Submission
No 122

INQUIRY INTO WINDSOR BRIDGE REPLACEMENT PROJECT

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SUBMISSION
TO THE
LEGISLATIVE COUNCIL

PORTFOLIO COMMITTEE NO 5 –

INDUSTRY AND TRANSPORT

INQUIRY INTO THE
WINDSOR BRIDGE REPLACEMENT PROJECT

Terms of reference:
The expenditure, performance and effectiveness of the Roads & Maritime Services' Windsor Bridge replacement project, and in particular:

a) the current Windsor Bridge, including its maintenance regime, renovation methods and justification for demolition;

b) the replacement bridge project, including:

i. options presented to the community
ii. post construction strategic outcomes, including traffic benefits, transport and network service capacity
iii. economic, social and heritage impacts
iv. flood immunity benefits
v. project assessment process
vi. planning and procurement strategies and associated project costs
vii. cost benefit analysis process; and

c) any other related matters.

PREFACE

This submission argues for the retention of the historic bridge over the Hawkesbury River at Windsor to serve local traffic and for the construction of a by-pass for heavy traffic and for traffic not intending to visit Windsor. It is the undeniable view of the Windsor community that the historic area of Windsor, known as Thompson Square, be preserved in its present state and that the existing bridge be retained as a working structure.

The submission has been prepared by two retired NSW Government Chief Bridge Engineers, Brian Pearson and Ray Wedgwood. Since the first road authority for New South Wales – the Department of Main Roads – was established about 1927 there have been eight chief bridge engineers. The position and title was abolished when the organisational structure was changed from pyramidal, governed by a Commissioner, to flat, controlled by directors and a CEO[1].

The Chief Bridge Engineer was responsible for the location, investigation, design, construction, maintenance and management of road bridges. Four of the chief bridge engineers were ranked as 'Chief Engineers' to be on a level with the Chief Engineer (Roads) in the DMR organisation. With the change in organisational structure to control by directors the position of chief bridge engineer was downgraded and the bridgework for the new organisation was distributed among consultants. Hence the in-house expertise was largely replaced by outside consultancies. Without in-house expertise an authority is dependent on its chosen consultants offering the most appropriate solution to the conditions of engagement – but such is not always the case in practice.

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Sydney, January 2018

[1] *This change commenced with the transition from DMR to RTA and continued with the transition to RMS.*

1. THE WINDSOR BRIDGE

The Windsor Bridge construction commenced in 1873 by contractors Turnbull and Dickson to replace a ferry. It was of timber superstructure on a substantial substructure comprising two metal cylinders per pier taken into bedrock. This was in an era when government policy was to use steel/metal for railway bridges and timber for road bridges, so the use of metal foundations significantly emphasizes the importance of the Windsor site. The length of the bridge was 468 feet, made up of 11 equal spans of 42ft 6in.

The pier cylinders were apparently sunk using the caisson technique, with air locks being mentioned in contemporary news articles. It is believed that construction of this type was a very early example of the use of caissons in NSW.

In 1897 the deck was raised eight feet by adding another cylinder to each of the cast iron piers. Some of the decayed timbers in the superstructure were replaced from time to time as part of routine maintenance.

A decision was made in 1919 to replace the timber superstructure with concrete. To maintain traffic flow on the bridge during reconstruction the new reinforced concrete beams were cast on the river bank by the contractor, State Monier Pipe and Reinforced Concrete Works, under the supervision of its engineering manager, Mr G W Mitchell. The design was unique. There were seven beams in each span and the central beam was split to allow traffic to use half the bridge width – a single lane – during reconstruction. It is our belief that this was the first use of precast concrete beams for an Australian road bridge.

The Chief Engineer of the Public Works Department at the opening ceremony in January 1922, Mr Percy Allan[2], attributed the design of the reinforced concrete beams to Mitchell. It is significant that the bridge has never been subjected to a load limit during the period from 1922 to the present, notwithstanding that the design loading in 1922 was for a tractor weighing only 16 tons. However, Allan was aware of a major increase in design loading being proposed by the State Road Authorities and suggested Mitchell adopt that loading. Subsequently, there has been an almost four-fold increase in bridge design loads over almost a century since the deck was designed. The relatively short span length of 42.5ft means that the individual spans can never be overloaded by a multi-axle semitrailer or a B-Double truck, because the vehicle axle spacings are too large.

