



**Emergency
Management Otago**

Te Rākau Whakamarumarū Ōtākou

Otago Lifelines Group

Vulnerability and Interdependency Study

2024

Executive Summary





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Executive Summary

Lifelines play a critical part in the daily lives of people living within the Otago Region; without these many other services would be unable to operate and everyday activities would be significantly affected. In any emergency lifeline services become far more critical for both effective and efficient response and recovery. This study has endeavoured to identify the lifeline services present within the region and the specific impacts of hazards and loss of other services upon their ability to function as normal. This has included the undertaking of a risk assessment, review of the interdependencies between sectors and the identification of critical assets, hot spots (areas where a number of services are co-located) and pinch points (single points of vulnerability within a network).

The overall aim of this study is to provide both Otago Emergency Management and the individual lifeline Group members with a source of information to support planning, both in readiness and in response. This includes ensuring awareness between each sector regarding the interdependencies of other sectors upon their service, to ensure that the prioritisation for resilience activities in readiness and restoration in response is fully understood.

Otago's lifeline infrastructure

The Otago region contains both nationally and regionally critical infrastructure. Each sector has identified their critical assets, and these are summarised in the review. Key elements of the Otago Lifeline infrastructure are outlined in the following section.

Electricity generation and distribution

The Otago region generates nearly 40% of New Zealand's electricity from the Clutha and Waitaki rivers. While the majority of this electricity generation is from hydropower generation, other renewable power sources, such as geothermal, wind and solar power generation are all increasing within the region, with a number of significant projects planned within the next ten years.

Otago's electricity generation sites currently include:

- **Contact Energy's** two hydropower stations, Clyde (432MW) and Roxburgh (320MW), on the Clutha River, produce nearly 10% of New Zealand's electricity. The Clyde Hydropower Station is a critical site as it also houses the Control Centre for the Roxburgh and Hawea Dams.
- **Meridian's** six hydropower stations, Ohau A/B and C, Benmore, Aviemore and Waitaki in the Waitaki Valley, generate a maximum of 1540MW and supply 20-30% of New Zealand's electricity.
- **Manawa Energy** supplies around 130MW from four schemes that are a combination of wind and hydropower. The largest is Waipori Falls, which generates 72MW.
- **Pioneer Generation's** fifteen generation sites, which are a combination of hydro, gas and wind, generate a total of 43MW. No single site produces over 10MW.

There are a number of nationally critical sites within the region, including the Benmore, Clyde and Roxburgh switchyards, which form a critical element of the national grid. In addition, the Three Mile Hill switching station controls supply to both the Halfway Bush and South Dunedin substations.

There are a number of regionally significant substations, including the Halfway Bush substation supplying Dunedin and the CBD, The South Dunedin substation and the Cromwell substation that supplies the wider Queenstown, Wanaka and Cromwell areas.

Distribution of electricity is currently provided to approximately 120,000 customers by four main companies, Aurora Energy (97,000 customers in Dunedin / Central Otago), Lakelands network (4800 customers in the Queenstown / Wanaka / Cromwell area), Network Waitaki (13,400 customers in the Waitaki District) and PowerNet/OtagoNet (15,640 customers in the across the region). Each company maintains a network of lines and zone substations that are critical to ensuring the continuous supply of electricity to residential, commercial, and industrial properties.

Fuel (Petroleum products and gas)

Nationally there has been a significant change in the refining and supply of petroleum products. Where previously a large majority of New Zealand's petroleum products were refined at the Marsden Point Refinery in Northland and then shipped to storage facilities around the country, since the last study the Marsden Point Refinery has ceased production and is now a major storage facility for pre-refined product to enter the country.

Within the region, bulk fuel storage is located within Port Otago at three terminals, operated by Z Energy and BP. These are supplied by approximately 30 bulk shipments per annum. The terminals hold approximately one month of normal demand in petrol / diesel and approximately two weeks of Aviation

fuel. However, this can vary according to the time between bulk shipments, or if there is increased demand.

The biggest risk to the supply of fuel within the region is a loss of power supply. The terminals require significant power and require large generators to operate without normal power supplies. In addition, petrol stations are unable to operate pumps without an electrical supply and very few have the capability to operate using a three-phase generator.

Liquid Petroleum Gas (LPG) is also stored within the region at the Liquigas Dunedin depot and is brought into the region via the port. This facility holds approximately 1300 tonnes of bulk LPG that is then distributed to four LPG distributors; Genesis, Rockgas, Vector Ogas and Elgas.

Both Rockgas and Genesis Energy supply customers via reticulated networks; Rockgas supply the Queenstown and Wanaka areas and Genesis provides a reticulated supply in Dunedin.

As with the petroleum supply network, LPG is also heavily reliant upon a consistent power supply to move fuel from storage to end user. Liquigas does not currently have the capability for alternate power supply at the Dunedin Depot to move bulk product.

Telecommunications

The telecommunications sector is varied within the Otago region, with the use of fixed line (copper / fibre), mobile and satellite networks to provide connections. The region has many challenges for telecommunications provision due to the varied topography.

Traditionally most telephone connections into homes and businesses were provided by copper lines. However, across New Zealand the copper network is being retired in many urban areas and smaller settlements and replaced with fibre connections. Those who are unable to connect to an existing copper or fibre network (often those in rural / remote areas) are increasingly utilising mobile (3g/4g/5g) connections or satellite systems such as Starlink.

