Emergency Bridging Strategy

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ABSTRACT

Main Roads WA, as the lead State road authority, has a responsibility under State emergency management arrangements for the restoration of the road network, including the clean-up and reconstruction of bridge assets during recovery operations. It was identified that there were limited emergency bridging options in the State that would be readily available in the event that a bridge was damaged or destroyed during an incident.

In 2012, Main Roads WA established a team to develop a strategy to address these deficiencies.

The strategy included the refurbishment of a Bailey bridging system owned by Main Roads WA and the supplementation of this with a larger span system. The strategy also included training of Main Roads WA staff in the use of these systems and the production of contingency plans for bridges where the use of the emergency bridging systems was not feasible.

This paper outlines the result of the work carried out including:

- the emergency bridging options assessed
- the condition assessment and refurbishment of the Bailey bridging system
- the acquisition and utilisation of a Mabey Compact 200 bridging system
- emergency bridge storage arrangements and training of staff
- development of other contingency arrangements including contingency plans.

1 INTRODUCTION

Main Roads WA (MRWA) has roles and responsibilities under the State Emergency Management Plan to respond to the loss of, or damage to, bridges on the State's road network. Following an assessment of MRWA's capacity, it was clear that MRWA did not have ready access to emergency bridging systems and therefore would be unable to respond effectively to the loss of any bridges on the network. Given MRWA's central role in providing expertise and support to all bridge owners in WA, this situation was considered unsatisfactory.

An Emergency Bridging Team (referred to in this paper as the Team) was convened in August 2012 to oversee the development of the Emergency Bridging Strategy (referred to in this paper as the Strategy) and implementation of any projects identified. The Team consisted of various MRWA staff - five regional structures representatives, a representative from Structures Engineering (central structures expertise) and the Crisis and Emergency Management Manager. The role of the Team was, in part, to thoroughly examine MRWA capability and capacity to respond to the catastrophic failure of bridge assets due to natural or man-made events.

2 EMERGENCY BRIDGING STRATEGY

2.1 The Need

MRWA, within the national emergency management framework, is classified an essential public asset owner. With accumulated assets of over 30 billion dollars, MRWA manages one of the largest asset inventories in the state of Western Australia.

Under the State emergency management arrangements, MRWA has a statutory obligation to be responsible for the restoration of the road network, including clean up and construction of bridge assets during recovery operations. In order to meet this obligation MRWA must have an effective emergency bridging system/s to demonstrate its capability and capacity to deliver on this requirement to the State and the people of Western Australia.

MRWA is a Support Agency defined under the Emergency Management Act with roles and responsibilities currently in 21 of the 26 state level plans. These roles and responsibilities include:

- assisting with traffic management planning
- assisting with traffic management support
- restoration of road asset and infrastructure.

Refer to Figure 1 for MRWA roles and responsibilities as defined in the State Emergency Management Plan. In particular, note the responsibility for bridge assets.

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- Provide a representative to the State Emergency Management Committee.

Response

- Provide executive officer and administrative support to establish and manage the State Disaster Council, if established.
- Activate the State Crisis Centre, if required under the NCTP.
- Provide a representative to the SECG, as required.
- Provide a representative to the National Crisis Committee, as required.
- Provide support to the State Security Committee, if activated.

Recovery

- Provide a representative to the SECG, as required.
- Provide a representative to the State Recovery Coordination Group, as required.
- Provide support to the State Disaster Council, if established.

MAIN ROADS WA

Role

Main Roads WA is responsible for delivering social, economic and environmental benefits to communities throughout Western Australia by managing the State road network and its usage as an integral part of the overall transport system.

Responsibilities

Prevention – Mitigation

- Provide engineering and technical advice with respect main roads infrastructure.

Preparedness

- Provide a representative on local and district planning committees (where practicable).
- Provide an appropriate representative on the flood warning consultative committee and operational group (where practicable).
- Provide traffic flow modelling, traffic light manipulation.

Response

- Provide advice to the HMA on the potential and actual impacts of identified hazards on the State road network.
- Close and open roads when requested to do so by the HMA. The Commissioner of Main Roads WA (or delegated officers) has the power to close or open roads under the *Main Roads Act 1930*.
- Provide current road information.

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- Communicate road closures to the public.
- Provide a liaison officer to the SECG, as required.
- Participate in ISG and OASG, as required.
- Provide a liaison officer(s) and other trained staff, as required and appropriate.
- Operate and coordinate control signals for all roads.
- Assist with quarantine and movement control as required (e.g. road blocks and checkpoints).
- Provide and assist in the acquisition of resources and engineering services.
- Participate in post-operational debriefs as required.
- Prepare and implement contingency traffic management plans arising from an emergency.
- To be contactable on a 24/7 basis.

Recovery

- Assist in the recovery process through road infrastructure repair and reconstruction.
- Restore assets for State highways and main roads including signage.
- Restore the Main Roads WA network, including clean-up and construction of bridge assets during recovery operations.
- Provide support as required by the incident controller.

4. SERVICE PROVIDERS

ATCO GAS AUSTRALIA

Role

ATCO GAS Australia provides a gas supply role as an 'infrastructure operator' during a disruption to gas supplies as a result of an emergency situation or state of emergency.

