QUEENSLAND CRITICAL INFRASTRUCTURE DISASTER RISK ASSESSMENT

Queensland Government

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https://www.disaster.qld.gov.au/qermf/Pages/Assessment-and-plans.aspx

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Foreword

Critical infrastructure is intertwined into our everyday lives. People depend on the availability of electricity, water, internet and phone service at their homes, and require access to transportation to go to work, school, and just about anywhere else.

Critical infrastructure is also crucial for us all before, during, and after disaster events, for the community generally and the response and recovery agencies working to keep the community safe. Without access to these services, society wouldn't be able to function as it currently does.

The Critical Infrastructure Disaster Risk Assessment (CInDRA) is Queensland's first assessment of climate and disaster risk to critical infrastructure. The assessment recognises the interdependencies between all the critical infrastructure sectors and how the sectors are exposed to different hazards.

Climate change presents ongoing challenges to critical infrastructure, with an increase in the frequency and severity of extreme weather events, and an increased likelihood of multiple events coinciding at the same time, or concurrently. Coastal hazards are also a significant concern for critical infrastructure, with the majority of Queensland's infrastructure and development located within 50km of the coastline.

The CInDRA assesses risk to four critical infrastructure sectors – energy, water, transport and communications. These sectors are recognised as being crucial in the context of disasters, and the interdependencies are complex. Twelve hazards were considered for the assessment – the ten hazards within the 2023 State Disaster Risk Report, along with space weather and cyber security.

Nikki Boyd MP

Minister for Fire and Disaster Recovery and Minister for Corrective Services

Steve Smith AFSM

Commissioner, Queensland Fire and Emergency Services

These additional hazards highlight the changing landscape of risk, and the growing threat from space weather events, and cyber-attacks targeting critical infrastructure. Space weather can disrupt communication systems, satellite operations and electrical grids, while cybersecurity threats can compromise the integrity, availability and confidentiality of critical infrastructure services.

There are currently significant reforms being led by the federal government to increase the resilience and security of critical infrastructure nationally. Within Queensland, it is important that risks are understood and managed across all levels of Queensland's Disaster Management Arrangements (QDMA). In particular, the risks identified within the CInDRA can assist local and district disaster management groups with understanding the risks to their communities and how to ensure their safety during disaster events.

As the Minister for Fire and Disaster Recovery and Minister for Corrective Services, and the Commissioner of Queensland Fire and Emergency Services, we greatly appreciate the efforts of all stakeholders within QDMA and their commitment to building safer and more resilient communities. We particularly thank those stakeholders who were involved in the development of the CInDRA, including the owners and operators of critical infrastructure in Queensland. We also acknowledge the ongoing cooperation of local governments, whose collaboration has been instrumental in our collective efforts. Together, we can continue to work towards a safer and more resilient Queensland.

INTRODUCTION

Introduction

Purpose and Intended Use

The Critical Infrastructure Disaster Risk Assessment (CInDRA) has been developed as a state-level risk assessment, looking at general trends and risks for critical infrastructure. This assessment fits within the suite of state-level risk assessments developed by Queensland Fire and Emergency Services and partners, under the State Disaster Risk Report (SDRR).[1] The assessment is not intended to be detailed and does not provide asset-level risk information. Local or district disaster management groups can use the CInDRA to understand these general risks and how they may manifest at the local, district, or asset level, when conducting a local or district level disaster risk assessment.

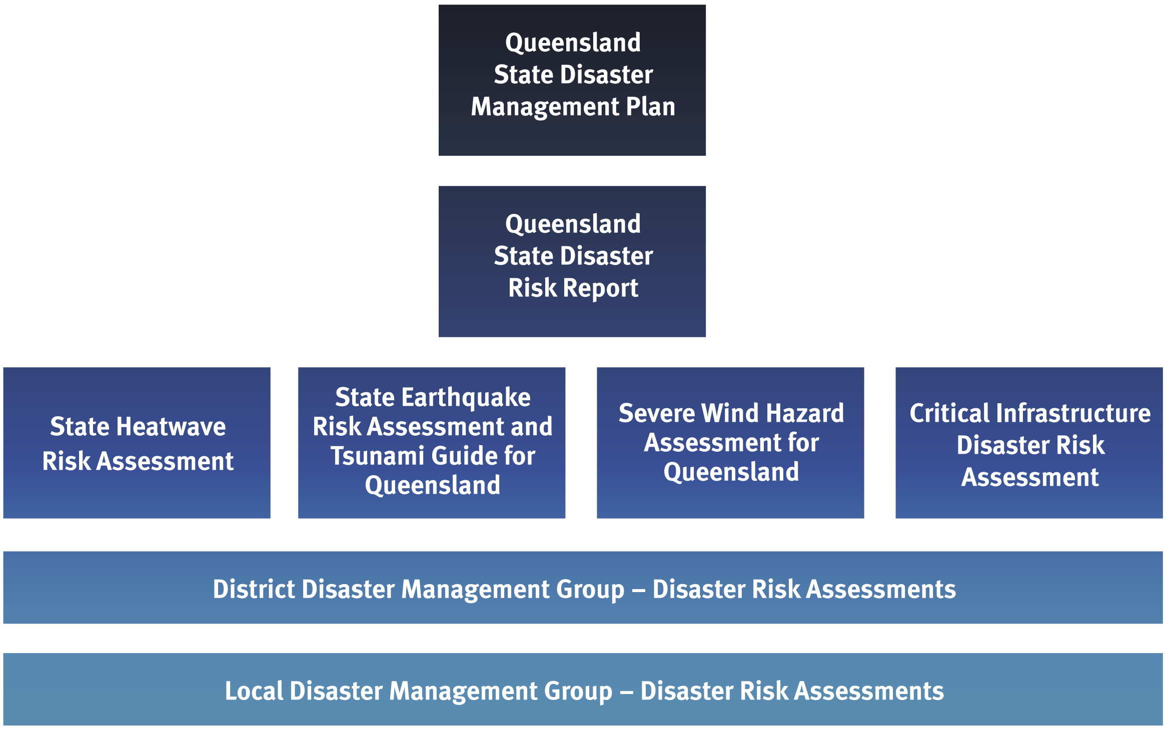


Figure 1: Context of the Critical Infrastructure Disaster Risk Assessment and where it sits with the other state-level hazard and risk assessments for Queensland.

The SDRR and other state-level hazard and risk assessments use the Queensland Emergency Risk Management Framework (QERMF) to assess and prioritise risk. The QERMF is the Queensland Disaster Management Committee's endorsed approach for disaster and emergency risk management, intended for use by stakeholders within Queensland's Disaster Management Arrangements (QDMA). Using the QERMF, the CInDRA prioritised risk statements by assessing the vulnerability and consequence of the risks and provided 3 priority risks for each of the sectors which were assessed in greater detail. These priority risks have been provided as examples for stakeholders within QDMA who may wish to consider critical infrastructure risks within their disaster risk assessments.

While the risks within the assessment may seem easily apparent, this is the first iteration of a state-wide critical infrastructure disaster risk assessment for Queensland. The consideration of risk across the four sectors brings a shared understanding within each sector and across sectors, acknowledging the interdependencies which exacerbate risk. This also highlights opportunities for further research and assessment to advance efforts in critical infrastructure resilience, to improve community outcomes during and after an event.

Iterative approaches to risk assessment and management are necessary to ensure understanding of risk remains current, including regular reviews of risk assessments and disaster management plans. This could include scenario analysis, stress testing, and options analysis, among others, to understand both the anticipated and unanticipated changes to how systems will respond.

As this is the first CInDRA for Queensland, it is intended the assessment will be regularly reviewed and updated to provide new and more detailed information. Future iterations of the CInDRA may consider additional critical infrastructure sectors - such as those listed within the Security of Critical Infrastructure Act 2018 (Cth)[2] (the SOCI Act), with the potential to also provide updates on treatments and implementation of resilience and risk reduction activities across Queensland. It is also intended that as the assessment is updated, information continues to be tailored for users to suit their needs.

Key Contacts

Further information and advice regarding critical infrastructure risk (for the four sectors within this report) can be sought from:

- Queensland Government Cyber Security Unit: cybersecurityunit@qld.gov.au
- Queensland Reconstruction Authority: hazard.risk@qra.qld.gov.au

General Context

This report delivers a detailed assessment of the climate and disaster risks facing critical infrastructure in Queensland, providing an in-depth analysis which is supplementary to the critical infrastructure failure chapter in the State Disaster Risk Report.[1]

The assessment aligns with the Royal Commission into National Natural Disaster Arrangements[3] recommendation to identify, assess, mitigate and monitor risks to critical infrastructure from natural disasters, and also acknowledges the obligations on the Queensland Government and critical infrastructure owners as a result of the SOCI Act.

Recommendations 9.4 Collective awareness and mitigation of risks to critical infrastructure

The Australian Government, working with state and territory governments and critical infrastructure operators, should lead a process to:

1) identify critical infrastructure
2) assess key risks to identified critical infrastructure from natural disasters of national scale or consequence
3) identify steps needed to mitigate these risks
4) identify steps to make the critical infrastructure more resilient, and
5) track achievement against an agreed plan.

This assessment considers risks for four key critical infrastructure sectors (See Figure 2):

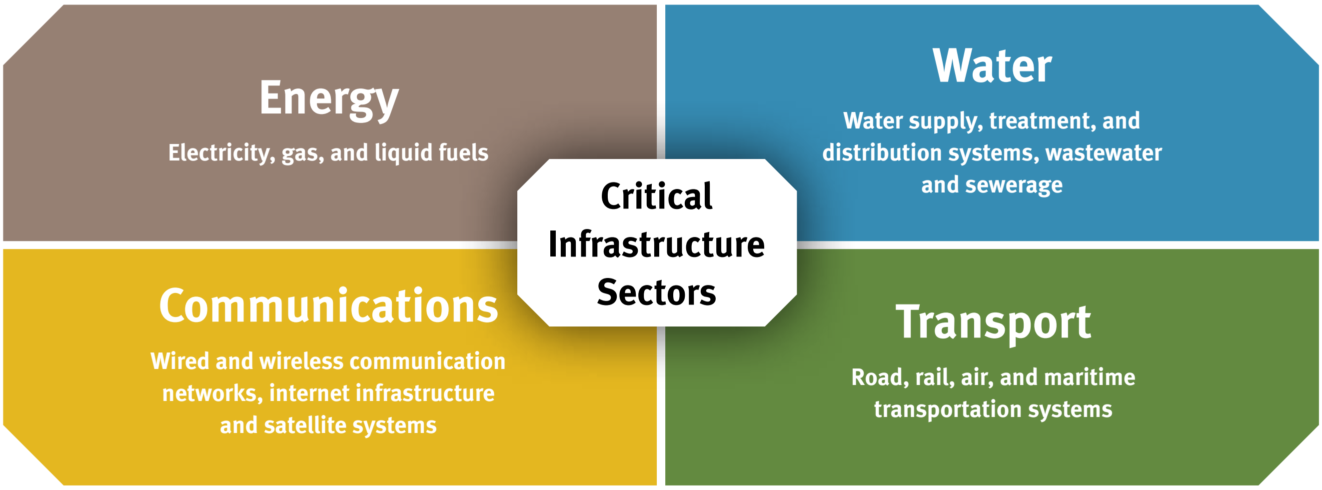


Figure 2. Four critical infrastructure sectors assessed in this report.

These sectors were identified as being the most critical infrastructure for the functioning of a community, with other critical infrastructure also dependent on these four sectors.[4] The hazards assessed in this report include all of the hazards identified in the State Disaster Risk Report, along with two additional hazards: space weather and cybersecurity. The inclusion of space weather and cyber security recognises the increasing interconnectedness of critical infrastructure systems and the growing threat from space weather events, and cyber-attacks targeting critical infrastructure. Space weather can disrupt communication systems, satellite operations and electrical grids, while cybersecurity threats can compromise the integrity, availability and confidentiality of critical infrastructure services. While it is recognised that there are many other hazards which could result in a failure of critical infrastructure, the assessment only considers these twelve hazards:

Table 1. Hazards which have been considered in this assessment.

Hazard	Icon	Hazard	Icon
Heatwave		Tsunami	
Bushfire		Earthquake	
Tropical cyclone		Pandemic	
Flooding		Chemical, Biological, Radiological	
Severe thunderstorm		Biosecurity	
Cybersecurity		Space weather	

The risks identified are based on the current timeframe, however with the influence of climate change and changes in other risk drivers, it is likely these risks will change into the future. For example, in some locations, hazards such as heatwave, bushfire, tropical cyclone, and flooding may increase in intensity and severity, while in other locations the risk from these hazards may decrease.

BACKGROUND

Background

Critical infrastructure (CI) refers to assets, systems, and networks that are essential for the function of society and the economy.[5] These include physical facilities, services and information systems that, if disrupted or destroyed in the event of a disaster would pose significant consequences for the community, environment, and economy.[6] Given the importance of CI, it is essential to identify critical assets and implement appropriate practices to manage and protect them from potential hazards.

Overview of Critical Infrastructure Disruption

> *"We should not expect critical infrastructure to be completely resistant to damage, or for essential services to be immune to disruption. Individuals and communities should be aware that they may lose power, water and electricity (including information technology services) and may be unable to access essential goods such as food at critical moments"*[3]

CI disruptions are quite common, usually with minimal impact on communities. However, when there are significant disruptions, during a disaster event or not, the consequences can be substantial. Critical infrastructure disruptions should be considered within most organisations business continuity plans, and residents should be prepared for disruptions within their own homes. Improving resilience to these disruptions is a common focus of Queensland Resilience and Risk Reduction Fund projects, with many projects funding backup power to critical infrastructure assets, improved floodways and upgraded drainage systems for example.

The complex interdependencies within CI systems increases the potential for cascading failures, transforming even minor initial failures into events of catastrophic proportions. A crucial aspect to understanding critical infrastructure failure is to perceive it within the context of an entire system. The repercussions of a critical infrastructure failure event are not confined to the initial point of failure; they can radiate across whole systems, influencing components that may appear distantly related or even completely independent. For instance, an interruption in electricity supply can affect water availability, which in turn disrupts cooling systems, limiting the effective operation of infrastructure within many sectors.[1]

Some key events across the energy, water, transport, and communications sectors have been captured below in Table 2. These events cover Queensland, Australia, and internationally, illustrating how a disruption in one sector can create complex and cascading consequences.

Figure 3. Callide coal fired power station. Source: Alamy

Figure 4. Damage to Unit C4 at Callide Power Station following the plant fire on 25 May 2023. Source: CS Energy

Table 2. Key events across the energy, water, transport and communications sector that have occurred in Queensland, Australia and internationally.