In addition to fixed line, mobile and satellite communications, the region also has an extensive network of mobile radio assets, operating both digital and analogue services. Many organisations, including the emergency services, local authorities, transport operators, lifeline providers and amateur user groups utilise VHF and UHF radio for the transmission of both voice and data.

The broadcast infrastructure for television and radio is operated by Kordia. Kordia operate a number of sites throughout the region that also house transmission for other services, including the mobile phone and mobile radio networks. This includes the nationally critical site at Mt. Cargill, which provides for the wider Dunedin area.

As with many services, the critical requirement for operation of the telecommunications sector is a consistent power supply. While many transmission sites have backup power supply, these are also reliant upon fuel to run. Transmission can be moved to other sites if a site should be non-operational, however, loss of a critical site can result in widespread loss of broadcasting capability, not just for radio and television, but also for mobile and VHF/UHF networks, as seen during Cyclone Gabrielle in Hawke's Bay (February 2024).

Roading network

The roading network within Otago is provided by New Zealand Transport Agency (NZTA) Waka Kotahi and each local authority. There are over 10,500km of roads within the region, both sealed and unsealed.

Road Authority Networks (km)	Sealed	Unsealed	Total
WDC	777	1035	1812 km
DCC	1070	694	1764 km
CDC	828	2070	2898 km
CODC	509	1376	1885 km
QLDC	490	348	838 km
NZTA Waka Kotahi	1306	0	1306 km

There are a number of key state highways that connect to neighbouring regions and the main centres within Otago. These include:

State Highway 1 – Main north to south route connecting Christchurch to Dunedin and Dunedin to Invercargill.

State Highway 6 – Only connection to the West Coast from Wanaka / Queenstown. Also, a key route to connect Queenstown and Invercargill.

State Highway 8 – Provides the main route connecting Dunedin with Queenstown / Wanaka via Alexandra and a link to the Canterbury region.

State Highway 85 / 87 – Alternate connection between Central Otago / Queenstown / Wanaka and Dunedin.

Sections of SH1, SH6, SH8 (link from Cromwell to Canterbury) and SH85 have been pre-identified through the Priority Routes project as priority 1 routes (first areas to be restored) in the event of a major emergency due to their criticality for keeping the region connected.

Roading infrastructure in the region is largely independent of other services and can operate without electricity and telecommunications, although this may create some issues on parts of the network (e.g. major intersections/traffic lights). The major threat to the network is direct impact from natural hazards such as earthquakes, flooding, and snowfall.

Rail network

The main rail network in the region is operated by KiwiRail and runs from the Waitaki River bridge north of Oamaru for 300km before entering Southland in the Waikaka Valley. The line provides freight for many industries, including forestry, dairy, coal and food supply.

The Taieri Branch line is managed by KiwiRail for the first 3km, but the remaining 61km to Middlemarch are operated by Dunedin Railways, who operate an inland tourist service.

The rail network in the region is vulnerable to the loss of other services, such as electricity, telecommunications, and fuel supply, all of which are critical for the safe operation of the network. In addition, the rail network consists of numerous bridges and tunnels and crosses a number of areas of low-lying land prone to flooding. Operation of the network is most likely to be caused by flooding or earthquakes, with impacts such as landslips and underslips resulting in damage to the lines and supporting infrastructure.

Airports

The Otago region has two nationally significant airports that provide both domestic and international travel, Queenstown and Dunedin. These are the fourth and fifth busiest airports nationally, moving over 3.3 million passengers annually.

In addition, the region has a number of smaller airports and aerodromes, which are largely used for commercial sightseeing operations and private use. These include Wanaka, Oamaru and Alexandra Airports.

Airports are heavily reliant upon electricity, telecommunications, and fuel to operate. The main airports in Queenstown and Dunedin are able to operate on backup services for approximately 3-4 days, with both having backup power generation and fuel storage. The smaller airports do not have the same capability for backup power generation but do have some bulk storage of fuel (although this would require power to transfer into aircraft).

All the airports within the region are susceptible to the impacts of natural hazards. Queenstown and Wanaka are both likely to be significantly impacted by an earthquake event, with likely damage to runways and infrastructure. Dunedin Airport is located in the Taieri floodplain and while there is flood protection in place, could be susceptible to flooding in an extreme event.

Maritime Ports

Port Otago consists of two main sites, Port Chalmers and Dunedin Bulk Port. Port Chalmers is the main port of call for cruise ships visiting the region and can support the largest container ships due to its depth. The Dunedin Bulk Port predominantly supports primarily fishing fleets with extensive wharf-side cold storage facilities. Port Otago provides 80% of freighted exports from the lower South Island. All logging from the region and Southland is exported via the port.

As with the other transport sectors, the port relies heavily on electricity, telecommunication, and fuel to operate its services. While there is some redundancy within the port, a significant event impacting power supply or fuel could have impacts on many parts of the port operations. With regards to natural hazards, the port is most vulnerable to severe weather events and tsunamis, although it is very protected due to its location within a harbour.

Water supply

Water production and supply networks are operated by local authorities within the region. These consist of reticulated systems in urban areas and some smaller towns and predominantly tank / bore systems in rural areas.

