ANALYSIS OF THE 2018 NEW SOUTH WALES (NSW) CRITICAL INFRASTRUCTURE RESILIENCE STRATEGY

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Executive Summary

In February 2018, the state of New South Wales (NSW) released its third state-wide infrastructure strategy. Tagged, “Building Momentum”, the 20-year strategy is an improvement on previous strategy documents which were mostly focused on implementing infrastructure projects in several sectors including transport, energy, water and health [1]. Unlike previous strategy documents, the 2018 State Infrastructure Strategy (2018 SIS) emphasises the importance of policies and reforms required to deliver infrastructure that satisfies the needs of the state’s expanding population and economy. The 2018 SIS also recognises that resilience, improved asset management and digital technology are critical to extending previous infrastructure successes recorded by the previous state strategies [2]. Accordingly, it situates infrastructure resilience as one of its six strategic directions, to facilitate resilience practices across infrastructure planning, delivery, operations, and maintenance processes. Alongside other measures to improve infrastructure resilience, the 2018 SIS indicates the ongoing development of the NSW Critical Infrastructure Resilience Strategy.

Released in September 2018 [3], the NSW Critical Infrastructure Resilience Strategy (CIRS) seeks to ensure critical infrastructures continue functioning despite shocks, resume operations after disruptive events and adapt to long-term pressures like climate change effects. The CIRS proposes to achieve these objectives through three strategic outcomes; improved infrastructure resilience, improved organisational resilience and improved community resilience. In this way, the strategy is less focused on actual physical infrastructure, and more on the effects of infrastructure outages or collapses on users (i.e., organisations and communities). The CIRS also identifies three priorities through which strategic outcomes would be delivered. Partnerships among public and private sector stakeholders and communities to drive shared responsibility for critical infrastructure resilience, preparing for foreseeable and anticipated hazards, and providing crucial infrastructure services are the agreed priorities. The CIRS further outlines initiatives for delivering these priorities to include the use of sector networks, resilience training on critical infrastructure and user resources to guide stakeholders in implementing resilience. Overall, the strategy aims to guarantee “a safer, more secure and more resilient NSW” [4].

The CIRS and its management are however not without a few shortcomings. Firstly, Resilience NSW which is responsible for the strategy does not currently host the CIRS and other critical infrastructure resilience information on its website. Instead, these resources are on the Office of Emergency Management website, the agency formerly charged with critical infrastructure resilience. Additionally, user resources which are intended to guide implementation of the CIRS are yet to be fully developed. As the CIRS would be due for a review by September 2021, user resources should be prioritised for completion and uploaded on the Resilience NSW website alongside other critical infrastructure resilience documentation, during this review. Finally, to ensure holistic strategic outcomes are distributed to all stakeholders, collaboration between Resilience NSW and government agencies including Infrastructure NSW and the Office of Environment is recommended. Such partnerships are advised to enable the CIRS benefit from relevant initiatives like the Spatial Digital Twin and Cross Dependency Initiative (XDI) which would provide data necessary for improving infrastructure owners/operators’ understanding of resilience requirements.

Background context for the NSW Critical Infrastructure Resilience Strategy

Constituted by an act of parliament, Infrastructure NSW is charged with developing New South Wales' (NSW) 20-year infrastructure strategy, and is expected to review the strategy every five years or as specified by the state's Premier [5]. Developed in 2012, the first State Infrastructure Strategy (SIS) tagged 'First Things First', was aimed at resolving economic challenges triggered by infrastructure-related factors like incoherent planning and cost overruns [6]. If implemented effectively, the 20-year strategy would increase the economy up to $18.4 billion[1] yearly by 2032. Resilience is mentioned as a criterion for the strategic assessment of infrastructure projects; the strategy cites resilient infrastructure as relevant to ensuring the lonegivty of NSW [6]. Furthermore, it identifies 70 programs and projects across nine sectors valued at $19.8 billion, recommended to bridge the state's infrastructure deficits [6].

