Enhancing Transport Network Resilience in Australia

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Sustainable Built Environment National Research Centre

Project 1.35
Transport Network Resilience:
Disaster Logistics and Infrastructure Vulnerability

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SWINBURNE UNIVERSITY OF TECHNOLOGY

BGC

SBEnrc Project Affiliates

ISCA

roads australia

The Future of Roads I: Reducing Environmental Pressures, Sustainability Reporting, and Considering Future Scenarios (2011-2013)

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Focus Areas

This project focused on three key areas:

1. *Identifying ways to reduce environmental pressures from road building;*

DESIGN

Route design
Pavement design
Material specifications
Alternative road users
Knowledge transfer

ASPHALT

Materials
The use of alternate materials such as rubber crumb and recycled asphalt.
Opportunities to innovate bitumen mix design.
Processes
The use of warm mix technologies.
The use of cold mix applications.
Innovations in methods and techniques for bitumen placement.

AGGREGATES

Placement
Saline or non-potable water stabilisation.
Non-potable water for dust control.
Alternative Materials
The use of waste products – concrete, tyres, glass, bauxite residue, and waste building materials.
Plant based bitumen alternatives.
The use of in-situ stabilisation techniques such as foamed bitumen to reduce the need for aggregate.

CONCRETE

Materials
Use of alternative aggregate material.
Use of cement alternatives including sulfo-aluminate, magnesium-phosphate, and alumino-silicate cements.
Processes
The potential to achieve carbon storage in concrete, in particular magnesium-phosphate cements.
Innovations in methods and techniques for cement placement.

LIGHTING AND SIGNALS

Potential to reduce consumption of electricity and associated greenhouse gas emissions through lighting choices, such as using energy efficient route lighting using LEDs, and demand management.

Focus Areas

This project focused on three key areas:

1. *Identifying ways to reduce environmental pressures from road building;*
2. *Enhancing the management of carbon by road agencies; and*

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- GRI (Global Reporting Initiative)
- Greenroads Rating System (developed in the US)
- The Highway Sustainability Checklist (developed by Parsons Brinckerhoff)
- EnvisionTM Sustainability Rating System (developed by Zofnass Program for Sustainable Infrastructure / Institute for Sustainable Infrastructure – ISI)
- CEEQUAL (developed by the Institution of Civil Engineers – ICE)
- Changer Greenhouse Gas Calculator (developed in Switzerland by the International Road Federation – IRF)
- GreenLITES (Green Leadership in Transportation Environmental Sustainability - developed by the New York State Department of Transportation – NYSDOT)

- IS (Infrastructure Sustainability) performance and rating tool (developed and administered by the Australian Green Infrastructure Council – AGIC)
- INVEST (Integrated VicRoads Environmental Sustainability Tool) rating tool (developed by VicRoads)
- Carbon Gauge® Calculator (developed by HAC and jointly funded by six road agencies across Australia and New Zealand)
- Bottom Line2 software (developed by the Dipolar Pty Limited and Integrated Sustainability Analysis – ISA, at the University of Sydney)
- eTool Life Cycle Assessment software

Focus Areas

This project focused on three key areas:

1. *Identifying ways to reduce environmental pressures from road building;*
2. *Enhancing the management of carbon by road agencies; and*
3. *Investigating future trends and scenarios that will affect roads.*

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Potential Trends Affecting Future Roads

- Climate change*
- Rising price of oil*
- Increased community action*
- Decreasing access to resources*
- Population growth*
- Increased freight*
- Maintenance costs*
- Increased community expectations of transport network*
- Employment and skill shortages*
- Global financial crisis*
- Water scarcity*
- A price on carbon
- Technology innovation, e.g. smart roads for driverless cars
- Rapid urbanization and densification
- On-line shopping
- Increased use of social networking
- Increased use of smart phones and applications
- Increased frequency and intensity of extreme weather events
- Growing environmental awareness and cooperation
- Modal shifts to rail and public transport
- Biodiversity degradation and collapse
- Loss of agricultural land
- Increased automation
- Waste reduction and harnessing
- Growing middle class
- Peaking of food production
- Alternative fuel sources
- Changing world powers
- Pressure for intergenerational responsibility
- The influence of the government
- Decentralisation
- Congestion increases or decreases
- Globalised tourism
- Health costs and impacts
- Changing lifestyles affecting mobility
- New transport paradigms
- Short political cycles
- Methods of energy generation

Issue	Implication for Roads
Costs of greenhouse gas emissions	• Reducing automobile fuel consumption through the design of road alignments (vertical and horizontal). • Reducing energy intensity of aggregates, cement and asphalt. • Reducing and avoiding fossil fuel use in hauling materials and water. • Reducing energy requirements of route and signal lighting.
Temperature increase and severe droughts	• Increased maintenance of surface cracking in roads due to changing landscape topography caused by evaporation. • Maintenance caused by increased wear and tear of road surfaces due to temperature increasing the fragility of the road surface. • Increased rehabilitation of road surfaces due to surface cracking, warping and asphalt bleeding (flushing).
Increased extreme rainfall events and flooding	• Increased amount of road maintenance caused by potholes created when water enters the road surface. • Increased road rehabilitation due to flooding events affecting large expanses of roadways. • Decreased ability for maintenance and rehabilitation to take place due to extreme wether events affecting construction days and access. • Road flooding putting pressure on road network and drainage systems.
Sea level rise	• Salt water corrosion of roads due to flooding increasing the water table and to sea level rise. • Increased storm surge and wave impact on coastal and low-lying coastal areas.
Increased cyclones	• Increased debris on roads causing road damage and traffic hazards.

	Potential Future Trends impacting Main Roads							
	Resource shortages: aggregate		Trips by walking, cycling and public transport increase		Increase in extreme weather events	Increase in the cost of road maintenance	Transport infrastructure reaches capacity	Freight vehicles increase in size and quantity
Clustered Mechanisms	QLD	WA	QLD	WA	QLD	QLD	WA	WA
Road pricing mechanisms	•	•		•	•	•	•	
Government action to support change	•	•	•	•		•	•	•
Investment in research and development	•	•	•		•	•		•
Analysing investment priorities		•	•	•	•		•	
Incentivising preferred practices	•	•	•		•	•		
Increasing the efficiency of existing infrastructure	•			•			•	•
Adaptable design standards	•	•	•		•			
Knowledge sharing and capacity building	•		•			•		
Investment in carbon management				•	•			
Transit oriented developments				•			•	

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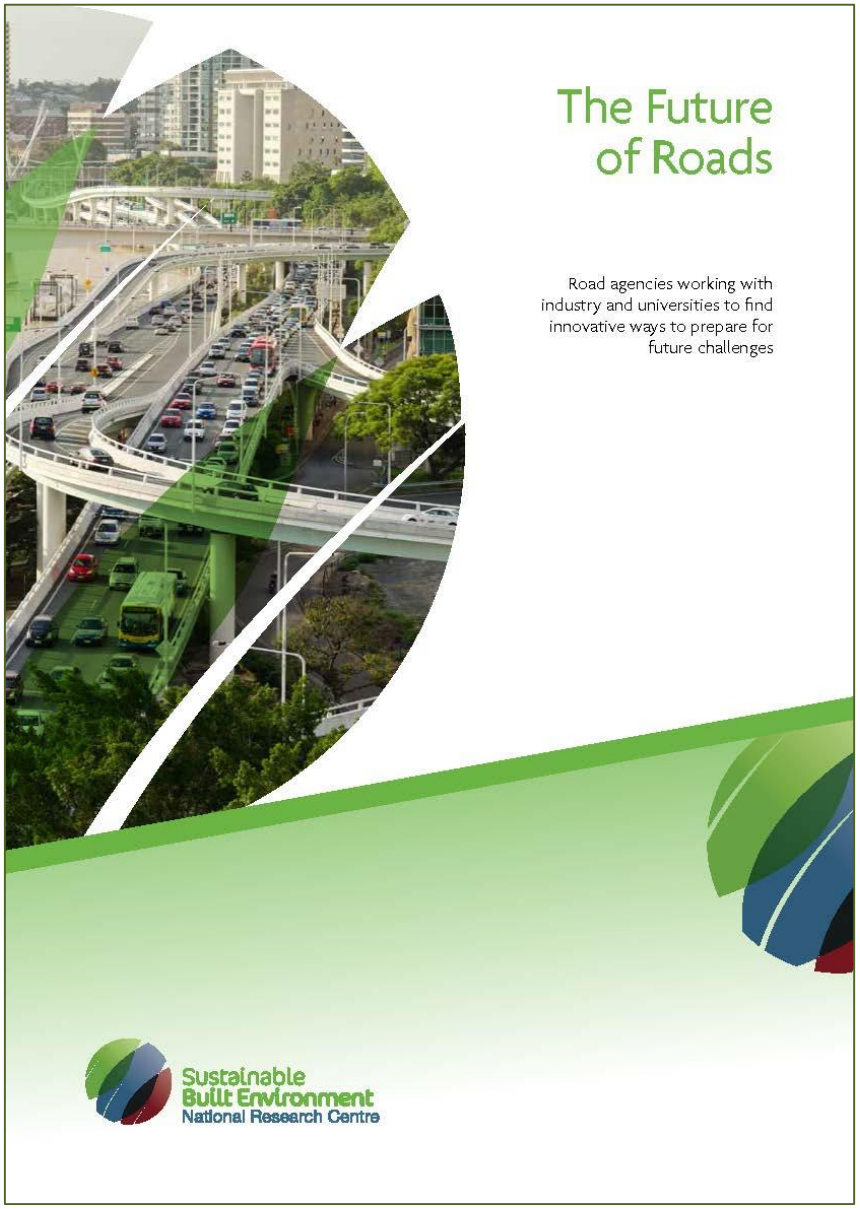

See the SBEnrc website for the Industry Report and a short film, along with supporting materials.

