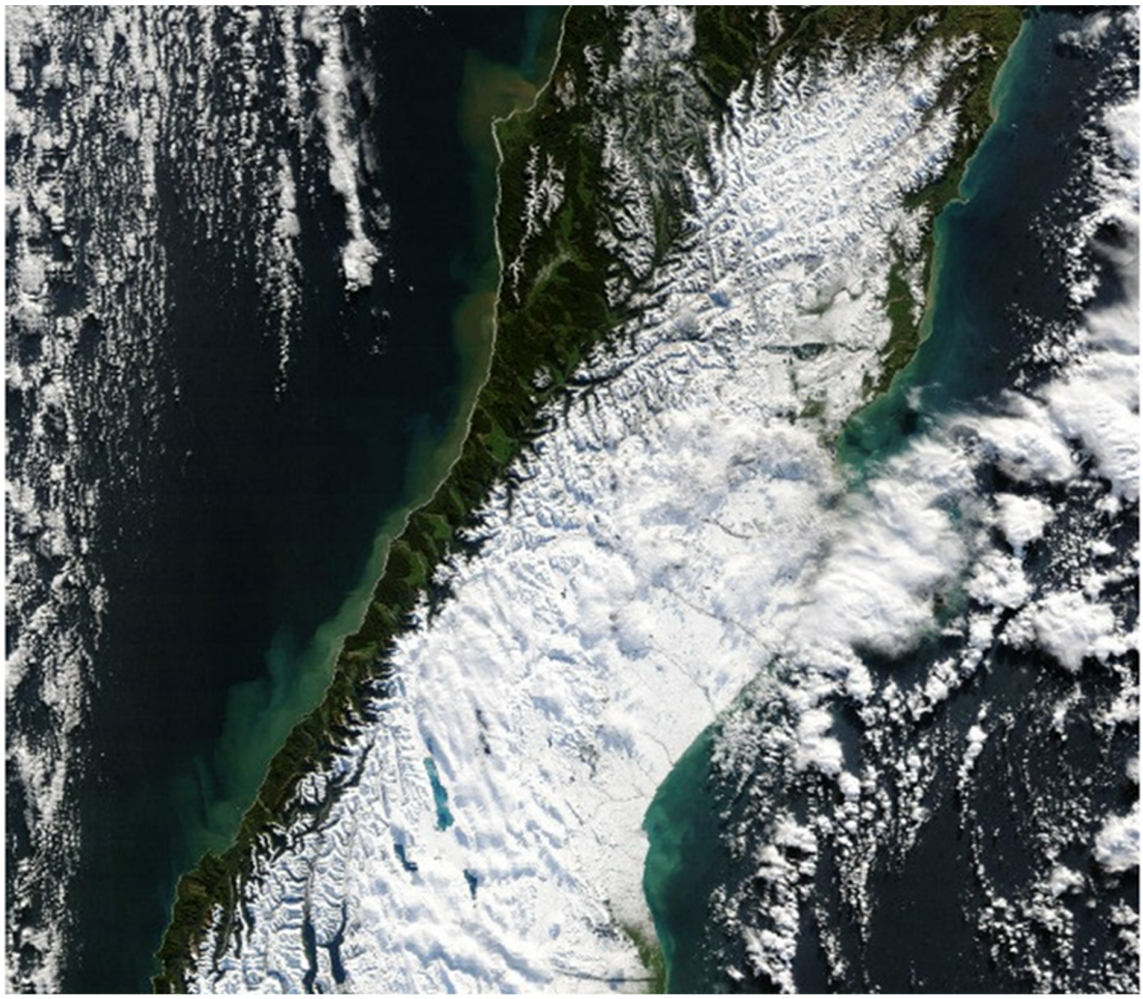
Risks and Resilience

Advancing the Maturity of Infrastructure Vulnerability and Resilience Investment Business Case Assessments

Pilot Approach and Data Needs Report

Canterbury Civil Defence Emergency Management Group



Quality Information

Document	Risks and Resilience: Advancing the Maturity of Infrastructure Vulnerability and Resilience Investment Business Case Assessments – Milestone 3: Pilot Approach and Data Needs Report
Ref	
Date	30 August 2022
Prepared by	Mark Gordon, Martyn Wooster
Reviewed by	Charlotte Brown

Revision History

Rev	Revision Date	Details	Authorised	
			Name/Position	Signature
1	30 August 2022	Final Report	Mark Gordon	

Table of Contents

1.0 Introduction 1
- 1.1 Context 1
- 1.2 Project Summary 1
- 1.3 Milestone 3 Tasks Summary 1

2.0 Project Approach 3
- 2.1 Overview 3
- 2.2 Lifelines GIS Portal 3
- 2.3 Urban Intelligence Platform 4
- 2.4 MERIT 4

3.0 Data Attributes / Data Schema 5
- 3.1 Data Schema 5
- 3.2 Data Input Formats 5
- 3.3 Lifelines Sectors 5
  - 3.3.1 Sector Types 5
  - 3.3.2 Sub-sector Types 6
  - 3.3.3 Sector Alignment 6
  - 3.3.4 Reference Files 6
- 3.4 Asset Class Analysis 7
  - 3.4.1 Asset Class Alignment 7
  - 3.4.2 Continuous Development 7
- 3.5 Asset Class Library 7
  - 3.5.1 Airfields 7
  - 3.5.2 Electricity 8
  - 3.5.3 Flood Protection 8
  - 3.5.4 Liquid Fuels 9
  - 3.5.5 Gas 9
  - 3.5.6 Ports 9
  - 3.5.7 Rail 10
  - 3.5.8 Roads 10
  - 3.5.9 Solid Waste 10
  - 3.5.10 Stormwater 10
  - 3.5.11 Telecommunications 11
  - 3.5.12 Wastewater 11
  - 3.5.13 Water Supply 11
  - 3.5.14 Exclusions 12
- 3.6 Asset Data Attributes 12
  - 3.6.1 Common Attributes 12
  - 3.6.2 Other Information Needs 12