However in 2014, following the launch of the $20 billion Rebuilding NSW plan targeted at channelling proceeds from leased electricity network assets into infrastructure projects [7], Infrastructure NSW updated the 2012 strategy. While some progress had been achieved with the 2012 SIS, the proposed revision intended to accelerate delivery of infrastructure projects selected in line with the state's critical priorities across Sydney, Greater Sydney and regional NSW [8]. The SIS was also further updated in 2018 to reflect the agency's vision for infrastructure investment. This new 20-year strategy recognises required changes in the planning, delivery, management, and maintenance of infrastructure, and is thus focused on reforms, policies and projects that extend infrastructure gains previously delivered in NSW. Six strategic objectives are proposed in the 2018 SIS to embed good practice in the state's infrastructure sectors. Of these objectives is ensuring the state's infrastructure remains resilient to "natural hazards and human-related threats" [2].

Outlined in the strategy are also actions to improve infrastructure resilience which include the 'Emergency Risk Management Framework' and 'NSW Critical Infrastructure Resilience Strategy Discussion paper'. The latter was deployed as a consultation instrument with stakeholders across NSW to obtain input on enhancing critical infrastructure (CI) resilience [9]. Given natural disasters experienced in NSW between 1967 and 2014, the Emergency Risk Management Framework was developed to strengthen the resilience of NSW through continuous identification, assessment, analysis and management of emergency risks including infrastructure-related risks [10]. Moreover, the 2017 State Level Emergency Risk Assessment categorises infrastructure failure as "extreme risk" with catastrophic consequence and identifies CI resilience as one of NSW's top implementation priorities [11]. Collectively, the three documents triggered by the State Emergency Management Committee (SEMC) form the basis for the NSW Critical Infrastructure Resilience Strategy 2018.

A part of the broader Emergency Management and Disaster Resilience Review, the five-year NSW Critical Infrastructure Resilience Strategy aims to enhance the resilience of CI that support essential services like "food, water, energy, transport, telecommunications and health care" [4]. Seeking collaborative partnerships among private and public sectors, CI operators and community members, the strategy implements a framework for identifying and addressing CI risks, and establishes "a plan to deliver, monitor and evaluate CI initiatives" [2,12]. Overall, the

[1] All figures are in Australian dollars.

strategy aims to ensure CI continues to function despite shocks, resumes operations after disruptive events and adapts to long-term pressures [4].

Main components of the NSW Critical Infrastructure Resilience Strategy

Recognising existing infrastructure interdependencies in NSW, the Critical Infrastructure Resilience Strategy (CIRS) sets out an agenda to embed resilience in CI to guarantee long-term prosperity and social wellbeing. It also seeks to deliver strategic benefits to diverse stakeholder groups comprising CI providers, NSW communities and the state government. Borrowing from the Commonwealth's National Guidelines for Protecting Critical Infrastructure from Terrorism, the CIRS defines criticality using a four-level hierarchical model. This model enables state and local government agencies, and organisations to evaluate CI criticality within their respective contexts and effectively design business continuity arrangements [4,13]. The CIRS is organised into two major components viz outcomes and priorities, jointly focused on improving CI resilience to guarantee "a safer, more secure and more resilient NSW" [4]. The outcomes and benefits are documented in appendices I and II.

Outlined in Table 1 are the three interwoven outcomes [4].

Table 1: *CIRS Outcomes*

Outcome	Description
Improved infrastructure resilience	Entails improving CI resilience along four dimensions; resistance, reliability, redundancy and enhanced response and recovery. Continued operations in the event of shocks, steady functioning of CI in diverse conditions, availability of backup infrastructure to compensate for primary failures and recoverability from disruptions all contribute to improve CI resilience. The CIRS also identifies the ways of enhancing CI covering infrastructure planning, design, and operations and maintenance.
Improved organisational resilience	Involves enhancing the organisations and people who provide and manage CI, as well as users and the community. Organisational resilience enables CI users to plan for disruptions to infrastructure provision that may impact their organisations. Identified channels to boost organisational resilience include ensuring emergency preparedness, fostering strong relationships, effective risk management, improved planning, and response and recovery.
Improved community resilience	Entails active engagement with the community by government and business stakeholders to ensure their preparedness when emergencies occur. Communities are an essential component in maintaining CI resilience as they are typically the first responders during emergencies. The means by which community resilience can be improved cover community information resources, reduced service disruptions, managed service disruptions and community partnerships.

To deliver the above outcomes and in turn CI resilience, the CIRS establishes three priorities (see Table 2). Identified initiatives for delivering these priorities are sector networks, CI resilience training and user resources [4].