Central Otago District

Central Otago District Council operates nine schemes, the two largest being Alexandra and Cromwell, each serving around 5,000 customers (approximately 6,150 connections). Other schemes at Clyde, Roxburgh, Naseby, Omakau/Ophir, Ranfurly, Pisa Village and Patearoa supply 2,950 dwellings. Each scheme includes storage, treatment and pumping. The schemes in Alexandra and Cromwell are the most significant and therefore the most critical, however, the reservoirs and source and treatment facilities in other schemes are also critical to the supply of potable water in the district.

Clutha District

The Clutha District Council operates two large water schemes in Balclutha (2000 properties) and Milton

(1000 properties). The Balclutha raw water supply comes from the Clutha River and is stored in two off-site reservoirs and two smaller onsite reservoirs at the treatment plant. The Milton raw water supply is taken from the Tokomariro River and has two storage reservoirs.

The council also operates 16 rural water schemes and eight small-town supplies.

Dunedin

In Dunedin, raw water is taken from Deep Creek and Deep Stream and treated at the Mount Grand water treatment plant (WTP). This site supplies approximately 53% of the city's water demands. This site also supplies raw water to the Southern WTP which supplies the remaining 47% of water to the city. Additional production is also possible at the Port Chalmers WTP from spring to Autumn.

The water supply in Dunedin is mostly gravity-fed from the WTPs, with some small areas supplied by booster pumps. Water is fed via the northern pipeline to Waitati, Warrington and Seacliff communities. Dunedin City Council also provides smaller water supply schemes in Outram, West Taieri, and Waikouaiti (it also supplies Karitane communities, Merton, and Hawksbury Village).

Queenstown Lakes District

Most of the raw water for the Queenstown Lakes supply is sourced from Lakes Wakatipu and Wānaka, with the remaining requirements taken from bores. This supplies twelve schemes across the district, supplying the majority of the district's dwellings. Water treatment occurs near to source through UV and chlorination. Several water treatment sites on bores are due for upgrade in 2024/25. The larger treatment sites have backup power generation. Smaller sites have provision for smaller generators and the council has trailer-mounted generators for this purpose.

The supply network feeds 17,000 properties through 680km of piping and 34 pump stations. Storage at most sites allows for 12-24 hours of usual supply.

Waitaki District

Waitaki District Council operates 23 urban and rural water supply schemes, which supply 20,000 people (95% of the district's population). Two key sites are critical to the system's operation; Oamaru's Redcastle Road Raw Water Pump Station (WPS), which supplies around 15,000 people (there are ten days of raw water storage) and The King George Park WPS which supplies around 14,000 people (one day's treated water storage).

Wastewater

Central Otago District

Central Otago District Council provides a reticulated wastewater network to around 7,700 properties in eight schemes – Alexandra, Cromwell, Bannockburn, Roxburgh, Naseby, Omakau, Lake Roxburgh Village and Ranfurly. From a wastewater perspective, the district's critical sites are the treatment plants in Alexandra and Cromwell and large and terminal pump stations in those towns. In addition, wastewater pump stations in Roxburgh, Bannockburn and Pisa have also been rated as critical to the operation of the system.

Clutha District

Clutha DC provides reticulated wastewater to around 5,500 properties across 11 wastewater schemes, the two largest being Balclutha and Milton, servicing the same population as the water supply.

Dunedin

Wastewater is processed at a number of sites; Tahuna wastewater treatment plant (WWTP), Mosgiel WWTP, Green Island WWTP, with a number of smaller sites in Middlemarch, Seacliff, Waikouaiti/ Karitane and Warrington.

Queenstown Lakes District

Queenstown Lakes District Council provides wastewater reticulation to around 70% of the district's dwellings, discharging to treatment plants in Wanaka, Hawea, Cardrona, and Queenstown. This is pumped from properties to the treatment plants via 551km of wastewater pipes and 65 pump stations. Significant upgrades are planned for the treatment plant in Queenstown to ensure it is capable of meeting increased demand in the future.

Waitaki District

Waitaki District Council provides 10 reticulated wastewater schemes servicing around 16,000 people.

Of the 28 pump stations in the networks, three pump stations in Orwell Street, Beach Road and Regina Lane are the most critical, servicing between 3,000 and 9,000 people each.

Stormwater / Land drainage

Stormwater networks are owned and operated by the local authorities. These consist of piped networks in urban areas and smaller settlements, with additional pumping in areas where the water is unable to be moved by gravity alone. In general, systems are built to a minimum 1:10 year rainfall event and secondary systems (overland flow paths, detention areas) to a 1:100 year event.

Many stormwater systems across the region are currently undergoing upgrades, due to age and a need to increase capacity. Major projects are underway in Dunedin and Queenstown as of 2024 and ongoing maintenance of the networks across the region will also involve upgrading the piping networks where necessary.

The Otago Regional Council operates flood protection and land drainage schemes to approximately 43,000ha of rural and urban land in the region. This consists of seven flood protection schemes, which include 200km of flood stopbanks, 12 pumping stations and 55 bridges.

Waste Management

Each local authority operates waste management sites within their area, including transfer and landfill sites. These can receive a range of different waste streams, however, some waste streams created by emergency events may be unsuitable for existing landfill sites or may exceed their capacity.