4.0 Pilot “Proof of Concept” Approach 14
- 4.1 Pilot Area 14
  - 4.1.1 North Canterbury Lifeline Utilities 15
  - 4.1.2 Community Sites 15
  - 4.1.3 Ports and Bulk Fuel Facilities 16
- 4.2 Hazards 16

Appendix 1: Glossary 17

Figures

Figure 2-1	Features of the Maturity Pathway	3
Figure 4-1	Pilot Area	14

Tables

Table 3-1	Lifelines Sector Types	5
Table 3-2	Sub-sector Types	6
Table 3-3	Sector Categorisation extract	6
Table 3-4	Lifelines Data Capture Review Files	6
Table 3-5	Fuel Sector Asset Class Review Approach	7
Table 3-6	Airfields Sector Asset Classes	8
Table 3-7	Electricity Sector Asset Classes	8
Table 3-8	Flood Protection Sector Asset Classes	8
Table 3-9	Liquid Fuels Sector Asset Classes	9
Table 3-10	Gas Sector Asset Classes	9
Table 3-11	Ports Sector Asset Classes	10
Table 3-12	Rail Sector Asset Classes	10
Table 3-13	Roads Sector Asset Classes	10
Table 3-14	Solid Waste Sector Asset Classes	10
Table 3-15	Stormwater Sector Asset Classes	11
Table 3-16	Telecommunications Sector Asset Classes	11
Table 3-17	Wastewater Sector Asset Classes	11
Table 3-18	Water Supply Sector Asset Classes	12
Table 3-19	Common Attributes	12

1.0 Introduction

1.1 Context

Lifelines infrastructure includes the transport, energy, telecommunications and water services sectors that are fundamental to New Zealand's communities and economy. The importance of these assets and the services they provide cannot be overstated, and the impacts of their failure has been evidenced in many recent national and international events.

Through the New Zealand Lifelines Council (NZLC) and 15 Regional Lifelines Groups, New Zealand's lifeline utility organisations work together on projects to understand and identify ways to mitigate the impacts of hazards on lifelines infrastructure.

Many significant national research programmes are improving our national understanding of hazard risks; the Alpine Fault, Wellington Fault, Hikurangi Subduction Zone, Climate Change, Auckland and Taupo Volcanic areas and Mount Taranaki, are all the subject of ongoing major studies.

Source: New Zealand Critical Lifelines Infrastructure, National Vulnerability Assessment (New Zealand Lifelines Council, 2020), Executive Summary.

1.2 Project Summary

This project seeks to "connect the dots" in relation to data, tools, resources, knowledge, and practice, with the aim of facilitating informed, up-to-date, and efficient vulnerability and resilience assessments using a lifelines GIS portal. A maturity-based approach has been developed and is to be tested along with a recommended data schema that can be nationally applied.

Engagement has to date largely focussed on the lifelines sector, universities, and research agencies. Drawing on research programmes and tools, an "intermediate" level approach that lies between the current methodology for vulnerability assessments and the more comprehensive "Wellington Regional Lifelines programme business case" approach[1] has been developed.

Using the North Canterbury region and Canterbury Lifelines Group as a pilot, this "intermediate" approach will also inform Phase 2 of the *Risks & Resilience* project, utilising the GIS portal and information documented in Phase 1 (Vulnerability Assessment).

1.3 Milestone 3 Tasks Summary

This report summarises the outcomes of the 'Describe Integrated Approach' milestone, comprising Tasks 7, 8 and 9 as described in the following table.

Task	Description	Summary
7	Scope up a pilot for Canterbury – agree selection of hazard event types (e.g., AF8 earthquake, tsunami, flood), select LLUs in key sectors and engage with them (including power, fuel, telecommunications, transport, water, wastewater). This could be a sub-regional area within Canterbury. The pilot will be used to test the "intermediate" approach using MERIT and extend on Canterbury's Risks & Resilience Phase 1 to develop broad-brush indication of potential economic impacts.	North Canterbury has been selected as the pilot area – comprising the Kaikoura, Hurunui and Waimakairiri Districts. The key hazards for vulnerability assessment are flooding and tsunami.

[1] Refer to https://www.wremo.nz/assets/Uploads/191111-Wellington-Lifelines-PBC-MAIN-20191009.pdf

Task	Description	Summary
8	Define the data attributes / data schema for each lifelines sector and by hazard event type needed to conduct an "intermediate" level analysis. Describe also the future data needs for "advanced" practice using RiskScape 2.0. Data schema will be tested, modified and recommended for national adoption as an outcome of this project.	Data schemas developed for all lifeline sectors for core and intermediate. Additional attributes to support loss modelling and economic analysis are defined.
9	Approach documented. Agreed participation in the pilot "intermediate" level analysis, defined scope of this analysis, agreed data schema and required data attributes for the pilot.	Modelling approach described and participants identified.

2.0 Project Approach

2.1 Overview

The overall approach is based on the steps presented in the Maturity Pathway report, shown in the diagram below. This shows a vertical sequence, highlighting maturity progressively increasing towards advanced. There are also degrees of maturity within each step (for example, the depth of modelling and analysis involved in assessing impacts and losses). However, for simplicity, this is not shown in the diagram.