Queensland				
Event	**Date**	**Impact**	**Cause**	**Description**
Callide Explosion[7]	25 May 2021	477,000 Queensland customers without power	Explosion and fire at the C4 generating unit at Callide Power Station, near Biloela QLD	Just before 2pm on 25 May, a major explosion at the C4 generating unit at Callide power station resulted in a major power disruption, affecting over 477,000 Queensland and northern New South Wales customers. The explosion had a domino effect, impacting power system security and resulting in trips at multiple other power plants in the network. The outages impacted customers from northern New South Wales border towns, all the way up to Cairns. Power was restored to most customers within a few hours; however Queenslanders were asked to reduce their energy consumption to lower demand and reduce the risk of further blackouts. Impacts were felt in a range of sectors, including manufacturing, traffic management, sewerage treatment, along with shopping centres, businesses, and households.

Australia				
Event	**Date**	**Impact**	**Cause**	**Description**
Esso Longford gas explosion[8]	25 September 1998	Two people killed, a number of people injured, and all gas supply from the Longford facilities ceased	Equipment failure resulting in a gas explosion and subsequent fires	An explosion took place at the Esso natural gas plant at Longford in Victoria. The fire at the plant was not extinguished until two days later. The Longford plant was shut down immediately. Within days, the Victorian Energy Network Corporation shut down the state's entire gas supply. The resulting gas supply shortage was damaging to Victoria's economy, greatly affecting industry and the commercial sector. Gas supplies to Victoria were severely affected, with many Victorians left without gas for nineteen days.
2008 Varanus Island Gas Explosion WA[9]	3 June 2008	Loss of 30% of WA's gas supply, impacting major industries in the region	Explosion of gas pipeline and subsequent fires	While nobody was injured in this event, there were major consequences for industry. BHP Billiton, Rio Tinto and Burrup Fertilisers were significantly impacted, with further impacts to small business and households. It was two months before gas supply from the plant was restarted, and more than a year to resume full gas production. It's estimated that the event cost the State's economy up to $3 billion.[10]
Warrnambool Exchange fire[11]	22 November 2012	Loss of telecommunica-tions for 20 days, affecting about 100,000 people and 15,000km² of south west Victoria	Electrical fault causing fire	A fire occurred in the vicinity of the maintenance control room at Telstra's Warrnambool Exchange. The exchange acts as a transmission hub and suffered significant damage to essential telecommunications and broadband equipment. Telephone and internet services were cut off to around 100,000 customers, which lasted for three weeks. The total cost has been estimated at around $950,000 per day of the outage. Essential services were affected, including 85 schools, 20 hospitals, 27 police stations, 92 fire stations and 14 SES services.
South Australia blackout[12]	28 September 2016	Almost total loss of electricity to entire state affecting 1.67 million people	Significant storm damage	Gale force winds across wide areas of the state, at least two tornadoes, and over 80,000 lightning strikes, damaged multiple elements of critical infrastructure. The wind damaged a total of 23 pylons on electricity transmission lines, including damage on three of the four interconnectors connecting the Adelaide area to the north and west of the state. More than 850,000 homes and businesses were affected by the power outage which lasted many hours, with some properties without power for days. The impact to businesses was estimated at approximately $360,000.
Melbourne Metropolitan Train Network Disruption[13]	13 July 2017	Entire metropolitan train network shut down during peak hour, stranding thousands of commuters	A computer fault led to a massive system-wide shutdown of the train network	A significant disruption occurred in Melbourne's metropol-itan train network in July 2017, caused by a computer fault. This technical glitch led to a shutdown of the entire network during peak commute hours, leaving thousands stranded with major delays. The automated control centre went offline, meaning trains were required to halt for safety reasons as controllers had no way of knowing where they were.

International				
Event	**Date**	**Impact**	**Cause**	**Description**
Quebec blackout[14]	13 March 1989	Total shut down of Hydro-Quebec, with power loss to six million customers	A coronal mass ejection (CME) which impacted earth and created geomagnetically induced currents (GICs)	The space weather storm, which resulted from a solar flare, tripped five lines from James Bay and caused a generation loss of 9,450 MW. With a load of some 21,350 MW at that moment, the system was unable to withstand this sudden loss and collapsed within seconds, thereby causing further loss of generation from Churchill Falls and Mania-Outardes. The blackout closed schools and businesses, kept the Montreal Metro shut down during the morning rush hour and disrupted Dorval Airport, delaying flights.
Morandi Bridge Collapse[15]	14 August 2018	Collapse of a critical transport link resulting in 43 fatalities and significant disruption to regional transport infrastructure	A violent storm caused structural damage to the Morandi Bridge, leading to its sudden collapse	Genoa, Italy, experienced a devastating infrastructure failure when the Morandi Bridge, a critical transportation artery, collapsed during a violent storm. The catastrophe claimed 43 lives and severely disrupted transportation within the region. It emphasised the importance of resilient and well-maintained infrastructure capable of withstanding extreme weather events. The bridge's collapse ignited discussions on infrastructure integrity and resilience across Italy and globally.
Texas State power crisis[16]	10-20 February 2021	Over five million people in Texas were without power, some for more than three days. These outages were felt disproportionately in lower-income and minority ethnic areas of the state. By 21 February, 70 people had died, with deaths linked to carbon monoxide poisoning, car crashes, drownings, house fires and hypothermia.	Severe winter storms resulting in temperatures as low as -19 °C impacted on inadequately winterised power (natural gas) equipment	In February 2021, the state of Texas suffered a major power crisis, as a result of three severe winter storms sweeping across the United States on 10-11, 13-17 and 15-20 February. More than 4.5 million homes and businesses were left without power, some for several days. The crisis drew much attention to the state's lack of preparedness for such storms and to a report from US Federal regulators 10 years earlier that had warned Texas its power plants would fail in sufficiently cold conditions. Damages from the blackouts were estimated at over $195 billion, making it the costliest disaster in Texas history. According to the Electric Reliability Council of Texas (ERCOT), the Texas power grid was "seconds or minutes away from" complete failure when partial grid shutdowns were implemented.
Colonial Pipeline ransomware attack[17]	7 May 2021	Fuel shortages occurred as customers were panic buying due to the pipeline shutdown. Fuel prices rose to their highest since 2014, and many fuel stations completely ran out of fuel. Airlines also experienced changes to their scheduling to account for additional fuel stops or plane changes.	Ransomware attack targeting the billing infrastructure of the Colonial Pipeline Company in Houston, Texas.	A hacker group targeted billing infrastructure of the Colonial Pipeline Company, which services approximately 55% of all fuel consumed on the East Coast of the United States. Colonial Pipeline shut down the pipeline as a precaution, to prevent hackers obtaining further information and undertaking additional attacks on vulnerable parts of the pipeline. The hacker group downloaded nearly 100GB of data and demanded 75 bitcoins as a ransom payment, which was paid by Colonial Pipelines and overseen by the FBI.

Case Study: Gold Coast Christmas Day 2023 storms

On the evening of the 25th December 2023, the Gold Coast, Scenic Rim, and Logan City regions were hit with severe storms, with one later confirmed by The Bureau of Meteorology as a tornado. Winds over 150km/h were recorded, comparable to those of a category 2 cyclone. Over 3,000 damage assessments were completed, with 10 premises completely destroyed, approximately 145 properties moderately damaged, and 386 properties with minor damage.[18] One fatality was recorded, due to a fallen tree. Response and recovery efforts were immense, with Queensland Fire and Rescue Service, Rural Fire Service Queensland and SES, New South Wales SES, Victoria SES and Country Fire Service, and the Australian Defence Force all responding to the event over the course of many weeks.

Figure 5 and 6. Gold Coast Storm Damage, 25 December 2023. Source: Cheryl van Hooft

Energy system impacts

Over 130,000 homes and businesses in the Gold Coast, Scenic Rim and Logan City regions lost power after more than 1,100 powerlines were downed by the storm. Restoration of the network was completed within two weeks from the storm, requiring the restringing of 120kms of powerline, 150 new poles, and 500 crossarms.[19] Storms were so severe that concrete power poles were knocked down and bent in half.[20]

Residents also faced difficulties pumping fuel and buying supplies with electricity outages, with shops such as Bunnings only able to accept cash due to EFTPOS systems relying on power supply.

Health impacts

Three days after the storm, heatwave conditions impacted most of Queensland, with temperatures in South East Queensland around eight degrees above the December average.[21] Electricity demand over this period reached more than 9,800MW on Thursday evening, only about 300MW short of Queensland's all-time peak demand.

At the same time, around 50,000 customers were still without power, putting their health at-risk without access to cooling. The City of Gold Coast opened multiple Community Centres for residents to access power and seek relief from the heat. Libraries were also open and aquatic centres were open free of charge for residents to escape the heat.[22]

Southeast Queensland hospitals experienced an increase in presentations related to both the heatwave and the storms, including social admissions due to medical devices requiring power. Residents were urged to check on vulnerable neighbours and not to present at hospital unless it was an emergency, due to the 30% spike in admissions linked to power outages.[23]

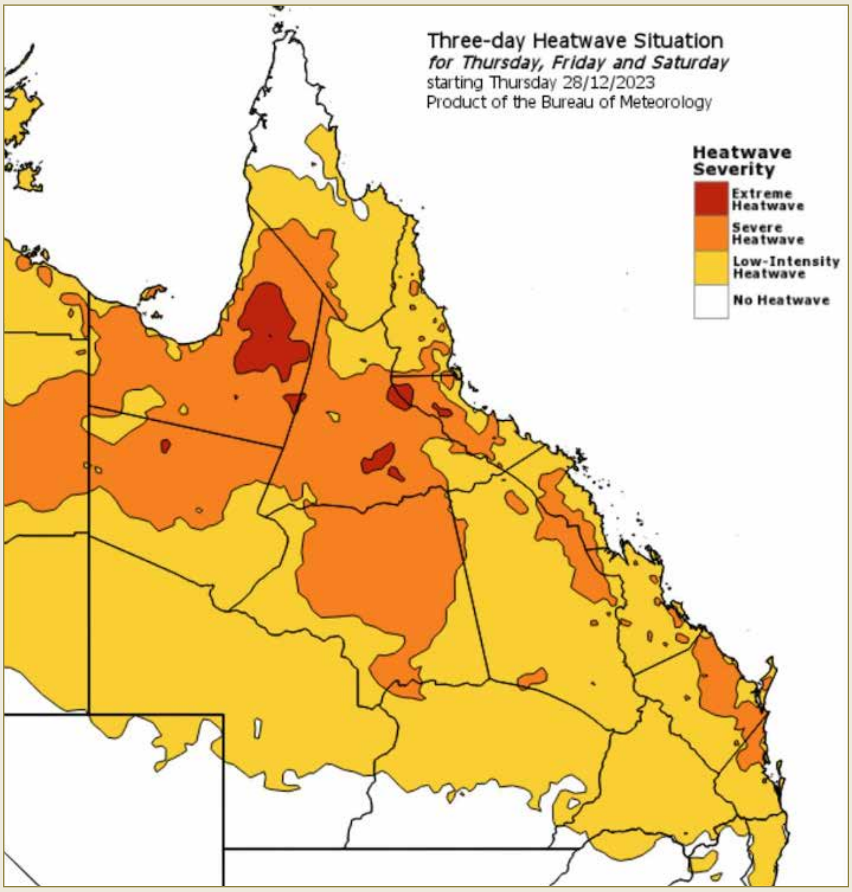


Figure 7. Heatwave forecast for 28, 29, 30 December 2023.

Some aged care facilities also experienced issues with power supply, however this was dependent on whether the facility had access to a generator for back-up power supply.

A family on the Gold Coast was reported to be utilising power from their electric vehicle to ensure continued power supply for their 11-year old's dialysis machine. Currently on a transplant list due to kidney failure, the family ran multiple extension leads from the car to the dialysis machine in a bid to continue his vital treatments and avoid presenting to a busy hospital in critical condition.[24]

Water Impacts

Widespread power outages and localised flooding affected several local water assets in Beaudesert, Kooralbyn, Rathdowney and Canungra, where residents were asked to reduce their water use where possible.[25] Smaller communities in the hinterland region, including Tamborine Mountain, are not connected to a reticulated water supply, and therefore rely on a power supply to pump water to their property. The local council responded by supplying bottled water and portable toilets to residents in this region without generators or who had damaged plumbing, until electricity supply could be restored.[26]

Communication Impacts

Over 1,000 fixed line customers experienced communication outages as a result of the storms on 25th December 2023, which increased again after further storms occurred on 30th December 2023. Mobile coverage was also impacted with multiple 3G, 4G and 5G sites offline in the region. Over 50 network sites lost mains power after the initial storms, increasing to over 100 following the storms on 30th December 2023.

NBN services were greatly impacted, with around 51,000 customers with no landline phone or internet access at the peak of the event. While some sites were able to remain functioning due to backup batteries, the majority of services offline were due to the ongoing power outages.

Some services in Cedar Vale, Coolangatta, Tamborine Mountain, and Upper Coomera experienced the longest outages, with Energex needing to complete aerial cabling to restore power and bring NBN services back online.[27]

Transport Impacts

Many roads across the Gold Coast were closed to all traffic for a number of days post-storm, with some remaining closed for weeks. These closures impacted restoration efforts, with response crews tasked with clearing debris and trees off of roads so that Energex could access sites for repairs. Emergency works for tree removal will be ongoing over the course of two to three months.

Queensland Rail and Glink experienced service disruptions, with buses replacing rail and trams on impacted sections.

Critical Infrastructure Owners and Operators

Within Queensland, a number of critical infrastructure assets are owned by Government Owned Corporations (GOCs). Queensland Treasury is responsible for monitoring the performance of these entities, with the Treasurer also acting as a shareholding minister. The portfolio agencies (e.g. The Department of Energy and Climate for energy infrastructure) also have a significant role in service level provision.

The Queensland Government Insurance Fund (QGIF) manages insurance risk for Queensland Government assets, including those owned by GOCs. Non-government CI asset protection is subject to the private insurance industry and may face issues related to the customisation and adequacy of coverage, premium affordability, availability of coverage, expertise in risk management, alignment of interests, and continuity and stability.[28]

Understanding the complexities of critical infrastructure governance and management is vital for effective disaster risk management. Table 3 shows the different types of critical infrastructure ownership in Queensland, which is a mix of both private and public.

This report aims to provide context on the challenges faced by both government and non-government CI asset owners, as well as the risks that can impact the continuity and stability of essential services. By addressing these challenges, stakeholders can work together to build more resilient and robust critical infrastructure systems, ultimately benefiting the community, environment, and economy.

