakarua South River bridge, Pleasant Valley bridges (two) and Balclutha bridge.
- SH6: Victoria bridge (Kawarau Gorge) and Albert Town bridge.
- SH90: Pomahaka bridge.
- SH8: Alexandra bridge, Beaumont bridge and Luggate bridge (SH8A).

The Arthurs Point Bridge is also at risk from seismic activity. The single lane bridge is the sole crossing of the Shotover River on the route between Arrowtown and Queenstown (the only alternative route to these destinations for SH6A). The heritage listed bridge was constructed in 1919 and is expected to fail catastrophically in a major earthquake event, such as an AF8 scenario. The bridge services between 4,500 and 8,000 vehicle movements per day depending on the time of year. Timely investment in this bridge is paramount, with the first steps in this process already taken in 2020 with a single stage business case developed by NZTA.[128]

Many bridges on the local roads network are not capable of supporting larger trucks, which could pose challenges for moving goods from the farm to final destinations. This challenge will be exacerbated by the upcoming rollout of an electric bus fleet in the next few years. An electrified fleet will be heavier than the current petrol vehicles, placing further pressure on bridges, including the Arthurs Point Bridge. Of bridges inspected in 2018 condition assessments, 49% were in Poor or Very Poor condition, with over half having less than five years of their remaining life.[129] The joint Otago-Southland 2024 RLTP calls for *"major investment in small to medium-sized bridges"*, noting challenges with providing sufficient local share to cover the cost of these works.[130]

6.2.4 Other Infrastructure

Port Chalmers is subject to low seismic risk given its distance from New Zealand's major fault lines, though it is important to note that previous earthquakes (e.g. Christchurch 2011) were on unidentified faults.[131]

It is assumed that ports in the Otago region will be exposed in some form to SLR and associated coastal flooding given port locations are constrained to coastal/low lying areas.

Queenstown, Dunedin and smaller regional airports are likely to play a critical role in any given recovery effort. This is acknowledged in Queenstown Airport's master plan.[132] Both are potentially exposed to liquefaction, while the Dunedin airport is also exposed to flooding over the medium term (2040).

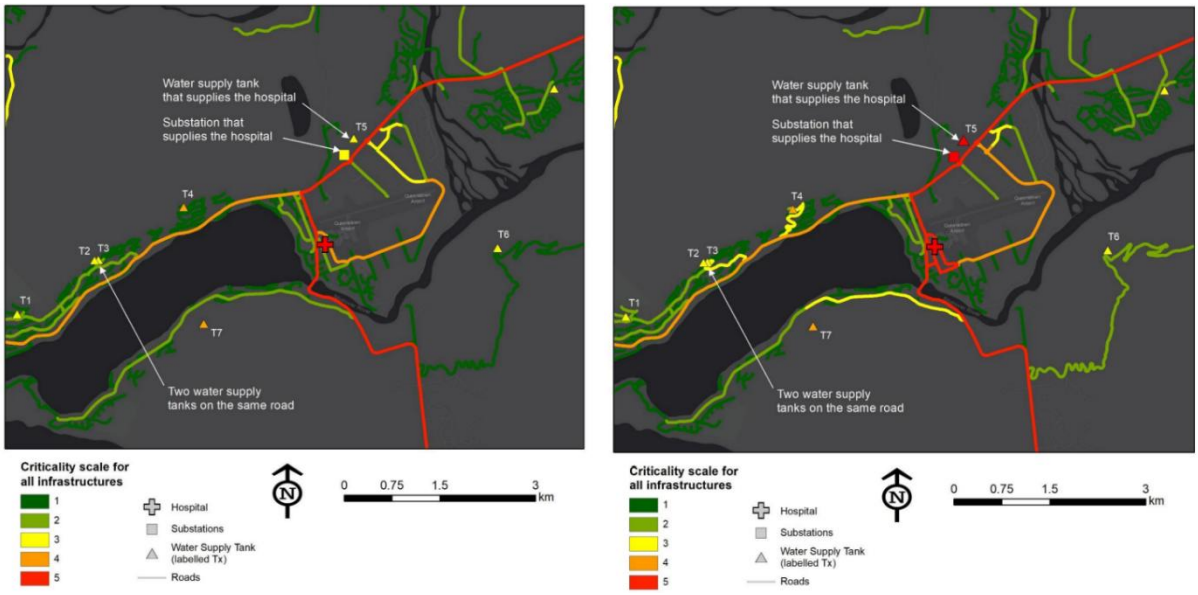
In the long term (2090), with a forecast 2 m SLR or greater, the Balclutha Aerodrome is also exposed to coastal flooding.[133] Work is underway to mitigate flood risks in the Taieri Plains, including planned upgrades to the Contour Channel and Outram floodbanks whose failure could inundate the Dunedin International Airport and between 4,000 to 7,300 hectares of highly productive land.[134] Damage to airports due to earthquake is considered very low probability.

To analyse wider lifeline utilities, a pilot study was applied to the physical and digital

interdependencies for an area within the Queenstown-Lakes district.

This study calculated a dependency rating, identifying the relationship between upstream and downstream infrastructure, and a modified asset criticality score, capturing how important an asset is to its dependent infrastructure. The study highlighted that the ONRC tends to undervalue key routes connecting to the hospital, airport and water supply tanks. As a result, nearby roads were then augmented from their status in the left visual, to the right (e.g. roads near the hospital), to ensure access to critical routes, highlighting the importance of SH6 and some local roads (e.g. Middleton Road).

Figure 17: Infrastructure Interdependency Assessment & Modified Criticality Pilot Study, Queenstown



7. Murihiku/Southland

The Murihiku/Southland region covers approximately 34,000 km^2, over 50% of which is uninhabited public conservation land, and is home to a rugged coastline – the longest of any in New Zealand. The region's economy is driven by tourism, agriculture and manufacturing, all of which are heavily reliant on the ongoing resilience of the transport network. Despite its large boundaries, Southland is sparsely populated with approximately 100,000 residents, though this tends to fluctuate heavily depending on tourist activities.[135] Towns and cities tend to be heavily dispersed and are typically separated by significant landforms, such as rivers, gorges and/or mountain ranges. Invercargill is the region's only city and the major population centre. It also hosts the Invercargill Airport and is connected to South Port via SH1.

An AF8 rupture is one of many challenges to Southland, noting that the region's distance from the Alpine Fault means the potential impact is comparatively less than other regions may face (two minutes of noticeable shaking is expected, compared to 2-3 minutes of severe and damaging shaking in other regions).[136] The region is significantly exposed to coastal erosion along its western coast, though flooding and landslips are the most common hazards across the region's network. The Ōreti, Waiau, Mataura and Aparima rivers split the region from their origins in the western mountain ranges. Landslips in these ranges can create temporary lakes, leading to flash floods in the instance they are breeched.