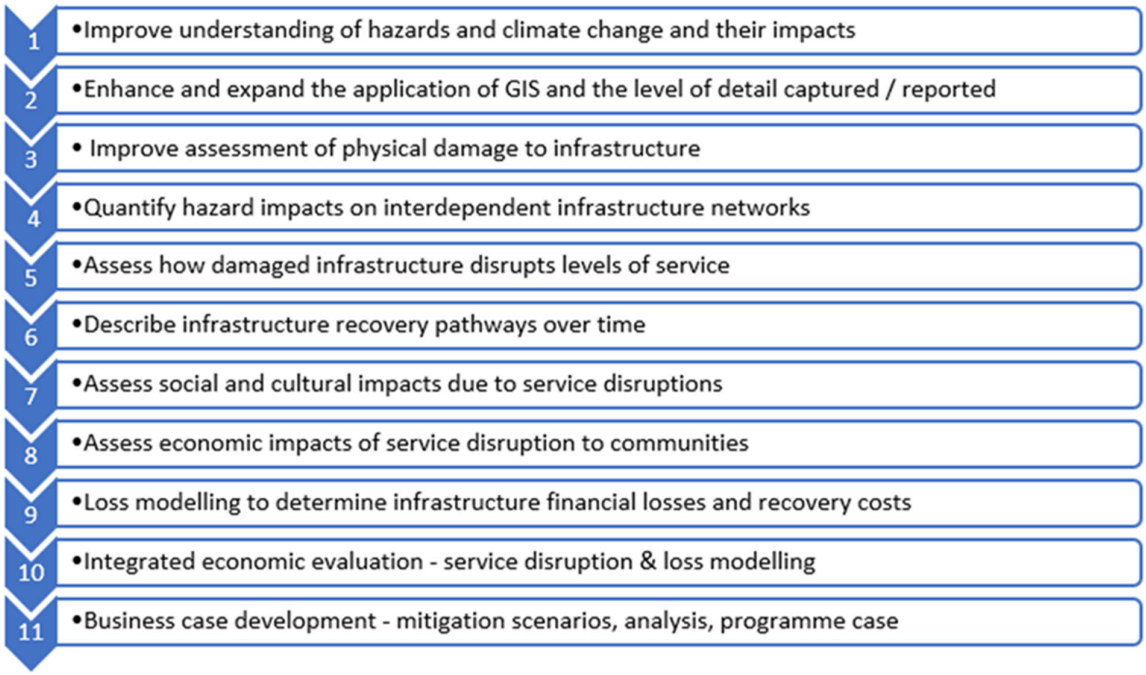


Figure 2-1 Features of the Maturity Pathway

Note that learning from the proposed pilot may lead to changes in the maturity pathway, the steps or order of the steps may also change.

The focus of this project is on scoping and defining process steps using a GIS-based platform leading in to economic modelling, noting that there are a number of tools that can be used. The intent is to demonstrate “proof of concept”, identifying information needs and showing integration between different steps in the process, rather than specifying specific tools that must be used. It is expected that different tools, new and emerging, could be used in future applications of this process. For example, as well as its application in loss modelling, RiskScape can be used to quantify model hazard impacts.

Further discussion around the tools being used in this “proof of concept” demonstration follows.

2.2 Lifelines GIS Portal

A GIS portal is being developed to capture and display both lifelines infrastructural asset data and natural hazards data from a variety of sources. Some of these are live feeds while for others shape files or static feeds are recorded.

These layers will be accessed by the Urban Intelligence platform for the vulnerability assessment process.

2.3 Urban Intelligence Platform

The GIS-based Urban Intelligence platform is to be used for hazard exposure impact modelling and visualization purposes. This platform links readily to the Lifelines GIS portal and the impact (fragility) models to be applied will draw from international research, supplemented by local knowledge and assumptions where necessary.

Input will need to be sought from lifeline utilities in the pilot area, both in terms of data provision, and around the impacts of the hazard event(s) on their networks, the level of disruption to service, recovery timeframes, and cascade (interdependency) impacts on other utilities. These will be built into the final models with the output being provided to MERIT for economic analysis.

The results of the economic analysis can then be utilised in benefit-cost assessment for potential intervention investments.

2.4 MERIT

The MERIT tool is a suite of 'Integrated Spatial Decision Support Systems' that estimate the economic consequences associated with disruption events across time. More information is contained in the *Scanning Stocktake* report.

MERIT will need to be configured for North Canterbury, and it requires disruption and recovery timeframes for each lifelines sector on a Statistical Area (SA) basis. Economic impacts are expressed on a GDP basis.

3.0 Data Attributes / Data Schema

3.1 Data Schema

The objective is to describe a Schema for "analysis ready" model input data. To provide meaningful outputs, models must be provisioned with suitable input data. A clearly codified data schema will assist utilities owners to ready their data for participation in resilience modelling initiatives.

The output of this work will be a taxonomy and schema definition that will provide a template to support preparation and transfer of corporate data to modelling software tools for vulnerability and resilience assessments.

3.2 Data Input Formats

GIS data can come in various proprietary and open-source formats. The preferred method for gathering and using data is for online services published from the asset owners' corporate systems. Rather than building a single data store of analysis data, loosely coupled services drive the system architecture. The key benefit of using this method is that repeated approaches to keep data current are no longer necessary, as the latest available data is being used for modelling.

For data published by Local and Regional Authorities, REST is the preferred format for publication, as that is the native format of those agencies GIS systems.

3.3 Lifelines Sectors

3.3.1 Sector Types

The following list of **15** Lifelines sector types has been adopted for this project. The list has been developed from previous data capture work carried out for Canterbury Lifelines and other regional Lifelines groups.

Sector Types
Airfields
Electricity
Fast Moving Consumer Goods
Flood Protection
Fuel
Gas
Irrigation
Ports
Rail
Roads
Solid Waste
Stormwater
Telecommunications
Wastewater
Water Supply
15

Table 3-1 Lifelines Sector Types

3.3.2 Sub-sector Types

The Electricity, Fuel and Gas sectors have been further classified into their sub-sector components to better reflect industry divisions and enable a more consistent sector list. The sub-sector types provide an additional level of hierarchy within the asset type schema.