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The Future of Roads II: Strategies and Solutions for the Future of Roads (2013-2015)

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Project Collaborator

LOW CARBON LIVING CRC

Focus Areas

This project is focusing on three key areas:

1. *Technologies and Processes (renewables in roads, route lighting, and smart/managed motorways);*

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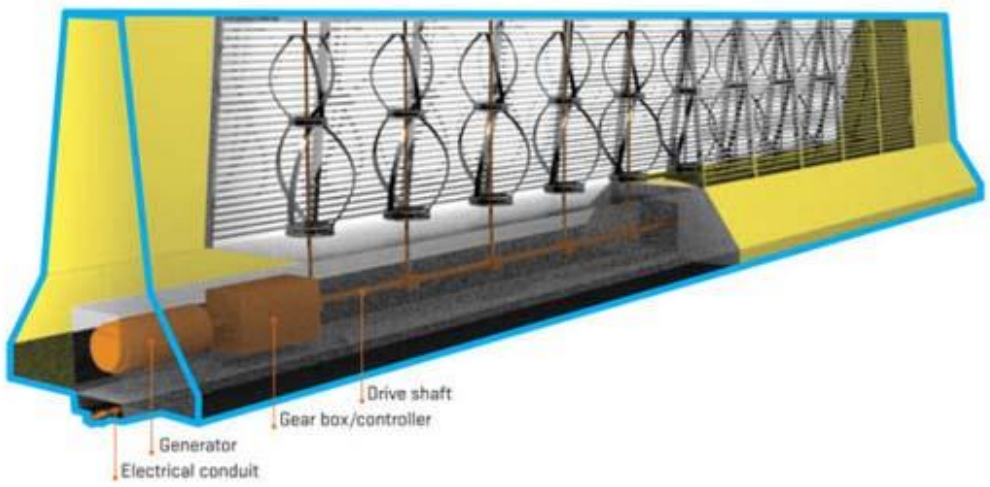
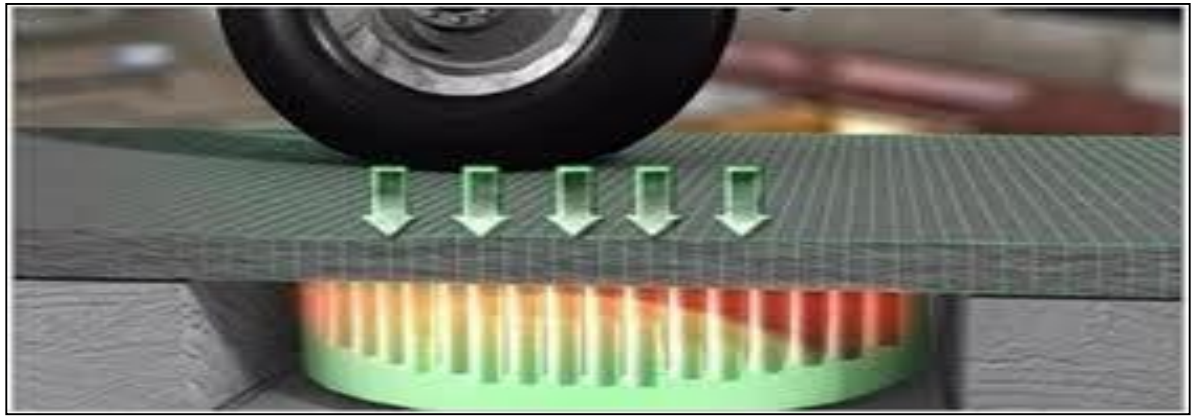
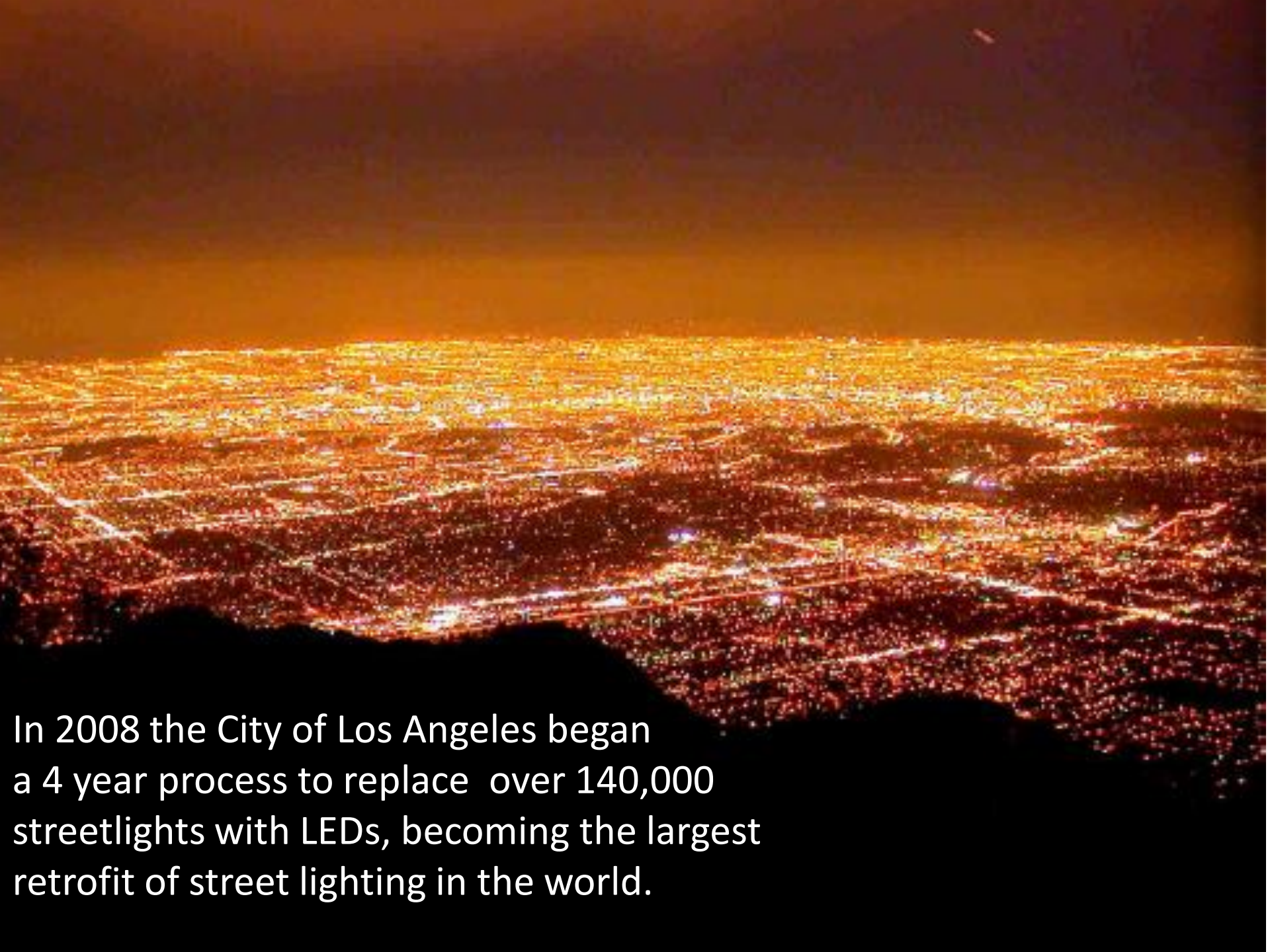
The Solar Highway Program (Oregon, USA): In 2008 a 1.75 MW solar array, containing just under 7,000 solar panels, was installed in the easement of Interstate 5 south of Wilsonville by the Oregon Department of Transport.

Photovoltaic Noise Barriers (PVNB): A photovoltaic noise barrier has been installed along the A22 Autostrada at Brennero in Italy. A 2014 study in Italy suggested that such structures can, *'help reduce the life-cycle cost of noise reduction devices by up to 30%'.*