Table 2: *CIRS Priorities*

Priority	Description
Partner	This priority advocates shared responsibility for CI resilience between infrastructure providers, all Australian government levels, and NSW communities. While providers remain responsible for infrastructure assets and service provision, the other stakeholders provide varied perspectives and abilities that would improve resilience. Through shared responsibility, stakeholders are made aware of the far-reaching effects of infrastructure failures beyond providers. The CIRS leverages the Trusted Information Sharing Network (TISN) set up by the federal government to guide collaborations between business and government on resilience issues. CI professionals in NSW are thus able to access information resources across different infrastructure sectors up to the national level.
Prepare	Involves preparing for all possible threats and hazards beyond foreseeable ones, to adequately cater for unanticipated shocks. This approach has been adopted to wholly address risks arising from interconnected CI and emphasises the impact of disruptive events over causal factors. Threats including cyberattacks, hazards such as bush fires, shocks arising from threats or hazards and stresses like climate change, are all considered inimical to CI resilience. For this priority, the CIRS has identified CI training programs at the local, regional, and state levels to enable NSW organisations to be prepared for disruptions to CI and institute "a culture of resilience" within their operations. Appendix III outlines scoped hazards and priority areas for NSW.
Provide	The provision of CI services with negligible disruptions is stressed in the CIRS. Given the economic, health and safety impacts of service outages, building resilience at the planning and design phases of infrastructure projects averts future costs from disasters and ensures long-term reliability of infrastructure services provision to the business and community. To this end, the CIRS advises user resources that provide implementation guidance for CI resilience across the three strategic outcomes discussed previously. Whereas certain resources will be aimed at topics like cost-benefit analysis, others will address specific infrastructure sectors. These resources are expected to support a wide scope of infrastructure stakeholders.

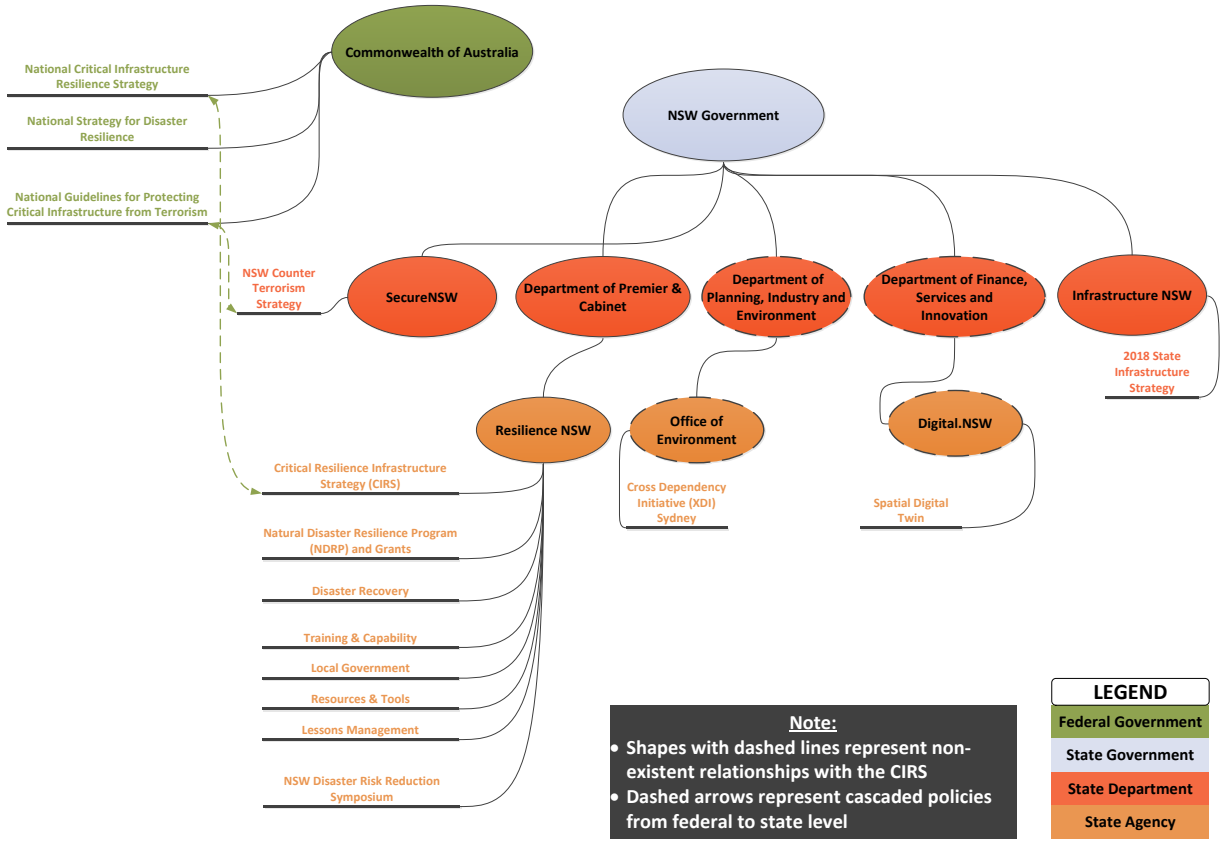
Although a local government user resource is accessible on the NSW Office of Emergency Management website [14], user resources for topics and sector-specific content like infrastructure planning and Energy, respectively are yet to be concluded [15].