Sector Types	Sub-sector Types
Electricity	Generation
	Transmission
	Distribution
Fuel	Bulk Storage
	Distribution
Gas	Bulk Storage
	Distribution

Table 3-2 Sub-sector Types

3.3.3 Sector Alignment

The sector alignment work has allowed for existing Lifelines data capture initiatives to be compared and harmonised into a standardised list of sector types. This work included the following tasks:

- Structuring and aligning previous data capture work according to sector types
- Adopting a consistent naming convention for the target sectors
- Considering how best to manage sub-sector elements for Electricity, Fuel and Gas
- Expanding the list to include additional sector types – for example, Irrigation
- Making a clearer distinction between Flood Protection and Stormwater sectors

The following extract from the sector alignment process illustrates the variation in naming and data gaps that can exist, and illustrates the value in adopting a standardised list.

Sector - Standard	Categorisation	Update	Schema	Regional
Airfields	Airfields	Airports (Needs to include Airways sites)	Transport Sites	Transport
Electricity	Electricity Transmission	Electricity - T&D		
Flood Protection	Stopbanks	Major Rivers Flood Control	Flood Protection	

Table 3-3 Sector Categorisation extract

3.3.4 Reference Files

The following table details the lifelines data capture files that were reviewed and used to help inform the sector and asset class alignment work.

Project File	Type	Tab Name	Year
Data Update 20180611	Excel	Update	2018
Data Overview 20180608	PDF	Overview	2018
Lifelines GIS Data Schema	Excel	Schema	2019
Data Categorisation	Excel	Categoriation	2020
Lifelines GIS Regional Asset Data Apr 2021	Excel	Regional	2021

Table 3-4 Lifelines Data Capture Review Files

3.4 Asset Class Analysis

3.4.1 Asset Class Alignment

An asset class library has been developed from the same suite of lifelines work on data capture used to define sector types. An additional step was introduced which considered available fragility reference information[2] and matched these to asset classes.

Key tasks included:

- Structuring previous data capture tables to support comparison work at an asset class level
- Performing alignment work for each sector and factoring in sub-sectors where appropriate
- Selecting a representative asset class name from available options or creating anew
- Review of asset class completeness and making additions to close any gaps
- Create library and check for naming consistency between sectors

This extract shows how the methodology was applied to the Fuel sector to produce a list of 7 asset classes from the different inputs channels.

Fuel	Fragility	Overview	Categorisation	Update	Schema
Comms Systems					
Control Centres			Control centres	Control Centres	
Pipeline		Fuel Pipeline	Pipelines - bulk fuel distribution	Fuel Pipeline	
Tank Farms	Storage Tanks (att.)		Tank farms storage	Storage Tanks	Tank
			Tank farms pipework	Pipework	Pipes
		Facilities	Tank farms - bulk fuel transfer	Fuel Transfer Facilities	
				Pumping Facilities	
Fuel Stations	Service Stations	Fuel Station Outlets	Fuel station outlets	Fuel Station Outlets	Fuel station
Storage Tanks		Storage Tanks		Storage Tanks	
Tanker Vehicle Depots		Tanker Vehicle Depots	Tanker vehicle depots	Tanker Vehicle Depots	

Table 3-5 Fuel Sector Asset Class Review Approach

3.4.2 Continuous Development

The draft asset class library has been designed to adapt and grow via feedback / testing from the Lifelines community. This library is intended to provide a useful starting point by reflecting the work to date and proposing a standards based model for more consistent capture of lifelines information.

3.5 Asset Class Library

3.5.1 Airfields

The library includes **10** different asset classes across the Airfields sector. There are no asset specific fragility references identified for Airfields at this stage.

Asset Class	GIS	Fragility Ref	Attributes - draft
Airfield Lighting	Point		Type
Comms Systems	Network		Type
Control Centres	Point	Buildings*	Material, foundation height, number of storeys
Control Systems	Network		
Fuel Facilities	Network	Storage Tanks	Type, storage volume
Helipads	Point		Material, capacity
Internal Utilities	Network		
Runways	Point		Material, capacity

[2] Fragility reference information refers to models that exist for specific types of assets that link physical disturbance from a hazard to expected levels of asset damage

Asset Class	GIS	Fragility Ref	Attributes - draft
Taxiways	Point		Material, capacity
Terminal Buildings	Point	Buildings*	Material, foundation height, number of storeys
10			

Table 3-6 Airfields Sector Asset Classes

3.5.2 Electricity

The library includes **15** different asset classes across the Electricity sector split by Generation, Transmission and Distribution sub-sectors. There is a single fragility reference to Electricity Infrastructure which could be further refined through input from industry specialists.

Sub-sector	Asset Class	GIS	Fragility Ref	Attributes - draft
Generation	AC/DC Pole	Point	Electricity Infrastructure	
	Canals	Linear		
	Comms Systems	Network		Type
	Control Centres	Point	Buildings*	Material, foundation height, number of storeys
	Control Structures	Point		
	Generation Sites	Point		
Transmission	Comms Systems	Network		Type
	Control Centres	Point	Buildings*	Material, foundation height, number of storeys
	Grid Exit Points	Point		Circuits
	Towers	Point		
	Transmission Lines	Linear		Voltage, Circuits
Distribution	Comms Systems	Network		Type
	Control Centres	Point	Buildings*	Material, foundation height, number of storeys
	Distribution Lines	Linear		Voltage
	Substations	Point		
	15			

Table 3-7 Electricity Sector Asset Classes

3.5.3 Flood Protection

The library includes **4** different asset classes across the Flood Protection sector. There are no asset specific fragility references identified for Flood Protection at this stage.

Asset Class	GIS	Fragility Ref	Attributes - draft
Comms Systems	Network		
Control Centres	Point	Buildings*	Material, foundation height, number of storeys
River Control - Linear	Linear		
River Control - Site	Point		
4			

Table 3-8 Flood Protection Sector Asset Classes

3.5.4 Liquid Fuels

The library includes **7** different asset classes across the Fuel sector split between the Bulk Storage and Distribution sub-sectors. Asset specific fragility references have been identified for Storage Tanks and Service Stations.