The mountainous terrain seen throughout Fiordland is home to a number of landslide deposits, which could be displaced following an earthquake. These cover 40% of the base of Milford Sound and threaten to trigger a tsunami, with a best-case survival rate of 5.2% within the affected catchment in the Milford Sound.[137,138] Other risks to the transport network include snow, ice and avalanche risks.

The Southland transport network is characterised by a handful of state highways with an extensive local roads network. The local roads network supports access to the state highway network, though many of the routes are exposed to potential flooding. SH1, 94 and 6 are the most important links in the region, connecting Invercargill to Bluff, Gore to Milford Sound, and providing the main route from Invercargill to the West Coast and Queenstown (respectively). Milford Road is a particularly challenging corridor due to its geological features and tourist-heavy vehicle movements. The road is ranked third for personal risk of any NZTA administered road in New Zealand.[139]

The road network is supplemented with a rail network which supports the efficient movement of freight via the MSL into South Port. There are a number of bridges incapable of supporting 50MAX trucks, highlighting the importance of a functioning rail network, with a number of small rail branch lines from Ohai to Invercargill providing alternatives to heavy transport. [140]

Stewart Island is serviced via a commercially operated ferry service as well as air transport from Invercargill. There is little information available to provide any commentary on the island's resilience.

7.1 Resilience Challenges

NZTA's National Resilience PBC identified two major and extreme risks to the Southland region's state highway network (this analysis excluded the Milford Road area). The PBC notes the risk that coastal inundation and sea level rise (SLR) pose to the entire coastal section of SH1 at Ocean view north of Bluff, and landslip risk at SH94 Gorge Hill (which is a strategic tourist route – the detour is four hours if this route was closed).

The NZTA State Highway Resilience tool indicates that the majority of Southland's state highway network faces relatively low levels of earthquake, storm, volcano and tsunami risks. Earthquake risks are greatest in the Milford Sound, while coast-adjacent stretches of the state highway network near Invercargill face moderate levels of storm and tsunami risk.[141]

A total of 15 major and extreme risks were identified along Milford Road, a 119 km route, including rockfall avalanche, earthquake, tsunami, landslide and flooding. The terrain of the Fiordland area and resulting high annual precipitation and snowfall are key contributing factors.[142] These risks are likely to worsen as climate change continues to impact the region, with particular impact on avalanche risk.[143]

Southland's climate is undergoing significant changes, with notable impacts on risks to the transport network. Shifting precipitation patterns have seen increased annual rainfall in the central part of the region, where heavy rainfall events are expected to occur three to four times as frequently as compared to the current climate, though other areas are forecast to experience fewer wet days.

A NIWA report prepared for Southland found that high intensity river flow events are likely to increase with climate change, with an estimated 15% increase in river flow during flood events, and SLR will continue to affect the region, intensifying storm tides, floods, coastal erosion, and groundwater levels. The report notes that, "*Transport infrastructure (roads, ports, airports) in the coastal margin will also be affected, both by increased nuisance shallow flooding of saltwater (e.g vehicle corrosion) and more disruptive flooding and damage from elevated storm-tides and wave overtopping.".*[144] Increasing tsunami and storm surge are expected to have a particular impact on roads connecting to the airport, Otatara and Bluff.[145,146]

While most regional councils have undertaken studies to assess vulnerability, the current Southland Regional Lifelines Group Vulnerability Study is dated, having been completed in 2012. Emergency Management Southland is investigating updating this work. This is expected to deliver an improved understanding of service impacts of natural disasters, supporting lifeline utilities to better invest in risk mitigation work.[147]

7.2 Critical Infrastructure

7.2.1 Roads

Similar to other regions, the state highway network carries much of the long-distance traffic in Southland. SH1 carries the most volume, providing the primary strategic link for the South Island and linking all major settlements along the east coast. This was identified as part of Arataki's strategic network and Priority 1 (P1) in the AF8 Priority Routes Project, as shown in Figure 18, with a series of smaller Priority 3 (P3) and Priority 4 (P4) routes connecting to SH1. A wider view is provided as Figure 19.

SH6 (also P1) carries a more moderate traffic volume and can be used as part of an alternative route between Invercargill and

Picton via the Lindis Pass. SH98 and 93 provide local connections between regional centres and tend to carry lower volumes.

While all the state highways in the region are classified as suitable for use by HPMV,[148] unpredictable traffic trips due to farm location and associated servicing by dairy tankers mean that HPMVs tend to also utilise local roads, which may offer more convenient routes despite not being designed for this purpose. Heavy vehicles are also required by law to travel at a slower speed than other traffic, which may result in drivers preferring to stay on secondary roads.[149] This emphasises the need for joined-up thinking between local and national stakeholders when discussing Southland's roading network.