ATCO GAS also is a member of the Essential Services Network Operators Reference Group (ESNROG), which exchanges information to assist or improve operations of essential services and functions in relation to EM for the benefit of the community. ATCO GAS is also represented on the Gas Emergency Planning Committee, which is responsible for non-operational strategic planning relating to gas supply issues in Western Australia and preparing and maintaining State Hazard Plan - Energy Supply Disruption.

Responsibilities

Prevention

- Contribute to prevention through adherence to relevant legislation and good industry practice.
- Prevent and minimise the risk of injury, death or damage to property or the environment.
- Prevent and minimise the disruption to essential network services.
- Assist in the prevention or reduction of the severity and impact of the hazard.

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Figure 1 Extracts from the State Level Emergency Management Plan

Following heavy rainfall events in the State when river flows increase to a level that heavy scouring or overtopping of bridges occurs, it is likely that bridge losses will be experienced. Also, during recent summer bushfire periods, there have been losses of bridges owned by local government, Department of Biodiversity Conservation and Attractions, Water Corporation and MRWA.

By way of example, in July 2013 following heavy rainfall, the Shire of Augusta Margaret River lost a significant culvert on Warner Glen Road. The culvert pipes were washed downstream leaving the guardrail suspended over the river (refer to Figure 2). The Shire requested MRWA to install a Bailey bridge to keep the road open. Although MRWA had a number of Bailey bridge components at that time, the condition and load carrying capacity of these components was unknown. Accordingly, MRWA had to decline the request.

Figure 2: Washed out culvert – Warner Glen Road, Shire of Augusta/Margaret River July 2013.

The Northcliffe bushfires in the South West in February 2015 crystalised this need when three timber bridges came under threat along the South Western Highway. A two-week closure of an affected section of the highway due to safety concerns from falling trees caused significant consequences for the economic and psycho-social wellbeing of the local community.

As a result of the Waroona bushfires in February 2016, the Samson Brook bridge (Bridge 0149) on the South Western Highway was destroyed (refer Figure 3) and the Harvey town bridge (Bridge 0170) was treated with fire retardant as fire threatened to enter the town.

Figure 3: Bridge 0149 on South Western Highway destroyed by the Waroona bushfires in 2016

A timber bridge on the Forrest Highway (Bridge 0231) over the Harvey Diversion Drain had to be protected by a temporary reticulation system as the fires threatened to reach the Highway. The following is an extract from the Special Inquiry into the Waroona bushfires (Page 216):

"On the evidence available, the Special Inquiry concludes that the essential services performed within their service standards. This, however, should not be reason for complacency. The cost arising from essential service interruptions to commercial businesses and their ability to get back to normal operations is inextricably linked to the resilience of infrastructure and its <u>rapid restoration when damaged</u>. Continually improving and hardening such infrastructure is good crisis management, sound business and is the expectation of customers and the community."

MRWA's emergency strategy has often been to detour traffic around closed bridges using other roads while a bypass (side) road is constructed allowing for the demolition and construction of a new structure. Emergency bridging capability and capacity has been limited typically to the use of temporary circular steel pipe culverts.

While this approach has generally been tolerated by the community, had an extended closure due to a replacement or multiple replacements of bridge assets occurred, there would have been major losses for tourism and the transport industry servicing the area. From a MRWA perspective, our ability to respond to such an event would need to be timely to meet our statutory, political, environmental, social, economic and reputational expectations.

This need had not been overstated and the Waroona bushfires in 2016 demonstrated that there is a real, not just a perceived need, to have our capability in emergency bridging systems quantified. The Strategy outlined in this paper addresses the gaps and meets the minimal need to demonstrate that MRWA as a network owner and operator can deliver on the expectations of emergency management agencies and community of Western Australia.

Currently, if a bridge is lost or damaged in an emergency, it can take several years to plan, design and construct a replacement structure. In the meantime, the crossing could be closed to traffic causing significant disruptions to users of the network. In many rural situations, this can result in lengthy detours sometimes involving a route of a lower standard and safety.

A suitable emergency bridging system would enable the crossing to be kept open (possibly at a lower level of serviceability) while the existing bridge is repaired or replaced. However, for larger bridges typically in the metropolitan and northern regions, the use of an emergency bridging system would not be feasible in many situations and alternative contingency arrangements would be needed (e.g. specific bridge traffic management plans).

In summary, there was a genuine urgency for MRWA to have emergency bridging systems with known load carrying capacities, to temporarily replace small to medium bridges across the State while they are repaired or replaced. There was also a clear need for MRWA to put in place contingency measures for bridges where the use of an emergency bridging system would not be feasible.

2.2 Existing MRWA Emergency Bridging Systems

The **Bailey bridge system** was developed in 1940-1941 by the British for military use during World War II. A Bailey bridge had the advantages of requiring no special tools or heavy equipment to assemble. The timber and steel bridge elements were small and light enough to be carried in trucks and lifted into place by hand, without requiring the use of a crane. The bridges were strong enough to carry tanks. Refer to Figure 4 showing a Bailey bridge being assembled by hand. Bailey bridges continue to be used extensively in civil engineering construction projects and to provide temporary crossings for foot and vehicle traffic.

Figure 4: Royal Engineers construct a Bailey bridge in Italy, September 1943. Timber planks are being laid over the stringers to construct the deck.