Sub-sector	Asset Class	GIS	Fragility Ref	Attributes - draft
Bulk Storage	Comms Systems	Network		Type
	Control Centres	Point	Buildings*	Material, foundation height, number of storeys
	Pipeline	Linear		Material, diameter
	Tank Farms	Point	Storage Tanks	Tank size, quantity
Distribution	Fuel Stations	Point	Service Stations	
	Storage Tanks	Point	Storage Tanks	Tank size, quantity
	Tanker Vehicle Depots	Point		
	7			

Table 3-9 Liquid Fuels Sector Asset Classes

3.5.5 Gas

The library includes **7** different asset classes across the Gas sector split between the Bulk Storage and Distribution sub-sectors. There is a single fragility reference to Gas Infrastructure which could be further refined through input from industry specialists.

Sub-sector	Asset Class	GIS	Fragility Ref	Attributes – draft
Bulk Storage	Comms Systems	Network	Gas Infrastructure	
	Control Centres	Point	Buildings*	Material, foundation height, number of storeys
	Pipeline	Linear		Material, diameter
	Pumping Stations	Point		Capacity
	Tank Farms	Point	Storage Tanks	Tank size, quantity
Distribution	Distribution Facilities	Point		
	Pipes	Linear		Material, diameter
	7			

Table 3-10 Gas Sector Asset Classes

3.5.6 Ports

The library includes **7** different asset classes across the Ports sector. There are no asset specific fragility references identified for Ports at this stage.

Asset Class	GIS	Fragility Ref	
Cargo Facilities	Point		
Comms Systems	Network		Type
Container Facilities	Point		
Control Centres	Point	Buildings*	Material, foundation height, number of storeys
Navigation Aids	Point		
Sea Channels	Linear		
Wharves	Linear		Length, capacity
7			

Table 3-11 Ports Sector Asset Classes

3.5.7 Rail

The library includes **7** different asset classes across the Rail sector. An asset specific fragility reference has been identified for Rail (Tracks).

Asset Class	GIS	Fragility Ref	Attributes - Draft
Bridges	Linear		Length
Comms Systems	Network		
Control Centres	Point	Buildings*	Material, foundation height, number of storeys
Passenger Stations	Point		
Signalling	Point		
Tracks	Linear	Rail	Rail scour type
Tunnels	Linear		Length
7			

Table 3-12 Rail Sector Asset Classes

3.5.8 Roads

The library includes **7** different asset classes across the Roads sector. Asset specific fragility references have been identified for Bridges and Roads.

Asset Class	GIS	Fragility Ref	Attributes - Draft
Bridges	Linear	Bridges	Bridge type, lanes, length
Comms Systems	Network		
Control Centres	Point	Buildings*	Material, foundation height, number of storeys
Fords	Linear		
Roads	Linear	Roads	Material, capacity, function
Traffic Signals & ITS	Point		
Tunnels	Linear		
7			

Table 3-13 Roads Sector Asset Classes

3.5.9 Solid Waste

The library includes **2** different asset classes across the Solid Waste sector. Asset specific fragility references have been identified for both Landfills and Transfer Stations.

Asset Class	GIS	Fragility Ref	Attributes – draft
Landfills	Point	Landfills	
Transfer Stations	Point	Transfer Stations	Capacity
2			

Table 3-14 Solid Waste Sector Asset Classes

3.5.10 Stormwater

The library includes **7** different asset classes across the Stormwater sector. Asset specific fragility references have been identified for Pumping Stations and Pipes.

Asset Class	GIS	Fragility Ref	Attributes - draft
Comms Systems	Network		

Control Centres	Point	Buildings*	Material, foundation height, number of storeys
Drains	Linear		
Flood Control Structures	Point		
Pumping Stations	Point	Pump	Capacity / size
Retention Basins	Point		Volume
Pipes	Linear	Pipes	Material, diameter
7			

Table 3-15 Stormwater Sector Asset Classes

3.5.11 Telecommunications

The library includes **6** different asset classes across the Telecommunications sector. An asset specific fragility reference has been identified for Mobile Towers at Cell Sites.

Asset Class	GIS	Fragility Ref	Attributes – draft
Broadcasting Towers	Point		
Cables	Linear		Type
Cell Sites	Point	Mobile Towers	Tower material, tower height
Comms Systems	Network		
Control Centres	Point	Buildings*	Material, foundation height, number of storeys
Exchanges	Point		Size
6			

Table 3-16 Telecommunications Sector Asset Classes

3.5.12 Wastewater

The library includes **6** different asset classes across the Wastewater sector. Asset specific fragility references have been identified for Pump Stations, Pipes and Treatment Plants.

Asset Class	GIS	Fragility Ref	Attributes - Draft
Comms Systems	Network		Type
Control Centres	Point	Buildings*	Material, foundation height, number of storeys
Disposal Sites	Point		Type
Pumping Stations	Point	Pump, Station	Material, capacity
Pipes	Linear	Pipes	Material, diameter
Treatment Plants	Point	Treatment	Type, building material,
6			

Table 3-17 Wastewater Sector Asset Classes

3.5.13 Water Supply

The library includes 7 different asset classes across the Water Supply sector. Asset specific fragility references have been identified for Pump Stations, Pipes and Stations.

Asset Class	GIS	Fragility Ref	Attributes - draft
Comms Systems	Network		Type
Control Centres	Point	Buildings*	Material, foundation height, number of storeys
Pumping Stations	Point	Pump	Capacity
Reservoirs	Point	Storage Tanks	Tank size, type

Pipes	Linear	Pipes	Material, diameter
Sources	Point		Type
Treatment Plants	Point	Stations	Type
7			

Table 3-18 Water Supply Sector Asset Classes

3.5.14 Exclusions

The Fast-Moving Consumer Goods (FMCG) and Irrigation sectors have been excluded from the asset class library at this stage due to limited data on key asset classes from previous work. It is proposed that Asset classes for these two sectors be identified as part of direct engagement with the lifelines owners.