Table 3. Predominate levels of government or sectors responsible for energy, water, transport and communications infrastructure in Queensland. This isn't exhaustive and there are exceptions to those listed below. Source: Queensland State Infrastructure Strategy 2022[29]

	Energy			Water			Transport					Communications	
	Electricity (generation, transmission, distribution)	Gas	Liquid Fuels	Regional water supply (source, treatment, transport)	Local water supply	Sewerage	State, local and toll roads	Busways	Heavy and light passenger rail	Maritime and seaports	Cycleways	National Broadband Network	Other telecommunications
Australian Government							✓	✓	✓	✓	✓	✓	
Queensland Government	✓			✓			✓	✓	✓	✓	✓		
Local Government				✓	✓	✓	✓	✓	✓	✓	✓		
Private Sector	✓	✓	✓				✓			✓		✓	✓

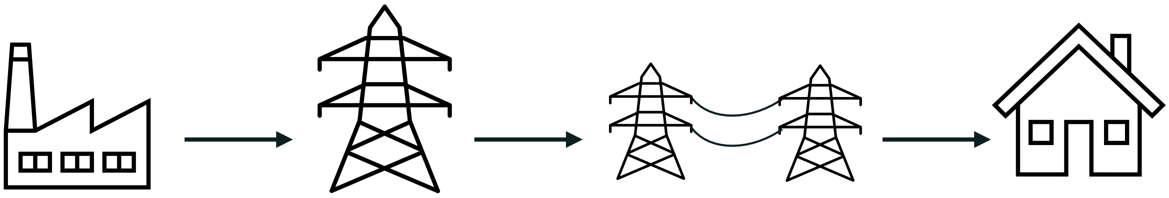
Energy

Electricity

The electricity network is owned and operated by a combination of GOCs and private entities, while gas and liquid fuels are mostly owned and operated by private entities (with the exception of some circumstances requiring the distribution and sale by local government).[30]

Table 4 below depicts the GOCs in Queensland which operate in the generation, transmission, distribution and retail sectors of the national electricity market (NEM). Queensland has an installed generation capacity of approximately 15,500MW (excluding rooftop photovoltaic systems), meaning that there is quite an extensive number of entities responsible for generation, many of which are private entities. This is in contrast to the transmission and distribution network which is owned solely by GOCs (Powerlink and Energy Queensland). The retail market in Queensland consists predominantly of private entities, with 43 retailers licenced to provide energy under the Energy and Water Ombudsman Queensland. [31]

Table 4. *Key electricity infrastructure owners and operators in Queensland*[31]



Generation	Transmission	Distribution	Retail
CS Energy (GOC)	Powerlink (GOC)	Energex (GOC)*	Ergon Energy (GOC)*
CleanCo (GOC)			
Stanwell (GOC)		Ergon (GOC)*	Over 40 private entities
Other private entities		Energy Queensland Limited (GOC)	

** Energex, Ergon and Ergon Energy are businesses of Energy Queensland*

Gas

Within the gas sector, most of the owners and operators of infrastructure are private entities, with the exception of some locations where the local government owns and operates the local distribution network.[32] There are five major gas pipelines in Queensland which services major industrial customers and gas-fired generators, and feeds into gas distribution networks for residential customers.

There are two main gas distributors, Allgas Energy, and Australian Gas Network, and thirteen licenced gas retailers in Queensland. Origin Energy and AGL are the primary retailers in the State.[32]

Liquid Fuels

All liquid fuel infrastructure in Queensland is privately owned. Ampol operates the only refinery in Queensland, which refines approximately 6.5 billion litres per year.[33] This represents approximately 60% of Queensland's fuel requirements.[34] Other suppliers of fuel include Viva Energy, Freedom Fuels, BP, and United Petroleum for example. Fuel is imported into ports across Queensland and distributed to retailers via trucks. As the majority of the population in Queensland is along the coast, transport from the port to a retailer is quite quick and takes an average of 3 hours to reach its destination.[35]

Water

The majority of water infrastructure is owned and operated[31] by government entities, however private entities such as mining companies and other industrial sectors own and operate their own water infrastructure. Table 5 depicts the organisations responsible for supplying water and managing wastewater in Queensland.

In South East Queensland, Seqwater is the only bulk water supplier, managing water storages, treatment and transport of water through to the distributors and retailers. Urban Utilities, Unitywater, Redland City Council, Gold Coast City Council, and Logan City Council then distribute and sell this water to customers.

Outside of South East Queensland, Sunwater owns most of the state's bulk water infrastructure.

Local government can also own dams, weirs and bores to access groundwater and generally operate as service providers owning most of the drinking water treatment facilities and distribution networks which provide retail services to homes and businesses.

There are also a number of local water boards that manage water supply (either Category 1 or Category 2). Category 1 water boards are for-profit authorities established under the Water Act 2000 to carry out a range of local water activities.[36] There are two of these in Queensland – the Gladstone Area Water Board, and the Mount Isa Water Board. Category 2 water boards are much smaller, and sometimes may only serve a few landholders.

Sewerage and wastewater treatment is the responsibility of local government.

Table 5. Key water infrastructure owners and operators in Queensland[36]

<table>
<tr><th>Region</th><th>Bulk water supply</th><th>Distributors, retailers, sewerage and wastewater</th></tr>
<tr><td rowspan="3">South East Queensland</td><td rowspan="3">Seqwater</td><td>Urban Utilities</td></tr>
<tr><td>Unitywater</td></tr>
<tr><td>Local government</td></tr>
<tr><td rowspan="5">Rest of Queensland</td><td>Sunwater</td><td rowspan="5">Local government</td></tr>
<tr><td>Mount Isa Water Board</td></tr>
<tr><td>Gladstone Area Water Board</td></tr>
<tr><td>Other water boards</td></tr>
<tr><td>Local government</td></tr>
</table>

Transport

The transport sector includes a variety of different assets and infrastructure, which are owned by both government and the private sector. Table 6 below outlines the different types of infrastructure and the key owners and operators.

Table 6. Key transport infrastructure owners and operators in Queensland[37]

<table>
<tr><th>Road</th><th>Rail</th><th>Bus</th><th>Maritime</th><th>Aviation</th></tr>
<tr><td rowspan="2">Department of Infrastructure, Transport, Regional Development, Communications and the Arts (Federal)</td><td rowspan="2">Queensland Rail (statutory body)</td><td rowspan="4">Most public transport bus and tram services are provided by DTMR, however some services are owned and managed by local government</td><td>Port of Brisbane</td><td rowspan="2">Brisbane Airport Corporation</td></tr>
<tr><td>Local government (Ferry operations)</td></tr>
<tr><td rowspan="2">Department of Transport and Main Roads (DTMR)</td><td rowspan="2">Aurizon</td><td>Ports North (GOC)</td><td rowspan="2">North Queensland Airports Group</td></tr>
<tr><td>Port of Townsville (GOC)</td></tr>
<tr><td>Local government</td><td rowspan="2">Sugar cane railway (owned and operated privately by sugar mills)</td><td rowspan="2">Greyhound Australia</td><td>North Queensland Bulk Ports (GOC)</td><td rowspan="2">Queensland Airports Limited</td></tr>
<tr><td>Transurban</td><td>Gladstone Ports Corporation (GOC)</td></tr>
</table>

There is over 186,000km of road network in Queensland, most of which is owned and managed by the Department of Transport and Main Roads (DTMR). There are a few exceptions with roads that are managed by the federal government, and by local government, with a number of toll roads in Brisbane also managed by Transurban (private entity).

The rail network is owned by both government and private entities, with around 9,300km of heavy rail (government and private), 4,000km of sugar cane rail (private), and 6,600km of passenger rail managed by Queensland Rail.

Public transport bus services are predominantly provided by DTMR, with a number of private entities also operating charter buses (Greyhound Australia being a key operator across Australia).

There are 16 trading seaports in Queensland, and 6 major airports, all operated by both government and private entities.

The majority of freight is transported by road (65%), followed by rail (32.5%), coastal shipping (2.4%), and air (<1%).[38] The transport sector also includes passenger services (such as public transport, ferries), and active transport (such as cycleways). Figure 8 below depicts the key freight routes across Queensland.

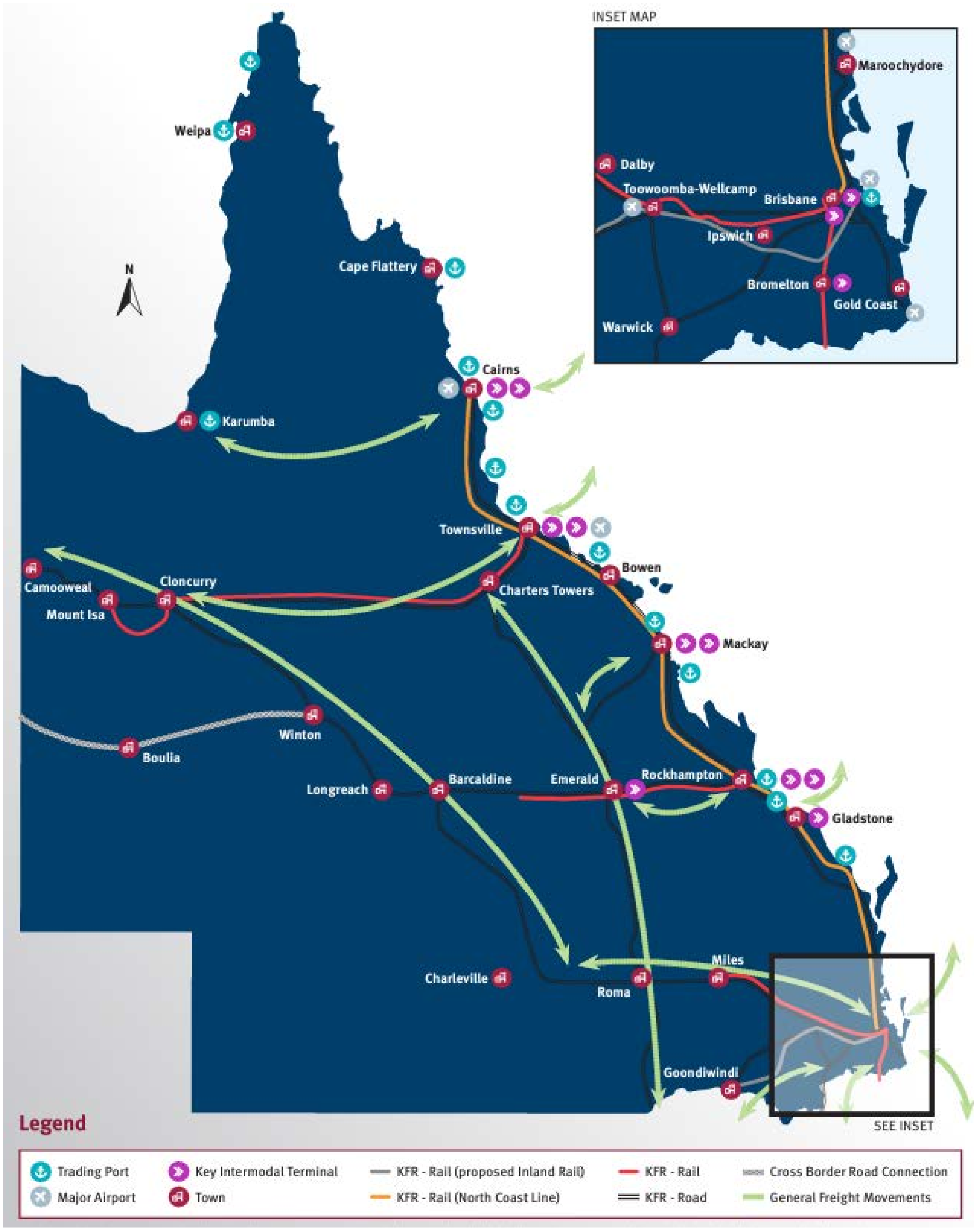


Figure 8. Major freight routes across Queensland.
Source: Queensland Freight Action Plan 2020-2022.[39]

Communications

Communications infrastructure in Queensland is privately owned, with the exception of the National Broadband Network (NBN) which is owned by the Commonwealth Government under NBN Co, and Powerlink and Energy Queensland (Queensland Government Owned Corporations) which also provide telecommunications services. The key owners and operators of telecommunications infrastructure include Telstra, Optus, and TPG/Vodaphone, however, there are numerous other private entities that own and operate infrastructure such as mobile towers and fixed broadband for example.

In regional and remote areas, infrastructure is often co-funded with industry by both the Commonwealth and State Government, under the Regional Connectivity Program and the Strengthening Telecommunications Against Natural Disasters Program.[40, 41] These programs aim to improve digital connectivity across regional, rural and remote Australia, through the provision of grants for telecommunications providers to increase service provision in these communities, and to improve infrastructure resilience.

Legislation and Policy

CI owners and operators, both public and private, are responsible for managing risks to their assets. Collaborative efforts and information sharing among these stakeholders is crucial to enhance the overall resilience of CI in Queensland. Listed in the table below (Table 7) are the key legislation and policy documents that relate to critical infrastructure and disaster resilience in Queensland. Key legislation for each level of government are described in more detail below the table.

Table 7. Key legislation and policy documents relevant to this assessment.