Fast moving consumer goods

The movement of food supplies, sanitary products and other household items (including medication) has recently been added to the lifelines environment. This sector is dominated by the two largest retail groups (Foodstuffs and Woolworths). Most supermarkets run with a 2-3 day supply of goods ('just in time' supply), however, buying behaviours may cut this down to 24hrs very rapidly.

Supermarkets in the Otago region are predominantly supplied from distribution centres located in Christchurch. However, Foodstuffs does have some distribution located in Dunedin.



The FMCG sector is greatly impacted by the loss of a range of other lifeline sectors, including electricity supply, telecommunications, fuel and roading / rail disruption. Physical damage to buildings from natural hazards such as flooding and earthquakes may also impact their ability to operate.

Financial sector

The importance of the financial sector is significant to the ability for people to carry out their normal daily lives. Access to banks, ATM's and the EFTPOS system allows the exchange of money and the purchasing of supplies. There are numerous banks and ATMS located throughout the region, and these are heavily reliant upon a consistent electricity supply and telecommunications infrastructure. Most sites within the region are exposed the risk of earthquake and several facilities located in Queenstown and Wanaka are exposed to the risk of flooding.

Lifeline interdependencies

Throughout the study the interdependencies between lifelines sectors has been a key element in the ability of many sectors to function, both in BAU and in response. The loss of another lifeline service can result in complete shutdown of other lifelines. The table on the next page shows the interdependencies between sectors and the criticality of the relationship for on-going provision of the service.

		Utility dependency														
		Potable water services	Stormwater services	Wastewater services	Electricity Generation	Electricity Transmission (Grid)	Electricity Distribution (Local)	Telecommunications	Roading Networks: State Highways	Roading Network: Local Authority	Rail network	Airports	Ports	FMCG / Finance	Waste Management	Fuel
Lifeline Service provided	Potable water services				1	1	1	1	2	1						1
	Stormwater services				1	1	1	1	2	1						1
	Wastewater services	1			1	1	1	1	2	1						1
	Electricity Generation	1		2	*	1	1	1	1	1		2	1	2		1
	Electricity Transmission (Grid)			2	1	*	1	1	1	1		2	1	2		1
	Electricity Distribution (Local)		2	2	1	1		1	1	1		1	1	2		1
	Telecommunications			2			2	*	2	2	2	2		1		1
	Roading Networks - State Highways		1		2	2	2	2	*						2	1
	Roading Networks - Local Authority		1		2	2	2	2		*					2	1
	Rail Network				2	2	2	2	1	1	*		2			1
	Airports	2	2	2	2	2	1	1	2	2		*		2		1
	Ports				2	2	2	2	1	2	1		*			2
	FMCG / Finance & Cash	1	2	1			2	2	1	1	2	2	2	*	1	1
	Waste Management								1	1						1
	Fuel	1			2	2	1	1	1	1			1			*
	Health	2		1			2	1		1		1		1	2	1
	Fire and Emergency	1					2	1	2	1		1		1		1
New Zealand Police	1					2	1	2	2		1				1	

Scoring / Key:

1	Critical for service provision	2	Critical, but some back-up capability in place		Not required for service to function in BAU	*	Reliant on inter-regional links or reliant on itself
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Table 1: Lifeline interdependencies within the Otago region



As can be seen in table 1 on the previous page, there is a common reliance across all lifeline sectors for the provision of fuel to operate. In addition, the distribution of electricity, telecommunications and roading networks are all critical for other lifelines sectors to operate.

Regional hazardscape

The Otago region has several hazards that can impact the operation of lifeline services. These include:

- Earthquake (Alpine Fault or local fault)
- Severe weather (Wind/rain) / Flooding
- Drought / Wildfire
- Snowstorm
- Tsunami (Local / Regional / Distant source)
- Coastal erosion/inundation (Storm surge)
- Cyber-attack / Global service outage
- Solar storm event
- Human Pandemic

Each of these hazards can occur to a varying degree, with earthquakes and severe weather the most likely to have a significant impact on the operation of lifelines within the region.

Earthquake

The Otago region is prone to earthquakes from faults located all across the region. The largest risk comes from the Alpine Fault, which runs from the south to the north of the South Island. This Faultline represents the intersection between the Australasian and Pacific tectonic plates and is capable of large earthquakes above magnitude 8. The fault has a recurrence interval of approximately 300 years, and it is currently thought there is a 75% chance of an earthquake in excess of magnitude 8 occurring in the next 50 years. This makes it a significant risk for the region and has the potential to be devastating to lifelines within the region, particularly in the Queenstown Lakes District and Central Otago Districts.

Other faults exist throughout the region and have the potential to rupture in close proximity to populated areas of the region, resulting in significant local impacts.

Severe weather/flooding

Severe weather is a common hazard across New Zealand and can result in widespread flooding and damage. The Otago region is exposed to significant winter storms from the Southern Ocean and Tasman Sea that can deliver very high wind speeds and significant amounts of rainfall. Not every event results in widespread flooding across the region, but on occasion, these storms can result in many of the region's rivers breaking their banks and flooding surrounding land. It is very possible that a significant storm resulting in widespread flooding will occur in the near future and these extreme events are becoming more prevalent with the advent of climate change.

Drought / Wildfire

Drought occurs due to significant periods without rainfall and sustained warm temperatures. This results in reduced river and groundwater levels and impacts to plant growth and services that utilise water. It can also greatly increase the risk of wildfires.