Figure 1818: AF8 Priority Routes, Invercargill Snapshot

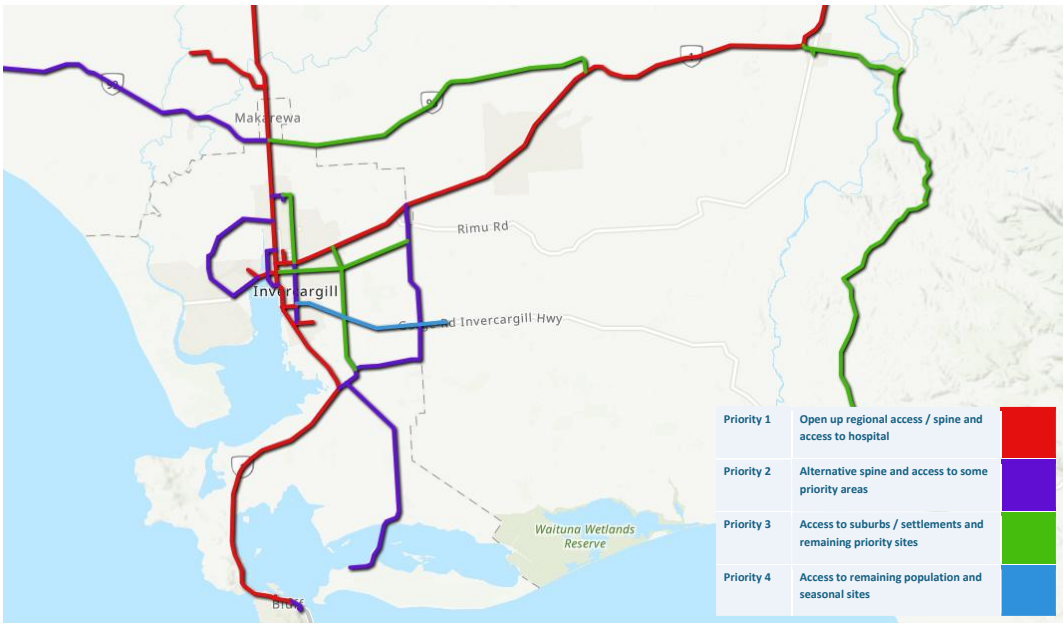
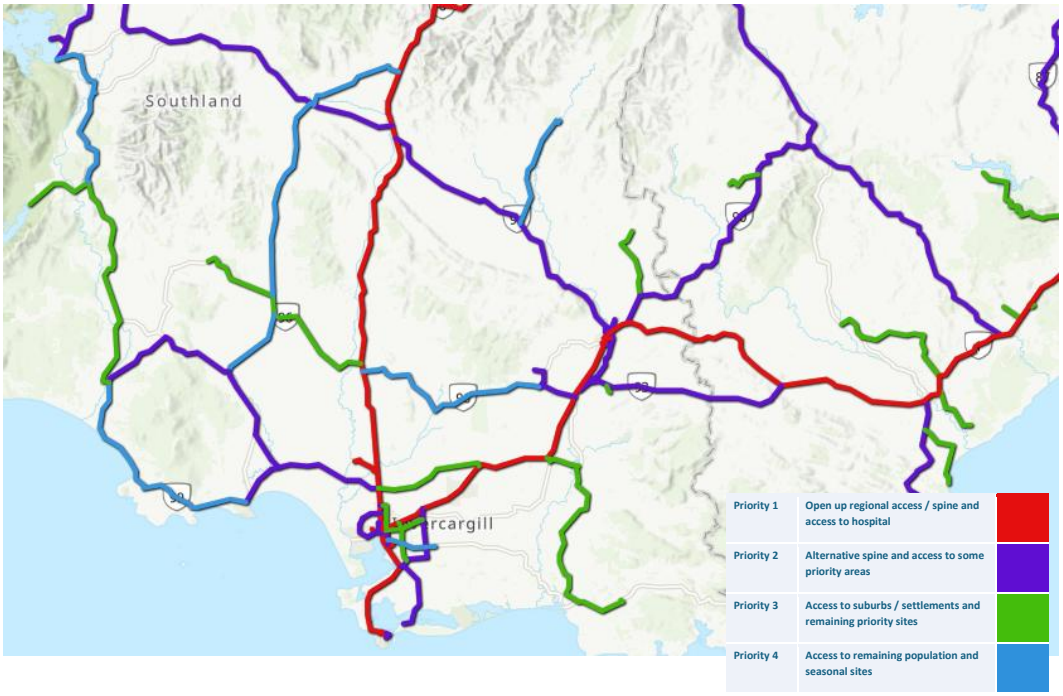


Figure 19: AF8 Priority Routes, Southland Snapshot



7.2.2 Rail

The MSL continues on from Dunedin, connecting into Bluff via Invercargill. The line is relatively resilient with few identified vulnerabilities.

Some line infrastructure requires investment to ensure ongoing resilience. For example, the current Gore main line rail bridge restricts the flow of the Mataura River during flood events and is at risk of significant damage. The Southland Regional Transport Committee is currently advocating to KiwiRail for upgrades to this bridge as a matter of urgency, particularly in the context of exploring an additional inland port connecting to the rail line.

7.2.3 Bridges

There are 1,084 bridges (including stock underpasses) on Southland's road network, averaging one bridge or large culvert for every 5 km of road.[150] Across the region, 134 of these bridges will need to be replaced over the coming 10 years, with the majority of structures approaching the end of their useful lives since their construction in a short span between 1950 and 1970.[151]Local government is faced with a significant task in deciding which of the region's bridges should remain open in light of funding challenges. This includes whether to invest in small to medium-sized bridges to support transport from the farm gate to export and economic opportunities.[152]

There are a number of one-way truss and concrete bridges that are at risk to flooding along SH94. A significant number of these bridges experience 8-9 m of rain every year and require ongoing work given a single failure will break the entire network. [153]

7.2.4 Other Infrastructure

Analysis to better understand key transport networks servicing ports found that South Port faces a high risk of the loss of connectivity caused by vulnerability to SLR. This is due to the number of low-lying transport corridors which connect to the port.[154] Climate change is guaranteed to worsen these impacts, with future coastal and rainfall flooding at high tide potentially resulting in approximately 70 m of traffic lanes being submerged, affecting access for freight to South Port.[155] It is expected that this is to be remedied in 2024/25; resilience of access corridors to seismic generated tidal waves is an ongoing concern.

South Port is not expected to be significantly impacted by an Alpine Fault event other than due to local liquefaction.

The Homer Tunnel, through which SH94 provides the only road access from Te Anau towards the Milford Sound (and vice versa), is exposed to landslide, rockfall and avalanche risk. In peak tourist season, the tunnel sees 6,000 people travel through it per day, meaning ongoing resilience of this asset is incredibly important. Work is underway by NZTA to develop a business case that will "*establish what short, medium, and long-term improvements to the tunnel and its approaches are required to respond to increasing visitor numbers.".* [156] The intention is to complete pre-implementation and start the improvements on this route in the next three years. This is in addition to recently completed resilience improvements.

This investment is much needed given there are no major capital improvement projects planned during the region's current 10-year plan period. Most of the work planned is related to renewal of assets – particularly bridges, sealed roads and footpaths.

Funding: Current State and Looking Ahead

8. Funding: Current State and Looking Ahead

Investing in proactive resilience improvements is key to capturing the double dividend of disaster risk reduction, whereby investments can reduce potential impacts from disasters as well as deliver broader economic, social and environmental benefits.

8.1 Current State

The majority of transport system resilience improvements are funded through the National Land Transport Programme (NLTP), administered by NZTA. Every three years the NLTP is published, which sets the proposed 3 and 10-year programmes of activities based on the Government Policy Statement on land transport (GPS). The NLTP is funded via the National Land Transport Fund (NLTF), which is generated from Road User Charges (RUC), Fuel Excise Duty (FED), vehicle registrations, and a few other smaller revenue streams. Some unplanned resilience investment is made through an Emergency Works fund, allowing the sector to respond to sudden events.

The 2024 GPS includes increased maintenance and resilience as a strategic priority, aimed at *"increasing access to markets and resilience on our state highway, local and rural roads"*. As such, many of the RLTPs submitted for consideration as part of the NLTP include numerous resilience-focused improvement activities. This is because RLTPs must "give effect" to the GPS.

The Crown Resilience Programme (previously the Transport Resilience Fund), a $419 million investment package of resilience improvement activities, is another funding source aimed at delivering improved transport resilience.

KiwiRail is due to release the second RNIP in 2025, detailing planned investment over 3 years and a 10-year investment forecast. It is expected that this will focus on maintaining current levels of service.

It is more challenging to map investment into other aspects of the transport network, including ports, airports and freight hubs, which may be led by private organisations. Many of these infrastructure-owning agencies operate as businesses, rather than public services, meaning future investment decision-making tends to be more commercially confidential.