MRWA has a significant number of Bailey bridge components and has used Bailey bridges in the past for emergency and semi-permanent applications. Originally the Bailey bridging system used timber chesses (planks) supported by steel stringers for the deck (refer to Figure 4). As MRWA did not have these components, jarrah decking “mats” were used comprised of 225mm wide by 125mm thick planks.

The **Small Box Girder bridge** (SBG) was a small assault bridge that could be used to span gaps of up to 30 feet. It was typically carried on a tank, such as the Churchill Armoured Vehicle Royal Engineers (AVRE) or something similar, and could be deployed without engineers having to expose themselves to enemy fire. The design had been formally adopted by the British Army in 1932. Refer to Figure 5 showing the use of the SBG bridge during World War 2.

Figure 5: A Small Box Girder Bridge (used as ramp, centre) at 'Nan White' Beach at Bernières-sur-Mer.

The Australia Army designed its own version of the SBG bridge and it is this type that MRWA owned. The small welded box girder is a robust under bridge girder. It comprises of end and intermediate trusses (refer to Figures 6 and 7). The intermediate trusses are 355mm wide, 670mm deep, and 4.24m in length. The tapered end trusses are 355mm wide with the depth ranging from 200mm to 670mm over a length of 4.24m. The Australian Army Museum at Holsworthy in NSW agreed it is almost certain to be ex-Army as it very closely resembles a slightly larger under-truss they produced in the 1940s.

MRWA has a smaller number of components for the SBG bridging system. The use of the SBG bridges by MRWA in the past is unknown.

Figure 6 – SBG Intermediate Truss

Figure 7 – SBG End Truss

2.3 Emergency Bridging Criteria

The Team agreed that the initial criteria for an emergency bridging system should be:

- minimum single span of 21m
- single lane
- VSR load capacity (as of right loads).

This minimum span length would be suitable for over 60% of the bridges around the State (for all bridge owners). Figure 8 shows the length ranges for all bridges in WA. As can be seen from the chart, the majority of bridges have overall lengths from 0m to 20m.

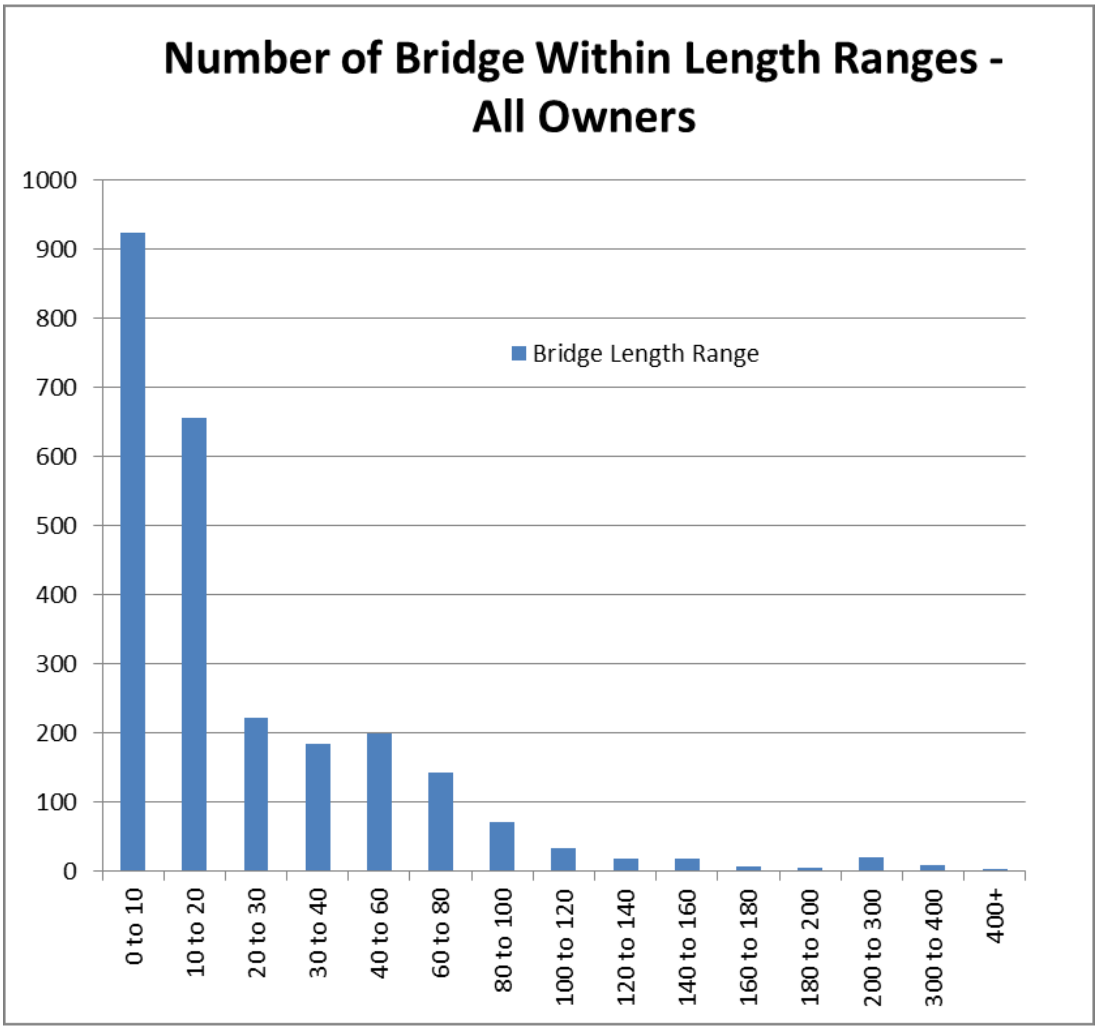

Figure 8 Overall bridge lengths in WA.