Recently, the authors of this submission independently checked the design strength of the beams and concluded that the beams have a substantial reserve of strength,

[2] *Percy Allan was a bridge designer of great renown. He was responsible for Pyrmont and Glebe Island Bridges, Tom Uglys Bridge and numerous timber truss bridges, of which the majority were known as "Allan Trusses". He was also a mentor of J J C Bradfield of Sydney Harbour Bridge fame. There is no doubt that he would have either suggested the use of a precast beam to Mitchell and/or checked the completed design before he authorised commencement of construction.*

sufficient to carry all current legal loadings without a need for the imposition of a limit for heavy vehicles.

The Windsor Bridge was constructed with a deck width of 20ft (6.1m). Although this width has been criticised by authorities as being inadequate it has not resulted in any serious accidents to our knowledge. The only recorded fatal accidents were in 1980 and 1986. In 1980 a driver crashed through the collapsible handrail into the Hawkesbury River resulting the death of a passenger. A crash barrier was installed later in 1980 when the footway was constructed. In 1986 a pedestrian fell from the bridge and died from his injuries.

A schedule extracted from BIOSIS RESEARCH of November 2012 (Table 4, page 145) detailing the history of improvements to the bridge since construction is at **Attachment A**.

For photographs showing the condition of the existing bridge see **Attachment B**.

Extract from contemporary Scientific American about constructing caissons under compressed air.

While the compressed air thus drives the water of the quicksand out of the shaft, it is said to infuse at the same time such energy into the miners that they can easily excavate double the work, without fatigue, which they could perform in the open air. Upon many of them the first sensations are painful, especially upon the ears and eyes; but they rapidly get accustomed to the bracing element. It is even said that old asthmatic men here become effective workmen, deaf persons recover their hearing, while others are sensitive to the slightest whisper. Much annoyance was at first experienced by the rapid combustion of the candles, but this was obviated by the substitution of flax for cotton wicks.

2. THE HAWKESBURY BASIN

For many years the Hawkesbury basin was Sydney's food bowl. Produce was taken by punt across the river to Windsor and transported by horse and buggy along Windsor Road to the Sydney markets or alternatively delivered via water (down the Hawkesbury to Broken Bay, out to sea, then back up Sydney Harbour). When the river flooded, however, the supply of produce was interrupted. With major floods the interruption was lengthy because of the inability of the basin to drain quickly (see **Attachment C**). Obstruction was due to a combination of Hawkesbury tides, discharge from downstream rivers and creeks, siltation, and natural phenomena known as "chokes".

The largest "choke" is in the Sackville Gorge and the obstruction is on the Ebenezer side of the Gorge (see **Attachment D**). It has been calculated that a quantity of 60,000 cubic metres of rock would need to be removed above normal water level to remove this obstruction (5 metres high by 50 metres across by150 metres long). The cost of this activity has not been estimated and would be influenced by the market value of the rock.

Free flow of floodwaters would also be resisted by tidal effects in the river, by sand deposition and by simultaneous flooding of downstream tributaries. It might be assumed that free flow would be available for approximately half of each 24 hour period (tidal effects). Extensive modeling would be required for a more accurate determination, if considered necessary. Further improvement for additional free flow would involve the dredging of the sand deposits on the river bed.

Some years ago the government expressed interest in raising the Warragamba Dam wall. Raising the wall by 23 metres could result in a lower flood level at Windsor Bridge by about five metres in an event equivalent to the once in 200 years flood.

Historically, flooding of the Hawkesbury basin has been of major duration, high intensity and slow draining.

The ten major floods recorded at Windsor to date were registered as follows:

Year	Flood Level (metres)
1867	19.7
1864	15.1
1961	15.0
1964	14.8
1900	14.5
1978	14.5
1870	14.1
1986	13.8
1879	13.6
1970	13.5

Four of the maximum floods occurred in the 19th century and the remaining six in the 20th century. None has occurred in the present century – at least not to date.

For the Windsor Bridge site the following data has been determined:

5 year	ARI (Average Return Interval)	RL* 11.04 AHD (Aust Height Datum)
10 year	ARI	RL 13.61 AHD
100 year	ARI	RL 17.29 AHD

* RL means Reduced Level in surveying terms

In effect, the maximum recorded flood level at Windsor is RL 19.7 (1867), so the 100 year theoretical level of RL 17.3 was reached in that flood. The deck level of the bridge at Windsor is RL 7.0 AHD. This is equivalent to a once in two year frequency.