Discussion and critical evaluation

CIRS and Institutional Arrangements

Previously called the Office of Emergency Management (OEM) and established after the 2019-2020 bushfires, Resilience NSW owns the CIRS and is domiciled in the Department of Premier and Cabinet [16]. Besides the CIRS, Resilience NSW manages other emergency functions including disaster recovery. It also borrows significantly from existing policy documents at the federal level. For instance, the "all hazards" focus, organisation-government partnership and Trusted Information Sharing Network (TISN) are derived from the Commonwealth's Critical Infrastructure Resilience Strategy [17] and National Strategy for Disaster Resilience [18]. While the CIRS does not specify counter-terrorism procedures, it references the Critical Infrastructure Protection Program managed by the NSW Police Force, as covering terrorism threats [19]. This program also leverages the National Guidelines for Protecting Critical Infrastructure from Terrorism and prioritises protection of critical infrastructure as a key focus area. Figure 1 shows the mapping of institutional arrangements implicated in NSW's critical infrastructure resilience planning.

Figure 1: Mapping of Institutional Arrangements



Given both Australia's and NSW's threat profiles, the CIRS reflects national priorities for critical infrastructure resilience as it specifies concerns like climate change effects, terrorism and

natural disasters [13,20,21]. NSW also extends the TISN to cater for its unique needs like education programs, which are currently not provided for (see appendix IV for details). However, unlike the national CI resilience strategy, the CIRS does not suggest a model to simulate how CI behave and interconnect. Access to quantitative and qualitative metrics which simulations provide is relevant for assessing and achieving resilience objectives [22,23]. In the absence of these, resilience planning and testing may not be fully practicable especially for interlinked CI.

Gaps are also noted in the interaction of the CIRS with other institutional arrangements. The Office of Environment in partnership with private and public stakeholders, is working on a Cross Dependency Initiative (XDI) to identify "extreme weather and climate change risks" to interdependent assets. Initially planned to be piloted in Sydney, the project aims to develop a tool capable of detecting cross-cutting climate change effects on critical infrastructures. Data generated from this tool would support decision-making by infrastructure owners and providers and improve stakeholders' understanding of resilience requirements. There is however no indication that Resilience NSW is involved in this initiative [24]. Similarly, the 2018 State Infrastructure Strategy recommends implementing an "Infrastructure Data Management Framework" and using spatial data to improve infrastructure processes. These may in turn be leveraged to model various ways that resilience can be built into CI during planning and design phases [2]. The Spatial Digital Twin managed by the Department of Finance, Services and Innovation, provides a digital model of NSW communities that could improve infrastructure planning and design objectives in a cost-efficient manner [25,26]. However, Resilience NSW appears to have only considered this functionality for emergency operations following the 2019-2020 bushfires [27] and not for resilience planning.

User Resources

The CIRS reflects a user-focused approach as it is directed at resolving effects of CI disruptions and not the factors leading to these events. Non-availability of infrastructure implies users i.e., business and communities would be deprived of services like energy, telecommunications, and transportation. With CI increasingly becoming interconnected, the failure of an infrastructure component could have downstream effects such that users are deprived of multiple services simultaneously. These failures impinge on users' ability to fulfil daily practices which in turn impacts their overall well-being. For instance, flooding spill-over effects from the Hawkesbury-Nepean area could disrupt transport services and cut off utilities supply [28]. Similarly, a study conducted after the 1989 Newcastle earthquake indicated high fatality rates from heart attacks a few days post the disaster, as well as increased occurrences of psychological distress [29].