2.4 Condition Assessments

SW Engineering Consultants P/L was engaged in May 2011 to carry out a broad condition assessment of the 1943 Bailey and Small Box Girder bridging system components and an assessment as to the suitability of these systems for MRWA. The report, which was completed in 2011, provided the following condition assessment of these emergency bridging systems:

- The Bailey bridging system was missing some components. Some components had been modified while others have been damaged from incorrect handling/lifting. Damage included bent sections and cracked welds. Many components were rusty.

- Some of the SBG components were also rusty. A number of connectors had also been damaged due to incorrect handling/lifting.
- Three depots were visited. These were the Bunbury and Narrogin depots in April 2011 and the Kununurra depot in late May 2011.

The emergency bridging components had been brought out in the open at Bunbury and Kununurra whilst a crane was required to obtain access to the components at Narrogin. The emergency bridging systems found in the depots were as follows:

- Bunbury - only Bailey bridging system
- Narrogin - both Bailey bridging system and SBG bridging system
- Kununurra – mainly SBG bridging system but there were also three Bailey transoms.

An inventory of all the components was produced including photographs.

The Bailey bridging components included 119 panels and 126 transoms along with other components such as bracing frames, rakers, sway bracing, end posts, transom clamps and panel pins. The SBG bridging components comprised 48 intermediate trusses and 12 end trusses.

The Team then engaged SW Engineering Consultants P/L to implement a detailed condition assessment of the Bailey bridge components. This report was completed in 2015.

The inspection included:

- visual observation (e.g. damage, previous repairs and condition of coatings)
- assessment of warping of panels and chords
- assessment of corrosion.

More sophisticated methods such as dye penetration and magnetic particle investigations were not pursued.

MRWA supplied a template table for checking warping of the Bailey panels and the reinforcing chords (refer Figures 9 and 10).

Figure 9 – template table used for checking warping of the panel and reinforcing chords.

Figure 10 – a panel being placed on the template table in readiness for condition assessment

Figure 11 – measuring the depth of corrosion on a panel chord

Figure 12 – Measuring pin hole wear in a panel

Each component was inspected separately. The larger components such as panels, reinforcing chords, and transoms were numbered and their condition and repair needs were documented. This helped MRWA to gain a better understanding of the extent of repairs needed when negotiating with contractors.

Other smaller items such as rakers, panel pins, and bracing frames were grouped and only those needing repair were separately documented.

A profile gauge was used to assess the depth of corrosion on components (refer to Figure 11) while a purpose-made gauge was used to check pin hole wear in the panels (refer to Figure 12).

Every component was colour coded as follows:

- green – good condition
- yellow – required repair
- red – to be scrapped or "cannibalized" for repair of other similar components.

Refer to Figures 13, 14 and 15 for typical colour coding of the Bailey bridging components.

Figure 13 – Colour coded sorted stacks of panels

Figure 14 – transoms requiring repair

Figure 15 – transom clamps in good condition

2.5 Options Considered For Single Spans > 21m

2.5.1 Option 1 (Base Case – Do Nothing)

As discussed in Section 2.1, MRWA would be very vulnerable in the event of the loss of a bridge until key elements of the Strategy are implemented including the provision of an emergency bridging system. The Department of Defence briefed MRWA senior management in 2016 outlining the historic and current capabilities of the Department should it be called on to provide assistance during an emergency. The following bridging systems were discussed:

- Bailey bridge – no longer used, no stocks and no experienced personnel
- Medium Girder Bridge – still used, stocks in NSW and Queensland, minimal experience personnel in WA.
- Fixed Modular Bridge – still used, no stocks in WA, no experienced staff in WA.
- Floating Support Bridge – still used, no stocks in WA, no experienced staff in WA.

In summary, the Department advised MRWA management that it was not in a position to provide a reliable emergency bridging service to WA. Option 1 was therefore rejected by the Team.

2.5.2 Option 2 (Refurbish Bailey bridge system)

The 2015 report by SW Consultants P/L (refer Section 2.4) confirmed that the existing Bailey bridge components owned by MRWA could be refurbished enabling three 21.3m long bridges to be assembled that would meet the criteria (refer Section 2.3). The Bailey bridge system also comes with a high level of flexibility in terms of the configurations that can be used to achieve various span lengths and load carry capacities.

2.5.3 Option 3 (Refurbish Small Box Girder system)

The Team decided not to consider refurbishing the Small Box Girder bridging system as the load capacity was unknown and, with the amount of components available, the total length of bridges that could be assembled was less than the Bailey bridge system. Whilst drawings could be made up so that load capacities of the trusses for different spans could be computed, manuals were not available for the SBG bridging system.

2.5.4 Option 4 (Purchase a new Emergency Bridging System)

A number of alternative, off-the-shelf emergency bridging systems were investigated by the Team including:

- Compact 200 by Mabey and Johnson
- Unibridge by Materiere
- Panel Bridge by Waagner Biro.