The Otago region is prone to drought and has experienced severe drought over the past two decades. In Central Otago, potential evaporation always exceeds precipitation (rainfall or snow), except in winter. This means that drought conditions are almost continuous.

The occurrence of drought is likely to increase with climate change, with the region seeing increased frequency and severity of droughts.

Wildfires can occur in forestry, agricultural production land and areas of scrub. Fires can be started naturally, by lightning strikes, or by arcing from electricity supply lines and acts of arson. Fire is most common when ground moisture levels are low and relative humidity in the air is also low, providing perfect conditions for ignition. High winds can also result in larger fires, providing mobilisation for hot embers and fanning flames.

The risk of wildfire is at the highest in summer months within Otago when ground conditions are at their driest. Areas in Otago exposed to wildfire risk include rural areas, native or plantation forests, shrub lands and grasslands. In addition, wildfires can also travel across the rural-urban divide, exposing buildings and infrastructure to this risk.

Snowstorm

During the winter months, the Otago region can be exposed to southerly storms that can bring low temperatures and high levels of precipitation. In high country areas of Central and Western Otago, this precipitation falls as snow, generally above 500m elevation. However, in some circumstances the temperatures can be low enough for the entire region to be exposed to significant snowfall and past events have seen several centimetres of snow down to sea level.

Tsunami / Lake tsunami and Seiche

Tsunami can be generated from earthquakes, volcanic eruptions or underwater landslides. These events may occur close to the New Zealand coastline or across the other side of the Pacific Ocean. These can be local source (Puysegur Trench, local offshore faults or landslide), regional (Hikurangi subduction zone / Tongan – Kermadec Trench), or from distant sources, such as South America. They may also occur within enclosed bodies of water due to the movement of the lakebed (Lake tsunami) or as a result of rockfall (seiche).

A tsunami could impact the districts of Waitaki, Dunedin and Clutha across 480 kilometres of coastline. Low-lying land near the coast and lakeside communities are most vulnerable to the effects of tsunami, although harbours, offshore islands and headlands do afford a degree of protection. Many lakes within the region are susceptible to tsunami and lake seiche due to their proximity to the Alpine fault.

Coastal erosion

The term storm surge describes a state of elevated sea level due to a combination of tides, wind stress, atmospheric pressure and waves and storms.

Detailed modelling of selected communities along the Otago coastline by NIWA (2008) considered a range of storm surge return periods between 20 and 500 years. This modelling suggests that for storm surge events with return periods as low as 20 years the sea may reach a level of up to 2.37m above msl on the Otago coastline (NIWA, 2008). Storm surge can inundate land, often for prolonged periods resulting in damage to buildings, roads and submerged infrastructure. Storm surge waters may also entrain debris which can cause additional damage.

Cyber-attack / Global service outage

A cyber-attack is an assault launched by cybercriminals using one or more computers against a single or multiple computers or networks. A cyber-attack can maliciously disable computers, steal data, or use a breached computer as a launch point for other attacks. Cybercriminals use a variety of methods to launch a cyber-attack, including malware, phishing, ransomware, and denial of service.

A global service outage can be triggered by a virus, or loss of a key component from a system, disabling its ability to operate. Global outages are fairly common, but for short periods of time and generally in specific systems, such as Microsoft 365. However, as seen recently, the loss or corruption of a core system component (such as security software) can lead to significant impacts across many services, including lifelines.

Solar Storms

Driven by the Sun, space weather occurs in the areas between the Sun and other planets in the solar system and tends to impact Earth much higher in the atmosphere than meteorological events. Solar activity follows an approximately 11-year cycle, with sunspot activity peaking at 'solar maximum.'

During times of high activity, coronal mass ejections (CME's) come from the Sun: these are large expulsions of plasma and magnetic field from the Sun's corona. When a CME reaches Earth, it affects our magnetic field causing auroras. The fastest Earth-directed CMEs can reach our planet in as little as 15-18 hours; slower CME's can take up to three days to reach earth.

Solar flares are large eruptions of electromagnetic radiation from the Sun. Unlike CME's which can be 'forecast,' the sudden outburst of electromagnetic energy travels at the speed of light: any effect upon the sunlit side of Earth's exposed outer atmosphere occurs around the same time that the event is observed.

Although uncommon, large space weather events have occurred in New Zealand in the past, causing electricity blackouts and damage to infrastructure.

Human Pandemic

A pandemic is an epidemic of infectious disease that spreads through populations across a large region. The most recent pandemic to impact New Zealand is COVID-19. Several other events have impacted New Zealand in the past, including the 1918 Spanish Flu epidemic.

Lifelines risk assessment

The risk of hazards on each lifeline have been determined utilising the National Emergency Management Agency's (NEMA) Risk Assessment tool, as outlined in the DGL23/22 Risk Assessment: Guidance for CDEM Group planning.

While this risk assessment provides an overview of the potential impact of a hazard across the region, it does not determine risk and impacts at a local level. The risk to specific assets has been determined through workshops, surveys and available hazard information. The overall risk is defined based on the likelihood of the hazard occurring and the scale of impact it may have upon a specific lifeline sector.