The observation that government efforts at the federal and state levels had predominantly focused on restoring physical or "hard" infrastructure largely influenced the development of the CIRS to include community resilience as a strategic outcome [29]. Consequently, the CIRS highlights the need to strengthen "soft" infrastructure by preparing communities to respond more dynamically to emergency events via education and awareness programs. A simple illustration is provided whereby communities are galvanised to deliberately reduce electricity use when heatwaves occur to enable continuous operation of electricity networks [4]. Communities can also access the "Get Ready NSW" resource which lists identified hazards, priority areas for building resilience and steps they can take to reduce these risks [30]. However, though the CIRS mentions user resources would specify how communities might contribute to enhancing resilience in NSW, a review of the OEM website indicates that these resources are still being developed [15]. Hence, communities may not be adequately informed on actions to take in supporting CIRS outcomes.

Likewise, user resources specific to resilience building targeted at organisations and infrastructure owners/operators are yet to be completed. While the OEM website appears to have some infrastructure maintenance resources, these are limited to four councils and appear not to have been fully incorporated in resilience activities [31]. This disconnect may prevent clear achievement of the CIRS outcomes thus hampering stakeholders from promised benefits.

A self-assessment tool is available to NSW local governments (LGs) to enable them to document baseline data for meeting their resilience targets. The tool also tallies scores inputted by LGs and informs them of their maturity levels and necessary steps to bridge identified gaps. It is expected that as LGs update their positions annually, enough data would be amassed to enable the NSW government assess improvements [32,33]. The CIRS does not however indicate how baseline self-reported assessments may be audited by a third party for accuracy. As baseline data form the basis for information required to build resilience at the LG level, the risk of not fully realising CIRS outcomes due to incorrect data and information collected overtime may crystallise.

Conclusions and recommended measures

Considering the risks faced by NSW, the CIRS provides an opportunity to build resilience in a multi-layered way that encompasses the needs of a wide stakeholder base. As a strategy, it is rightly concerned with outcomes i.e. the "why" rather than the "how" [4]. However, this is where it may fall short, as the mechanism (user resources) for attaining CI resilience is yet to be completed. Although the CIRS does not indicate this, the choice to prioritise user resources for local governments may be due to their proximity to and impact on communities [32]. Still, this component could do with further enhancement.

To facilitate more holistic outcomes to stakeholder groups, the following measures are recommended:

- **CIRS Update**
  Given that the CIRS is due for a review half-way into its lifespan, there is an opportunity to update it to reflect its ownership by Resilience NSW [4]. The review should also include finalising user resources for all stakeholder groups. It is further recommended that Resilience NSW integrate infrastructure resilience findings from the 2018 State Infrastructure Strategy [2].

- **Partnership with Government agencies**
  - Resilience NSW could adopt the Critical Infrastructure Program for Modelling and Analysis (CIPMA) functionality used by the federal government to simulate CI behaviour [34,35]. Stakeholders can assess CI infrastructure either as individual components or as a network of assets and facilitate cost-effective resilience planning and design. Given that it may be ineffective to perform simulations on operational infrastructures [23], the Spatial Digital Twin presents a suitable environment for low-impact analysis. Furthermore, indicators derived through this process would be useful for running scenario analysis to inform infrastructure investment decisions [22].

  - Incorporate the XDI being developed by the Office of Environment to obtain a view of infrastructure risks arising from climate change effects. Data obtained from this tool would support stakeholders to conduct more extensive analysis for infrastructure resilience decisions than benefit-cost ratios would allow. As highlighted by Infrastructure Australia's report on COVID-19 responses, rather than building new infrastructure, existing infrastructures can be used more efficiently instead [36]. Likewise, access to indicators generated from the data could be instrumental in measuring and improving infrastructure resilience effectively [22].

- **Website harmonisation**
  The CIRS and other CI resources are currently hosted on the Office of Emergency Management website. These resources should be transferred to the Resilience NSW website to ensure stakeholders access information from the right location.

Appendix I: Critical Infrastructure Resilience Strategy

A: Outcomes

The importance of Critical Infrastructure Resilience

NSW benefits from critical infrastructure (CI) that provides secure and reliable essential services, such as food, water, energy, transport, telecommunications and health care. Without these services, our social cohesion, economic prosperity and public safety are detrimentally affected.