The various bridging systems assessed are summarized in Table 1 below.

Temporary EB System	Supplier	Repair Costs	Purchase Costs (New)	Possible Configurations	Load Capacity	Comments
Compact 200	Mabey and Johnson	N/A	$108,550	12.19m span	T44	4.2m wide Includes launching/erection equipment
			$122,117	15.24m span	T44	4.2m wide Includes launching/erection equipment
			$145,494	18.29m span	T44	4.2m wide Includes launching/erection equipment
Unibridge	Materiere	N/A	$390,000	34.2m span	T44 and MS1600	Single lane
				22.8m span	T44 and MS1600	Two lane
Panel Bridge	Waagner Biro	N/A		Over 70m span	Bridge Class 1 and MLC 30 -70	Uses truss panels, steel cross girders and steel deck. Extra wide single lane width is 4.2m.

Table 1 – Summary of Emergency Bridging Systems Assessed For Purchase

These alternative systems were considerably more expensive to purchase than the cost to refurbish the existing emergency bridging systems owned by MRWA. Also, the size of crane required to install these bridges would be significantly larger than for the existing emergency bridging systems which was considered a disadvantage particularly for difficult-to-access rural bridges.

However, the Team decided to investigate emergency bridging systems that could provide single spans considerably longer than 21m where access for craneage was not an issue. The Team considered the MRWA' emergency bridging strategy should provide flexibility for bridging systems for small rural roads and for main roads where the use of emergency bridging systems was feasible.

2.6 Options Considered For Longer Single Spans

2.6.1 Materiere Unibridge

In 2013 a bushfire in the Shire of Donnybrook/Balingup destroyed Bridge 3291A on Southampton Road over the Blackwood River (refer to Figure 16). This was a significant bridge approximately 60m in length and provided access for the management of State forest, access for private landowners and formed part of the World Heritage Bibbulmun Track. Following an assessment of options, it was decided to replace the bridge using a Unibridge by Materiere.

Unibridge is constructed from prefabricated girders either 11.4m or 6m in length. They are pinned end-to-end and connected transversely with spacers which allows for the installation of a steel deck with anti-skid coating or a concrete deck in-situ. The prefabricated girders are provided in three different heights (1m, 1.25m and 1.6m) and the span of the bridge dictates which girder to use.

All bridge connections are made with either pins or bolts and there is no need for any welding on site. Unibridge can be transported in standard shipping containers and on conventional trucks and trailers.

The replacement bridge was 57m long, 2 spans, 4.7m wide and supported on reinforced concrete abutments and pier. The main justification for using the Unibridge was the pressure to reinstate a bridge at this crossing within a tight timeframe.

Figure 16 – Bridge 3291A on Southampton Road over the Blackwood River in the Shire of Donnybrook/Balingup destroyed by a bushfire in 2013

The Unibridge was successfully installed within the required timeframe (refer to Figure 17). The Unibridge superstructure took only one week to assemble and place. However, given the length and weight of the steel girders, a 220 tonne crane was required to place the girders (refer to Figure 18).

Figure 17 – Bridge 3291B completed using the Unibridge superstructure

Figure 18 – a 220 tonne crane being used to place the Unibridge steel girders

Given the expense of having Unibridge girders in stock (refer Table 1) and access limitations often encountered when installing an emergency bridging system, the Team decided not to proceed with using the Unibridge as part of the Strategy.

2.6.2 Mabey Compact 200 Bridge

The Mabey Compact 200 bridging system is a larger version of the 1943 Bailey bridging system.

The system uses standard, interchangeable steel components similar to the Bailey bridge. The truss panel are 3.048m long (same as the Bailey bridge) but are 2.234m high enabling longer single spans to be achieved. The minimum requirement of 40m single span would be achievable at higher loading than VSR (i.e. T44). The Team decided to use the Mabey Compact 200 bridging system as it was similar to the Bailey bridge system meaning training of staff in its use would be in line with the training needed for the Bailey bridging system. Also, its modular form lent itself to easy transportation, assembly and placement onsite.

2.7 Adopted Strategy

2.7.1 Emergency Bridging System – Single Span > 21m

Option 2 (Refurbish Bailey bridging system) was the preferred option. Costings for Option 2 are detailed below in Table 2:

Item	Cost Estimate
Structural repair of Bailey bridge components	$200,000 (1)
Sandblasting of some components	$10,000 (2)
Galvanising of some components	$30,000 (3)
Purchase of new decking	$50,000 (4)
Provision of suitable storage facility	$230,000 (5)
TOTAL	**$520,000**

Table 2 – Costings for Preferred Option (Option 2)

Given the historical significance of the SBG bridging system, extensive enquiries were made with a number of organisations, including the Australian Army Museum at Holsworthy in NSW, to gauge whether there was any interest in refurbishing and displaying the bridging system. Given the costs to transport the components interstate and the lack of display space, the Museum declined this proposal.

Contact was also made with the Bunbury RSL Military Collection at the Dardanup Heritage Park and the Collie RSL to see if there was any interest in obtaining the Small Box Girder bridge components. Unfortunately, due to lack of space and funding, these organisations did not take up the opportunity. Accordingly, it was decided to scrap the SBG bridging components.