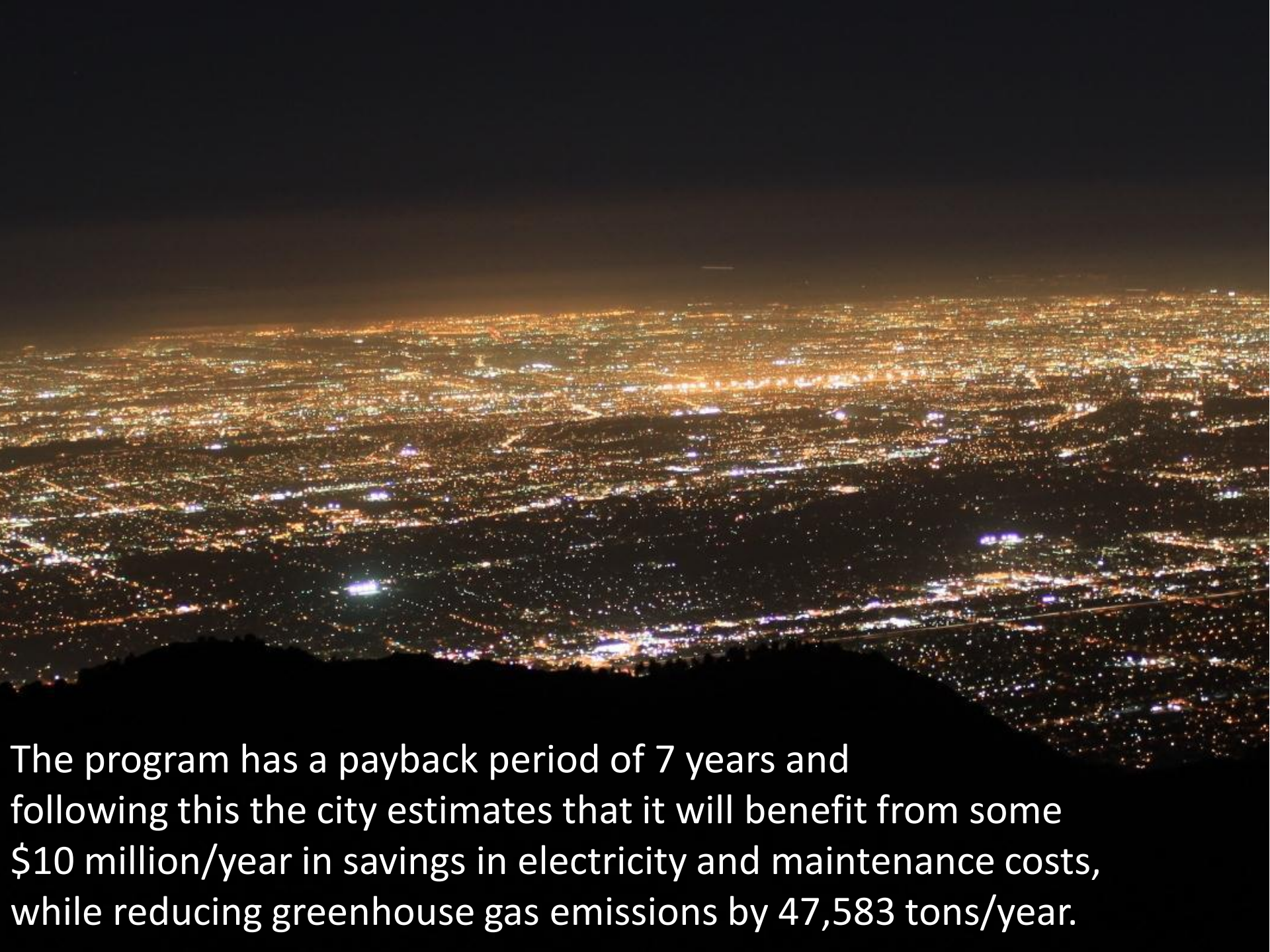


Harnessing Energy from Vehicle Movement

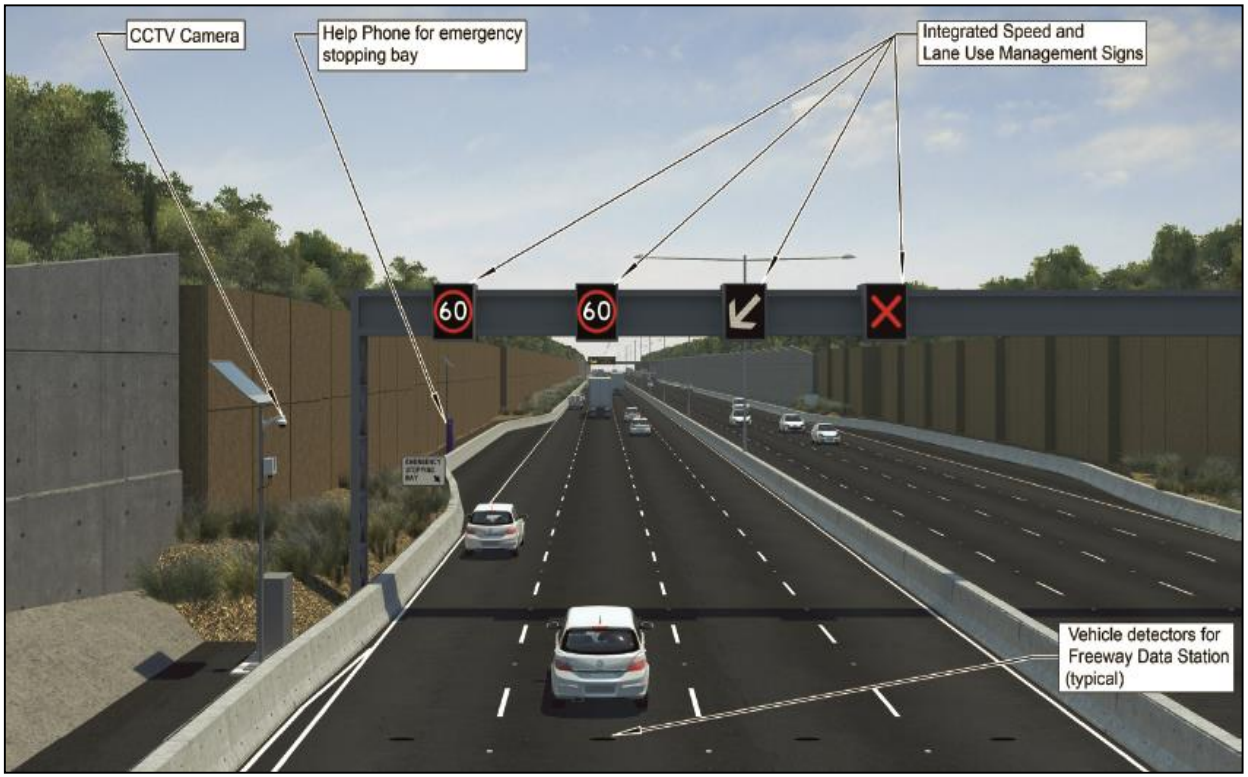




In 2008 the City of Los Angeles began a 4 year process to replace over 140,000 streetlights with LEDs, becoming the largest retrofit of street lighting in the world.



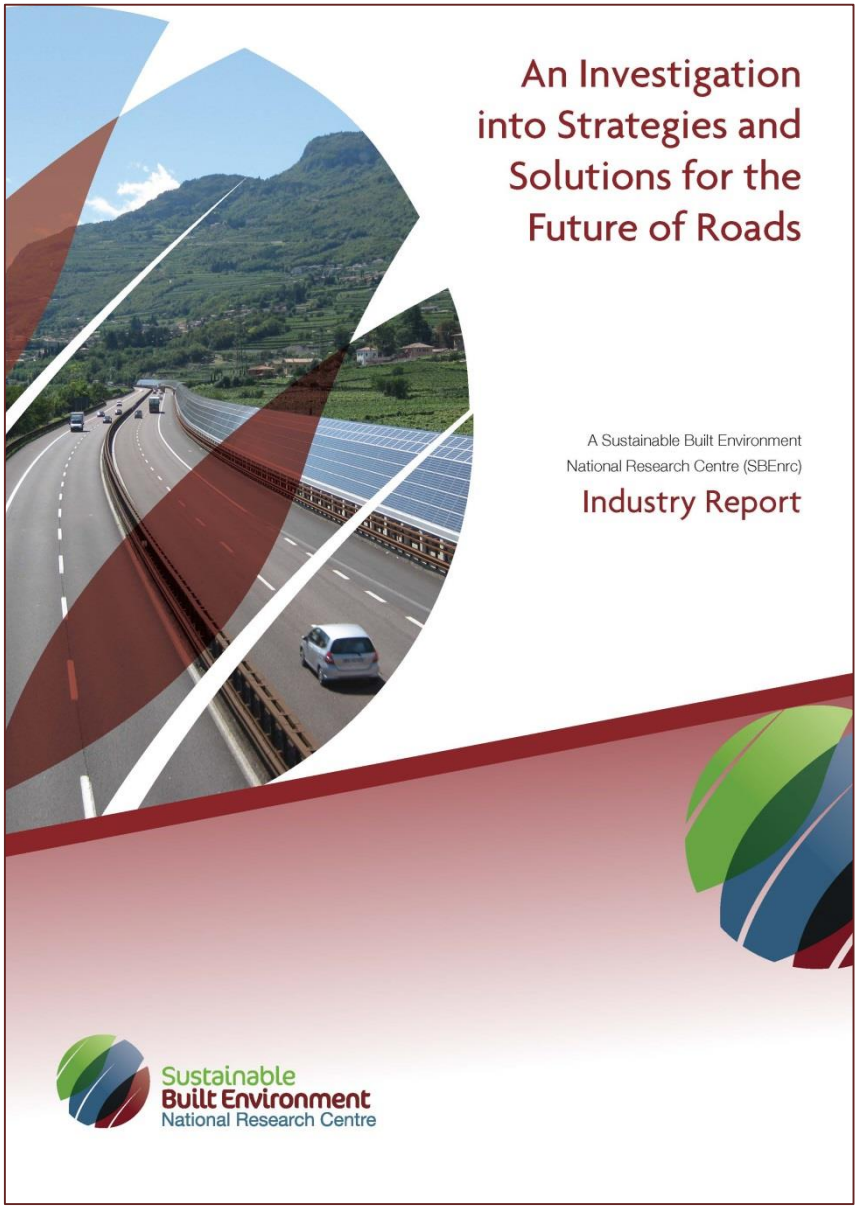
The program has a payback period of 7 years and following this the city estimates that it will benefit from some $10 million/year in savings in electricity and maintenance costs, while reducing greenhouse gas emissions by 47,583 tons/year.


CCTV Camera
Help Phone for emergency stopping bay
Integrated Speed and Lane Use Management Signs
60
60
Vehicle detectors for Freeway Data Station (typical)


ONE VEHICLE PER GREEN
EACH LANE
FORM 1 LANE


4


38
9
mazda 2



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Focus Areas

This project is focusing on three key areas:

1. *Technologies and Processes (renewables in roads, route lighting, and smart/managed motorways);*
2. *The Value of Sustainability Reporting using the 'IS Rating Tool'; and*

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IS Rating Scheme

- First and only national sustainability rating tool for infrastructure
- Measures sustainability performance across the quadruple bottom line (environmental, social, economic and governance)
- Voluntary

ISCA Infrastructure Sustainability Council of Australia

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Focus Areas

This project is focusing on three key areas:

1. *Technologies and Processes (renewables, lighting, and smart motorways);*
2. *The Value of Sustainability Reporting using the 'IS Rating Tool'; and*
3. *Informing Low Carbon Tendering (with CRC Low Carbon Living).*

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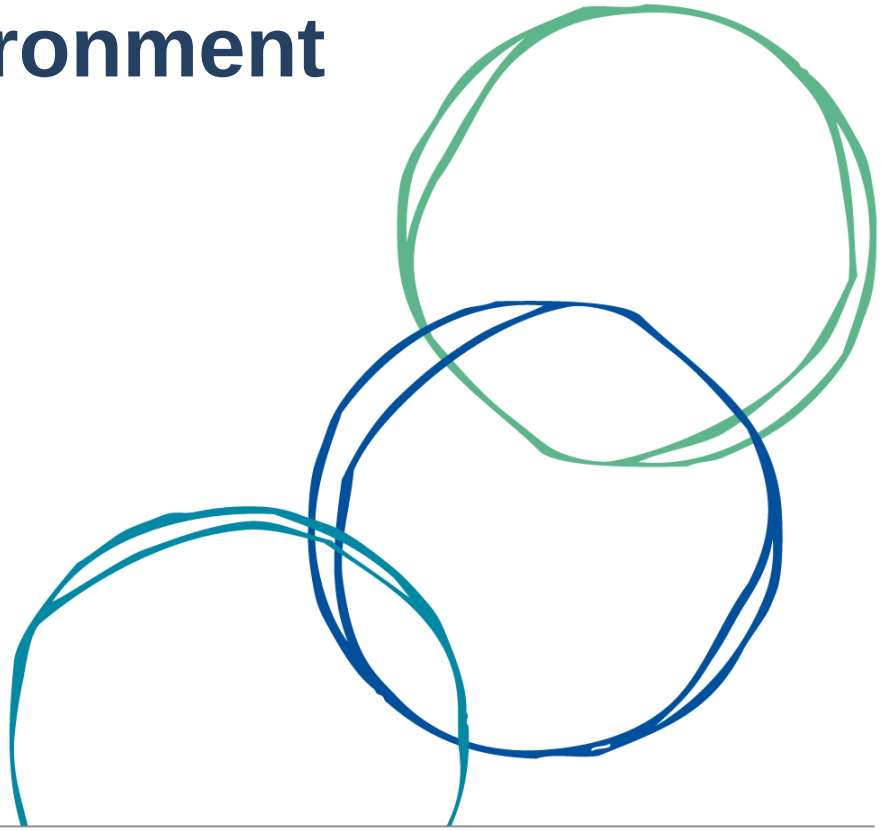
RP2010
Informing and Trialling Low Carbon Inclusions in State Government Built Environment Sector Tenders