The NSW Critical Infrastructure Resilience Strategy encourages leaders in business and government to support the NSW community by improving critical infrastructure resilience (CIR) across NSW.

Outcome 1
Improved Infrastructure Resilience

Infrastructure resilience is focused on the resilience planned for, designed, and built into assets, networks and systems.

Outcome 2
Improved Organisational Resilience

Organisational resilience (OR) refers to the resilience of the organisations, personnel and processes supporting the infrastructure to supply the service.

Outcome 3
Improved Community Resilience

Community Resilience focuses on the role the community plays in building and maintaining its own resilience while contributing to Critical Infrastructure Resilience. Building resilience within the community requires an integrated approach involving both government and business.

Partner

We must **Partner** in shared responsibility for critical infrastructure resilience.

Prepare

We must **Prepare** for all threats and all hazards, not just the ones we can foresee.

Provide

We must **Provide** critical infrastructure services with minimal interruptions.

NSW GOVERNMENT

Appendix I: Critical Infrastructure Resilience Strategy

B: Ways to improve Critical Infrastructure Resilience

Improving Infrastructure Resilience

Infrastructure Planning	• Integrated planning and investment • Good data enabling good decision making • Locating infrastructure in less risk-prone locations • Risk avoidance in the planning stage • Hazard mitigation
Infrastructure Design	• Resilience by design • Security by design
Infrastructure Operations and Maintenance	• Maintenance resilience – Maintenance planning – Remote sensors • Operations resilience – Faster service restoration • Reconstruction resilience – Infrastructure betterment in restoration or reconstruction

Improving Organisational Resilience

Emergency Preparedness	• Exercises • Recommendation Implementation • Training
Strong Relationships	• Closer integration of NSW Emergency Management Arrangements with infrastructure providers • NSW and Federal Critical Infrastructure Networks – Sector Networks (explored further in Priority 1: Partner) – Cross-sector Networks (geographical)
Effective Risk Management	• Standards-based risk management • Tools for risk management
Improved Planning	• Emergency • Security • Business Continuity
Response and Recovery	• Improved co-ordination of response and recovery through partnerships • Formalised mutual aid agreements (within and across borders) • Alternative methods of supply or service provision • Critical spares • Pre-staging supplies and personnel

Appendix I: Critical Infrastructure Resilience Strategy Outcomes

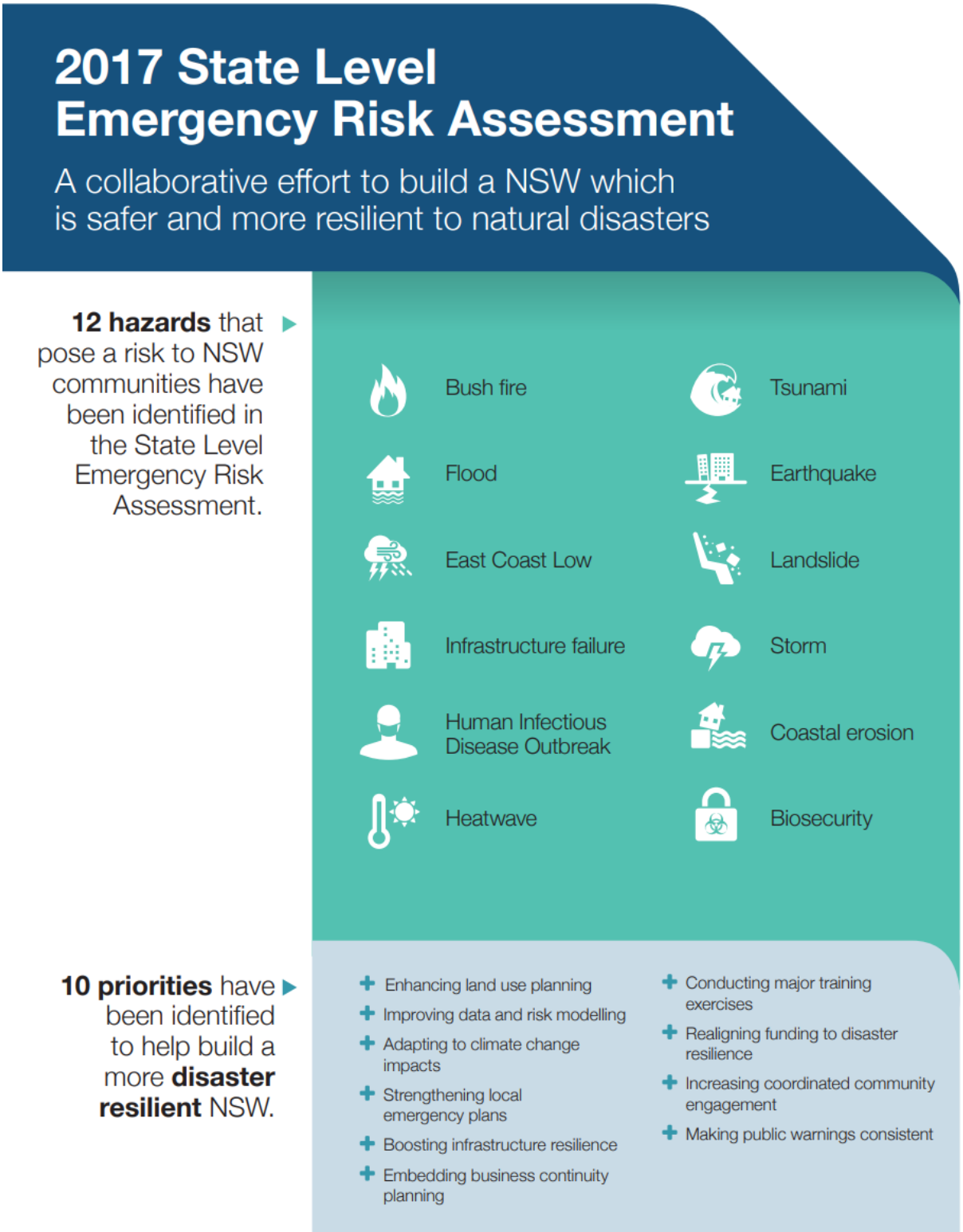
B: Ways to improve Critical Infrastructure Resilience