Local engineering fabrication company Spurling Engineering was engaged to undertake the structural repairs to the Bailey bridging components including arranging the sandblasting and galvanizing of these components. Figure 19 shows a pin hole reamed out so that the pins can be installed correctly. Figure 20 shows a previously damaged gusset plate on a panel having been straighten out.

Where there were insufficient numbers of components, Spurling Engineering fabricated extra components for MRWA (e.g. chord bolts).

Figure 19 – pin hole reamed out

Figure 20 – Panel gusset plate straightened

New decking was purchased from Big River Group. The decking is 170mm thick cross-laminated plywood (“Bridgeply”). These decking panels are 3.048m long to match the length of the truss panels. The panel width is 1.2m and the stress grade is F17. Three panels are used side by side to provide the required deck width (3.6m) and the outer panels have timber kerbs attached. The panels have been designed to support T44 loading (minimum required was VSR) with a maximum span between transoms of 1.5m.

The Team engaged AECOM to design precast concrete abutments and guardrail on the bridge and approaches/departures. At the time of writing this paper, these designs are in progress. However, the early indications are:

- The precast concrete abutments will be designed for a 24.4m long Bailey bridge and are based on a working load of 250kPa to the underside of the footing. The width of the abutment footing will be 1.0m, 0.5m deep and 6m long. No expansion joints will be used and a nominal gap of 15mm between the deck and the abutments will be provided. The abutments will be designed to be lifted by a 20 tonne Franna All Terrain mobile crane.
- Bearings will be fabricated as per the original bearing design (MRWA has no Bailey bridging bearings available). The bearings will sit in a recess in the precast concrete abutments.
- It is envisaged that W-Beams barriers will be clamped onto the side of the Bailey bridge truss panels to act as “rub rails” and should be satisfactory for glancing blows to the barriers as well as reducing the chance of a vehicle snagging on the truss panels and causing significant damage.
- Temporary guardrail will be designed for the approaches/departures. This could use W-beams with extruder end terminations. Alternative, Ironman barriers may be used.

2.7.2 Purchase of an Emergency Bridging System With Longer Single Span

In 2018, MRWA purchased a 40m long Mabey Compact 200 bridging system. In the first instance, it was used on a sidetrack for the replacement of Bridge 0270 on the Boyup Brook Cranbrook Road over Tone River. The 40m configuration used provided a load capacity of 100% T44. Refer to Figure 21 showing the Mabey Compact 200 bridge installed on the side track alongside the original Bridge 0270 which was being demolished.

Figure 21 – 40m long Mabey Compact 200 bridge installed on Boyup Brook Cranbrook Road over Tone River

Further Mabey Compact 200 bridging components have been purchased by MRWA to enable the installation of a 30m long bridge with a load capacity of 100% SM1600.

2.7.3 Training

Training of MRWA staff in assembling/dissembling the Bailey and Mabey Compact 200 bridging systems is a requirement of the Strategy. It is planned to engage SW Engineering Consultants P/L in June 2019 to undertake the necessary training of MRWA staff with the Bailey bridging system. Training for the Mabey Compact 200 bridging system will follow later.

The Bailey bridging system training will include theoretical training and onsite practical training. The theoretical training will help staff understand the function of each component, the correct naming of the components, and how to determine what configurations are required for various spans. To assist in this aspect of the training, it is planned to use a scale model kit from the Army Museum in Holsworthy, NSW. Figure 22 shows some of the scale model components.

The practical aspect of the training will involve the assembly of a Bailey bridge onsite so that staff understand all aspects of transportation, assembly and disassembly.

Figure 22 – Model Bailey Bridge Set Type A

2.7.4 Storage

SW Engineering Consultants P/L provided recommendations on a storage facility for the emergency bridging components.

The storage shed is 60m long by 10m deep comprising six 10m x 10m bays. Refer to Figure 23 for the storage shed layout and Figures 24, 25 and 26 for the complete storage shed and some of the Bailey bridging components stored in the shed. The shed is big enough to house both the Bailey and Mabey Compact 200 bridging systems.