The risk assessment utilises Maximum Credible Event (MCE) scenarios to ensure that all the possible impacts of a specific hazard are captured. The scenarios utilised to determine the risk levels from each hazard are shown in the appendices. While these scenarios represent the worst case scenario, they represent only one possible scenario amongst many that could occur. The use of MCE scenarios also means the likelihood of occurrence is different to smaller scenarios, which may occur more frequently.

The likelihood for a hazard is determined using the Annual Return Interval (ARI) or Annual Exceedance Probability (AEP). These are set based on historical records of event and scientific research.

	Severe Earthquake		Severe weather - Flooding		Drought - Wildfire		Snow storm		Tsunami		Coastal erosion / inundation (Storm surge)		Cyber attack		Solar storm event	
	Likelihood of MCE scenario occurrence															
	Possible*		Possible		Possible		Possible		Rare		Possible		Unlikely		Unlikely	
	Consequence / Impact	Risk level	Consequence / Impact	Risk level	Consequence / Impact	Risk level	Consequence / Impact	Risk level	Consequence / Impact	Risk level	Consequence / Impact	Risk level	Consequence / Impact	Risk level	Consequence / Impact	Risk level
Water production and supply	Extreme	Very High	Moderate	High	Moderate	High	Moderate	High	Minor	Low	Minor	Medium	Moderate	Medium	Moderate	Medium
Wastewater services	Extreme	Very High	Major	Very High	Moderate	High	Moderate	High	Moderate	Low	Minor	Medium	Major	High	Moderate	Medium
Stormwater services	Extreme	Very High	Major	Very High	Minor	Medium	Minor	Medium	Moderate	Low	Moderate	High	Insignificant	Low	Insignificant	Low
Flood schemes	Extreme	Very High	Extreme	Very High	Insignificant	Low	Minor	Medium	Moderate	Low	Moderate	High	Insignificant	Low	Minor	Low
Electricity production	Extreme	Very High	Major	Very High	Insignificant	Low	Minor	Medium	Insignificant	Low	Insignificant	Low	Major	High	Major	High
Electricity distribution	Major	Very High	Moderate	High	Major	Very High	Moderate	High	Moderate	Low	Insignificant	Low	Extreme	Very High	Major	High
Telecommunications	Extreme	Very High	Major	Very High	Major	Very High	Moderate	High	Moderate	Low	Minor	Medium	Major	High	Major	High
Roading networks - State Highways	Extreme	Very High	Major	Very High	Moderate	High	Moderate	High	Moderate	Low	Moderate	High	Insignificant	Low	Insignificant	Low
Roading networks - Local Authority	Extreme	Very High	Major	Very High	Major	Very High	Moderate	High	Moderate	Low	Moderate	High	Minor	Low	Minor	Low
Rail network	Major	Very High	Major	Very High	Moderate	High	Moderate	High	Moderate	Low	Major	Very High	Moderate	Medium	Moderate	Medium
Airports	Extreme	Very High	Major	Very High	Moderate	High	Minor	Medium	Minor	Low	Insignificant	Low	Minor	Low	Minor	Low
Port Otago	Moderate	High	Moderate	High	Minor	Medium	Minor	Medium	Moderate	Low	Minor	Medium	Moderate	Medium	Major	High
Fuel storage and distribution	Major	Very High	Moderate	High	Minor	Medium	Minor	Medium	Moderate	Low	Minor	Medium	Minor	Low	Moderate	Medium
Waste management facilities	Extreme	Very High	Major	Very High	Minor	Medium	Minor	Medium	Insignificant	Low	Minor	Medium	Minor	Low	Minor	Low
Fast moving consumer goods	Extreme	Very High	Extreme	Very High	Moderate	High	Minor	Medium	Insignificant	Low	Insignificant	Low	Insignificant	Low	Insignificant	Low
Finance	Major	Very High	Major	Very High	Minor	Medium	Minor	Medium	Insignificant	Low	Insignificant	Low	Major	High	Major	High
Overall Risk of hazard to regional lifelines	Very High		Very High		High		Medium		Low		Medium		High		Medium	

Table 2: Otago region lifeline risk assessment

As can be seen in the table above, earthquake and severe weather / flooding present a significant risk to the lifelines within the region. In addition, drought / wildfire and Cyber Attack / Global service outage also present a high risk.

It is also of note that several individual lifeline sectors are at very high or high risk from the majority of hazards that may occur in the region. These include electricity distribution, telecommunications and roading which may all be adversely affected. Only tsunami would have limited impacts on the lifeline services within the region and this is largely due to the lower risk the region faces when compared to other regions within New Zealand.

Critical Regional Assets

Lifeline infrastructure criticality has historically been defined in three levels; Nationally significant, Regionally significant and Locally significant

Nationally Significant

Nationally significant infrastructure is defined as:

“Failure of the asset/supply would have national significance and cause loss of utility supply to most of the region or loss of supply to another nationally significant site that depends upon its service”

Within the region, there are a number of nationally significant assets and sites. These include:

- Benmore, Roxburgh, and Clyde power stations and switchyards (critical to the national grid)
- Kordia Mt Cargill Transmission Site (Criticality 1)
- Chorus Eastern Core Fibre Route
- Queenstown Airport (international tourism hub)

Regionally Significant

Regionally significant infrastructure is defined as:

Failure of the asset/supply would cause loss/disruption to more than **20,000** customers or reduction in service across the region or loss of supply to a regionally significant site.