Improving Community Resilience	
 **Community Information**	• Community warnings • Community information - before, during and after service outages and emergencies
 **Reducing Service Disruptions**	• Infrastructure investment based on community needs • Resiliency investment based on community needs
 **Managing Service Disruptions**	• Increasing community preparedness for lack of service – Get Ready NSW[2] • Supporting vulnerable customers and communities – More rapid service restoration – Advice to vulnerable customers – Allocation of emergency resources to vulnerable customers
 **Community Partnership**	• Community engagement • Community partnerships • Community input into emergency risk planning and management • Mutual assistance (e.g. Public reporting suspicious behaviour around CI) • Crowdsourcing emergency information and intelligence (e.g. Social media)

Appendix II: Critical Infrastructure Resilience Strategy Stakeholder Benefits

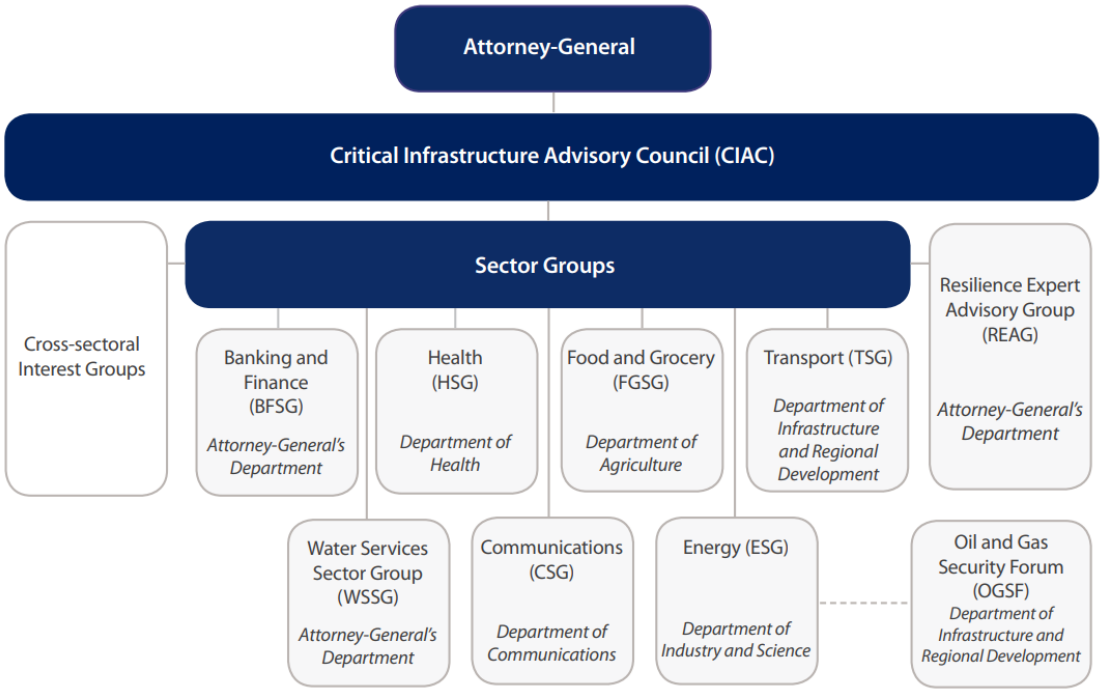
Strategy Benefits	