	Disaster Management and Risk Reduction	Critical Infrastructure	Climate Change
Federal	National Disaster Risk Reduction Framework[42] and the Second National Action Plan[43]	Security of Critical Infrastructure Act 2018[2] and the Telecommunications and Other Legislation Amendment Act 2017[45]	National Climate Risk Assessment[46]
Federal	National Emergency Declaration Act 2020[44]		National Climate Resilience and Adaptation Strategy 2021-2025[47]
Federal	Royal Commissions into National Natural Disaster Arrangements[3]		
Federal	Australian Government Disaster Response Plan (COMDISPLAN 2020)[48]	Australian Government Critical Infrastructure Resilience Strategy[5]	Climate Change Act 2022[49]
Federal	Australian Government Crisis Management Framework (AGCMF)[50]	Sector Risk Assessment Advisories (CISC): Communications[51] Energy[52] Transport[53] Water[54]	
Federal		Powering Australia plan[55] and the National Energy Transformation Partnership[56]	
State	Disaster Management Act 2003[57] and the Disaster Management Regulation 2014[58]	State Infrastructure Strategy 2022[29]	Queensland Climate Action Plan[59] and the Queensland Climate Adaptation Strategy 2017 – 2030[60]
State	Prevention, Preparedness, Response and Recovery Disaster Management Guideline[61]		
State	Queensland Strategy for Disaster Resilience 2022-2027[62]		
State	State Disaster Management Plan[63] and State Hazard Specific Plans	Built Environment and Infrastructure Sector Adaptation Plan[64]	
Local	Regional Resilience Strategies		
Local	Local and District Disaster Management Plans	Indigenous Councils Critical Infrastructure Program[65]	Local Coastal Hazard Adaptation Strategies (funded through QCoast2100)
Local		Local Government Act 2009[66] and Local Government Regulation 2012[67]	Queensland Climate Resilient Councils Program

Federal

The key federal government legislation relating to critical infrastructure resilience is the *Security of Critical Infrastructure Act 2018* (Cth).[2] This Act was amended in 2022 to strengthen the security and resilience of critical infrastructure by expanding the sectors and asset classes, and to introduce new obligations.[68] The eleven sectors included are:

- Communications
- Data storage or processing
- Financial services and markets
- Water and sewerage
- Energy
- Health care and medical
- Higher education and research
- Food and grocery
- Transport
- Space technology
- Defence industry

The new obligations apply to owners and operators of critical infrastructure assets, and businesses who have a direct interest in the critical infrastructure asset. The amendments introduced in 2022 include:

- a new obligation for responsible entities to create and maintain a critical infrastructure risk management program, and
- a new framework for enhanced cyber security obligations required for operators of systems of national significance (SoNS), Australia's most important critical infrastructure assets.[68]

Further amendments are underway to improve security and resilience to cyber attacks, following significant events in recent years. This process will introduce new legislative initiatives to address gaps in current laws and will seek to make additional amendments to the SOCI Act.[69]

The telecommunications sector is also covered by similar legislation - *Telecommunications and Other Legislation Amendment Act 2017*[45], known as the Telecommunications Sector Security Reforms (TSSR). This legislation introduced obligations for carriers, carriage service providers and carriage service intermediaries to protect telecommunications networks and facilities from risks of unauthorised interference or access, and to inform government of changes to their systems or services that may impact national security.[70]

Queensland

The *Disaster Management Act 2003* and the *Disaster Management Regulation 2014* sets the legislative basis for disaster management in Queensland. The State Disaster Management Plan outlines the roles and responsibilities under Queensland's disaster management arrangements.

The Prevention, Preparedness, Response and Recovery Disaster Management Guideline (the Guideline), provides guidance on the approach to disaster management under each phase of disaster management. The guideline provides users with a toolkit for undertaking disaster management planning, including resources for use by Local and District Disaster Management Groups. It is the responsibility of these disaster management groups, in collaboration with CI owners, to manage risks associated with CI failure when related to a disaster event.

Climate Change and Critical Infrastructure

Australia's average temperature has already increased by approximately 1.4°C since 1910, with Queensland's average increase in temperature higher than this at 1.5°C since 1910.[71, 72] Climate change is already occurring and there are impacts being felt in every sector. Critical infrastructure will experience challenges from climate change, not just from increased average temperatures, but from the increasing frequency and severity of climate-influenced hazards. The interdependencies of critical infrastructure also mean that impacts to only one sector (e.g. energy) can have knock-on impacts to other sectors which can then cascade through the whole economy.[64]

While critical infrastructure is exposed to climate risks across the state, exposure to coastal hazards is of particular concern, with the majority of Queensland's infrastructure and development located within 50km of the coastline. The areas of most concern include North Queensland, and predominantly, South East Queensland. This is consistent with the Intergovernmental Panel on Climate Change's (IPCC) identification of South East Queensland as a 'climate change hotspot' due to the high concentration of population (and infrastructure) in proximity to the coast.[64]

Climate change also increases the likelihood of multiple events coinciding at the same time, or concurrently.[73] The IPCC has projected that cascading, compounding and aggregate impacts will grow due to a concurrent increase in heatwaves, droughts, fires, storms, floods and sea level.[74] This can result in communities becoming more vulnerable, as the impacts are amplified and more complex, and recovery may still be ongoing when the next event impacts. Compound events place increased pressure on emergency services and other responders, where capacity to respond can be exceeded depending on the number or severity of events. The natural environment will also be severely stressed, limiting the ability to recover before the next event occurs, potentially reducing the environment's ability to protect areas from impacts (e.g. mangroves reducing the impacts of wind and waves along coastlines).

Gympie, in southeast Queensland, has experienced devastating compounding events in recent years.[75] Since 2019, the region has experienced bushfires, severe drought and flooding, with each event being described as never experienced before. The Gold Coast storms experienced on Christmas Day 2023 also provide a prime example of compounding events, when the severe storms led to power outages, resulting in significant health concerns for the community as they suffered through a heatwave without access to cooling. These examples are not the first time concurrent and compounding events have occurred, and there are many other examples of a heatwave or other event occurring at the same time as another hazard or during the recovery period. The effects of compounding and concurrent events put enormous pressure on communities, the environment, infrastructure, and essential services.

The Queensland Built Environment and Infrastructure Sector Adaptation Plan (SAP) provides a framework for the sector to plan for and adapt to the impacts of climate change. Released in 2017 (and due to be updated), the SAP acknowledges that the sector recognises climate change as a material risk to business operations in the short and medium term, and that the sector is already undertaking a broad range of activities directed at managing climate risk and building organisational resilience. There are seven Priority Actions identified in the SAP which focus on collaboration within and outside of the sector, risk identification, and information development across the sector. The highest priority action is to:

> "Identify incentives to encourage and facilitate the built environment and infrastructure sector to adapt to climate change and to design and build assets to go beyond minimum standard requirements."[64]

This priority action recognises that infrastructure is only built to meet a minimum standard which does not always consider future climate change. By considering climate change within and beyond the expected lifetime of the asset, infrastructure can be safeguarded from projected climate hazards into the future.

The Queensland State Disaster Risk Report 2023 provides general information on climate projections across Queensland, including for Queensland's regional plan areas. The Queensland Future Climate Dashboard has detailed climate information, including projection data which can be downloaded and used for risk analysis.[76] These information sources can be useful for the identification of climate risk for the critical infrastructure sector, to understand what regions are at greater risk for particular hazards. General climate trends for Queensland are provided below, with examples of how this may impact the critical infrastructure sector (energy, water, transport, and communications) in Table 9.

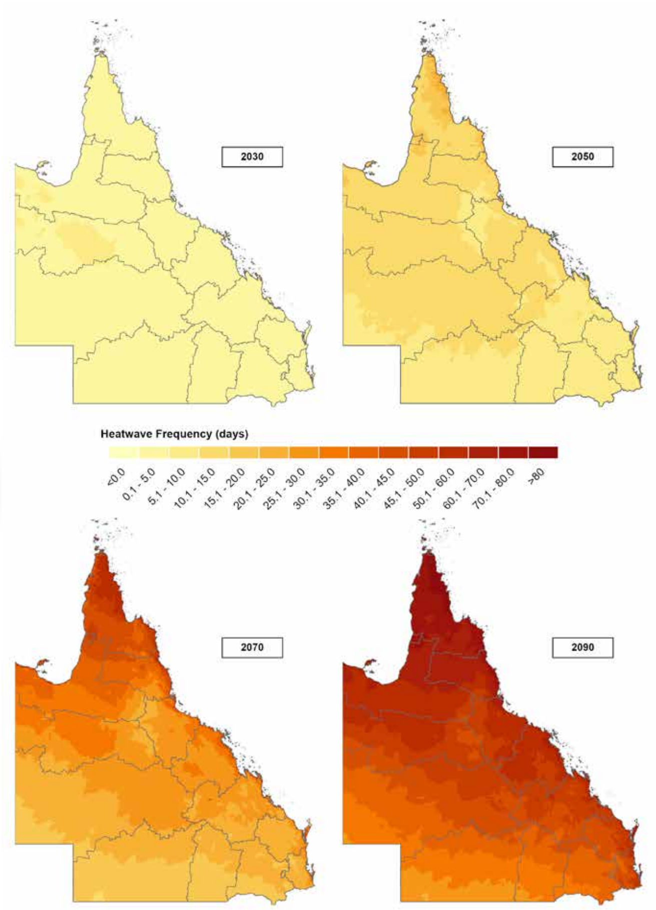


Figure 9. Projections of heatwave frequency (number of days above 1986-2005 baseline) under a high emissions scenario for 2030, 2050, 2070 and 2090

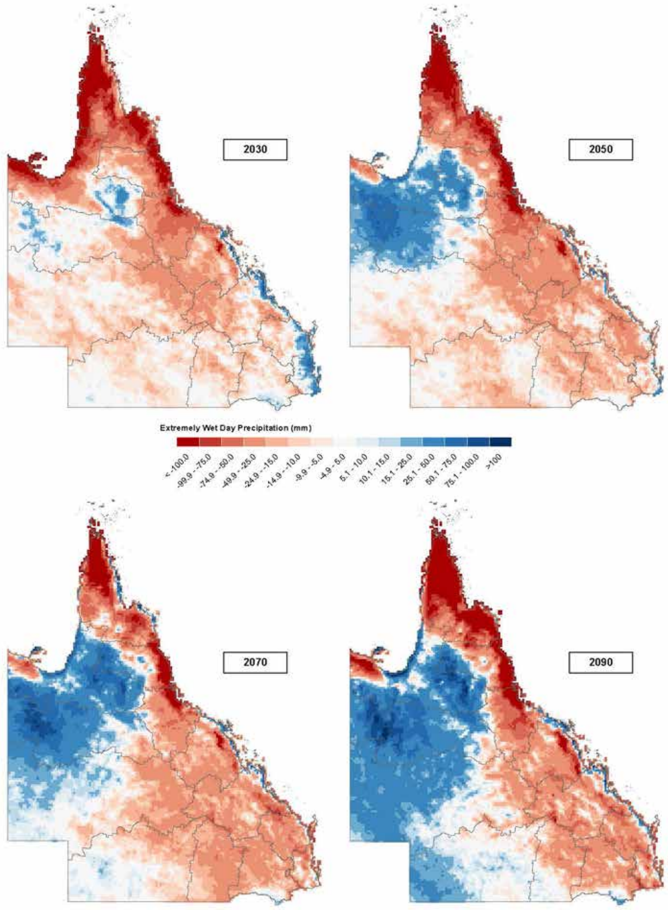


Figure 10. Extremely Wet Day Precipitation for 2030, 2050, 2070 and 2090 under a high emissions scenario (mm change from 1986-2005 baseline).

General climate trends for Queensland:

- **Higher average temperatures:** By 2030, Brisbane's climate will be more like the current climate of Bundaberg, while Cairns' climate will be more like the current climate of Cooktown. In 2070, under a high emissions scenario, the average temperature is projected to be 2.9°C higher than the historic average (1986-2005).[77]
- **More extreme heat:** Queensland will experience more intense and more frequent hot days. By 2050, Brisbane will see an increase from approximately 2 to 8 hot days (above 35°C) per year, and Toowoomba will see an increase from approximately 4 to 14 days per year.[78]
  - Urban areas are at greater risk of increased temperatures due to urban heat island effect (caused by dark, heat-absorbing materials, heat radiating infrastructure and the canyon-like design of cities). This means that urban areas can often experience temperatures approximately 2-12°C higher than nearby rural areas.[78]
- **Harsher fire weather:** The fire season will become longer, with around 40% more very high fire danger days.[72]
- **Rainfall variability:** Rainfall remains highly variable, however there may be an increase in Summer/wet season rainfall and a decrease in Winter/dry season rainfall. Extreme rainfall events are projected to become more intense.[77]
- **Drought:** Under a high emissions scenario, it's projected that the south of the state will experience more time in drought by the end of the century.[77]

- **Coastal hazards:** Sea levels are projected to rise by 0.8m above current levels by 2100.[72] This increases the risk from storm tide inundation across Queensland's coastline.
- **Cyclones:** The number of tropical cyclones is projected to decrease by around 8%, however the intensity of cyclones is projected to increase.[77] Heavy precipitation from all weather systems, including cyclones, is likely to increase, along with storm surge associated with cyclones.[79] There is also potential for cyclones to travel further south, however this projection has low confidence and further research is continuing.

These climate trends result in a number of risks for critical infrastructure owners and operators. There are the more obvious physical risks (examples provided in Table 9), but there are also a number of other risks such as financial, reputational, legal, and regulatory risks to consider. The SAP provides examples of these risks (Table 8 below), where stakeholders noted greatest concern with infrastructure, regulatory, insurance, and labour force risks.[64]

Table 8. Examples of the types of risks facing critical infrastructure owners and operators due to climate change.[64]

Risk	Explanation
Infrastructure risk	Physical damage to land and/or premises stock.
Supply chain risk	Disruption of access to production inputs that affect (sub) contractor productivity and/or ability to deliver as agreed.
Reputational risk	Damage due to actions taken or not taken to address climate change.
Financial risk	Limited access to finance as needed at a reasonable cost and terms.
Insurance risk	Loss of access to insurance due to reduction of insurance coverage at reasonable rates.
Market risk	Risk that final product is not bought, leased or operational at anticipated price or purpose.
Regulatory risk	Burdensome and/or unstable regulation targeted at climate change mitigation and adaptation.
Political risk	Instability due to climate change related disasters.
Labour force risk	Climate related impacts that affect staff productivity and ability to work.
Legal risk	Costs and resources dedicated to both remunerating and defending legal actions due to actions taken or not taken to address climate change.

Table 9. Examples of physical risks to critical infrastructure resulting from climate change in Queensland.