Charlie Hargroves, Peter Newman, Russell Kenley, Juliana Bedggood

25 February 2015



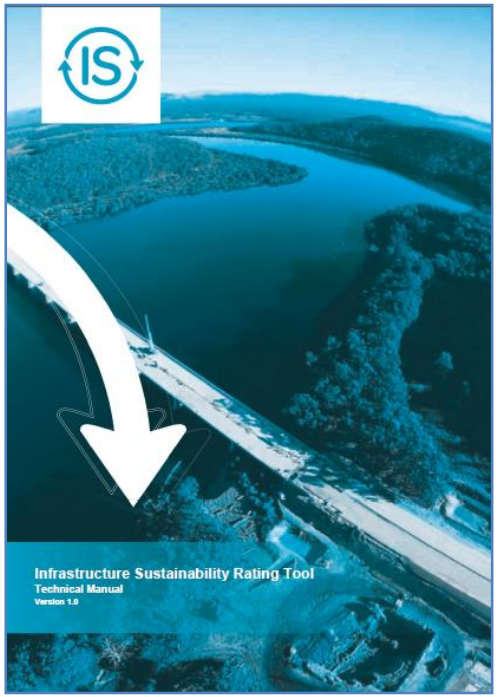
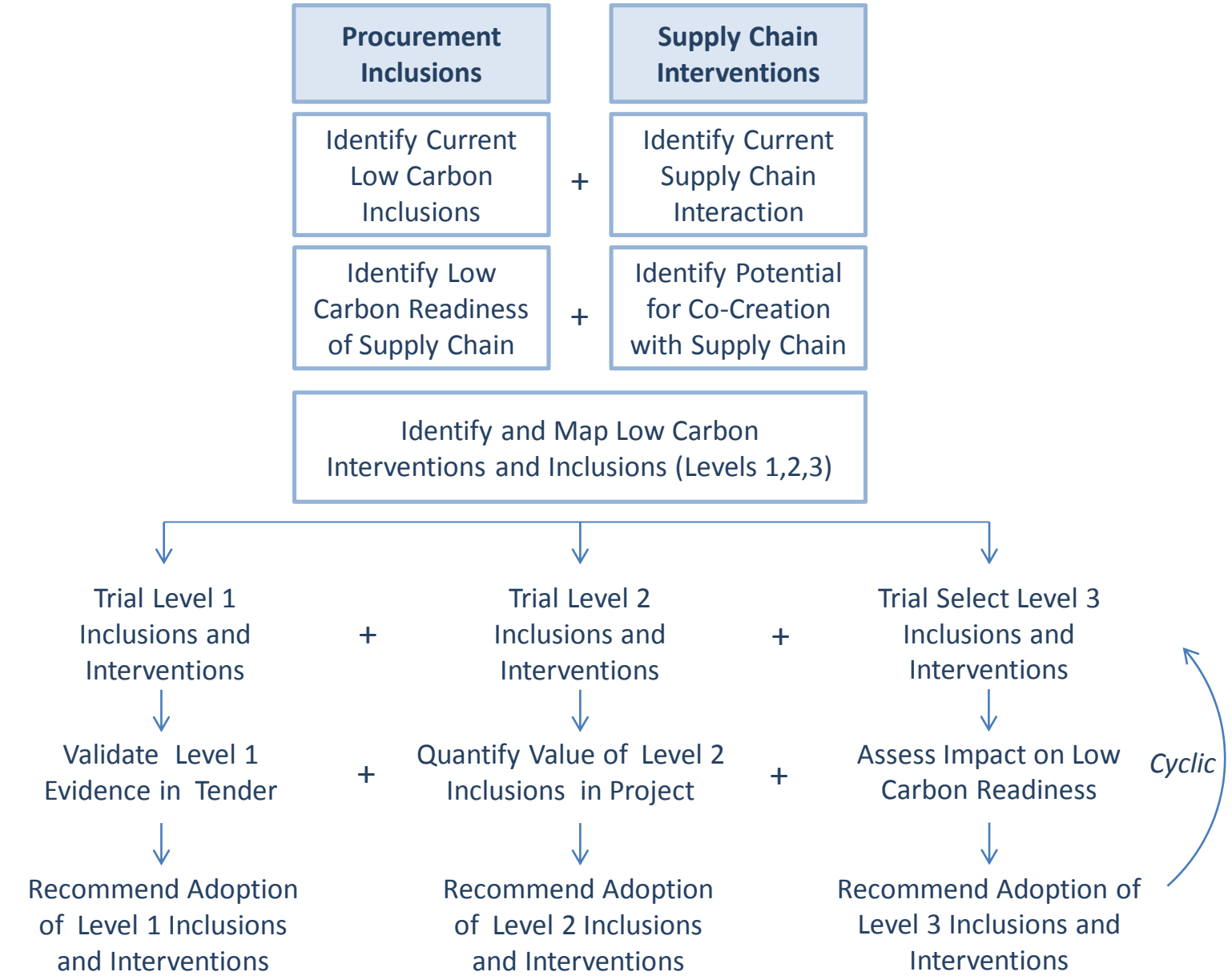


Table 1: Summary of 'IS Rating Tool' credits related to Low Carbon Tendering

Code	Credit	Evidence requirements relevance to Low Carbon Tendering
Credits Directly Related to 'Low Carbon Readiness' (27.54 Total Points Possible)		
Energy and Carbon		
Ene-1 4.67	Energy and carbon monitoring and reduction	Evidence of the modelling and monitoring of actions to reduce energy use and greenhouse gas emissions (Scope 1, 2, and 3 emissions).
Ene-2 4.67	Energy and carbon reduction opportunities	Evidence that opportunities to reduce energy use and greenhouse gas emissions are identified and implemented.
Ene-3 1.17	Renewable energy	Evidence that renewable energy opportunities have been investigated and implemented.
Procurement and Purchasing		
Pro-1 1.25	Commitment to sustainable procurement	Evidence of a commitment to sustainable procurement that includes environmental, social and economic considerations.
Pro-2 1.25	Identification of suppliers	Evidence of supplier pre-qualification questionnaires including items related to the presence and implementation of a sustainability policy.
Pro-3 1.25	Supplier evaluation and contract award	Evidence of sustainability consideration in supplier evaluation criteria and contract documentation, including provision for auditing.
Pro-4 1.25	Managing supplier performance	Evidence of the sustainability performance monitoring of suppliers, with active management of non-compliance and rewards available.
Materials		
Mat-1 6.29	Materials lifecycle impact measurement and reduction	Evidence of the modelling and monitoring of materials lifecycle impacts across infrastructure lifecycle, and demonstrated reductions.
Mat-2 0.74	Environmentally labelled products and supply chains	Evidence of the use of major material products with environmental credentials nominated or approved by ISCA.
Innovation		
Inn-1 5.00	Innovation	Evidence of contribution to broader market transformation towards sustainable development, locally, nationally and internationally.
Credits In-Directly Related to 'Low Carbon Readiness' (15.5 Total Points Possible)		
Management Systems		
Man-1 1.07	Sustainability leadership and commitment	Evidence of a commitment to sustainability through a sustainability policy and inclusion in management plans and project contracts.
Man-2 0.43	Management system accreditation	Evidence of accreditation of asset management systems to ISO14001 standard for environmental management systems.
Man-3 0.86	Risk and opportunity management	Evidence of the assessment of environmental, social, and economic risks and opportunities in a risk register with annual reviews.
Man-4	Organisational structure,	Evidence of a member of the project senior management with central


Procurement Inclusions
Supply Chain Interventions
Identify Current Low Carbon Inclusions
+
Identify Current Supply Chain Interaction
Identify Low Carbon Readiness of Supply Chain
+
Identify Potential for Co-Creation with Supply Chain
Identify and Map Low Carbon Interventions and Inclusions (Levels 1,2,3)
Trial Level 1 Inclusions and Interventions
+
Trial Level 2 Inclusions and Interventions
+
Trial Select Level 3 Inclusions and Interventions
Validate Level 1 Evidence in Tender
+
Quantify Value of Level 2 Inclusions in Project
+
Assess Impact on Low Carbon Readiness
Cyclic
Recommend Adoption of Level 1 Inclusions and Interventions
Recommend Adoption of Level 2 Inclusions and Interventions
Recommend Adoption of Level 3 Inclusions and Interventions

ISCA 'Infrastructure Sustainability' Rating Tool and Low Carbon Tendering

A Collaborative Project between the Sustainable Built Environment National Research Centre (SBEnrc) and the CRC for Low Carbon Living

University Research Team
Program Leader: Professor Peter Newman (Curtin University)
Project Leader: Dr Charlie Hargroves (Curtin University)
Steering Group Chair: Dr Kenneth Michael, AC
Industry Advisor: Rick Walters (ISCA)

Acknowledgement

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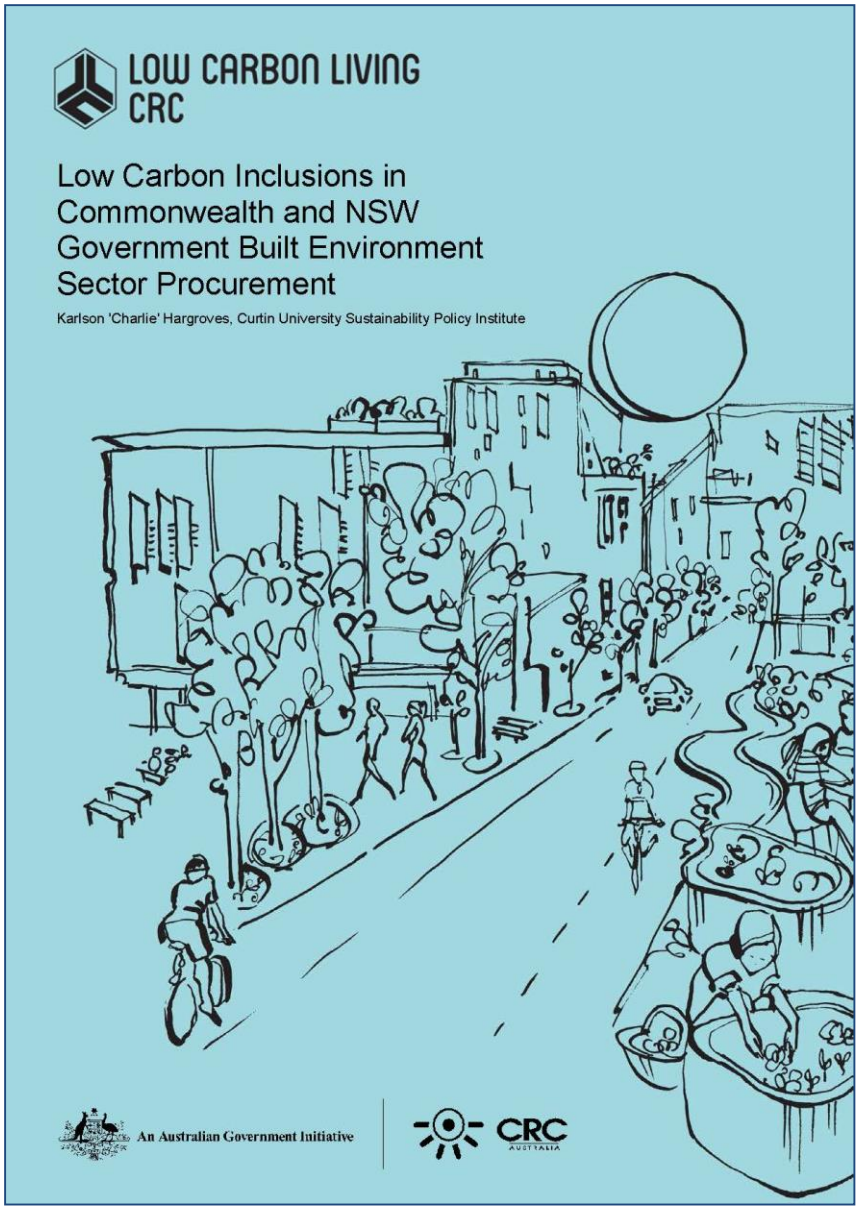
Citation: Hargroves, K (2015) *ISCA 'Infrastructure Sustainability' Rating Tool and Low Carbon Tendering: A Report to the Sustainable Built Environment National Research Centre and the CRC for Low Carbon Living*, Curtin University Sustainability Policy Institute, Curtin University.