Critical Infrastructure Providers (Regardless of ownership)	• Reduced business disruption • Enhanced reputations and business confidence • Reduced total cost of asset ownership and increased return on investment • Better understanding of infrastructure interconnectedness, allowing vulnerabilities to be addressed across multiple CI provider organisations • Stronger cultures to meet business challenges (not just emergency events)
For communities	• Reduced service disruption to the people and businesses of NSW • More effective emergency management arrangements • More resilient communities, reducing the social costs of disasters
For government	• Enhanced capability and co-ordination of response and recovery agencies • Reduced response, reconstruction, and recovery costs arising from emergency events
For all of us	• Stronger partnerships between business, government and the community • Enhanced resilience against hazards and threats • Insurance premiums that incorporate the benefits of resilience-building activity • Improved adaptation to long-term stresses such as climate change and population growth

Appendix III: NSW Hazards & Priorities

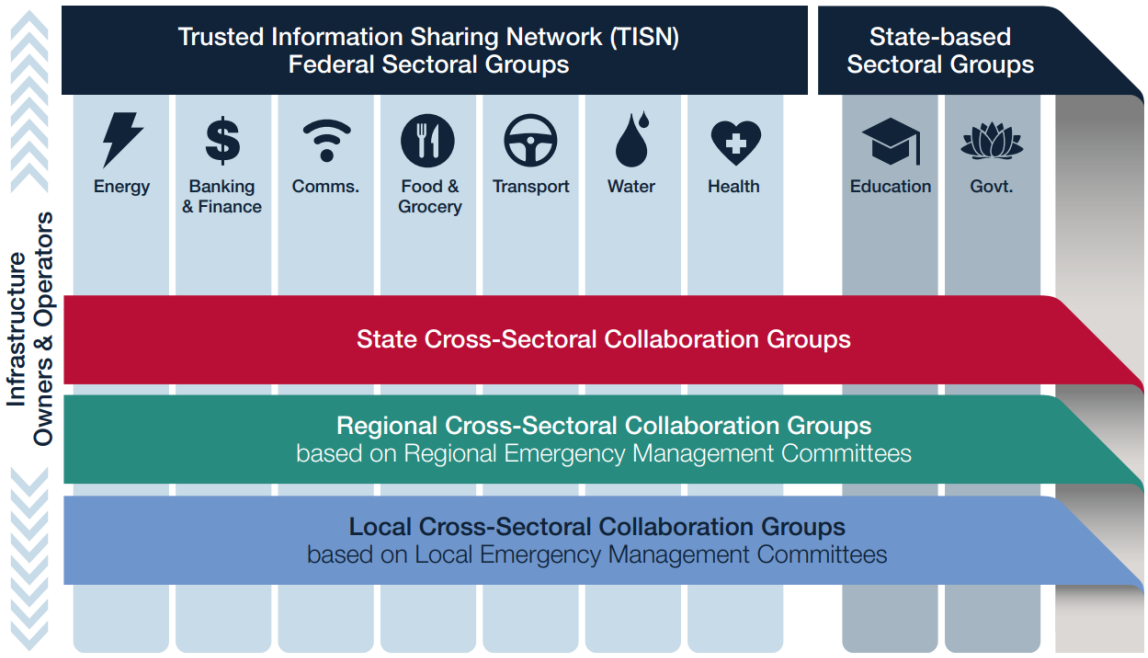


Appendix IV: Trusted Information Sharing Network (TISN)

A: TISN at Commonwealth level



B: TISN at NSW level



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