Climate trend	Sector	Physical impact to infrastructure/sector
Higher average temperatures and extreme heat	**Energy**	The efficiency of thermal power plants may decline due to higher ambient temperatures, reducing their capacity to meet electricity demand.[80] Higher temperatures can reduce the efficiency of transmission lines due to increased line losses and decreased power-carrying capacity. This can also shorten the lifespan of assets.[80] High solar radiation combined with high temperatures and low winds, creates challenging conditions which can result in de-rating of equipment.[80]
	Water	Increased evaporation rates from high temperatures can reduce surface water availability.[81, 82] Increased temperatures can also result in increased demand for water for both human consumption and crop irrigation.[83] Increased temperatures in storage facilities (such as dams) can increase the risk of bacterial and algal growth, impacting water quality.[83]
	Transport	Increased temperatures can cause damage to pavement, bitumen, and other materials used for transport systems.[84] Extreme temperatures can cause thermal expansion of rail tracks, increasing the risk of buckling and derailment.[84, 85]
	Communications	Increased temperatures lead to increased maintenance requirements and possibility of overheating.[86, 87]
Harsher fire weather	**Energy**	Dangerous bushfire conditions can affect overhead lines and other structures.[80]
	Water	More frequent and intense fires can damage plants, increase erosion and reduce water availability and quality in rivers and dams.[81]
	Transport	Bushfires can result in damage to electrical equipment and other roadside infrastructure (e.g. noise walls).[84] Other damage to road infrastructure can destabilise slopes and batters along roads, causing rockfalls and slips. Increased smoke presents risks for motorists, cyclists and pedestrians.[84]
	Communications	Bushfires can result in damage to communications infrastructure and extended service disruption.[86]
Extreme rainfall	**Energy**	Storms and strong winds can down powerlines and disrupt access for repairs.[80] Flooding may damage substations, underground cables and pipes.[80]
	Water	Extreme rainfall can increase the likelihood of flooding, erosion and overtopping of dams.[81] Flooding can overwhelm stormwater systems and disrupt water treatment processes.[83]
	Transport	Flooding can directly inundate transport infrastructure, cause bridge scour, damage electrical infrastructure of transport systems, and cause aquaplaning. Road pavements, slopes, batters and other structures such as culverts can be damaged.[84, 88] Debris can block road infrastructure such as bridges and ports for example. The safe movement of shipping can be impacted due to increased currents, debris and shoaling. Particularly at ports based at river entrances, such as Brisbane.
	Communications	Flooding can result in infrastructure damage and extended service disruptions.[87]

Climate trend	Sector	Physical impact to infrastructure/sector
Drought	Energy	Increased water scarcity may affect the availability of cooling water for thermal power plants, impacting the efficiency and potentially leading to shutdowns during periods of high demand.[89] Drought and reduced water availability can impact hydroelectric power generation, limiting its ability to meet electricity demand.[90] Drought can affect ground conductivity through underground cables and can damage aboveground structures through ground movement.[80] Dust storms can cause flashovers of overhead lines.[80]
	Water	Changes in precipitation patterns can lead to more frequent and severe droughts, impacting groundwater recharge rates and surface water storage levels.[81] Drought can have significant impacts on water quality.[81]
	Transport	Drought can impact longer-life elements of transport infrastructure such as drainage, road base and bridges. Soil cracking and subsidence can lead to instability and more frequent maintenance.[84]
	Communications	Increased water scarcity may impact the availability of water for cooling systems used in the communications sector.[91]
Coastal hazards (including cyclones)	Energy	Severe wind can damage transmission lines, reducing network capacity. Downed distribution lines from wind can also result in widespread power outages. Sea level rise, coastal erosion and storm tide can result in inundation and damage to substations, transformers and circuit breakers.[80] Salt particles in the air (from salt spray) can cause flashovers and increase the need for maintenance.[80]
	Water	Rising sea levels exposes fresh surface water and groundwater in low-lying areas to saltwater intrusion.[81]
	Transport	Severe wind can damage electrical infrastructure and cause safety concerns from debris blowing onto the transport corridor.[84] Coastal erosion and storm tide can expose footings (and other structures) resulting in damage and potential collapse.[84] Severe wind and waves can disrupt the safe movement of shipping, affecting supply chains.
	Communications	Severe wind and storm tide can damage infrastructure resulting in extended service disruptions.[87] Sea level rise can damage low-lying infrastructure, including roads, and result in increased costs for repair or relocation.[87]
Other variables	Energy	Fluctuating weather patterns can impact the efficiency and reliability of renewable energy sources such as solar and wind generation.[92] Lightning can disrupt energy supply and accelerate asset deterioration.[80] Increased vegetation growth patterns can increase the maintenance of overhead lines.[80]
	Water	Changing weather patterns and climate drivers can influence the amount and location of rainfall which dams are reliant on.[83]
	Transport	Increased vegetation growth patterns can increase the maintenance required for transport corridors (particularly rail).[84]
	Communications	Lightning can damage communications infrastructure.[86]

Other Risk Drivers

While climate change evidently has a strong influence on risks to critical infrastructure, there are many other drivers which will influence future risk. The following section discusses some additional risk drivers for each of the four sectors and what impact these may have on future critical infrastructure risk. Understanding how each of the sectors may change into the future may also provide insight into how the disaster and climate risks facing each sector may change over time.

Energy

Future energy needs are a key consideration for planning future infrastructure and development. Network planning needs to consider areas of development and demand many years in advance, to ensure a stable and secure energy supply. The energy network is currently undergoing a rapid transformation towards renewable energy, focused on reducing emissions in the energy sector and to lower the cost of electricity for consumers.

Renewable energy technology is constantly evolving, with incentives to increase solar PV, and commitments to build new hydrogen plants, hydropower and wind generation paving the way for Queensland to meet its renewable energy targets - 50% by 2030, 70% by 2032, and 80% by 2035.[93] There are proposals for twelve Renewable Energy Zones (REZs) within Queensland, providing opportunities to increase diversity of energy technologies where needed, and to ensure efficient development of infrastructure within Queensland for the National Electricity Market (NEM).[94] These REZs consider current and future population centres to understand future demand, prioritising low or no emissions technologies which can be integrated into the NEM and continue to provide reliable and secure electricity to customers.

This increased diversity in generation technologies reduces any risks where certain technologies may decrease in efficiency or may become unavailable for a period of time (e.g. solar PV's reliance on sunshine, wind farm reliance on wind, etc.). These technologies also assist both the Queensland and Australian Government to meet emissions reduction commitments of net zero emissions by 2050.

Figure 11. Solar power installation is increasing across Queensland.

Transport

Electric Vehicles (EVs) are becoming increasingly popular, moving away from traditional modes of fossil fuel-powered vehicles to a cleaner and more environmentally friendly alternative. Predicted to be the next step in transportation and technology, EVs are becoming more affordable and accessible worldwide. Whilst EVs are praised as a more sustainable and economic choice, they pose new risks that need to be considered and mitigated.

The Queensland Government has released a Zero Emissions Vehicle Strategy 2022-2032[95] and Action Plan 2022-2024[96] which sets a vision for a cleaner, greener, integrated transport and energy network that encourages zero emission transport solutions, working towards achieving net zero emissions by 2050. The strategy aims to increase EV uptake across Queensland, with a target of 50% of new passenger vehicle sales to be zero emissions vehicles by 2030. However, there are a number of risks associated with a higher uptake of EVs, particularly relating to the lithium-ion batteries:

- Overheating and flammability – overheated batteries can cause thermal runaway, a chain reaction of increasing heat that can damage the battery and create a hazardous situation.[97]
- Spontaneous combustion.
- Electrochemical reactions – if damaged or exposed to water the battery chemistry can lead to electrochemical reactions that produce explosive hazardous gases.
- Toxicity and logistics challenges such as proper disposal and transportation.[98]
- Limited resources for recycling batteries in the industry. Greater planning intervention to manage the volume of discarded batteries that is predicted with the rise of EVs is required. The Queensland Government's Battery Industry Strategy 2024-2029[99] will help to manage this risk.

These challenges could increase safety risks for users, and for emergency response personnel who attend road crashes, rescues and car fires. Research is currently being undertaken on developing a flame-resistant lithium battery prototype, which may reduce these risks if proven successful.[100]

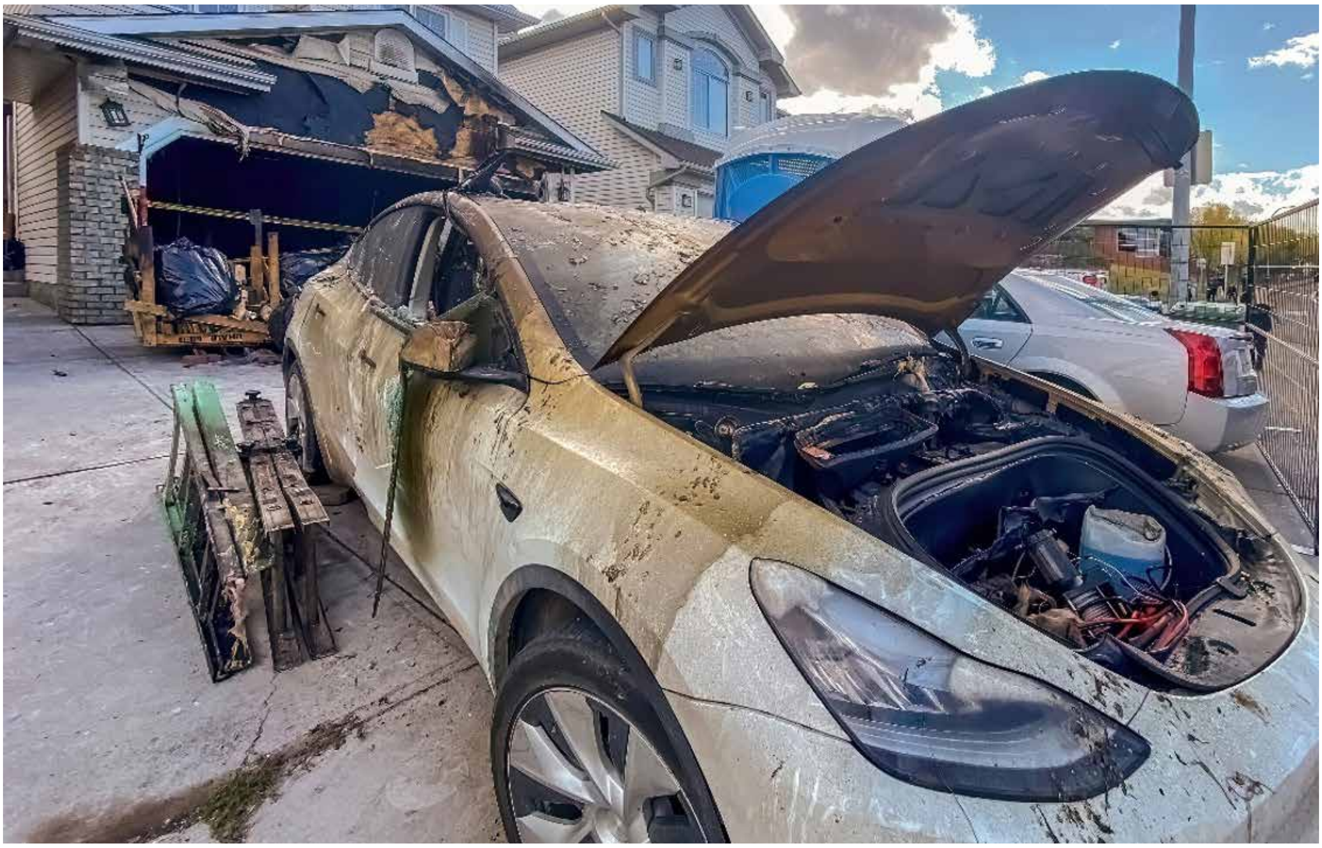


Figure 12. Electric vehicle with fire damage

Water

Queensland's population is predicted to grow significantly in the coming decades, from the current 5.4 million to between 6.4 and 8.27 million by 2046.[101] Most of the growth within South East Queensland is expected to occur in the Ipswich, Logan and Moreton Bay regions, seeing an increase of around 2 million people by 2041.[102] This will have impacts in many sectors, as industry attempts to keep up with growth to ensure the population has access to required services and infrastructure. For example, the energy sector will also need to ensure that new generation and transmission infrastructure are able to service the future population.

This will also place strain on existing water supply infrastructure as demand increases. Numerous future planning initiatives have been developed to compensate for the growing population, with a focus on:

- new technologies to improve water supply management,
- population growth trends to determine total demand for water,
- water supply infrastructure to adapt to changing water demands,
- and increasing environmental stewardship to view water as an asset to enhance people's lives.[103]

The Queensland Government Queensland Water Strategy[104] and the State Infrastructure Strategy (Water)[105] assist in planning and managing water requirements into the future. Some key initiatives to manage future water supply risk include:

- Upgrades and improvements to local government water and sewerage infrastructure.
- Dam improvements to ensure infrastructure is resilient against natural hazards and severe weather events.
- Securing water supply for specific sectors (such as agriculture and industry) through new infrastructure (e.g. construction of weirs).
- Identifying new infrastructure and non-infrastructure solutions to maximise water supply.
- Ensuring water supply is secured for the future by remaining unallocated in the near-term.

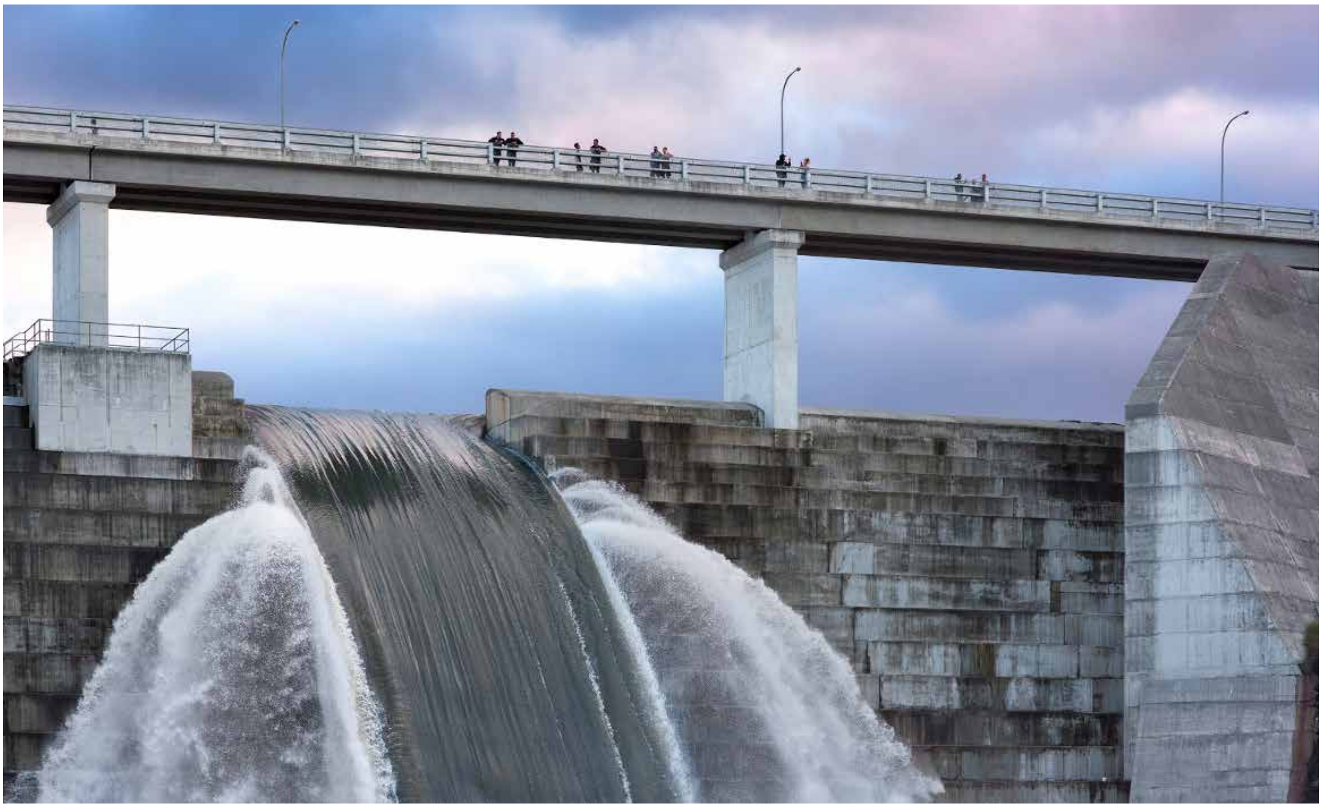


Figure 13. Hinze Dam overflowing at spillway, Gold Coast, Queensland.