SBEnrc Industry Report and CRC Report in final stages of development.

Transport Network Resilience: Disaster Logistics and Infrastructure Vulnerability (2014-2015)

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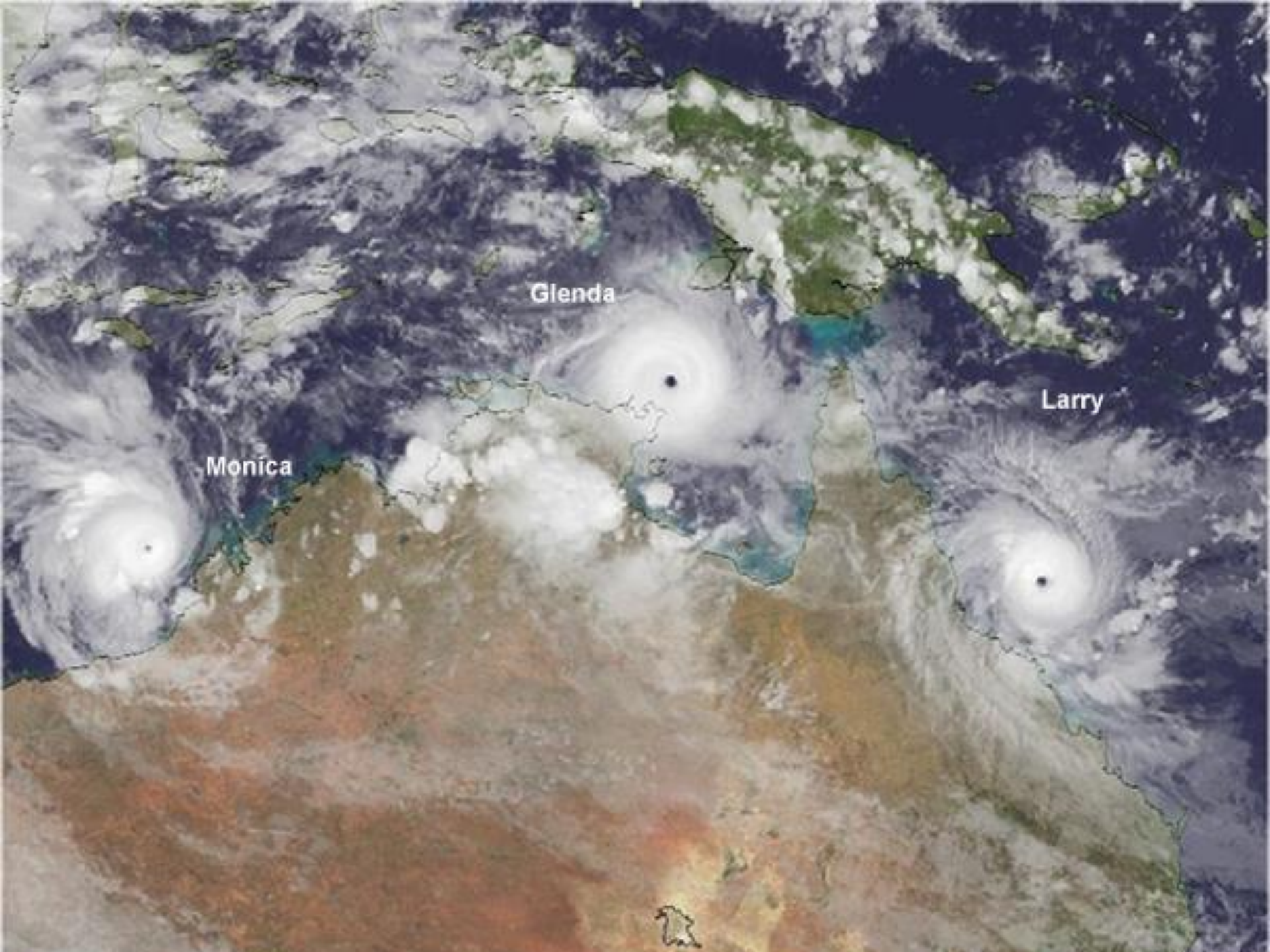
BGC

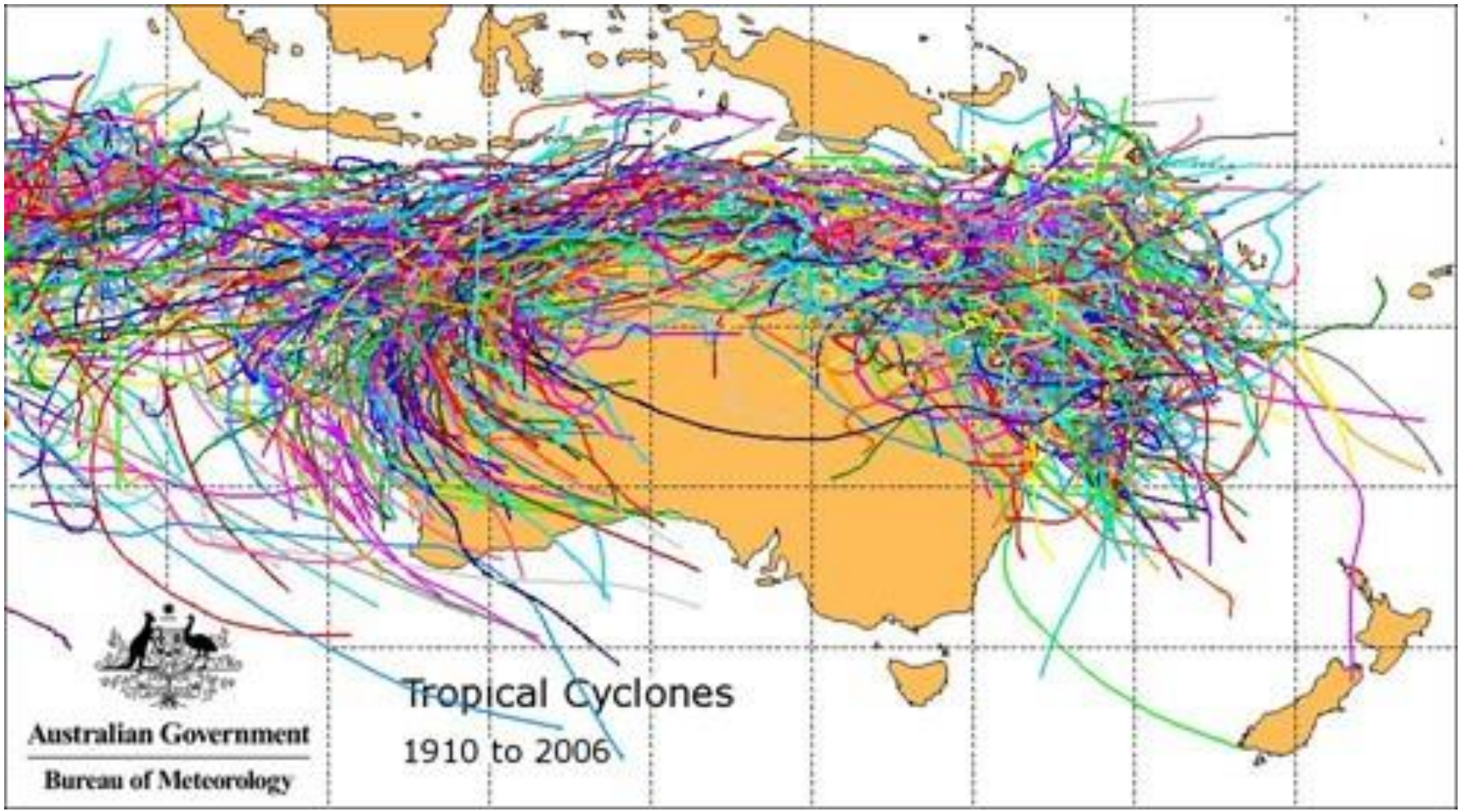
Project Collaborator

City of Townsville

Shire of Broome
people • place • prosperity

clarence VALLEY COUNCIL


Glenda
Larry
Monica


Tropical Cyclones
1910 to 2006
Australian Government
Bureau of Meteorology

Stakeholder Workshops

Vision

"In the face of natural disasters our cities and towns will be well prepared and supported to activate an effective response, that harnesses leading edge technologies and practices, to minimise disruption to transport networks, and achieve a swift return to normal for our communities and businesses."

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Transport Network Resilience

- The assessment of the natural disaster readiness of infrastructure and consideration of betterment options.
- A process to undertake ‘Disaster Repurposing’ at a city or town infrastructure level.
- Streamlining governance structures to support disaster recovery.
- An informed and prepared community.
- The use of data to inform a rapid response to transport network interruption.
- Strategic planning to increase whole-of-community resilience to natural disasters.
- Multi-Agency coordination and communications strategies and practices.

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Australian Business Roundtable

"Raising the Warragamba Dam wall in NSW by 23 meters would cost in the order of $400M and would result in a reduction in the present value of flood costs between 2013 and 2050 from $4.1 billion to $1.1 billion, a benefit of some $2.5 billion."

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During the 2009 Far West Floods, the New South Wales Government provided an overwhelmed local government with an experienced State Government recovery expert to provide consultation on important strategic decision-making. Following this event, the same area was again flooded during March 2010, and the benefits of the initial involvement of the State Government's liaison the year before were extremely evident.