At a level of about RL 9.8 AHD, the Hawkesbury River breaks its bank at Cordners Corner, between Freemans Reach and Argyle Reach, some three kilometres upstream from Windsor on the Freemans Reach Road. This results in "The Breakaway", a major flood flow, which rejoins the river downstream between Windsor and Wilberforce (see Attachment E). Approximately 80% of flood flow discharges across "The Breakaway", the effect of which is to reduce the flow volume downstream from "The Breakaway" at Windsor. This in turn reduces the quantity of flood debris flowing down the river between "The Breakaway" and Windsor. For any new bridge constructed between "The Breakaway" and Windsor, while the flood level would not change, the possibility of damage from flow forces and debris is considerably reduced, particularly if the new bridge is located upstream of the Rickabys Creek junction.

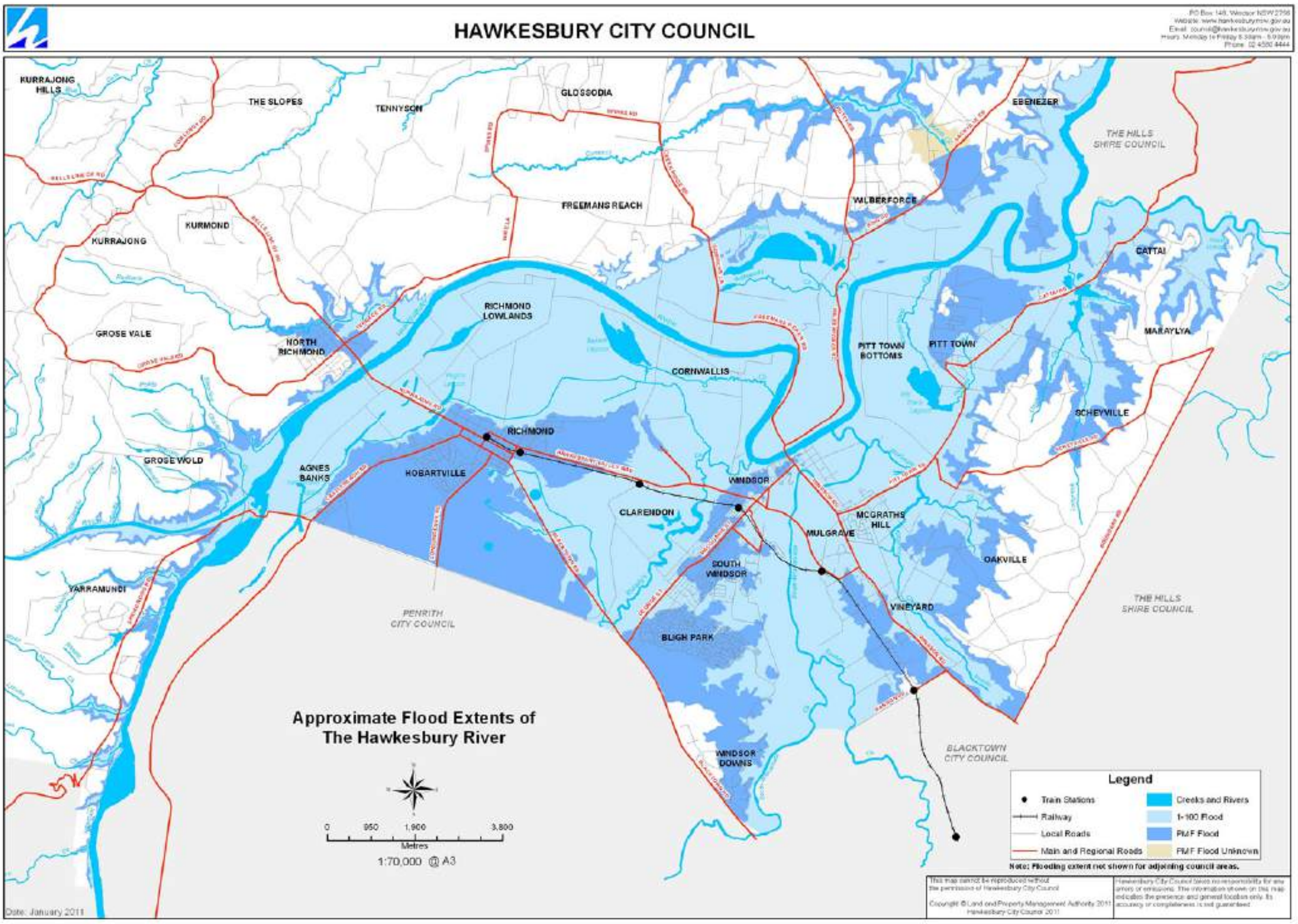
To improve the situation for traffic during local flooding, a bridge was constructed recently across the South Creek floodplain upstream from Windsor Road between Windsor and McGraths Hill, which is prone to flooding. This Jim Anderson Bridge links Hawkesbury Valley Way/George Street to Windsor Road east of McGraths Hill. This structure is part of The Hawkesbury Valley Flood Evacuation Route (see **Attachment F**). The deck level of this bridge is RL 17.1 AHD.