3.6 Asset Data Attributes

3.6.1 Common Attributes

The asset schemas will consist of a mix of common and asset specific attributes.

A list of proposed common attributes has been developed based on a combination of previous lifelines work and knowledge of data handling within asset management and GIS environments.

Points to note:

- The list can be further refined once asset data is sourced from lifelines organisations.
- Pick lists may be used to help streamline data entry for selected attributes.
- Themes have been used to help group related attributes.
- Level of maturity may be used to filter attribute requirements according to organisational size and resources.

Theme	Attribute Name	Maturity	Notes
Identification	Asset Owner	Core	Name of organisation
	Asset ID	Core	Unique owner ID
	Asset Name	Core	Asset / site name
	Asset Type	Core	Level 2 type description
Profile	Criticality	Intermediate	Internal criticality rating
	Install Date	Core	Installation date for the asset
	Renewal Value	Core	Current asset replacement cost
Location	Street Address	Intermediate	AIMS/LINZ
	Object ID	Core	GIS host ID
Dependencies	Electricity Required	Core	For site to function
	Electricity Backup	Core	Generator, plugs, battery
	Fuel Stored Onsite	Intermediate	Days running for generator
Metadata	Date Supplied	Core	Date of data supplied
	Data Source	Core	Format of source data

Table 3-19 Common Attributes

3.6.2 Other Information Needs

Additional information will be needed as the maturity level of the modelling moves towards advanced. These include the following.

Loss modelling:

- Replacement cost valuation of each asset
- Level of damage resulting from each hazard scenario

Economic analysis:

- Outage area of impact – GIS based, linked to zoning (residential, commercial, industrial etc.) mesh blocks and the location of key facilities.
- Outage level of service disruption.
- Restoration of service – stepped profile (if possible) by days/weeks/months.
- Assumed interventions – i.e., changes to infrastructure networks.

4.0 Pilot "Proof of Concept" Approach

4.1 Pilot Area

The pilot area will cover North Canterbury comprising three Territorial Authority areas: Kaikoura, Hurunui, and Waimakariri District Councils.

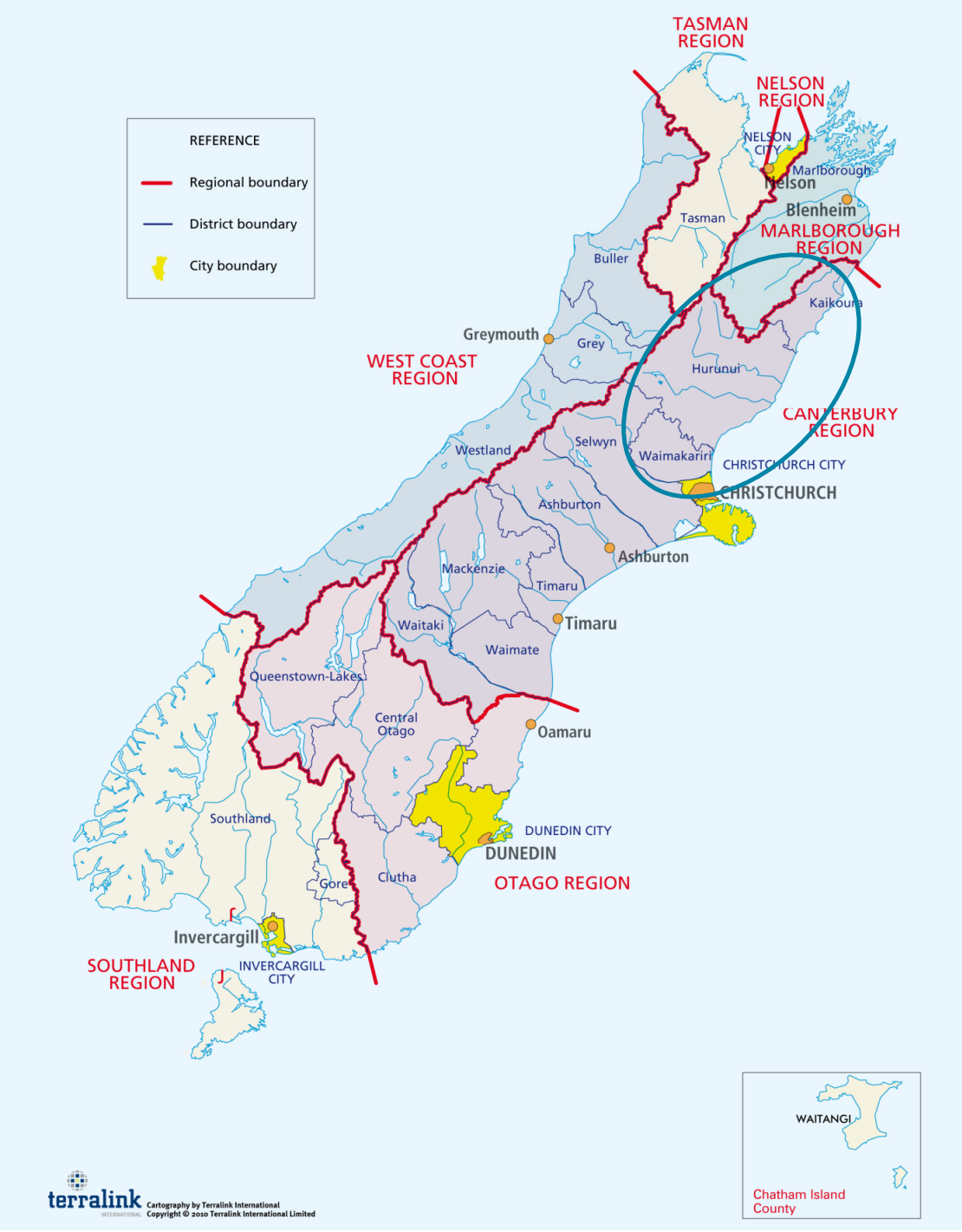


Figure 4-1 Pilot Area

4.1.1 North Canterbury Lifeline Utilities

Together, these Councils cover the following lifelines sectors of interest:

- Local roads, including bridges, tunnels and fords
- Potable water supply
- Wastewater
- Stormwater
- Solid Waste

In addition to the above Councils, the following lifeline utilities will also be invited to participate:

- Electricity – Transmission and Distribution
  - Transpower
  - MainPower
- Telecommunications – Fibre, Cellular and Copper networks, Broadcasting facilities
  - Chorus
  - Enable
  - Vodafone
  - Spark
- Transport
  - Waka Kotahi NZTA – State Highways, including bridges, tunnels and fords
  - KiwiRail – Rail Network lines, bridges, tunnels and rail systems
- Flood Protection
  - ECan
- Others – potentially:
  - Fuel
  - Kate Valley Solid Waste facility
  - Irrigation
  - Fast Moving Consumer Goods

Note that it is not necessary to involve every lifeline utility within a particular sector to test the “proof of concept”, but all interdependent sectors should be included.

Points to note include the following:

- Extensive flood hazard and coastal mapping work has been done by Waimakariri District Council to supplement ECan hazards data
- The Council also has good experience in understanding the impacts of earthquake events on infrastructure
- There is also the work of the Building Innovation Partnership on the Digital Twin for Kaiapoi – with a need to collaborate on this
- Need to also consider how climate change and the sinking of coastlines would be considered, perhaps through “now” and “then” simulations
- Different versions of MERIT could be considered for short vs long-run events and pathways to recovery.
- A Transport MERIT tool exists that may be useful.

4.1.2 Community Sites

In addition, important community sites, sites of cultural significance, and those of importance to the economy may also be considered, in terms of the social and economic impacts that infrastructure disruption causes.

4.1.3 Ports and Bulk Fuel Facilities

If resources permit, the "proof of concept' work could be extended to consider Ports and Fuel, as these are vulnerable to tsunami and coastal events but are not in the North Canterbury area:

- Potentially a second analysis, covering Lyttelton, Timaru, and bulk fuel facilities at both ports and at Woolston (liquid and gas fuels) and including:
    - Lyttelton Port Company – port facilities/
    - NZOSL (BP) – bulk storage tank farm Lyttelton
    - Z – bulk storage tank farm Lyttelton
    - Mobil – pipeline and bulk storage tank farm Woolston
    - Liquigas – pumping facility at Lyttelton, pipeline, and bulk storage of gas at Woolston
    - Rockgas – bulk storage of gas at Woolston
    - PrimePort Timaru – port facilities
    - Z Energy – bulk storage tank farms Timaru
    - Timaru Oil Services Ltd (TOSL) – bulk storage tank farms Timaru
- Such analysis would need to consider other lifeline utilities that these sectors rely on, namely electricity supply, telecommunications, road access, and water supply for firefighting.
- Note that one MERIT study was done on Lyttelton Port – however, the results are not public.

4.2 Hazards

Lifelines vulnerability to the following hazards is to be assessed in the Urban Intelligence platform:

- Tsunami affecting coastal areas:
    - Hikurangi Trench Tsunami scenario – noting that this would be initiated by a large earthquake that could also damage lifelines infrastructure. This could be subsequently modelled as coincident hazards.
- Flooding from a range of river catchments in North Canterbury (100 to 500 year return periods):
    - Rangiora, Kaiapoi and rural areas in the Waimakariri and southern part of the Hurunui District resulting from river breakout (e.g., Ashley River, Eyre River). Spatially, this is the most significant in North Canterbury.
    - Kaikoura and surrounding rural areas resulting from river breakout (e.g., Kowhai River).
    - Note that flooding could occur on a wider scale as a result of a major weather event bringing intense rain in from the east from Christchurch north to Marlborough.

Appendix 1: Glossary

Term	Definition
Asset	The physical hardware (e.g., pipes, wires), software and systems to own, operate and manage Lifelines Utilities (energy, transport, telecommunications, water). In the broadest sense this includes utility business owners, operators and contractors.
Business Continuity Planning	An organisational activity to build its ability to maintain its internal systems and operations, in order to promote service continuity to customers.
Consequence	The impact of a supply outage on direct customers, usually extending to include the downstream impacts of the outage on society as a whole.
Critical Assets (Sites / Facilities / Routes)	Assets that have a high consequence of failure with potentially significant consequences to societal wellbeing. *Note:* Both Infrastructure and community sites/facilities will generally feature in regional lifelines group critical sites / facilities lists.[3] A broad criticality rating of *Nationally Significant, Regionally Significant and Locally Significant* has been used.
Critical Customer	An organisation that provides services deemed critical to the functioning of communities and that rely on lifelines services to function. For this report, these include emergency services, health, banking, Fast Moving Consumer Goods and Corrections services, as well as the lifeline utilities themselves.
Emergency	A situation that • is the result of any happening, whether natural or otherwise, including natural hazard, technological failure, failure of or disruption to an emergency service or a lifeline utility; and • causes or may cause loss of life, injury, illness or distress, or endangers the safety of the public or property; and • cannot be dealt with by emergency services, or otherwise requires a significant and co-ordinated response under the Civil Defence Emergency Management Act 2002. *Paraphrased from the Civil Defence Emergency Management Act 2002*
Event	An occurrence that results in, or may contribute substantially to, a utility supply outage (i.e. an inability to continue service delivery). Notes: This informal term is often used by lifeline utilities to refer to the onset of a hazard or an emergency. Events can be 'external', i.e. something that happens to the utility, or 'internal', i.e. a breakdown within the utility.
Exposure	The extent to which an asset is potentially exposed to a hazard.
Four R's	Categories that form a framework for emergency planning and post-event actions. New Zealand's civil defence emergency management framework breaks down into four such categories: Reduction, Readiness, Response and Recovery. • Reduction means identifying and analysing risks to life and property from hazards, taking steps to eliminate risks if practicable, and, if not, reducing the magnitude of their impact and/or the likelihood of occurrence • Readiness means developing systems and capabilities before an event happens to deal with risks remaining after reduction possibilities have been put in place, including self-help and response programmes for the general public