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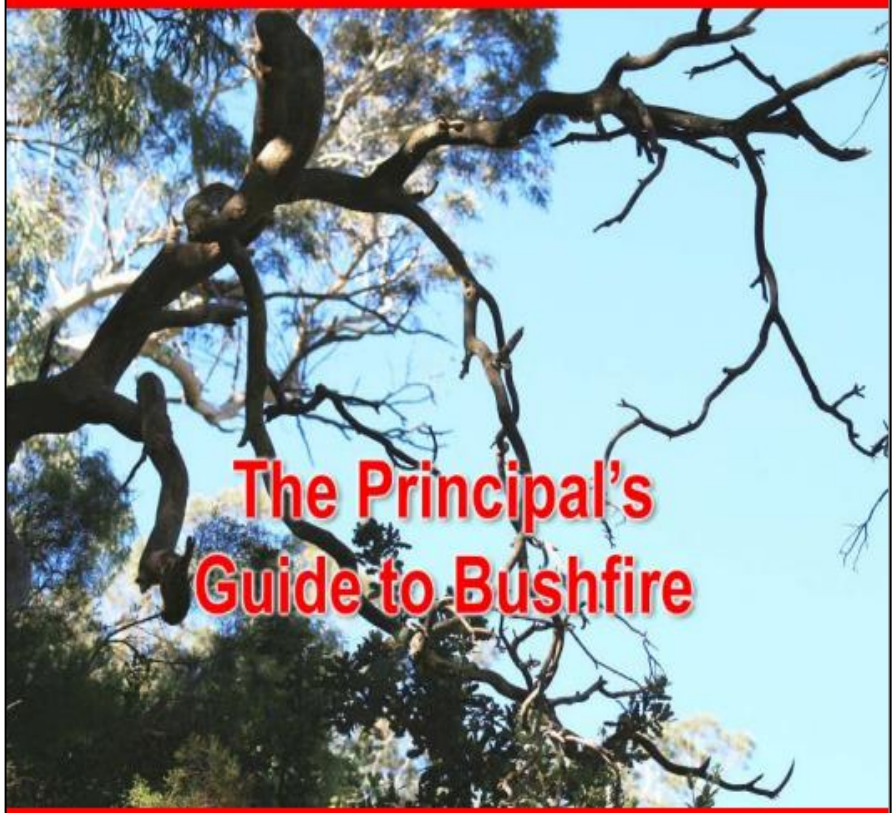
Department of
Education



The Principal's Guide to Bushfire

Preparing Your School for the Bushfire Season

This document must be read in conjunction with the
Emergency and Critical Incident Management Plan

Updated August 2015

Transport Network Resilience

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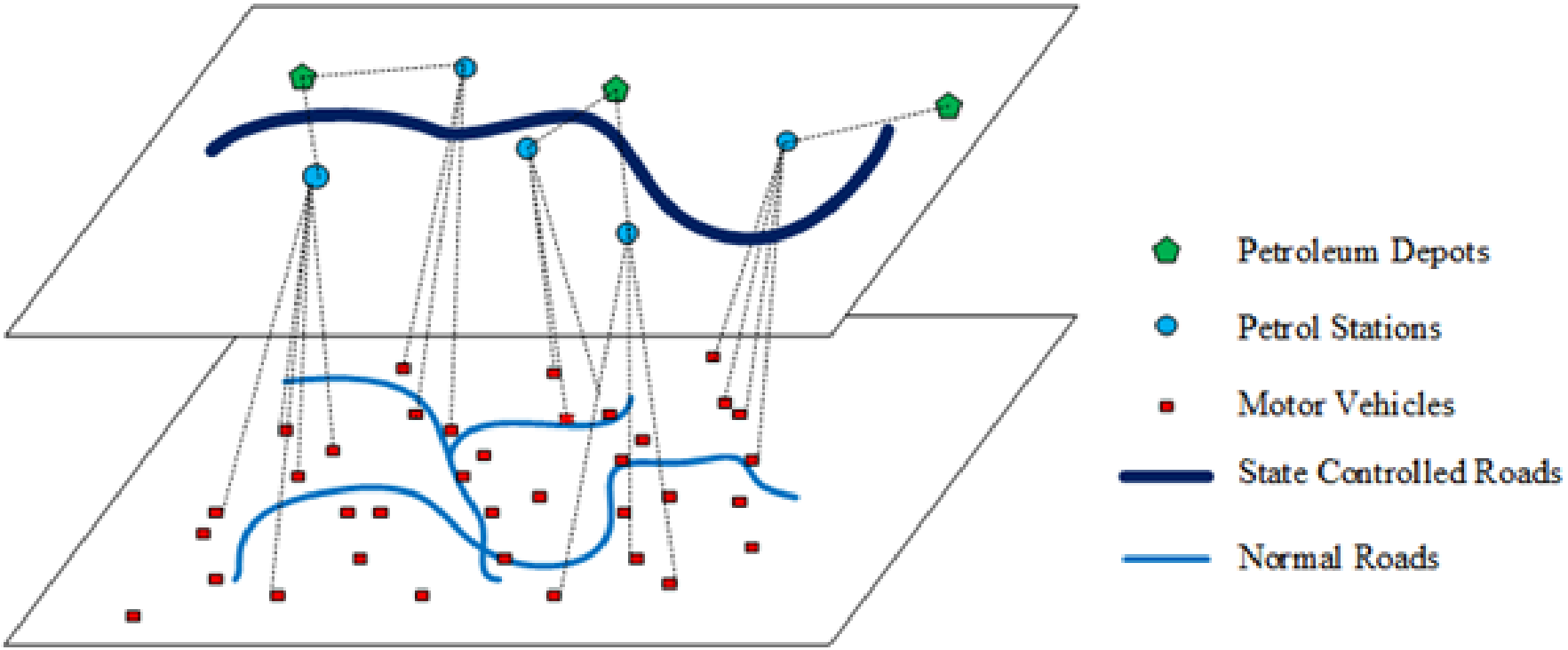
Using Data to Increase Resilience

This phase sought to provide an empirical modelling case study to explore disaster damage and recovery, and to attempt to model flows of commodities, selecting access to vehicle fuel in Queensland as the cast study. However useable data was difficult to source. Time series road closure data was provided by QTMR and a range of other datasets, including Queensland motor vehicle registration data, were used to synthesize and replicate petroleum fuel suppliers focused on road transport demand for petroleum fuels (not agricultural or mining) and used to estimate demand. Geo-coded locations of petrol stations, key depots and road network links were obtained from government sources, allowing a meaningful representation of the fuel supply network.