Within the region, there are a number of regionally significant assets and sites. These include:

- Halfway Bush Substation (supplies large parts of Dunedin, including the CBD)
- Three Mile Hill, and South Dunedin Substations
- Oamaru, Livingstone, and Balclutha Substations
- Frankton, and Cromwell Substations
- Naseby Substation (future critical infrastructure for planned solar farm)
- Port Otago (primary import for fuel in the region)
- Kordia Obelisk Transmission Site
- Z and NZOSL Fuel Terminals (backed up by overland transport from north/south)
- Starlink Base Station: Cromwell
- One NZ: Dunedin POP / Balclutha POI (Point of Interface) /
- Northeast Dunedin Radio Access Network transmission hub.
- Regional VHF / UHF repeater sites: Cape Wanbrow, Mt. Cargill, Razorback, Remarkables, Roys Peak

Locally Significant

Locally significant infrastructure is defined as:

Failure of the asset/supply would cause loss of supply to more than **2000** customers or reduction in service across part of the region or loss of supply to a locally significant customer.

Within the region, there are many locally significant assets and sites. These include:

- Water and sewage pipelines
- Key arterial routes, such as main highways and council roads
- Individual electricity supply assets, such as roadside cabinets and supply lines (overhead and buried lines)
- Telecommunications cabinets (for Copper and fibre connectivity)
- Local repeater sites

Regional “Hot Spots” and “Pinch points”

- A **hotspot** is an area with a high concentration of different lifeline assets, for example a road or rail bridge which has fibre, electricity, and water infrastructure running through/beneath it.
- **Pinch points** are significant areas for one lifeline sector. There is usually no satisfactory alternative available, or an alternative is difficult to implement, and it is therefore essential to service delivery.

Geographic Hotspots

South Dunedin/Portsmouth Drive

The low-lying South Dunedin and Harbourside area is at risk of flooding either due to runoff from the surrounding hills or groundwater ponding from an elevated water table in South Dunedin, storm surge, tsunami and liquefaction and contains several critical utilities, including:

- The South Dunedin sub-station GXP, which services 17000 customers.
- The Tahuna wastewater treatment plant and the Musselburgh pumping station pump Dunedin's wastewater to the treatment plant.
- The main telecommunications exchange.

Future mitigation plans:

Delta is evaluating a project to link the Halfway Bush and South Dunedin substations to provide back-feed options if the South Dunedin substation is not operating.

Kawarau Gorge

The Kawarau Gorge has numerous locations, such as Nevis Bluff, that are prone to alluvial fan activity, rock falls, and landslides, many of which interact with areas of appreciable seismic risk.

The electricity transmission lines to Queenstown run along or near the Gorge, as does SH6 and the main fibre cable owned by Chorus.

SH6 through the Kawarau Gorge is the main route from Cromwell to Queenstown, with alternative State Highway routes adding around 4 hours to the journey.

Roxburgh Dam

Transpower's Roxburgh substation/switchyard and three major electricity transmission lines through the area make this a key electricity hub for the South Island. Loss of the switchyard would cause significant disruption to the electricity supply on South Island. However, the criticality of the transmission lines depends on the time of year (demand is high in winter, and the Aurora transmission lines through the area provide some diversity).

SH8 passing by the Dam is also part of the key roading route from Dunedin to Cromwell (the alternative route of SH 85 adds at least another 30 minutes to the journey)

The main risks to the area are landslides, and those located on the slopes above Lake Dunstan are monitored on an ongoing basis.

Waitaki Bridge

The Waitaki Bridge area is at risk of flooding from the Waitaki River, tsunami and liquefaction during an earthquake. SH1, Transpower overhead transmission lines, the Chorus fibre cable, and the main South Railway line all pass over the river nearby. The alternate route to SH1 via Kurow adds 1.5 hours to the journey.

Haast Pass

The Haast Pass is a key inter-regional link to the southern portion of the West Coast and becomes increasingly mountainous and remote around the divide. The area is prone to tree fall due to strong winds, snow, ice and heavy rain. There are significant areas of rockfall hazard around the shores of

Lake Wanaka and the upper reaches of the pass. Heavy rainfall can result in several creeks and streams crossing the highway, depositing a significant amount of material. Other critical infrastructure assets, such as fibre, utilise the road network.

Lindis Pass

The area is most vulnerable to snow due to its altitude, but parts of the road can be affected by flooding and alluvial fan activity during times of heavy rainfall. Several landslides are mapped over the Pass, and strong seismic shaking may trigger them.

Significant assets crossing the Lindis Pass include one of two Chorus fibre cables supplying Otago, SH8 and Transpower transmission lines, and it is a significant freight route for food and fuel from and into Central Otago.

Taieri Plain

Assets on the Taieri Plains include SH1 and SH86, KiwiRail's main trunk railway line, Dunedin International Airport, critical Transpower transmission lines and Berwick Switchyard and transmission lines connecting Mercury's Mahinerangi power generation assets (Wind Farm) to the grid.

Many of these assets rely on the Taieri flood protection and drainage schemes for flood protection; however, larger 'super-design' events are still possible and could potentially inundate large amounts of the Taieri Plains. The basin is bound by active faults to the north and south and consists of fine silts and sands that are potentially susceptible to liquefaction.