Communication

Figure 14. Communications radio tower.

Technological advancements have given people greater access globally, significantly increasing our reliance on the internet, communication devices and services. Online engagement has increased substantially since 2020, likely due to COVID-19 restrictions.[106] Whilst our reliance on older forms of communication continue to decline, such as fixed-line home phones, Australian internet users are increasingly using multiple types of devices to access the internet.[107]

Technology and online engagement have increased our reliance on different types of technologies for almost every aspect of our lives – i.e., social interactions, employment, banking, legal, education, and health services. This heavy reliance poses increased risks and impacts to the community if critical infrastructure is damaged during a disaster, as communication channels can become disrupted or inaccessible.

Cyber-security also poses significant challenges, with cyberthreats continuing to grow in scale and complexity.[108] As more data becomes available, more users are accessing digital platforms, and as CI operational technology becomes more integrated into organisational ICT ecosystems, more information technology systems are exposed to cyber disruption. Greater dependence on information systems combined with larger population needs will lead to increased community risks associated with a loss of ICT systems availability, particularly due to disruptive natural hazards such as flood, bushfire, heatwave, space weather and severe weather events for example.

The Queensland Government has developed the Cyber Security Hazard Plan[109] to respond to and protect Queensland communities from the potential consequences of a cyber crisis. The Cyber Security Hazard Plan is a sub-plan to the Queensland State Disaster Management Plan and is supported by the Queensland Government Cyber Security Arrangements.

RISK ASSESSMENT

Risk Assessment

Priority Risks

General risk statements were identified by subject matter experts (government and industry) from each of the sectors during workshops. Scenario analysis was used for each of the hazards assessed, based on data where available. These risk statements are at Appendix A.

For local or district Disaster Management Groups (LDMGs or DDMGs) identifying risks, it may be useful to consider a broader definition of critical infrastructure. For example, the risk assessment may assess the sectors considered within the Essential Utilities category of the QERMF, or it could consider the critical infrastructure sectors identified within the SOCI Act. It will be up to the LDMG/DDMG to determine the most appropriate sectors to assess, relevant to the local area.

Risks were then prioritised in-line with the QERMF, assessing the hazard, vulnerability and consequence through qualitative research and input from industry and government stakeholders through a risk prioritisation workshop. Three priority risks were identified for each sector, as well as for 'All-sector risks', which provide more detail on the vulnerability and consequences of the risk.

The priority risks have not been provided in order within this assessment and are provided as an example of how to consider the hazard, vulnerability and consequence of a risk. As the intention of this assessment is to provide general information and advice to stakeholders within QDMA, it is up to the user to determine how this information could be used within other disaster risk assessments (at the local or district level).

All Sectors

For all-sector risks, the tables below highlight that timely decision making, compounding events, and cyber security were the priority risks. Whilst risk statements have been individually identified, it is important to note the complex relationship between sectors and the possibility of compounding effects from one risk to another.

Figure 15. Coronavirus border control measures, Coolangatta, Queensland.

Risk	**A1:** Decision-making of government and infrastructure owners/operators to the event is unclear resulting in a delayed response and increased consequences.
Description	This risk describes how decision making in government, or by CI owners/operators, may not be able to keep up with the events unfolding in real-time. Delays in decision-making (such as time spent waiting for approval processes for example) can result in delayed actions and increased consequences. It may be unclear which agency, local government, or owner/operator is responsible for which elements of a response to a hazard event. While certain agencies are identified as lead agencies for each hazard, response itself can be coordinated across multiple agencies and with owners/operators directly. An example of this risk may be an unfolding biosecurity emergency or pandemic, with movement restrictions needing to be put in place immediately. Another example could be space weather, with multiple sectors impacted within a short timeframe.
Vulnerability	Impacts from disaster events on one element of CI may have impacts on other elements, potentially in other sectors. If there is no mechanism for information and data sharing, or for coordination of response to these events, a vulnerability may arise. A lack of response planning and business continuity planning may lead to a lack of clarity during response. Furthermore, a lack of a communication and coordination strategy for CI owners/operators may cause this risk to arise.
Consequence	Delayed response may result in several consequences: • Compromised cohesion across government and industry can lead to miscommunication and lack of support where required during an event. • Response agencies and critical infrastructure crews may not be pre-positioned appropriately for the event, potentially leading to isolation and an inability to conduct repairs as needed. • Reputational risks to critical infrastructure organisations and the government. • The costs of returning to business-as-usual may be significantly higher following delayed responses. • Delayed response could increase the length of service outages or may worsen shortages of materials. • Loss of life due to delays in disaster warnings, evacuation orders, and emergency response.

Risk	**A7:** Compound and cascading events result in failures of critical infrastructure and extended disruptions.
Description	This risk describes the possibility of multiple events occurring at once, or when the second event occurs while recovery is still underway for a previous event. This requires the management of two different events, stretching resources and potentially putting more people at risk. An example of this could be a cyclone occurring during a pandemic, introducing complexities with managing the virus in emergency shelters and hospitals during a cyclone. Another example could be a cyclone followed by flooding or severe storms, such as those experienced in Queensland over December 2023.
Vulnerability	Almost any CI is vulnerable to the impacts of compound and cascading events, since multiple or concurrent events introduce additional stressors to already strained assets. Some key issues experienced during these type of events include: • Staffing shortages due to deployment of staff in response to one of the compounding events, or due to unavailability of impacted staff. • Vulnerabilities in different parts of the CI system may be exposed concurrently, leading to multiple, simultaneous failures. • Reserves of materials and devices used during response may only suffice for a single event and may not be able to meet the demand of multiple events. This includes, for instance, backup generators, Communications on Wheels (COWS), and personal protective equipment (PPE).

Consequence	Compounding and cascading events amplify the consequences of the individual hazard events, while introducing more significant consequences that may impact CI more broadly: • Staffing shortages may significantly reduce the effectiveness of response to events, particularly for concurrent events across regions. • Damage to assets may be significantly worsened by multiple events. • Service disruptions may last considerably longer due to damage and staffing shortages. • Accessibility is hampered due to already affected transport infrastructure. • Depleted essential supplies and inability to meet further emergency demands. • Severe mental and physical effects on the community. • Broad economic impacts to the community due to lack of services available.

Risk	**A15:** Information systems damage or deliberate cybersecurity attack leads to disruption of critical services resulting in physical and reputational damage, and economic impacts.
Description	This risk could occur due to a disaster event damaging critical infrastructure information systems with severe downstream effects on other critical infrastructure and/or community services; or from a deliberate cybersecurity attack leading to sabotage of information communications or operational technology systems with similar (or more severe) impacts. An example of this could be a malicious actor illegally obtaining private customer information, or shutting down communications for a large telecommunications company, resulting in impacts across multiple sectors.
Vulnerability	Vulnerability is higher for organisations delivering community services and supporting the Queensland economy, and may be exacerbated by poor cybersecurity measures, poor network configurations, outdated hardware and software, lack of employee training, and those who are highly dependent on digital technologies for their operations.
Consequence	The consequences include disruption of critical services, flow on effects to other critical infrastructure, shortages, or impacts to essential services such as medical supplies, food and grocery supplies, impacts on water supply, telecommunications networks, reduced services or shutdown of banking and retail, reduced community access to emergency services, or the inability of business or government to function.

Energy

The priority risks identified for the energy sector were all related to infrastructure damage. Fallen power lines are a risk to community safety, widespread damage would put a strain on generator availability leaving more homes without power, and demand for repairs would increase supply stress resulting in extended outages.

Risk	**E6:** Significant damage to the electricity network and fuel infrastructure leads to high demand for replacement parts and difficulties sourcing these parts, resulting in extended power outages.
Description	This risk describes the difficulties sourcing spare parts/components and specialty skills to repair the electricity network after a significant event. This could be due to a number of hazards which result in significant damage to the network. An example of this risk could be a significant space weather event which damages network components across the east coast of Australia, and potentially overseas. The demand for spare parts is high and not able to be met at short notice. Electricity outages continue over long periods of time until the parts are able to be sourced, with high competition for those that are available.
Vulnerability	Energy supply chains are quite vulnerable due to the specialised nature of parts and skills required. The lack of one critical component in the global supply chain could result in the failure of an entire system.[110] Significant damage to energy infrastructure over a large footprint could overwhelm the available supply of spare parts, with only limited domestic manufacturing capability. The COVID-19 pandemic highlighted Australia's vulnerability to international supply chains, impacting the procurement of key components and skilled migration.[111]
Consequence	Without the required components or specialist skills to complete repairs, electricity outages would extend over long periods of time. This could be managed on a small scale through deployment of portable generators, however this would likely not meet the required demand over a large scale. With sections of the electricity network damaged, the National Electricity Market (NEM) would also face high vulnerability with power system security likely to be compromised. This could result in more widespread outages, depending on the conditions of the event. Extended power outages could result in multiple second and third order impacts, for example: • Shut down of water plants and loss of potable water and loss of sewerage transportation impacting on sanitation and public health. • Large outages would put a strain on generator supply, causing a prioritisation problem for CI such as hospitals and health care facilities. • Impacts on emergency service capability. • Loss of mobile communication.

Figure 16. Powerlines damaged by fallen tree during severe storms on the Gold Coast.

Risk	**E8:** Disaster event impacts a large region and/or multiple jurisdictions, resulting in a lack of generators to service the population required.
Description	This risk describes a large-scale event where reconnection is not possible (due to continuing repairs, safety concerns, lack of fuel, or other reasons) and the demand for generators exceeds the resources available. It is likely that there would be extended service outages for some customers. An example of this risk could be widespread fires occurring across Queensland, impacting many different regions. Energy supply could be restored for some communities through the provision of generators, however there are not enough to supply the entire impacted area.
Vulnerability	As climate change continues to influence extreme weather events, it becomes more likely that widespread and severe natural hazard events will impact Queensland. This increases the need for additional resources, such as generators, to supply communities with electricity while repairs are taking place. The distribution of generators may also be hindered due to access concerns (closure of roads, rail, airports), and safety issues related to access.
Consequence	It is likely there would be some communities with long-term power outages, especially more remote or regional communities where access is more difficult. This could also potentially affect other critical infrastructure, such as communications, if there weren't any generators or back up power supply available. A lack of generators would result in similar second and third order impacts as described for E6. Vulnerable communities and CI would need to be identified and prioritised. There would be additional costs associated, and impacts would spread across all sectors.

Risk	**E15:** Strong wind and debris lead to downed powerlines resulting in safety concerns for communities.
Description	This risk describes the safety issues around live powerlines which can fall during and after a severe weather event or other hazard (e.g. earthquake). An example of this risk would be damage to powerlines during a cyclone which causes them to fall in a suburban area, putting the community at risk if they were to come into contact.
Vulnerability	All powerlines are vulnerable to strong winds, with damage dependant on the location of the powerlines, the construction materials (i.e., timber or concrete), and the severity of the hazard. This would most likely occur due to severe wind from a cyclone or severe storm, however earthquakes, tsunami, flooding, and other hazards can also cause powerlines to fall.
Consequence	Powerlines in remote areas, particularly areas that are difficult to access during and after an event, may be unable to be restored for extended periods. Powerlines downed in urban areas may have implications for the physical safety of residents, the pole itself potentially becoming a projectile from strong wind, as well as the risk of electrocution from the fallen power line. Power outages may cause cascading impacts for other critical infrastructure, particularly communications, and in other sectors including emergency services, health, and public administration. These broader impacts may significantly hamper response and recovery to the disaster event.

Water

The priority risks for the water sector were related to failure of water supply systems and associated infrastructure due to a severe event such as extreme rainfall or an earthquake. The third priority risk was the ability to access critical supplies to restore systems and repair damage.

Risk	**W8:** Extreme (or constant) rainfall leads to inundation of water treatment facilities resulting in failure of water supply systems.
Description	This risk describes the possibility of service disruption to water treatment (including sewerage), or water supply due to inundation at water treatment facilities or impacts to raw water quality due to elevated turbidity in raw water services. This could cause significant water supply issues over an extended period, requiring water restrictions, boil water notices, or the requirement to 'truck-in' water supplies for the community.
Vulnerability	Water treatment plants ability to operate are often impacted by severe weather through asset damage, loss of power supply, or raw water quality impacts through increased turbidity from flooded catchments. These events can carry pathogens, particulate matter and soluble substances, impacting water quality and supply.[112] This has been experienced in Queensland many times. For example, Cyclone Jasper in December 2023 resulted in water restrictions for weeks around Cairns, as severe flooding caused large amounts of debris to raw water inlet structures.[113] Additional heavy rainfall can also affect water distribution networks through saturating soils leading to land movement that can cause water main bursts. If water remains in distribution systems for long periods, there is potential loss of residual disinfectants and an increased concentration of disinfection by-products. There is also the potential development of nitrification in chlorinated systems which results in uncertainty in the reliability of water supply, and concerns of it becoming a source of biological and chemical contamination.[112] Heavy rainfall in urban areas have also been known to cause sewer overflow events through storm water infiltration of the sewer system, reducing surface water quality and exposing the community to health concerns.
Consequence	Quality of water impacted – If the water treatment process fails, such as intermittent chlorination, this could lead to low levels of chlorine concentrations in the water distribution system, allowing the potential of faecal and opportunistic pathogens to be detected in treated drinking water. If contaminated water is released for drinking there is a significant threat to human safety, especially those with vulnerable or compromised health.[112] Limited or delayed supplies of water, especially if in rural and remote areas, pose significant risks to the community. Agricultural farming's heavy reliance on consistent water supplies, which if interrupted or limited, could result in long term economic impacts for individuals and communities.[112] Water supply disruptions can also have cascading effects on other critical infrastructure including health services, cooling systems for both energy and communications infrastructure and fire fighting for communities.