(b) Multi-Agent Relationships in Petroleum Supply Chain

Figure 1 Framework for Estimation of Fuel Demand

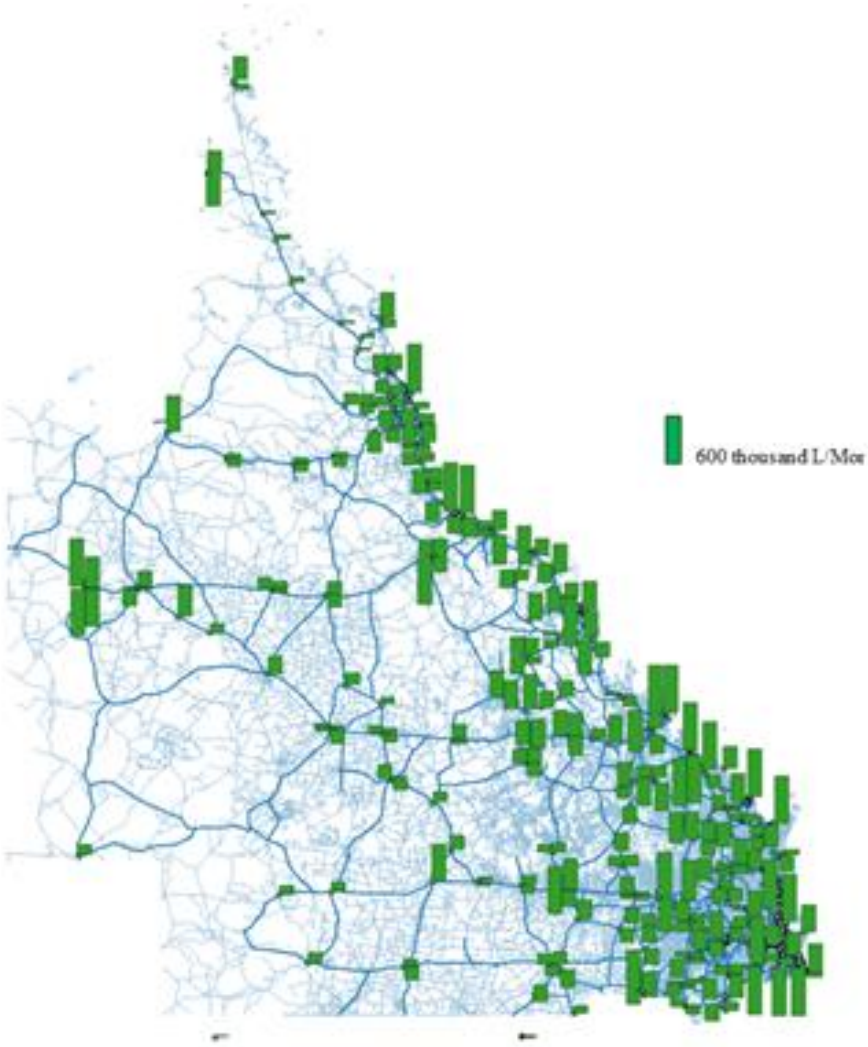


Figure 2 Estimated Fuel Demand at Each Petrol Station

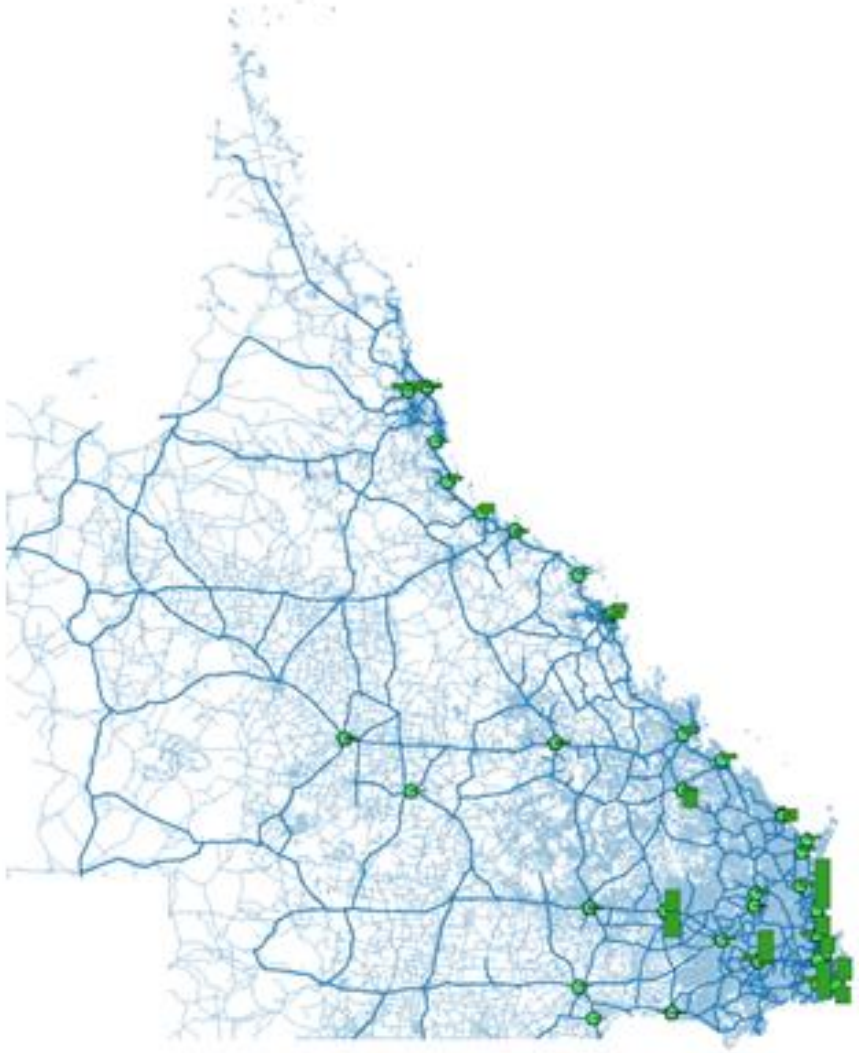


Figure 3 Estimated Fuel Demand at Each Petroleum Depot

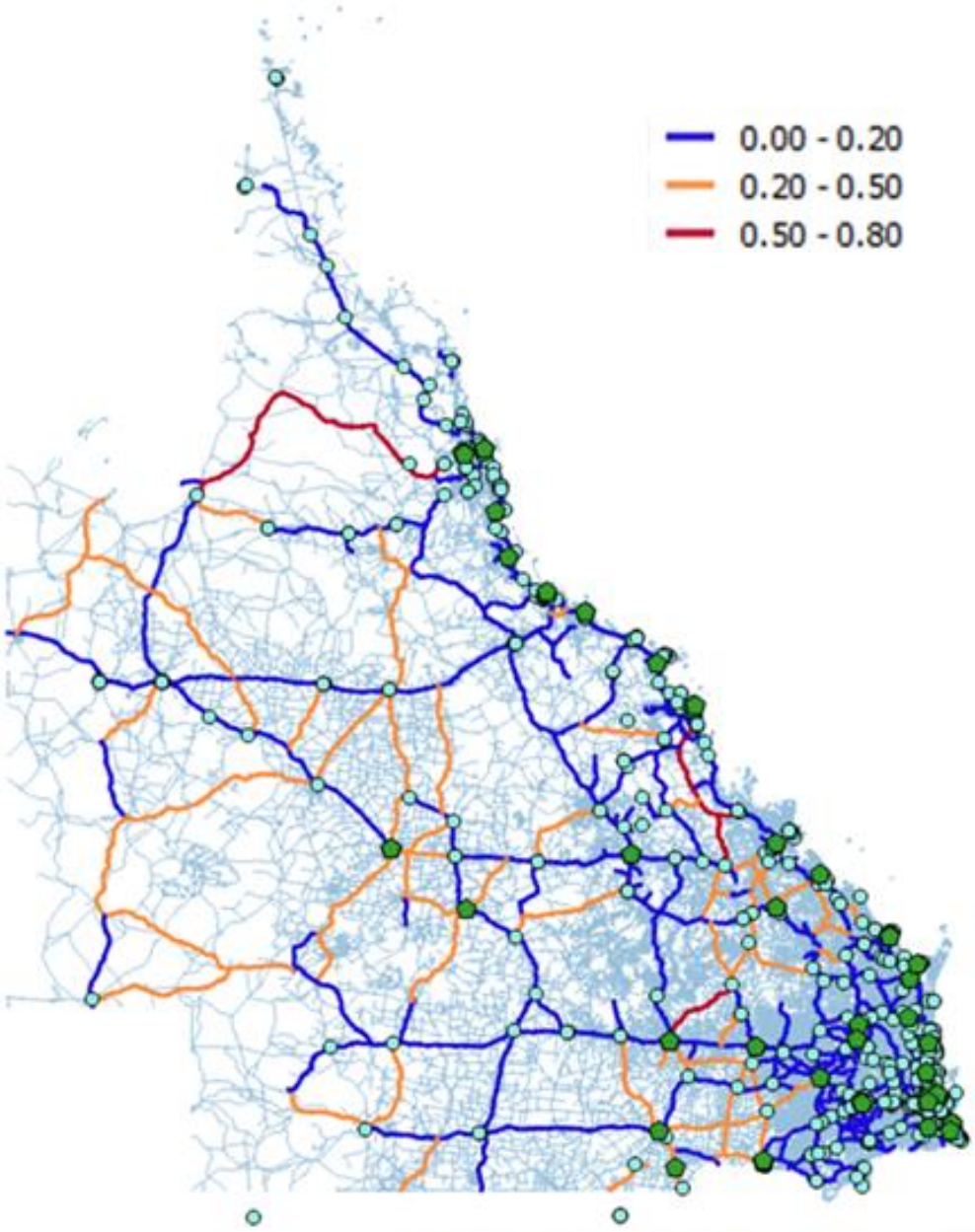


Figure 4 Monthly Link Failure Probabilities

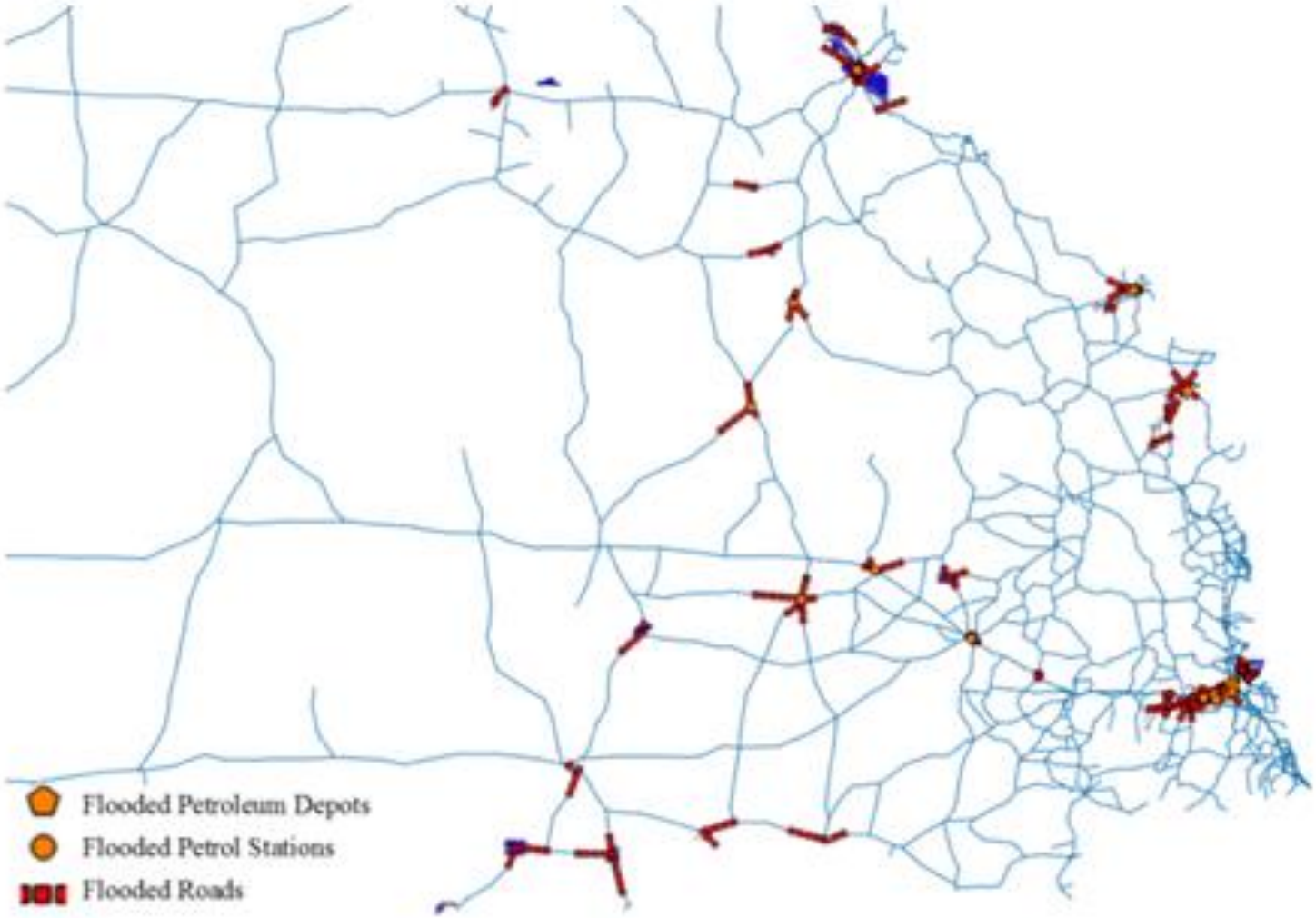


Figure 5 Impact of the 2011 Flood

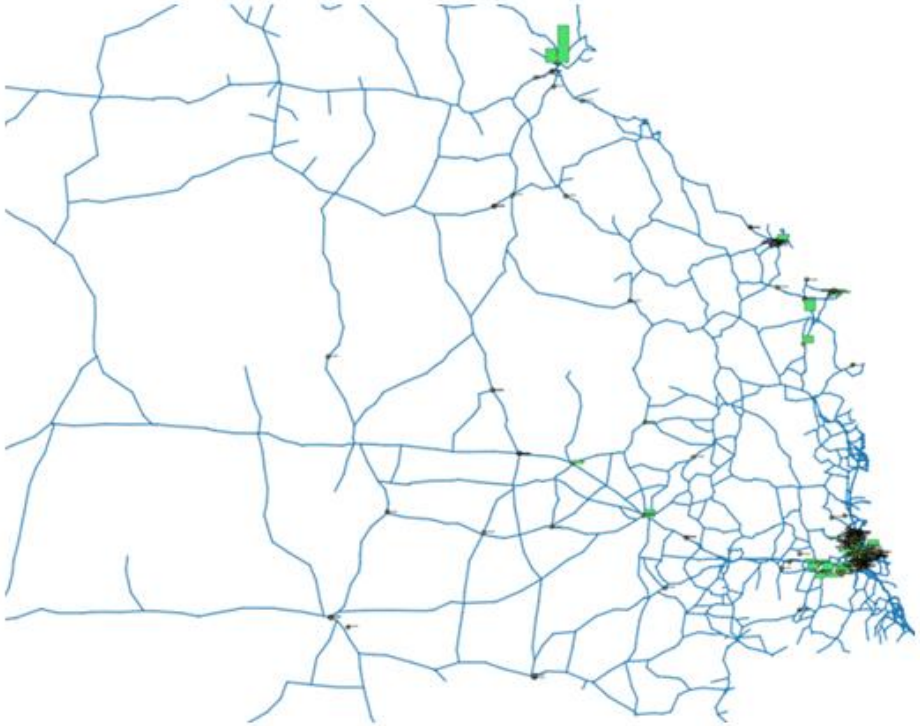


Figure 8 Increased requirement of petroleum fuel at each of the accessible petrol stations