Investment made outside of the immediate transport sector can also have a substantial role in delivering resilience. For example, significant flood protection works have been funded via the Before the Deluge Business Case as part of the Regional Infrastructure Fund.[157] While not directly administered by NZTA, this is likely to have considerable benefits to the transport network, particularly given one of the investment priorities is targeted at "*transport infrastructure that provides resilience following climate or extreme weather events*". [158]

8.2 The Gap

Compared to other high-income countries, New Zealand tends to spend an above average share of GDP in public capital and an average share of GDP in network infrastructure. However, turning that investment into performance has proven to be a challenge, with New Zealand ranking 46 overall of 54 high-income countries on infrastructure quality.[159]

Efficient investment tends to be heavily correlated with population size, population

density, institutional quality, and investment volatility. While size and density are challenging to control, improved long-term infrastructure decision-making would support value-for-money. This is particularly relevant given New Zealand is ranked in the bottom quarter of indicators developed as part of OECD research infrastructure governance for high-income countries.[160]

When it comes to transportation, both state highways and local roads have renewal-to-depreciation ratios below one. If this continues over time, it signals that assets are wearing out faster than they are being renewed. Between 2012 and 2022, state highway renewal spending is estimated to be at least 12% lower than forecast depreciation, possibly as much as 63% lower. Looking ahead, local roads renewal expenditure forecast over the 2019-28 period is expected to be approximately 18% lower than forecast depreciation over the same period.[161] Declining or overburdened asset condition is likely to contribute to existing resilience challenges and reduce the sector's ability to absorb shocks in the future, or provide alternate options when other infrastructure is compromised.

8.3 Planned Investment

Despite these concerns, there remains significant funding allocated to delivering road-based resilience improvements over the next NLTP cycle. Across the South Island, $0.92B has been allocated to maintenance and operations, $1.43B to pothole prevention and $1.02B to improvements. Investment highlights are provided in Table 5for illustrative purposes; this is not an exhaustive list of planned investment.

Table 5: South Island NLTP Investment Highlights, 2024

Top of the south	**West Coast**
Work will progress on the Hope Bypass Road of National Significance, a new route for traffic travelling on SH6 in Richmond.	Replace the end-of-life SH6 Coal Creek Overbridge and 10 local roads bridges and culverts.
Improve safety and resilience of more than 272 lane kilometres of state highway through targeted maintenance operations and fixing potholes.	Improve safety and resilience of almost 460 lane kilometres of state highway through targeted maintenance operations and fixing potholes.
Continue resilience recovery work on SH60 Tākaka Hill, SH6 Dellows Bluff and phase 3 of the Marlborough Sounds Future Access Road project.	Reconstruct a 6 km section of SH7 through Lewis Pass, from the summit through to Maruia Springs.
Completed the second roundabout on SH6 outside Marlborough Airport as part of the Blenheim to Woodbourne safety improvements.	Complete 3 km of road condition improvements on SH6 at Fergusons Bush, south of Ross, along with drainage work.
	Complete road condition and drainage improvements on SH73 Jacksons to Darby.
Otago / Southland	**Canterbury**

Progress the Roads of Regional Significance Queenstown Package of corridor improvements along SH6 and SH6A, and SH6 Frankton Flats network improvements.	Work will progress on the SH1 Belfast to Pegasus Motorway and Woodend Bypass Road of National Significance.
Support central city changes in Dunedin on SH1 and SH88.	Work will progress on 3 Roads of Regional Significance: • SH1 Rolleston access improvements – design completion and property purchase, with construction to begin towards the end of the period. • SH75 Halswell Road improvements, including new bus lanes • A second Ashburton Bridge
Reseal or rebuild almost 560 lane kilometres of state highway in Otago and almost 380 lane kilometres in Southland.	Reseal or rebuild 575 lane kilometres of the state highway network.
Progress resilience improvements on SH1 Kakanui River and SH1 Waikaouaiti.	Complete design and strategic property purchase for SH76 Brougham Street.
Start work to build greater resilience into SH6 from Cromwell to Frankton, Frankton to Kingston, and Haast to Hawea.	Replace two bridges on SH82 – Waihao North Branch and Elephant Hill.
Replace the culvert at Shepherds Hut Creek between Queenstown and Glenorchy.	Replace a key Christchurch emergency evacuation bridge on Pages Road.
Replace 17 bridges and culverts on local roads.	Construct the northbound Commercial Vehicle Safety Centre at Rakaia.

There is significant investment being made in other components of the South Island's transport network outside of roading.

While airports that are designated as critical infrastructure are already required to maintain a very high level of resilience to comply with Civil Aviation Authority regulations, this has not stopped considerable effort being made to improve resilience. Examples include the planned expansion of freight capacity at the Christchurch International Airport, installation of rooftop solar systems at Dunedin Airport, establishment of a new water supply and wastewater treatment system for the Kaikōura airport, and additional infrastructure to support timely maintenance of planes in Queenstown.

These investments improve resilience by improving preparedness and therefore the ability to handle external impacts while maintaining operations.

These investments will all strengthen each airport's ability to respond to local, or wider, shocks, acknowledging that these sites are constrained in their ability to relocate to more resilient locations.

Ports are faced with a similar challenge that, due to their necessary and therefore fixed coastal location, they are faced with natural hazard risk. Limited information regarding plans for future investment is available in

each port-owning entities' annual reports. Many of these reports cite resilience as a key strategic priority, with resilience including in terms of infrastructure, operational and financial considerations.

Finally, there is ongoing uncertainty regarding the iReX project. iReX was initiated to procure new ferries and develop the landside infrastructure in Picton and Wellington to accommodate them. It aimed to improve the efficiency and resilience of the national supply chain. There have been few developments since the project was cancelled, which is a significant risk to the national and South Island transport network, as signalled earlier in this report. It is critical that clear guidance on the project's status is given in the near future to provide confidence to stakeholders.

It is important to note the current challenge faced by decision-makers to assess the scale of required investment in the transport system.

Information and data related to investment decision making tends to be dispersed, hosted by the entities who hold the funding (e.g. NZTA, other government agencies and private companies). Te Waihanga New Zealand Infrastructure Commission's infrastructure pipeline is a first step to remedying this pain-point. The pipeline provides valuable information regarding project costs, timings, funding status, capacity implications and more. If cross-sector collaboration ensures ongoing contribution to this pipeline, this could prove to be a valuable resource in understanding where funding is being directed and any resilience implications this may have.[162]

Conclusion

9. Conclusion

This report has highlighted the significant vulnerabilities and resilience challenges facing the South Island's transport network. By examining various natural hazards, infrastructure limitations and climate-related risks, it is clear that the South Island's major corridors are at risk of significant disruption.

A recurring challenge in producing this report and assessing the resilience of the transport network is the lack of consistent and centralised data. Currently, much of the existing data is fragmented across various local, regional and national agencies, making it difficult to aggregate knowledge into a central source of truth. This fragmentation creates barriers to effective decision-making and complicates efforts to plan cohesive resilience strategies.

Furthermore, data gaps in hazard exposure, particularly in remote areas, hinder the full understanding of potential vulnerabilities. While for some hazards, such as active faults, there are national datasets (e.g. GeoNet), for others, hazard and risk information has been developed at a regional or local scale and not always on a consistent basis. Even then, hazards are often assessed on different return periods making any comparison difficult. Without a coordinated approach to data collection and sharing, developing accurate risk assessments remains challenging.