[3] A list in *The Guide to the National CDEM Plan* identifies these and other sectors and areas that should be prioritised in *response* and *recovery.*

Term	Definition
	and specific programmes for lifeline utilities, emergency services and other agencies. The term preparation is sometimes used • Response means actions taken immediately before, during, or directly after an event to save life and property and to help communities begin to recover • Recovery means efforts and processes to bring about the immediate, medium-term, and long-term holistic regeneration and enhancement of a community after an event. *Paraphrased from the National CDEM Plan*
Hazard	Something that may cause, or contribute substantially to the cause of, a utility performance failure. *Adapted from the CDEM Act 2002.*
Hotspot	Place where especially significant assets of different infrastructure utilities or sectors are co-located. Notes: It is envisaged that the 'location' will be 'tight' – the underlying principle is 'if a hazard strikes here, several asset-types will be affected'. Bridges often offer good examples. There doesn't need to be a 'supply' relationship between the assets for a hotspot to exist. Simple co-location is the test.
Interdependence	Relationship between infrastructure types characterised by one's need for supply from another in order for their service to function.
Lifeline Utility	Lifeline utilities own and operate the assets and systems that provide foundational services enabling commercial and household functioning. Notes: Lifeline utilities are defined formally in the CDEM Act to include those operating in the following sectors: electricity, gas, petroleum, telecommunications, broadcast media organisations, ports, airports, roads, rail, water, and wastewater. The term 'critical infrastructure' is sometimes used.
Lifelines Groups	Regional collaborations, typically bringing together representatives of utilities, the science community, emergency managers, emergency services and other relevant professionals, with the objectives of improving the resilience of the region's lifeline utilities. Lifelines Groups focus on the first two of CDEM's Four R's: Reduction and Readiness.
Likelihood	The probability that an event will occur. Note: Depending on the context, 'likelihood' can be applied either to natural hazard return periods (e.g.,1:100 year flood) irrespective of whether a supply outage results, and to events (essentially, outage-causing occurrences whatever the cause).
Locally Significant	An asset or facility that, if it failed, would cause a loss of service of local impact (broadly, loss of service to more than 2,000-5,000 customers, or partial loss of service across the country). Note: The threshold for 'locally significant' used in regional lifelines projects has varied.
Mitigation	The asset-related or operations related steps of a utility to reduce or eliminate supply outages.
Nationally Significant	An asset or facility that, if it failed, would cause a loss of service of national impact (broadly, loss of service to more than 100,000 customers, or partial loss of service across the country).
Pinchpoint	Utility asset or site where a satisfactory alternative is not available, and which is therefore essential to service delivery. *Note: Pinchpoint* is equivalent to a 'single point of failure' (a term sometimes used in telecommunications) or 'bottleneck' (a term often used in road transport).
Resilience	The state of being able to avoid utility supply outages, or maintain or quickly restore service delivery, when *events* occur.

Term	Definition
	Notes: It is sometimes helpful to distinguish: • 'technical' or 'asset-related' resilience: i.e. the ability of physical system(s) to perform to an acceptable/desired level (and beyond the design event to prevent catastrophic failure) when subject to a hazard event • 'organisational' resilience: i.e. the capacity of an organisation to make decisions and take actions to plan, manage and respond to a hazard event in order to achieve the desired resilient outcomes. Adaptation by the utility following an outage-threatening event can be an important aspect of resilience. *Similarly, the broad 'service delivery' resilience focus adopted in this glossary draws attention to three components adopted by the New Zealand Lifelines Council):* • Robust assets (bringing in the engineering perspective) • Effective coordination pre-event and during response and recovery (participation in Lifelines Groups and sector coordination entities assist here) • Realistic end-user expectations (utilities have roles in fostering an appreciation that occasional outages will occur) *The National Infrastructure Unit's (NIU's) description of resilience (one of its six 'guiding principles') is 'national infrastructure networks are able to deal with significant disruption and changing circumstances'. The extension to 'changing circumstances' broadens the interest to include pressures other than outage events.*
Regionally Significant	An asset or facility that, if it failed, would cause a loss of service of regional impact (broadly, loss of service to more than 20,000 customers, or partial loss of service across the region). *Note:* The threshold for 'regionally significant' used in regional lifelines projects has varied.
Risk	The effect of uncertainty in meeting objectives. Usually described as the combination of *likelihood* and *consequence*.
Risk Management	A **systematic process to identify, analyse, evaluate, treat, monitor, and review** *risks* that cannot be reduced. *Notes: Risk management has an 'event-specific' emphasis, i.e. typically addressing identified risks – likely to be those where the likelihood and consequence are greatest. In common with business continuity planning, risk management may be undertaken both by utilities and by organisations that depend on infrastructure services.*
Vulnerability	The utility state of being susceptible to loss of utility service delivery/outages when *events* occur and being unable to recover quickly. *Notes: The serviceability loss could arise from a failure of the utility's assets or systems, or from any external event. Vulnerability and resilience can be regarded as opposite ends of a continuum.*
Vulnerability Study	A review of and report on utility *vulnerability*, generally undertaken at regional level by Lifeline Groups. *Notes: Vulnerability studies generally include description of interdependencies and may also identify hotspots and pinchpoints.*