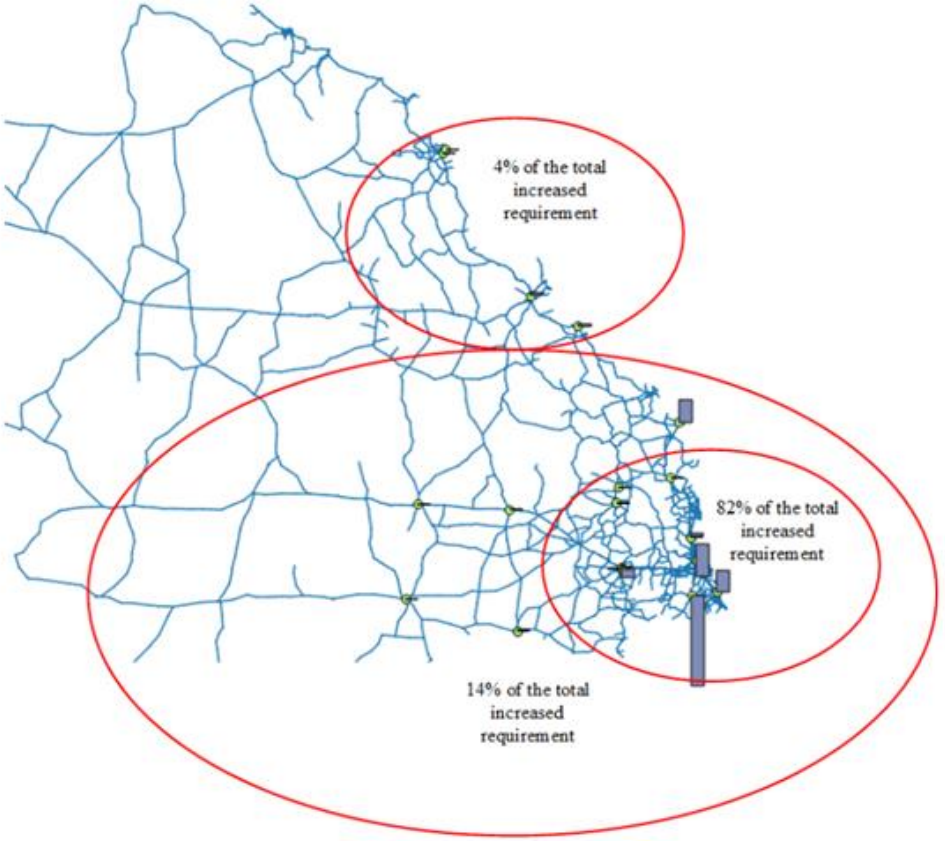


Figure 9 Increased requirement of petroleum fuel at each of the accessible petroleum depots

Transport Network Resilience

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Organisational Maturity for Disaster Preparedness

Regardless of the systemic differences between the State-based disaster management arrangements, there are some universal commonalities that underpin the various forms that these arrangements take. As such, while the particulars of contributing disaster management agencies and the systems to manage them might vary between States, each jurisdiction will have similar needs. This phase of the project focused on creating a procedure to measure and map the effectiveness and maturity of the associated core processes, and the organisations in which they are embedded, in order to enhance intra- and multi-agency and multi-agency functioning in response to disaster situations.

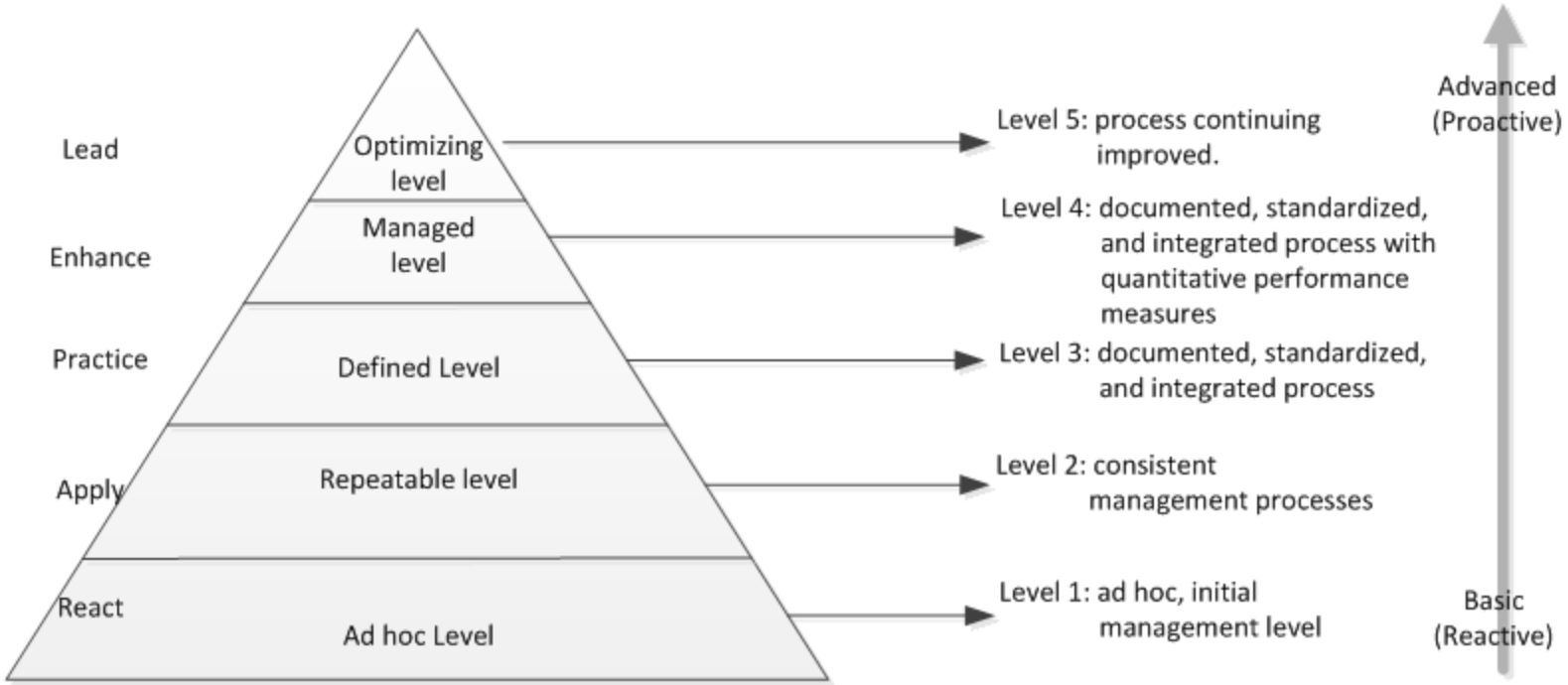
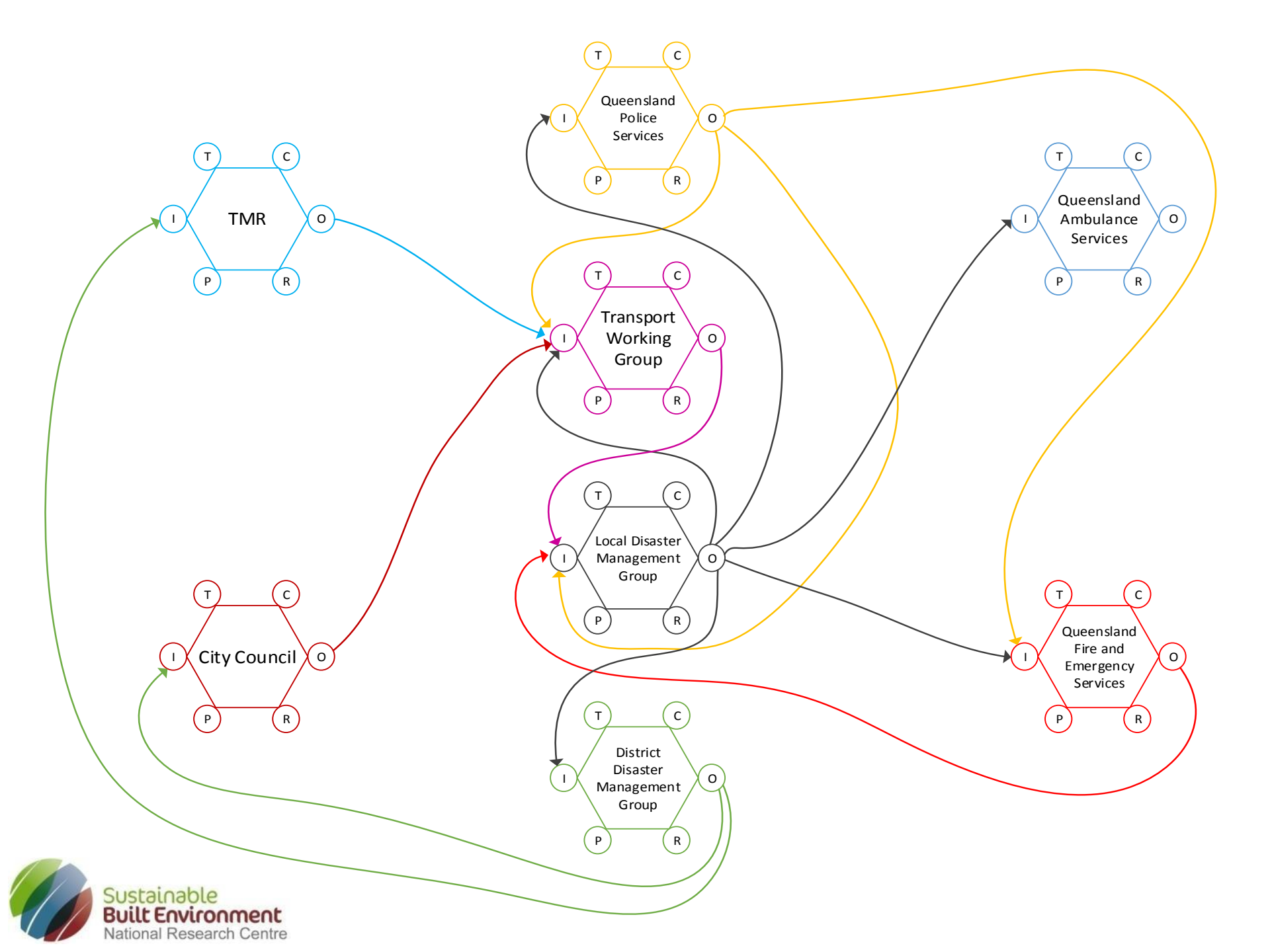


Fig. 1: Organizational Maturity Model for Disaster Preparedness



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Dimension	Practices
Organisational Planning/Managing	• Developing of disaster management plans • Providing the availability of disaster management plans • Evaluating of the maturity level of disaster management plans • Introducing of disaster management responsibilities
Role of management in managing Disaster Events	• Introducing of the dedicated disaster manager/director role • Involving of disaster manager/director in the disaster management planning • Performing the media training for relevant staff • Developing of a formal disaster communication plan • Evaluating of disaster communication effectiveness
Organisational Culture/Processes	• Embedding the disaster management into organisational processes • Promoting the importance of disaster management • Including the key performance measures of disaster management into the staff performance evaluation process • Evaluating of overall effectiveness of the organisational culture in disaster management
Learning and Development	• Developing of formal disaster management training plans • Evaluating of the effectiveness of disaster training activities • Evaluating of the satisfaction level of the disaster training frequency • Performing the post disaster reviews • Evaluating of the effectiveness of post disaster reviews • Rating of training evaluation measures

New Industry Research Project

In October 2015 the SBEnrc will be starting a new industry project on the value of Big Data to road and transport agencies, with a focus on:

- *Big Data: Hype or Opportunity:* Looking into the realty of using data to reduce congestion.
- *Next-Gen Technology:* Exploring the use of drones in disaster response.

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How can drones be used to support disaster response?

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New Industry Research Project

In October 2015 the SBEnrc will be starting a new industry project on the value of digital scenario planning tools. This project will investigate areas related to decision making and planning for the future of our large cities in the coming decades, in particular the balance between urban development and the provision of transportation infrastructure.