Even in the instance that data can be collated, ensuring this is achieved in an accessible and easy to understand format remains challenging. Many of the hazard maps, GIS tools, and other figures illustrate only one part of a multi-pronged issue since adding further layers and information can clutter the desired message, damaging the initial intent of these tools. New Zealand's infrastructure pipeline database is still in its infancy, and it will take time for Te Waihanga to scale this tool to an appropriate level of information.

Natural hazards, including earthquakes, landslides, flooding and sea level rise (SLR), present another layer of complexity. The looming threat of an Alpine Fault earthquake (AF8) stands out as one of the most significant risks, potentially causing widespread and long-term disruptions across vital transport routes, such as SH1, SH6 and SH73. Given the South Island's rugged terrain and the network's reliance on limited state highway routes to connect the many rural and local routes, the impacts of an AF8 event could be catastrophic, isolating communities for extended periods. Additionally, climate change is exacerbating existing risks. Communities are faced with increasing rates of flooding and SLR, while these continue to affect low-lying transport corridors.

The lack of redundancy in many parts of the network further compounds these challenges. Routes like SH1, especially in areas such as Kaikōura and the West Coast, have little to no viable alternatives in the event of a major disruption.

Redundancy challenges extend to individual infrastructure pressure points throughout the network. For example, bridges spanning braided river networks in Canterbury and powerful river flows dividing Southland are critical to the transport network, yet often have few alternatives. Further, while the Interislander connection plays a fundamental role in the national economy, there is little redundancy available for freight via coastal shipping or alternate transport options for passengers. Risks to key port infrastructure continue to grow as the iRex project stalls, heightening the existing challenges.

This dependence on a few critical pathways increases the overall vulnerability of the transport system.

Despite these challenges, opportunities exist to enhance the resilience of the South Island's transport network. Investments in GIS tools and hazard mapping provide valuable insights into potential disruptions and can guide more targeted mitigation strategies. The development of the National Resilience PBC and the AF8 Priority Routes Project illustrate the importance of taking a proactive approach to resilience planning. These initiatives offer a framework for identifying and prioritising routes that need immediate attention, helping to allocate resources more effectively. This will support agencies across the sector in their response to natural hazards.

Collaboration is also essential in building a more resilient network. Pooling knowledge, resources and capabilities across agencies and groups can help address some of the data fragmentation challenges and create a more unified response to natural hazards. This may include strengthening information sharing requirements, and paying heed to the New Zealand Lifelines Council's recommendation that every region should conduct a regional infrastructure vulnerability assessment and develop programme business cases for any identified significant regional or national risks.

In summary, while the South Island's transport network faces significant challenges, particularly in terms of investment needs, natural hazard exposure and data limitations, there are clear opportunities for improving resilience. By investing in coordinated data-sharing platforms, proactive infrastructure upgrades, and collaborative planning frameworks, the South Island can better prepare for future challenges and ensure its transport network remains a reliable lifeline for communities and the economy.

Preparation of any recommendations was not in the scope of this project, given the intention to collate existing work for decision-making purposes.

Appendices

Appendices

Appendix 1: West Coast Vulnerabilities, Importance Rankings

		Road Link	ONRC	Reg Econ	Av Traff	Heavy Veh	Services	Redundancy	Score	Rankni g	ONRC
1	SH 6	Murchison – Kawatiri	4	5	4	3	5	5	30	A	A
2	SH 6	Murchison – Inangahua	2	4	3	2	2	2	17	C	P
3	SH 65	Murchison – Springs Junction	2	5	3	2	5	2	21	B	P
4	SH 6	Inangahua – Westport	4	4	3	2	2	2	21	B	A
5	SH 69	Inangahua – Reefton	2	4	3	2	4	2	19	C	P
6	SH 7	Springs Junction – Hanmer	2	5	3	3	1	2	18	C	P
7	SH 7	Springs Junction – Reefton	2	4	1	1	5	2	17	C	P
8	SH 7	Reefton – Stillwater	2	4	3	2	5	3	21	B	P
9	GDC	Ikamatua – Cobden	1	2	1	1	3	3	12	C	
10	SH 67	Westport Bridge	2	5	4	4	5	5	27	A	P
11	SH 67	Westport – Mokihinui	2	5	3	1	4	5	22	B	P
12	BDC	Karamea Highway	4	3	1	1	4	5	22	B	A
13	SH 67A	Westport – Cape Foulwind	2	2	2	3	5	2	18	C	P
14	SH 6	Westport – Rapahoe	4	3	3	2	5	2	23	B	A
15	SH 6	Rapahoe – Cobden	4	4	5	3	5	4	29	A	A
16	SH 6	Cobden bridge	4	5	5	5	5	3	31	A	A
17	SH 7	Stillwater – Greymouth	2	5	5	4	5	2	25	A	P
18	GDC	Stillwater – Jacksons	1	3	2	1	5	2	15	C	
19	SH 73	Kumara Junction – Jacksons	5	4	4	2	2	2	24	B	R
20	SH 73	Jacksons – Springfield	5	4	4	3	5	2	28	A	R
21	SH 6	Greymouth – Hokitika	4	5	4	5	5	4	31	A	A
22	SH 6	Hokitika – Ross	4	5	3	2	4	4	26	A	A
23	SH 6	Ross – Franz Joseph	4	5	3	2	4	4	26	A	A
24	SH 6	Franz Joseph – Haast	4	5	2	1	2	4	22	B	A
25	WDC	Haast – Jackson Bay	1	2	1	1	3	5	14	C	
26	SH 6	Haast – Wanaka	4	5	2	1	1	4	21	B	A

Table 2.3b: Importance Rating

Rating	Score	Description
ONRC	1	2ndry Collector
	2	Prmry Collector
	3	
	4	Arterial
	5	Regional