Risk	**W9:** Earthquake compromises the structural integrity of water storages resulting in failure of infrastructure and potential inundation of surrounding communities.
Description	This risk describes the potential damage an earthquake could cause to water storage infrastructure, potentially resulting in dam failure and inundation of downstream communities. There is also the potential for earthquakes to damage pipelines and water supply systems, impacting water supply to communities.
Vulnerability	Dams are highly vulnerable to earthquakes. Internationally, failure of dams (including tailings dams) has often resulted in devastation of nearby communities, with 25% of global tailings dam failures due to an earthquake.[114] While the risk of an earthquake in Queensland is relatively low, they are still possible and could result in significant consequences. Dams in Australia are built to withstand a one-in-10,000-year earthquake event, however ageing infrastructure and lack of maintenance can result in higher vulnerability. There are more than 650 dams in Australia. More than half of these are over 50 years old, and more than 50 have been in operation for more than a century.[115] Studies show that dam failure is most common within the first 5 years of a dam's operation, or after 50 years of operation.[116] The type of soil can also play a large role in how much impact an earthquake will have, with large areas of Australian cities vulnerable to liquefaction in the event of an earthquake.[116] The State Earthquake Risk Assessment provides detailed information on earthquake risk for Queensland.[117]
Consequence	Dam failure could result in substantial loss of life and destruction of infrastructure (including other critical infrastructure), resulting in forced displacement of communities due to damage and lack of services available. Widespread impacts to water supply and security are also possible, along with significant consequences to the environment. Development downstream of dams also continues to occur as population increases, increasing the exposure of communities to this risk.[115] There are also a number of consequences to water supply due to earthquake damage to pipelines and other infrastructure. Broken water mains can result in service disruptions, leaving communities without a water supply until repairs are able to be conducted across the impacted area. This also limits water availability for firefighting to respond to any post-earthquake fires.[116] Localised flooding and soil inundation may occur due to burst pipes, along with contamination of water supply.[116]

Risk	**W13:** Ability to access critical supplies (e.g. spare components, chemicals, fuel) impacted.
Description	This risk describes the difficulties accessing critical supplies to repair the water network after a significant event. This could be due to several hazards which result in significant damage to the network, or due to supply chain issues both domestically and internationally. An example of this risk could be accessibility issues to damaged infrastructure caused by downed power poles and trees cutting off road access, or from movement restrictions put in place due to a significant biosecurity event.
Vulnerability	During severe storms and other events causing debris and damage, it is likely that repairs to water infrastructure will be delayed until access to the infrastructure is safe. The location of spare components, chemicals, and fuel stocks will also determine length of service disruption as these also could have been impacted during the event. Supply chain issues are much more complex, as this is dependent on how many contributors are part of the supply chain, and where the disruption originally occurred. Disruptions can be experienced due to physical damage anywhere in the supply chain, or through disruptions to the workforce.[118]
Consequence	Delayed access to water infrastructure to conduct repairs results in extended water supply outages for communities. Water infrastructure owners and operators will generally have supplies of spare components, generators, fuel, and chemicals, however access to this may also be restricted, causing further delays to water supply. Without the chemicals necessary to maintain water quality, water supply will be compromised and not safe for consumption.

Transport

Priority risks for the transport sector relate to disruption to services resulting from power outages, causing delays and concerns to safety, damage to rail and road infrastructure and the costs associated to repair, and cyber-attacks that will impact control and community safety.

Risk	**T1:** Power outages result in disruptions to service availability (particularly for trains). **T2:** Power outages lead to signalling issues, resulting in traffic congestion and safety concerns (road).
Description	These two risks have been grouped together as they are both caused by power outages, impacting operations of many different transportation systems. For example, disruptions to power can impact traffic lights, resulting in traffic congestion and safety concerns for motorists. Power outages can also impact signalling systems used in rail, causing disruptions due to safety concerns. Any hazard which could disrupt power supply could result in this risk occurring.
Vulnerability	Most transportation systems rely on power supply to operate, making the systems highly vulnerable to electricity outages. While some systems will have backup power supply available, this may not be enough for long-term outages.
Consequence	Safe travel on road networks – particularly roads with traffic lights – relies on power supply. Without power, motorists are exposed to traffic safety risks and increased congestion. Rail control systems, including signalling and communications are also reliant on power supply. If these systems failed to function, rail operations would need to cease to ensure the safety of passengers and operators. Air traffic control, communications, and airport operations for both freight and passenger services rely heavily on power supply. Disruptions to these operations can have significant flow-on consequences to scheduling. Disruption to transport infrastructure can also lead to significant impacts on the ability to access and resupply areas impacted by disaster. This may have implications both for the CI sector, where operation, maintenance and repair of CI assets relies on materials being transported into impacted areas and for communities, especially if everyday items such as groceries, medications, and fuel are unable to be transported.

Figure 17. Flooded creek damaging roadway – Ex-TC Debbie, March 2017

Figure 18. Flooding at Macrossan Bridge over the Burdekin River, near Charters Towers, Feb 2019

Risk	**T6:** Flooding leads to damage or destruction to roads or rail resulting in increased repair and maintenance costs.
Description	This risk describes the cost of repairing and replacing transport infrastructure damaged by flooding.
Vulnerability	Flooding is Queensland's highest priority hazard, with much of the state exposed.[1] Climate change is also projected to increase the variability of rainfall, with extreme rainfall events projected to become more intense. This means that repair and replacement of transport infrastructure after flooding is inevitable and may increase in frequency as Queensland experiences more intense rainfall events. Road and rail bridges are vulnerable to flooding as water levels rise and may also be damaged by debris travelling along floodwaters. Low-lying roads and rail are directly impacted by flooding, whether riverine, flash flooding or coastal flooding. Unsealed roads are particularly vulnerable and can be completely washed away by flood events.
Consequence	Repairing and re-building roads and rail can be incredibly costly, particularly for local governments who are responsible for the majority of roads across Queensland. This can be particularly difficult for local governments with low levels of revenue. After a very wet La Nina summer in 2022, the cost of repairing flood and rain damaged roads was over $3.8 billion across Australia.[119] In Toowoomba, repair costs (for local government-owned roads only) were estimated at around $100 million, with an estimated repair timeline of 2 years.[120] With climate change and increasing construction costs, the costs to repair infrastructure will continue to increase into the future. It is also possible that the next flood event occurs before the roads have been repaired from the previous event, resulting in significantly higher costs and longer repair timelines. These issues place pressure on other levels of government and has the potential to impact the reputation of government due to high costs and continued closure of roads.

Risk	**T21:** Cyber-attack leads to operational technology disruptions resulting in significant safety concerns for customers using transport systems (public transport, signalling, and signage), and economic impacts due to disruptions to freight and shipping systems.
Description	This risk describes targeted sabotage of operational technology which controls transportation networks. This could include total system control of public transportation systems such as train signalling, road variable messaging signs, and freight and shipping systems for example.
Vulnerability	The transport sector's accelerated digital transformation makes it highly vulnerable to cyber security threats. Transport systems share a large range of data for monitoring physical and digital networks, with multiple opportunities for cyber attackers to access valuable data and take control of systems.[121] Both public and private systems (including private cars) are vulnerable to cyber-attacks.
Consequence	Cyber-attacks have a variety of consequences, including compromised safety, personal data breaches (including passport information and credit card details for example), disruption to booking systems and functioning of transportation, supply chain impacts, costs to respond to an event, and reputational risks post-event.[122] Data shows that malicious data breaches make up around 27% of all events, costing an average of $330,00 per incident.[122] A worst case scenario could result in fatalities if attackers had control of vehicles or control systems.

Communications

Priority risks for the communication sector identified that the main concerns were for disruption to networks such as NBN and mobile communication, with a significant risk to safety and communication for responders. The third priority risk was the inability to deploy temporary telecommunication facilities due to access issues or evacuation orders.

Risk	**C4:** Power disruptions result in outages of NBN (impacting community safety and disrupting essential services).
Description	This risk describes the inability to access the internet via NBN during a power outage.
Vulnerability	The NBN is highly vulnerable to power outages, and any equipment connected via the NBN network will not work during a power outage. The only case where a landline phone may remain available during a power outage is if the premises is within a Fixed Wireless or Sky Muster satellite area and the existing landline phone service remains active across the copper network.[123]
Consequence	Equipment that will be affected by an NBN disruption could include: • **Modems and Routers**: The device connects your home to the NBN network. If it experiences an outage, your entire NBN service may be affected. • **Phone Services**: VoIP Phones and Landline Phones. • **Computers and Laptops**: Any devices connected to your home network via Wi-Fi or Ethernet cables will lose internet access during an NBN disruption. • **Home Security Systems**: Security Cameras and Alarm Systems. • **Point-of-Sale (POS) Systems**: Retail businesses using NBN for transactions may face interruptions. • **Cloud-Based Services**: Businesses relying on cloud applications or data storage will experience downtime. • **Telehealth Devices**: Patients using remote health monitoring systems may lose connectivity. • **Emergency Alarms**: Elderly or vulnerable individuals with emergency alarms connected to the NBN may be at risk during outages.[123] Disruption to these services can result in impacts to retail and health services, along with impacts to people's safety and security, or ability to access emergency assistance. Without NBN available, mobile networks are also likely to experience more traffic as people still seek to use the internet and contact other people, placing increased pressure on these networks.

Risk	**C5:** Power disruptions result in loss of mobile communications (impacting community safety, emergency services, emergency alerts, etc.).
Description	This risk describes the inability to use mobile communications due to a power outage.
Vulnerability	Telecommunications infrastructure, especially cell towers, rely on continuous power supply for operation. While battery backups exist in some cases, they have limited capacity and may be unavailable or degraded due to a number of factors (e.g. flood waters, high temperatures).
Consequence	Loss of communications can significantly impact community and personal safety. For example, emergency alerts and messaging might not be able to reach a community about to be impacted by a hazard. To mitigate this, the SES conduct doorknocking in impacted communities. However, this is not practical across larger impacted regions. Similarly, individuals may not be able to seek assistance from emergency services or check on friends and family members pre/post event. This can be of particular concern to communities or households with vulnerable people. During the 2023 Optus outage, while not a result of power disruption, around 2,700 customers tried to call 000 and were unable to due to the outage.[124] Another incident in Victoria resulted in 148 Telstra customers not able to contact 000 over a 1.5 hr period, with one of these calls resulting in a death from cardiac arrest.[125] The Parliamentary Inquiry into co-investment in multi-carrier regional mobile infrastructure also details multiple stories where communications weren't available when needed during disaster events.[126] Effective response to disaster events also requires availability of reliable communications, to coordinate operations and support situational awareness. This can be particularly difficult in rural and remote regions, where communication black spots are common, or the community are relying on just one communications provider which may be disrupted due to a power outage.[126] Ongoing communications outages can delay response activities and hinder access and resupply for communities.

Risk	**C6:** Deployment of temporary telecommunications facilities, such as Cells on Wheels are not able to be deployed due to road access issues, evacuation orders, movement restrictions, or other technical restriction.
Description	This risk describes the difficulties in deploying temporary communications facilities due to damage or closure of access routes, resulting in longer communications outages. Temporary communications facilities are generally deployed as a result of significant physical damage to infrastructure when service restoration faces delays. This generally occurs due to fire damage, flood damage, or wind damage from a cyclone for example.
Vulnerability	The deployment of temporary telecommunications facilities requires access into communities where the disaster has occurred. This is often difficult due to debris, and damaged or closed access routes. There may also be other restrictions that prevent deployment of these facilities, such as the ability to transport equipment long distances via aircraft.
Consequence	Extended communications outages can have significant impacts on access and resupply operations, as well as during the entire recovery process. Without communications it is difficult for communities to begin to clean up and rebuild, or to seek additional support as required (through government services, or family and friends for example). Additionally, consequences identified for C4 and C5 are exacerbated if temporary solutions are delayed or not possible. Inability to access the Queensland Government Wireless Network (GWN), which can also be serviced through Cells on Wheels, can significantly hamper response to the event.

Treatments and next steps

The treatments below have been identified through desktop research and discussion with government and industry stakeholders. Many of the treatments listed are already implemented as business-as-usual risk management practice, while other treatments are provided as potential 'next steps' in risk management. The list of risks which have been listed against each applicable Treatment can be found in Appendix A.

Treatment	Risks	Stakeholders
Business continuity planning, focusing on working collaboratively with other owners/operators. BCPs are frequently prepared by CI owners/operators, and these plans are generally robust. However, BCPs should be prepared to address vulnerabilities to, and prepare for consequences of, compounding and cascading events. Additionally, harmonisation of BCPs with whole-of-sector and cross-sector input will strengthen each agency's ability to mitigate disaster risk and respond to disaster events. State and local governments should also have robust BCPs in place which account for disruption to CI.	**Relevant to all risks:** All critical infrastructure sectors should have well practiced BCP's to manage risks faced.	CI sector State and local governments LDMGs and DDMGs Community
Development of training programs for staff. Training is essential to ensure general knowledge of disaster risk, Queensland's disaster management arrangements, and how CI owners/operators fit in these arrangements.	**Relevant to all risks:** Training on disaster management and the Queensland disaster management arrangements (QDMA) should be completed by all critical infrastructure owners and operators.	CI sector LDMGs and DDMGs Local government
Data-sharing with government and infrastructure owners/operators to facilitate accurate risk assessments, intelligence products, and risk reduction effort during all phases of disaster management (PPRR). These data may pertain to assets, services, and the status of the network.	**Relevant to all risks**	CI sector State government Commonwealth government
Undertaking exercises with broad participation from the CI sector will strengthen general knowledge of response to disaster events. Particularly, roles during response can be defined, and BCPs can be stress tested.	**Relevant to all risks**	CI sector All levels of government Other impacted sectors
Committees or groups, with a meeting rhythm aligned to the disaster season. This will allow for the coordination of planning and response. Creating connections between CI owners/operators, government, and the broader community will strengthen response to events, particularly in the case of compounding and cascading events.	**Relevant to all risks**	CI sector State government
Investment for further research in understanding hazards, including compound and cascading events, and other hazards which may not have been subject to extensive research efforts thus far. This may include enhancing early warning and predictive modelling for these kinds of events.	A7	CI sector Research and development sector