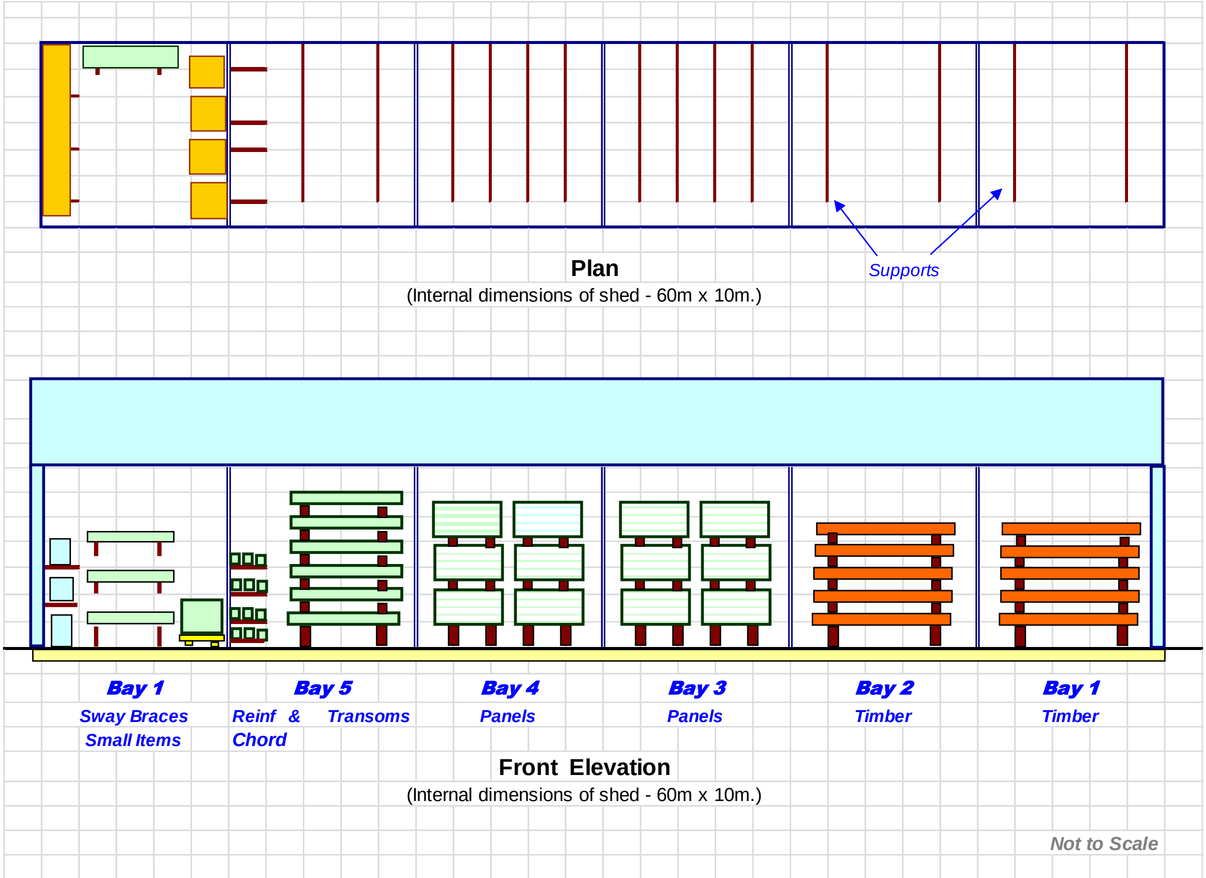

Figure 23 – Storage shed layout

Figure 24 – Completed storage shed for emergency bridging systems

Figure 25 – Bridgeply decking for Bailey bridging system

Figure 26 – Bailey bridge panels stacked on purpose made pallets

2.7.5 Documentation

The original 1944 Bailey Bridge Manual and the Mabey Compact 200 Manual provide guidance on the use of these bridging systems. However, these manuals are quite detailed and cover many aspects that will not be relevant to MRWA (e.g. launching the Bailey bridge – MRWA will place the complete length of the bridge using a crane). It is planned to produce more abbreviated manuals for MRWA staff.

As part of the production of these manuals, general arrangement drawings will be produced including tabulated information on configurations required for various span lengths, installation of abutments, geotechnical considerations and guardrail requirements.

At the time of writing this paper, AECOM is producing load rating tables and general arrangement drawings for the Bailey bridging system.

It is planned to engage SW Engineering Consulting to produce the abbreviated Bailey bridge manual in June 2019.

2.7.6 Other Components of the Strategy

Other contingency options are being explored by the Team including stockpiling of precast concrete beams to enable rapid replacement of small to medium bridges. Also, bridge specific contingency plans are required for larger bridges where the use of emergency bridging is not feasible.

While all bridges are yet to have Asset Management Plans (AMPs) produced, the majority of the large, significant bridges do have AMPs. Section 7.4 of the AMP is a Contingency Plan which includes actions to be taken in the event of closure of the bridge due to accidents, damage and failure. Any available detours are detailed in this section of the AMP. This may include specific Traffic Management Plans.

For dual carriageways where there are pairs of adjacent separate bridges (each carrying a carriageway), MRWA has, in some cases, installed crossovers. In the event that one bridge has to be closed to traffic for repairs, the traffic can be contra-flowed onto the other bridge using the crossovers. Refer to Figure 27 for an example of the use of crossovers on the Forrest Highway. The figure shows the crossover south of Bridge 1272 and 1381 – there is also a crossover to the north of these bridges. These crossovers have already proved to be invaluable for planned repair and maintenance activities.