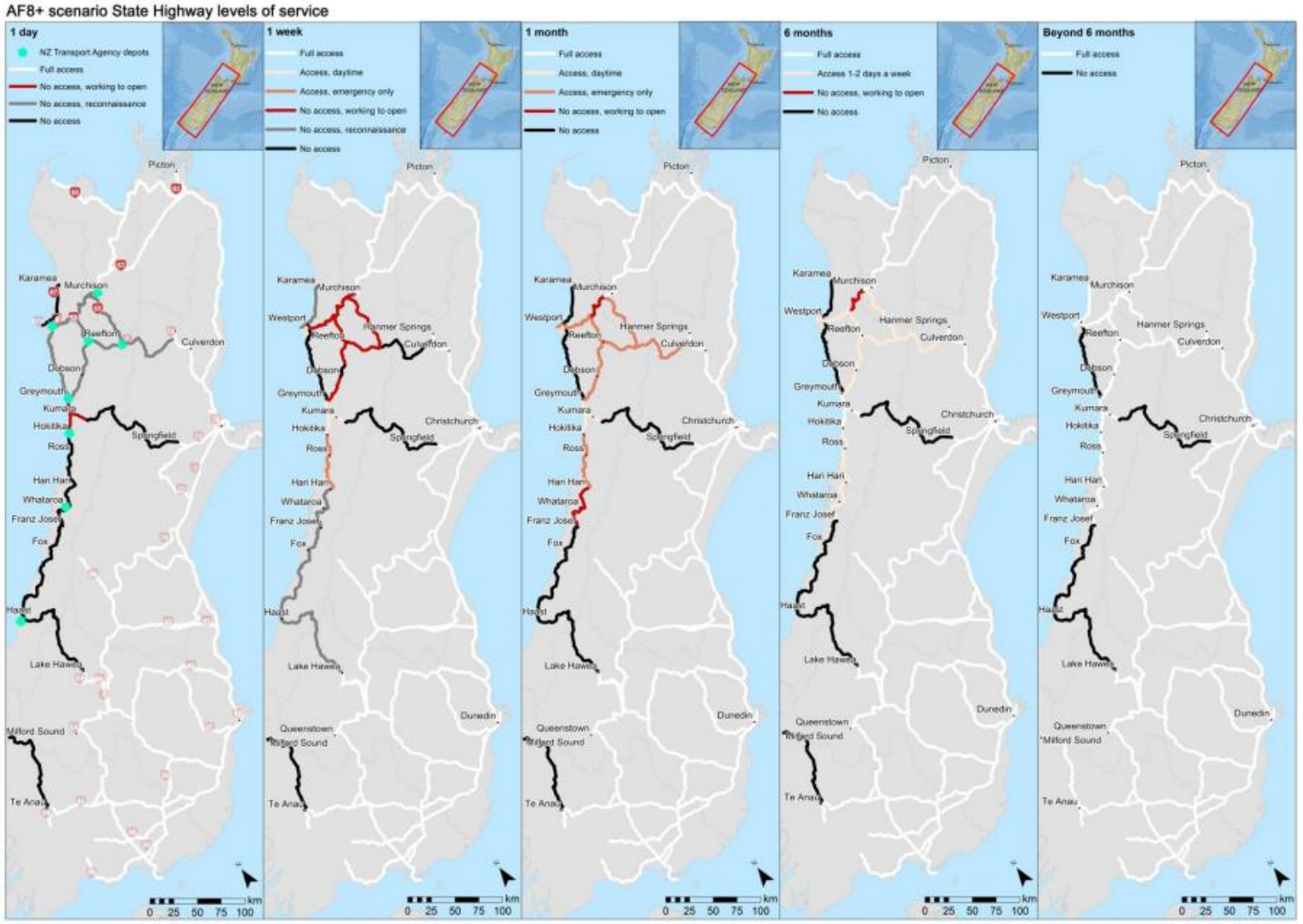
Rating	Score	Description
Average traffic (vehicles/d)	1	< 500
	2	500 – 800
	3	800 – 1300
	4	1300 - 2000
	5	> 2000

Rating	Score	Description
Heavy Vehicle (vehicles/d)	1	<100
	2	100 – 2100
	3	200 – 300
	4	300 – 400
	5	>400

Regional economy	1	Very little	2	3	4	5	Major	

Services	1	No services in corridor or accessed by road
	2	General access to other utilities
	3	Local distribution lines/pipes in corridor
	4	Important services/ fibre optic cable along route
	5	Multiple services including trunk fibre optic cable route
Redundancy	5	Only access, no alternative
	4	Single road, no alternative but access both ends
	3	Alternative route but lesser robustness or subject to same hazard area
	2	Alternative routes separate, not impacted by same event to same degree
	1	Multiple routes

Appendix 2: Expected Levels of Service of the Road Network in Five Time Steps for AF8+ Scenarios[163]



Appendix 3: NZTA Resilience Assessment

Route Information		Significance of Route & Significance of Impact on Route							Likelihood of a Disruptive Event Affecting Route					Overall Resiliency Rating
Route	Resiliency issue(s)	Nat. Strategic Network?	AADT >10,000 Vehicles/Day? 2013	Freight Volumes >400 Heavy Vehicles/Day? 2013	Lifeline function? 2011	Absence of a Viable Alternative Route? *1	Tourism Route >60,000 travellers on route/year 2009	Impact Significance Rating (H, M, L)*2	Incident Management <12 Hrs	Small Scale Route Closures < 3 Mths	Large Scale Route Closures > 3 Mths	Major Unplanned Route Closures > 12 Mths	Likelihood Significance Rating (H M L)*3	H M L *4 (A high ranking means that there is a high likelihood that an event will have a significant impact on the operation of a route.)
Northland														
SH1 – Cape Reinga to Ohaeawai (incl Awanui)	Flooding and landslips	N	N	N	N	Y (Upper cape area)	N	Low	Medium	Low	Low	Low	Medium	Low
SH1 - Kawakawa to Whangarei	Flooding, landslips, tsunami warnings	N	N	Y	N	N	Y	Low	Medium	Medium	Low	Low	Medium	Low
SH1 - Whangarei to Brynderwyns	Flooding, landslips, tsunami warnings	Y	Y	Y	N	N	Y	High	Medium	Medium	Low	Low	Medium	High
SH1 - Brynderwyns to Puhoi Tunnels	Landslips and flooding	Y	Y	Y	N	Y (Te Hana Bridge)	Y	High	Medium	Medium	Low	Low	Medium	High
SH10 - Kawakawa to Awanui	Flooding, landslips, tsunami warnings	N	N	N	N	N	N	Low	Medium	Low	Low	Low	Medium	Low
SH 11 - Kawkakawa to Puketona	Landslips	N	N	N	N	N	N	Low	Low	Low	Low	Low	Low	Low
SH12 - Ohaeawai to Kaikohe	Flooding and landslips	N	N	N	N	N	N	Low	Low	Low	Low	Low	Low	Low
SH12 - Dargaville to Brynderwyns	Flooding and landslips	N	N	N	N	N	N	Low	Low	Low	Low	Low	Low	Low
SH 14 - Dargaville to Whangarei	Flooding	N	N	N	N	N	N	Low	Low	Low	Low	Low	Low	Low
Auckland														
SH1 - Auckland Harbour Bridge	High volume, limited alternate routes	Y	Y	Y	N	Y (alternate route capacity constrained during peak)	Y	High	High	High	Low	Low	High	High
SH1 - Takanini to Drury	High volume, very limited alternate routes	Y	Y	Y	N	N	Y	High	High	High	Low	Low	High	High
SH1 - Northern Motorway (Awanohi Rd to Wilks Rd)	Slips will block one lane of highway	Y	Y	Y	N	N	Y	High	Medium	Medium	Low	Low	Medium	High
SH1 - Victoria Park Tunnel to Victoria Park Viaduct	High volume, limited alternative	Y	Y	Y	N	Y (alternate route capacity constrained during peak)	Y	High	Medium	Medium	Low	Low	Medium	High
SH 16 - Wellsford to Kumeu	Flooding	N	N	N	N	N	N	Low	Medium	Medium	Low	Low	Medium	Low
Waikato														
SH 29 – western side Kaimai Range	Steep and windy with high number heavy vehicle	Y	N	Y	N	N	N	Low	Medium	Medium	Low	Low	Medium	Low
SH1 - Hatepe to Turangi	Single constrained route	Y	N	Y	N	N	N	Low	Medium	Medium	Low	Low	Medium	Low
SH2 - Paeroa to Waihi (Karangahake Gorge)	Single constrained route	N	N	Y	N	N	N	Low	Medium	Medium	Medium	Low	Medium	Low
SH3 - Mahoenui to Mokau (Awakino Gorge)	Single constrained route, landslips	N	N	Y	N	Y	N	Low	Medium	Medium	Low	Low	Medium	Low
SH25 - Thames to Manaia	Single constrained route, sea level rise, rock fall	N	N	N	N	N	N	Low	Low	Low	Low	Low	Low	Low
SH25 - Whangamata to Kuaotunu	Single constrained route	N	N	N	N	N	N	Low	Low	Low	Low	Low	Low	Low
SH31 - SH39 to Kawhia	Single route	N	N	N	N	Y	N	Low	Low	Low	Low	Low	Low	Low
SH41 - Turangi to I/S with SH4	Ground instability, slips	N	N	N	N	N	N	Low	Medium	Medium	Low	Low	Medium	Low
SH1 - Huntly to Rangiriri	Flooding	Y	Y	Y	N	N	Y	High	Medium	Medium	Low	Low	Medium	High
SH1 - Mercer to Meremere (Waikato Expressway)	Flooding	Y	Y	Y	N	N	Y	High	Medium	Medium	Low	Low	Medium	High
Bay of Plenty														
SH2 – Otamarakau to Matata	Flooding and landslips	N	N	Y	N	N	N	Low	Medium	Medium	Medium	Low	Medium	Low
SH2 – Edgecombe to Opotiki	Flooding and landslips	N	N	Y	N	Y	N	Low	Medium	Medium	Low	Low	Medium	Low
SH2 - Opotiki to BOP/Gisborne Boundary	Flooding and landslips	N	N	N	N	N	N	Low	Medium	Medium	Medium	Low	Medium	Low