Treatment	Risks	Stakeholders
Investment in building cybersecurity capability for each agency (and government), ensuring that management of these risks respond to obligations under the SOCI Act, including: • Adoption, maintenance and compliance with a cyber security risk management program. • Development of incident response plans. • Development and participation in cyber security exercises. • Vulnerability assessments. • Maintenance of a near real-time threat picture.	A15 T21	CI sector Commonwealth and state government
Coordinate generator and fuel inventory with other CI owners/operators and local government. Memorandums of Understanding or agreements for resource sharing as needed during events should be developed through Local or District Disaster Management Groups, or sector-led groups where these may already be in place.	A5, A6, A7, A8, A10, A16, A17 E4, E6, E8, E10, E11, E12, E13, E14 W2 T1, T2, T16 C4, C5	CI sector LDMGs and DDMGs Commonwealth, state, and local
Investment in increased local manufacturing capacity, with a focus on diversifying supply across jurisdictions. This should include investment in building a skilled workforce, and strengthening the representation of women, people with disabilities, and First Nations peoples in the industry.[111]	E6, E8 C7, C11	CI sector Commonwealth and state government
Continued development of new technology, including more resilient infrastructure and an increase in uptake of renewable energy systems (including standalone power systems and other strategic battery systems).[127, 128]	A10, A18 E1, E2, E11, E12. E13, E14, E15 W6, W9, W15 T3, T4, T8, T12, T13, T16 C1, C2, C3, C4, C5, C8	CI sector Research and development sector
Replacement programs for assets which exceeds minimum or 'last-event' standards. This could include increased wind loading standards, infrastructure that can withstand higher temperatures, or bridges/roads replaced at a greater height to withstand flooding.	A5, A13, A18 E3, E9, E15 T5, T6, T8, T18, T22 W8, W9	CI sector State government Research and development sector
Investment in more resilient road infrastructure at priority locations to maintain connectivity for freight and access to communities and for repairs.	A6 E4, E10 W14 T22 C6	Commonwealth and state government
Real-time monitoring systems to detect impacted assets with automatic shutdown. This prevents further asset damage and increases community safety.	E15 W9 T3, T21	CI sector

Treatment	Risks	Stakeholders
Community education and information messaging to inform the community of safety risks and increase personal resilience.	A3, A5, A7, A8, A12, A16 E11, E12, E14, E15, E16 W1, W4, W9, W11 T1, T2, T9, T10, T12, T14, T15, T16, T17 C4, C5, C10	All stakeholders with community messaging responsibilities (CI owners/operators and government)
Multiple lines of communication (satellite, radio, etc.) to enhance redundancy in the case of power or communication outages.	A1, A2, A7, A8, A12 W3 T12 C8, C9, C10	CI sector
Regular inspection and maintenance programs to ensure infrastructure is secure and functioning as expected.	**All risks with physical assets.**	CI sector
Effective planning and risk assessments conducted for asset sites to minimise exposure to a hazard.	**All hazards potentially located in an area exposed to hazards** (e.g. flood zone, bushfire prone area)	CI sector Local and state government
Adequate stockpile of critical supplies, ensuring that this stockpile is consistently maintained so repairs can be made easily during times of crisis.	E6, E8 C7, C11	CI sector
Increase cross agency collaboration to: • develop agreements and priority response mechanisms to support the functioning of other reliant critical infrastructure during disaster events. • Improve awareness of roles and responsibilities. • Expedite response to community during disaster events.	**Relevant to all risks**	CI sector

The treatments listed above are examples of best practice risk management, aimed at reducing risk to critical infrastructure and to the community. There are varying levels of risk maturity across the critical infrastructure sectors, and across regions in Queensland. Many organisations have already implemented or begun implementing some of these treatments into their work to minimise the impacts caused by climate change and other hazards. Some organisations may still be at the risk identification stage and are focused on the initial development of a risk management program, to ensure compliance with the SOCI Act.

The Queensland Strategy for Disaster Resilience recognises the need for resilient critical infrastructure, with success of Objective 2 dependent on the "reliable and continuous operation of critical infrastructure despite the stresses or shocks that may occur."[62] This Objective requires the coordination and collaboration of stakeholders across industry and government to address the cross-cutting consequences of climate and disaster risk. As seen throughout this assessment, several risks and treatments are applicable across multiple sectors. The development of sector specific resilience strategies or action plans, aligned with the Queensland Strategy for Disaster Resilience, may be a beneficial means of facilitating collaboration and achieving better outcomes than organisations working in silos.

While this assessment only considers risks to four critical infrastructure sectors, there are multiple other sectors that provide critical infrastructure to Queensland communities. The Critical Infrastructure Disaster Risk Assessment is Queensland's first state level risk assessment for disaster risks to critical infrastructure. Future iterations of this assessment have the potential to consider additional sector risks, building on the state's knowledge and understanding of the impacts to communities when critical infrastructure fails, and how the sector is continuing to work on increasing resilience to these hazards.

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APPENDIX A

RISK STATEMENTS

Appendix A – Risk Statements

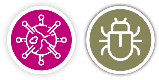
Cause of risk legend

Hazard	Icon	Hazard	Icon
Heatwave		Tsunami	
Bushfire		Earthquake	
Tropical cyclone		Pandemic	
Flooding		Chemical, Biological, Radiological	
Severe thunderstorm		Biosecurity	
Cybersecurity		Space weather	
Energy disruption		Water disruption	
Transport disruption		Communications disruption	

All sectors

The risks which have been highlighted red indicate a priority risk.

ID	Risk Statement	Timeframe	Cause of Risk
A1	Decision-making of government and infrastructure owners/operators to the event is unclear resulting in a delayed response and increased consequences.	Immediate	*All hazards*
A2	Lack of timely and relevant information on the disaster event results in delays to the response.	Immediate	*All hazards*
A3	Increased temperatures and/or smoke lead to poor working conditions for staff resulting in health concerns (e.g. heat stroke, asthma) and staff shortages.	Immediate and ongoing	
A4	High number of infections in the workplace results in lack of skilled staff to operate control centres, conduct maintenance and repairs, etc.	Immediate and ongoing	
A5	Disaster event results in direct physical damage to infrastructure impacting critical service delivery, including impacts to supply chains.	Immediate and ongoing	

ID	Risk Statement	Timeframe	Cause of Risk
A6	Repair of infrastructure and/or distribution of generators is not possible due to lack of access (land, sea and/or air) resulting in longer disruptions.	Immediate and ongoing	
A7	Compound and cascading events result in failures of critical infrastructure and extended disruptions.	Immediate and ongoing	*All hazards*
A8	Extended periods of critical infrastructure disruptions result in public disorder.	Longer term	*All hazards*
A9	Sudden changes in government policy/ mandates impact operations for the critical infrastructure sector (for example, limits on number of people per workspace, movement restrictions, etc.).	Immediate	
A10	Increased temperatures result in decreased battery life of backup power to assets.	Immediate and ongoing	
A11	Disaster event leads to staff shortages due to issues with access or impact, resulting in decreased critical service delivery.	Immediate	
A12	Disaster event results in greater impacts on vulnerable people.	Immediate and ongoing	*All hazards*
A13	Extensive levels of damage to assets leads to significant demand for engineers and damage assessors to complete assessments, resulting in significant delays to repair.	Longer term	
A14	Disaster event leads to changes in local geology resulting in geotechnical issues for critical infrastructure assets (e.g. unstable ground).	Immediate and ongoing	
A15	Information systems damage or deliberate cybersecurity attack leads to disruption of critical services resulting in physical and reputational damage, and economic impacts.	Immediate	
A16	Short lead times to impact and less notice to prepare for impact results in increased damage to infrastructure.	Immediate	
A17	Generators are not able to be refuelled due to lack of fuel stocks, resulting in increased power outages.	Medium term	*All hazards*
A18	Ageing or pre-code infrastructure is more susceptible to damage and longer-term outages.	Immediate and ongoing	*All hazards*

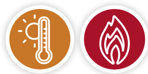
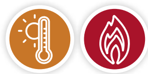
Energy

ID	Risk Statement	Timeframe	Cause of Risk
E1	Increased temperatures cause lines to sag, resulting in reduced efficiency of the lines.	Immediate	
E2	Increased temperatures lead to increased demand, resulting in interruptions to electricity supply.	Immediate	
E3	Water ingress to substations results in interruptions to electricity supply.	Immediate	
E4	Road, rail and port closures result in loss of fuel supply (for vehicles and for electricity generation).	Immediate and ongoing	
E5	Increase in people working from home results in increased electricity and gas demand, resulting in interruptions to supply.	Longer term	
E6	Significant damage to the electricity network and fuel infrastructure leads to high demand for replacement parts and difficulties sourcing these parts, resulting in extended power outages.	Longer term	
E7	Generating units do not operate due to high costs, resulting in lack of supply within the National Electricity Market.	Longer term	
E8	Disaster event impacts a large region and/ or multiple jurisdictions, resulting in a lack of generators to service the population required.	Immediate and ongoing	
E9	Space weather event corrodes liquid fuel and gas pipelines resulting in increased maintenance costs.	Longer term	
E10	Access to fuel and chemical storages (e.g. jet fuel, nitrogen) impacts ability to refine fuel, supply hospitals, airports, emergency services, etc.	Immediate and ongoing	
E11	Fuel stations are unable to pump fuel resulting in local fuel shortages.	Immediate	
E12	Telecommunications are unavailable due to lack of or insufficient backup power supply.	Immediate	
E13	Control rooms are not functional due to lack of or insufficient backup power supply.	Immediate	
E14	Transportation systems are not functional due to lack of or insufficient backup power supply.	Immediate	
E15	Strong wind and debris lead to downed powerlines resulting in safety concerns for communities.	Immediate	
E16	Restoration priorities (of electricity and fuel supply) do not align with community needs resulting in distress and concern in the community.	Immediate and ongoing	

Water

ID	Risk Statement	Timeframe	Cause of Risk
W1	Increased temperature results in contamination of water supply (including algae production, E. coli, thermal stratification, etc.).	Immediate	
W2	Power disruptions result in inability to operate water treatment sites and pumping stations.	Immediate	
W3	Communications outages result in inability to operate water and sewer infrastructure.	Immediate	
W4	Flooding and extreme rainfall results in contamination of water supply, impacting the environment and public health.	Immediate	
W5	Space weather event corrodes pipelines resulting in increased maintenance costs.	Longer term	
W6	Earthquake compromises the structural integrity of pipelines resulting in increased repair costs.	Immediate	
W7	Drought and increased temperatures result in blockages, contamination and damage to wastewater treatment infrastructure.	Longer term	
W8	Extreme rainfall leads to inundation of water treatment facilities resulting in failure of water supply systems.	Immediate	
W9	Earthquake compromises the structural integrity of water storages resulting in failure of infrastructure and potential inundation of surrounding communities.	Immediate	
W10	Inability to supply water results in issues for power generation, mining, data centres, and other industries that rely on water.	Immediate	
W11	Inability to supply water to towns results in significant health concerns for the community.	Immediate	
W12	Inability to supply water results in issues for emergency services (firefighting capabilities, etc.).	Immediate	
W13	Increased demand for bottled water and consequent pressure on supply chains.	Immediate and ongoing	
W14	Ability to access critical supplies (e.g. spare components, chemicals, fuel) impacted.	Immediate	
W15	Increased temperatures result in failure of control systems due to overheating.	Immediate	

Transport

ID	Risk Statement	Timeframe	Cause of Risk
T1	Power outages result in disruptions to service availability (particularly for trains).	Immediate	
T2	Power outages lead to signalling issues, resulting in traffic congestion and safety concerns (road).	Immediate	
T3	Bushfire is sparked from rail infrastructure, resulting in disruptions to services and damage to infrastructure.	Immediate	
T4	Disaster event results in track buckling and damage to rail infrastructure.	Immediate	
T5	Extreme temperature leads to damage to roads from melting resulting in increased repair and maintenance costs.	Immediate	
T6	Flooding leads to damage or destruction to roads or rail resulting in increased repair and maintenance costs.	Immediate	
T7	Movement restrictions lead to major supply chain delays resulting in impacts on the economy and communities.	Longer term	
T8	Damage or destruction to bridges results in interruptions to services across the bridge (e.g. electricity, pipelines), increased repair costs, and isolation of communities.	Immediate	
T9	Reduced visibility due to dust storms or smoke results in increased risk of collision (road and rail).	Immediate	
T10	Reduced visibility due to dust storms or smoke results in increased safety risks and aviation delays.	Immediate	
T11	Strong tidal currents, flood waters, high winds and unsafe waters lead to disruption or closure of ports resulting in delays to transportation.	Immediate	
T12	Communications outages (UHF and VHF radio) result in inability to operate transport systems (traffic controls, rail and maritime operations, etc.).	Immediate	
T13	Isolation of airports and aviation facilities results in delays with resupply operations to communities and critical infrastructure.	Immediate	

ID	Risk Statement	Timeframe	Cause of Risk
T14	Nearby bushfires lead to decreased visibility due to smoke resulting in decreased safety and potential closures for motorists.	Immediate	
T15	Overcrowded train stations, resulting in customer distress and health concerns.	Immediate	
T16	Power disruptions lead to stranded trains, resulting in safety concerns for passengers requiring evacuation.	Immediate	
T17	Inaccessibility of critical services (such as healthcare) results in significant health and safety issues for the community.	Immediate	
T18	Damage and closure of transport routes leads to congestion, resulting in delays to repairing infrastructure.	Immediate and ongoing	
T19	Disruption or closure of sea, air and land transport routes result in inability to transport essential goods (e.g. fuel, food, medicine).	Immediate and ongoing	
T20	Road closures lead to inefficient evacuation routes, resulting in increased safety concerns for motorists.	Immediate	
T21	Cyber-attack leads to operational technology disruptions resulting in significant safety concerns for customers using transport systems (public transport, signalling, and signage), and economic impacts due to disruptions to freight and shipping systems.	Immediate	
T22	Long-term closure of roads results in isolated communities.	Longer term	

Communications

ID	Risk Statement	Timeframe	Cause of Risk
C1	Disaster event places increased pressure on communications networks resulting in disruptions and congestion.	Immediate	
C2	Space weather event results in VHF and UHF systems being unavailable for long periods.	Immediate	
C3	Space weather event results in issues with global navigation satellite systems (GNSS), resulting in unavailability of GPS and other positioning systems.	Immediate	
C4	Power disruptions result in outages of NBN (impacting community safety and disrupting essential services)	Immediate	
C5	Power disruptions result in loss of mobile communications (impacting community safety, emergency services, emergency alerts, etc.).	Medium-term	
C6	Deployment of temporary telecommunications facilities, such as Cells on Wheels are not able to be deployed due to road access issues, current evacuation orders, movement restrictions or other technical restriction.	Immediate and ongoing	
C7	Disaster event impacts a large region and/ or multiple jurisdictions, resulting in a lack of temporary communications facilities (e.g., Cells on Wheels) to service the population required.	Immediate and ongoing	
C8	Unavailability or errors with GNSS systems result in customers being unable to use ATMs and eftpos systems.	Immediate	
C9	Lack of communications results in inability to provide other critical services (including disaster response) during a disaster event.	Immediate	
C10	Restoration priorities do not align with community needs resulting in distress and concern in the community.	Immediate and ongoing	
C11	Significant damage to communications infrastructure leads to high demand for replacement parts and difficulties sourcing these parts, resulting in extended communications outages.	Longer term	

Queensland
Government