West Taieri is especially low-lying and may be affected by tsunami and storm surge events that restrict the passage of water down the Taieri River during high flows. Alluvial fans and landslides have been mapped on the margins of the Taieri Plains, although most assets are sufficiently set back from slopes to be directly affected.

Future mitigation plans:

ORC has an ongoing programme of work to ensure there is backup generation available at pump stations across the Taieri.

Katiki Strait

Assets passing through this area include SH1, Transpower overhead transmission lines supplying areas from Waitaki to Oamaru and Chorus's trunk telecommunications cable.

This area is most susceptible to coastal hazards, including coastal erosion, storm surges, and tsunamis, and will be increasingly affected by such hazards under the predicted rise in future sea levels.

Three Mile Hill – Dunedin

Three Mile Hill is a critical road route into Dunedin from the south, as well as having Transpower transmission lines and a switchyard supplying a significant portion of Dunedin's electricity. Three Mile Hill is most susceptible to closure due to snowfall and ice.

Clyde and northwards to Cromwell Gorge

Clyde is a significant electricity hub, and SH8 passes through the area. Northwards from Clyde is the Cromwell Gorge, which has a large exposure to landslide risk.

The Clyde switchyard feeds power into the National Grid for the supply of electricity north or south, as well as the local distribution network from Alexandra to Raes Junction and out towards the Maniototo. There is some local generation (Pioneer) that can supply a small area. Clyde PowerStation has the ability to Black Start in case of a total South Island national grid blackout.

Pinch Points (Single Sector)

Upper State Highway 8 main route from Christchurch to Central Otago

SH8 is a key regional transport route and the main route from Christchurch to Queenstown. It is highly vulnerable at several points to slips and flooding, and the alternate route is via SH1/SH85, which adds approximately 1 hour to the journey.

Dunedin's Motorway network

Dunedin's Motorway network is a critical transport route and is vulnerable to landslides and snow/ice. There is alternate access via the Mount Cargill route, but this may be unsuitable for larger vehicles. Kilmog Hill, north of Waitati on SH1, is also vulnerable to landslides and snow/ice. The alternate route via the Coast Road is suitable for light vehicles but also has a number of mapped, active landslides present

Bulk fuel supply – Port Otago

All regional fuel is brought in and stored at the facility in Port Otago. Inability for vessels to offload, or access to the port by tankers, could have significant impacts upon the region. While alternative storage facilities are located in Bluff, Timaru and Lyttleton, these are a significant distance to transport the volumes of fuel needed.

Recommendations for future work

Otago CDEM Group Catastrophic Planning

Lifeline providers will play a huge part in the response and recovery to major events within the region. It is therefore essential that the CDEM Group is provided with information pertaining to the restoration of services to support the preparation and planning for any significant event within the region.

Identification of impacts of lifeline infrastructure failures on the wider environment

The identification of the social, economic, and natural impacts of lifeline utility failures can provide the CDEM Group and partner lifeline organisations with critical information to support prioritisation of reduction and mitigation works and planning for service restoration in an emergency. This may include the use of systems such as Riskscape to provide analysis of the impacts of outages and identification of critical assets.

Emergency Debris Management Plan

Debris management in an emergency event is critical to the recovery of impacted communities. Often the debris created by emergencies requires specific processes and management to ensure the risk to people and environment is minimised. The development of a waste management plan can

support identification of processes for different waste streams and ensure effective management of assets in response and recovery.

Development of a regional generator plan

There is a high reliance across lifeline providers for back-up power generation. These resources are limited within the region and will require significant coordination to ensure their placement and use is prioritised for maximum effect in response and recovery. As such, the Otago region should strongly consider developing a regional generator plan which identifies the requirements across lifelines and other key response organisations, coordination and logistical arrangements and prioritisation for specific hazards and their impacts.

Further development of the GIS portal

The inclusion of lifeline utility data in the GIS portal can assist the CDEM Group to identify where gaps in resilience exist, and to plan for response and recovery. While this is a solid step forward for situational awareness, further efforts are required to best leverage the collected information, such as refining what is displayed/clarifying what needs to be viewed.

Future work should include further identification of assets likely to be impacted by specific hazards, integration with the Southland Priority Routes project, and including the locations of alternate / backup utilities to support community facilities (such as Civil Defence Centres (CDCs)).

Ensuring this is accessible to all lifeline members will increase the understanding of key interdependencies between agencies.

Otago CDEM Group Regional Communications plan

Communications in an emergency is critical for clear coordination and the sharing of information. This is supported by a number of methods, as illustrated in this study. Therefore, it is critical to understand where key communications equipment is located and who owns and operate the resource, which agencies have access to which services (e.g. VHF / UHF / Satellite etc), which frequencies are currently being used and the contacts within each organisation (both personnel and call signs). This would enable a clear communications plan for use in emergencies to be established and provide prioritisation for restoration of critical sites to enable its enactment.

Lifelines Group training and exercising

The coordination of lifeline utility providers in response is critical to ensuring effective response and recovery. Familiarity with the systems and requirements of response, as well as the current plans and procedures, is vital to enable this to occur. Training and exercising are a keyway to ensure readiness for response and this should be encouraged across the lifeline Group, both with utility providers to test their individual arrangements and across the wider Lifeline Group to ensure effective coordination. Where possible, collaboration should be sought between Otago Lifelines Group members when organising training events such as CIMS, to further develop relationships and reduce the cost of training to each participating organisation.