Route	Resiliency issue(s)	Nat. Strategic Network?	AADT >10,000 Vehicles/Day? 2013	Freight Volumes >400 Heavy Vehicles/Day? 2013	Lifeline function? 2011	Absence of a Viable Alternative Route? *1	Tourism Route >60,000 travellers on route/year 2009	Impact Significance Rating (H, M, L)*2	Incident Management <12 Hrs	Small Scale Route Closures < 3 Mths	Large Scale Route Closures > 3 Mths	Major Unplanned Route Closures > 12 Mths	Likelihood Significance Rating (H M L)*3	H M L *4 (A high ranking means that there is a high likelihood that an event will have a significant impact on the operation of a route.)
Gisborne														
SH2 - BOP/Gisborne Boundary Gisborne (Waioeka Gorge)	Single constrained route, landslips	N	N	N	N	N	N	Low	Medium	Medium	Medium	Low	Medium	Low
SH35 - Opotiki to Gisborne (East Cape)	Single route, flooding and landslips	N	N	N	N	N	N	Low	Low	Low	Medium	Low	Medium	Low
SH2 - Gisborne to Wairoa	Single constrained route, landslips	N	N	N	Y	Y	N	Medium	Medium	Medium	Medium	Low	Medium	Medium
Hawkes Bay														
SH 5 - Pohokura to Eskdale (Napier-Taupo Road)	Single constrained route (Mohaka Bridge), snow and ice, slips	N	N	Y	N	Y	N	Low	Medium	Medium	Low	Low	Medium	Low
SH2 Wairoa to Bay View (SH5 intersection)	Single constrained route, landslips	N	N	Y	Y	Y	N	High	medium	Medium	low	low	Medium	High
SH2 Bay View (SH5 intersection) to Hastings	Substandard bridge Waitangi (HPMV)	N	N	Y	N	N	N	low	low	low	low	low	low	low
SH2 Hastings to Takapau Plains (SH50 intersectn)	Wind gusts	N	N	Y	N	N	N	low	low	low	low	low	low	low
SH50 Napier to Takapau (SH2 intersection)	One lane bridges floods, slips,Fernhill (Ngaruroro) Bridge non- HPMV	N	N	N	N	N	N	low	low	low	low	low	low	low
SH38 Wairoa to Waikaremoana	Slips, flooding, snow no alternative routes	N	N	N	N	Y	N	low	medium	low	low	low	Medium	low
SH2B & 50A Napier Airport to Hastings (HB Expressway)	Crashes, spills	Y	Y	Y	N	N	N	Medium	low	low	low	low	Medium	Medium
Manawatu-Whanganui														
SH1 - Turangi to Waiouru (Desert Rd)	Snow and ice	Y	N	Y	N	N	N	Low	Medium	Medium	Low	Low	Medium	Low
SH1 - Whirokino Bridge, Foxton	Substandard bridge (HPMV)	Y	N	Y	N	N	N	Low	Medium	Low	Low	Low	Medium	Low
SH3 - Ashurst to Woodville (Manawatu Gorge)	Landslide and rockfall	Y	N	Y	N	Y (note; viable alternative on local roads)	N	Medium	Medium	Medium	Medium	Medium	Medium	Medium
SH56 - Tiakitahuna to SH57	Flooding	N	N	Y	N	N	N	Low	Low	Low	Low	Low	Low	Low
Taranaki														
SH3 - Urenui to Tongaporutu (Mount Messenger)	Single constrained route	N	N	Y	N	Y	N	Low	Medium	Medium	Low	Low	Medium	Low
SH3 - Waiwhakaio Bridge (New Plymouth)	Single route	N	Y	Y	N	N	N	Low	Low	Low	Low	Low	Low	Low
Wellington														
SH1 - Wellington to Ngauranga	High volume, very limited route options	Y	Y	Y	N	Y	N	High	Medium	Low	Low	Low	Medium	High
SH1 - Ngauranga to Plimmerton	High volume, very limited route options	Y	Y	Y	N	N	N	Medium	Medium	Low	Low	Low	Medium	Medium
SH1 - Plimmerton to Waikanae	High volume, very limited route options(sea level rise Porirua to Paekakariki)	Y	Y	Y	N	Y	N	High	Medium	Low	Low	Low	Medium	High
SH1 - Waikanae to Levin	High volume, single route (single bridge option at Otaki, Manakau & Ohau)	Y	Y	Y	N	Y	Y	High	Medium	Low	Low	Low	Medium	High
SH2 - Ngauranga to Petone	High volume, single route. Landslide and sea level rise	Y	Y	Y	N	N	N	Medium	Medium	Low	Low	Low	Medium	Medium
SH2 - Kaitoke to Featherston (Rimutaka Hill)	Wind, snow and ice	N	N	N	N	Y	N	Low	Medium	Medium	Low	Low	Medium	Low
Cook Straight														
Cook Straight Ferries	Single route, storm events	Y	N	Y	N	Y	Y	High	Medium	Low	Low	Low	Medium	High
Marborough														
SH1 - Picton to Wharanui	"Single route with limited detour options Wairau River Bridge sensitive to scour and seismic risk"	Y	N	Y	N	Y	N	Medium	Medium	Medium	Low	Low	Medium	Medium
SH6 - Blenheim to Nelson	Flooding & slips	N	N	Y	N	N	N	Low	Medium	Low	Low	Low	Medium	Low
Nelson														
Tasman														
SH60 - Riwaka to Takaka	Single constrained route	N	N	N		Y	N	Low	Medium	Medium	Medium	Low	Medium	Low
SH65 - Murchison to Lewis Pass	Snow and ice, landslip	N	N	N	N	N	N	Low	Medium	Medium	Low	Low	Medium	Low