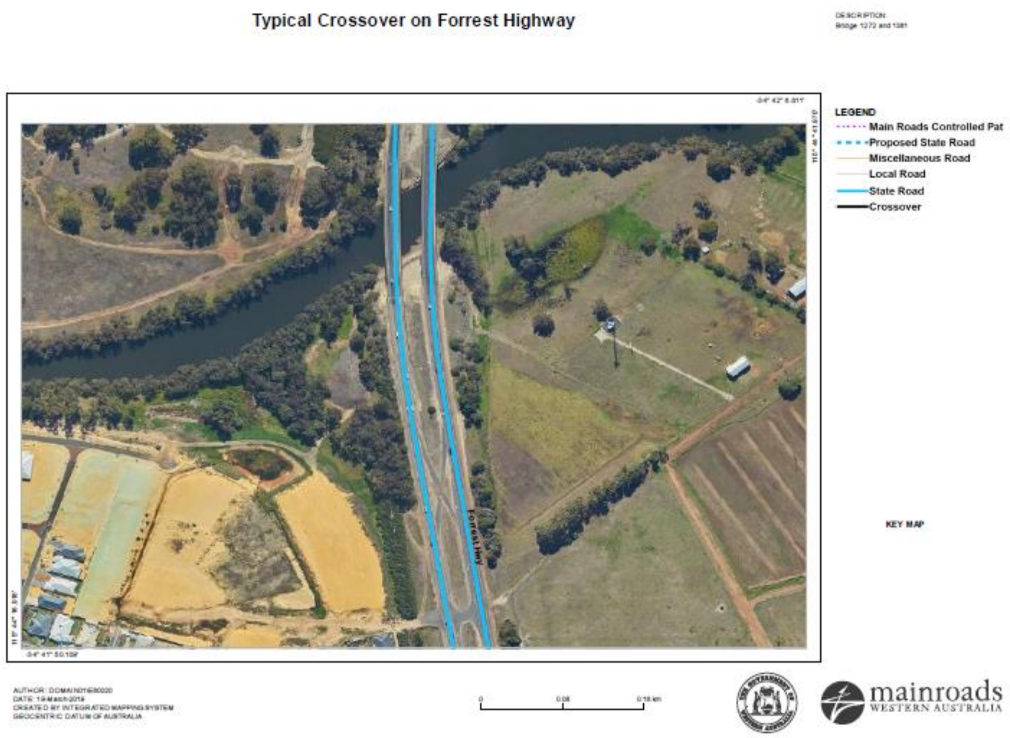

Figure 27 – Typical Crossover For Dual Carriageway

2.7.7 Further Actions Required

There is an expectation that MRWA will make the emergency bridging systems available to other bridge owners (e.g. local government) dealing with the damage or destruction of their bridges. MRWA staff would arrange the transportation, assembly, disassembly and checking of the emergency bridging systems while in use. Consideration could be given to recovering some of the costs associated with refurbishing and purchasing the emergency bridging systems by charging these bridge owners for the time they utilize these systems.

There are a number of Bailey bridges currently installed in various locations in WA as semi-permanent superstructures. Where possible, these superstructures will be removed and the components refurbished and added to the existing inventory of available Bailey bridging components. The superstructures will be replaced with alternatives such as precast concrete beams.

MRWA will need to develop a mechanism to quickly install and remove the Bridgeply deck panels and to attach the panels to the transoms. Through-bolts will be avoided as this can provide a path for moisture ingress which could lead to the early deterioration of the deck panels.

3 CONCLUSION

The adopted Strategy includes of the following items:

1) Refurbishment of an existing Bailey bridging system.
2) Procurement of a Mabey Compact 200 bridging system.
3) Centralisation of these bridging systems at Bunbury in the South West Region including the provision of an appropriate storage facility.
4) Documentation for the management of these emergency bridging systems.
5) Training of MRWA staff in the use of these bridging systems.
6) Development of contingency plans for bridges where the use of emergency bridging systems would not be feasible.

To date, Items 1, 2 and 3 of the Strategy have been put in place. Item 4 is in progress and Item 5 is planned for June 2019. Item 6 is ongoing.

By July 2019, MRWA should be in a position to install an emergency bridging system with a single span over 21m long (e.g. 40m at T44 load capacity) during recovery operations following the loss of, or damage to, a bridge on the road network. Through the ongoing production of contingency plans, other bridges where the use of an emergency bridging system is not feasible, will have detours and traffic management requirements identified in the event of bridge loss or damage.

4 REFERENCES

- Emergency Bridging Check in Western Australia for Main Roads – Western Australia (SW Engineering Consultants P/L dated June 19, 2011)
- Emergency Bridging Check in Western Australia for Main Roads – Western Australia (SW Engineering Consultants P/L dated May 11, 2015)
- Bailey Bridge Manual (1944)
- Bailey Bridging System – Emergency Bridge Replacements (Report Number 60344161 by AECOM dated February 26, 2019)
- Mabey website.
- Unibridge website.

5 ACKNOWLEDGEMENTS

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- Main Roads WA regional staff, Structures Engineering staff and the Crisis and Emergency Management Manager (development and implementation of Emergency Bridging Strategy)
- SW Engineering Consultants P/L (Bailey bridging system condition assessment and training)
- AECOM (Bailey bridging system load rating, design of abutments and guardrail system)
- Spurling Engineering, Bunbury (refurbishment of Bailey bridging system steel components)
- Big River Group (supply of cross-laminated decking panels for Bailey bridging system)

6 AUTHOR BIOGRAPHY

Peter Newhouse (MIEAust CPEng) is Asset Manager Structures with Main Roads WA. Peter has worked in Main Roads WA since 2001. Prior to that, he work in the water industry for 18 years.

While in Main Roads WA, Peter has been responsible for managing bridges on the State and National road network in the South West Region of WA. He has also worked closely with other bridge owners in the Region such as local government, by providing technical advice and programming bridge repairs and refurbishment on their behalf.

Following the outsourcing of all road and bridge maintenance to the private sector by the State Government in 2000, Peter was involved in the re-establishment of a Bridge Maintenance Team that continues to provide specialist preventative maintenance services for timber bridges in the State.

More recently, Peter has lead a team in developing and implementing an emergency bridging strategy for Main Roads WA.