Route	Resiliency issue(s)	Nat. Strategic Network?	AADT >10,000 Vehicles/Day? 2013	Freight Volumes >400 Heavy Vehicles/Day? 2013	Lifeline function? 2011	Absence of a Viable Alternative Route? *1	Tourism Route >60,000 travellers on route/year 2009	Impact Significance Rating (H, M, L)*2	Incident Management <12 Hrs	Small Scale Route Closures < 3 Mths	Large Scale Route Closures > 3 Mths	Major Unplanned Route Closures > 12 Mths	Likelihood Significance Rating (H M L)*3	H M L *4 (A high ranking means that there is a high likelihood that an event will have a significant impact on the operation of a route.)
Canterbury														
SH1 – Wharanui to Hundalee (Kaikoura Coast)	Single route with limited detour options, Landslips and rockfall, sea level rise	Y	N	Y	N	Y	N	Medium	Medium	Medium	Low	Low	Medium	Medium
SH74 – Christchurch to Lyttleton (Tunnel)	Single constrained route	Y	Y	Y	N	Y (note: no viable alternative currently available due to earthquake damage	N	High	Medium	Medium	Low	Low	Medium	High
SH73 - Springfield to Otira	Single constrained route, landslips, rockfall, snow and ice, avalanche	N	N	N	Y	Y	N	Medium	Medium	Medium	Low	Low	Medium	Medium
SH7 - Waipara to Springs Junction (Lewis Pass)	Single route with very long detour options, landslips, rockfall, snow, ice , washouts from adjacent rivers	N	N	N	N	Y	N	Low	Medium	Medium	Low	Low	Medium	Low
SH82 – Kurow Bridges	Substandard bridge (HPMV)	N	N	N	N	N	N	Low	Low	Low	Low	Low	Low	Low
Westcoast														
SH6 – Westport to Haast	Single constrained route, sea level rise, coastal erosion, rockfall	N	N	N	N	Y	N	Low	Low	Low	Low	Low	Low	Low
SH6 – Haast to Hawea (Haast Pass)	Single constrained route, snow and ice, rockfall	N	N	N	N	Y	N	Low	Medium	Medium	Low	Low	Medium	Low
SH67 – Westport to Mokihinui	Single route, sea level rise	N	N	N	N	Y	N	Low	Low	Low	Low	Low	Low	Low
SH69 - Inangahua to Reefton	Flooding	N	N	N	N	N	N	Low	Low	Low	Low	Low	Low	Low
SH73 – Otira to Jacksons	Single constrained route, landslips, flooding	N	N	N	Y	Y	N	Medium	Low	Low	Low	Low	Low	Low
SH73 – Jacksons to Kumara Junction	Landslips, flooding & alternative route available	N	N	N	N	Y	N	Low	Low	Low	Low	Low	Low	Low
Otago														
SH1 – Glenavy to Oamaru	Flooding, erosion	Y	N	Y	N	N	N	Low	Medium	Medium	Low	Low	Medium	Low
SH83 – Oamaru to Duntroon	Flooding	N	N	N	N	N	N	Low	Low	Low	Low	Low	Low	Low
SH85 – Palmerston to Dunback	Flooding	N	N	N	N	N	N	Low	Low	Low	Low	Low	Low	Low
SH1 – Hampden to Palmerston	Flooding, sea level rise	Y	N	Y	N	Y	N	Medium	Medium	Medium	Low	Low	Medium	Medium
SH1 – Waitati to Waikouaiti	Flooding, sea level rise, subsidence	Y	N	Y	N	N	N	Low	Medium	Medium	Low	Low	Medium	Low
SH1 – Dunedin to Waitati	Snow and ice	Y	N	Y	N	N	N	Low	Medium	Medium	Low	Low	Medium	Low
SH6 – Cromwell to Frankton	Single constrained route, rockfalls, slips, snow, ice	N	N	Y	N	Y	Y	Medium	Medium	Medium	Low	Low	Medium	Medium
SH6 – Frankton to Kingston	Single constrained route (Kawarau Falls Bridge, Devils Staircase), rockfalls, slips, snow, ice	N	N	N	N	Y	Y	Low	Medium	Medium	Low	Low	Medium	Low
SH8 – Omarama to Tarras (Lindas Pass)	Snow and ice	N	N	N	N	Y	N	Low	Medium	Medium	Low	Low	Medium	Low
SH 8 - Cromwell to Alexandra	Snow, ice, slips, no detours, Crowell Gorge	N	N	N	N	Y	N	Low	Medium	Medium	Low	Low	Medium	Low
SH8 - Alexandra to Milton (incl Beaumont Bridge, Mt Benger)	Snow, ice	N	N	N		N	N	Low	Medium	Low	Low	Low	Medium	Low
SH87 – Outram to Middlemarch	Snow and ice, flooding	N	N	N	N	N	N	Low	Low	Low	Low	Low	Low	Low
Southland														
SH94 – Te Anau to Milford Sound (inc Homer Tunnel)	Single constrained route, avalanche, rockfall, snow, ice, slips	N	N	N	N	Y	Y	Low	Medium	High	Medium	Low	High	Medium

NOTES:

*1 Viable Alternative = < 3 hours additional journey time on SH network.

*2 Impact Significance Rating Criteria

meets ≥ 4 criteria	High
meets 3 criteria	Medium
meets ≤ 2 criteria	Low

Routes identified as a life line are counted as 2 criteria in recognition of their importance to local communities.

*3 Likelihood Significance Rating for each route is identified by the highest ranking across the likelihood rows.

*4 Risk Assessment Matrix

Likelihood of Diruptive Event	Significance of Route & Impact on Route: Low	M	H
Low	L	L	M
Medium	L	M	H
High	M	H	H

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