Recent investigations for the Hawkesbury-Nepean Valley Flood Risk Management Strategy, prepared by Infrastructure NSW (*Resilient Valley, Resilient Communities- January 2017)* have determined that the most suitable scheme for reducing flood damage, but not eliminating it, is to raise the wall of Warragamba Dam by 14 metres, at a cost of $600m, with net benefits of $170m. This raising is to provide increased freeboard, not additional water supply.

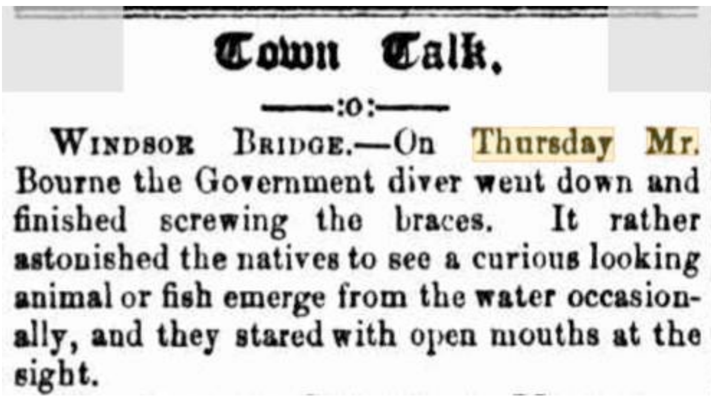
Other options investigated included lowering the water supply level of Warragamba Dam, dredging the Hawkesbury, constructing diversion channels downstream to reduce the length of river channel, removing significant "chokes" and upgrading of major regional roads (see **Attachments G & H**). None of these options was considered appropriate, because they resulted in lower or negative net benefits.

This Flood Strategy study has developed nine outcomes to be delivered (**Attachment I**). Outcome 8 requires "adequate local roads for evacuation". The Windsor Bypass proposed by this submission perfectly matches Outcome 8.

Map Showing Approximate Flood Extents of The Hawkesbury River



Extract from local paper 23 May 1874



Town Talk.

—:o:—

WINDSOR BRIDGE.—On Thursday Mr. Bourne the Government diver went down and finished screwing the braces. It rather astonished the natives to see a curious looking animal or fish emerge from the water occasionally, and they stared with open mouths at the sight.

3. THE RMS PROPOSALS

The two authors of this submission were instrumental in the initial setting up and co-ordination of the National Trust / DMR Liaison Committee for bridge heritage matters in the late 1970s. That Committee has metamorphosed into the current RMS Heritage Committee with its wider view of all heritage aspects of RMS projects and representation by other heritage organisations. The authors were invited to be ex-officio members of this Committee.

Early in year 2011 the RMS Heritage Committee was presented with an RMS proposal to demolish the existing Windsor Bridge and replace this structure by one of nine alternatives. Eight of these alternatives were located at Windsor while the remaining one was located downstream near Wilberforce (see **Attachment J**).

Because no proposal was located upstream to link to the Hawkesbury Valley Flood Evacuation Route, we questioned the RMS members of the Committee as to the reason for this omission. No member of the Committee could offer a reasonable explanation.

We decided that we would independently visit the area, investigate thoroughly all nine proposals and then, if all were found unsatisfactory in our opinion, we would investigate the upstream topography to determine whether a suitable site could be found for a bridge crossing of the river with a connection to the Flood Evacuation Route.

We believe that with our combined period of 80 years in the planning, location, design, construction, maintenance and management of bridges, our experience was unrivalled for such an investigation to be undertaken.

We found that all nine RMS proposals are unsatisfactory. Each of the seven proposals for new bridge structures at Windsor would eventually feed 26,000 vehicles daily through the town, creating an unworkable situation with the town drowned in vehicles. RMS option 6 would require a crossing of South Creek larger than the present Fitzroy crossing.

The Wilberforce proposal was described in the EIS in the following terms:

> **Option 8 – New bridge at Pitt Town Bottoms (Wilberforce)**
>
> Option 8 would involve replacing the existing bridge with a new bridge located at Pitt Town Bottoms and connecting to Wilberforce, about six kilometres downstream of the existing bridge. There would be no bridge crossing of the Hawkesbury River at Windsor if this option was implemented.
>
> From the southern approach, traffic would be diverted down Pitt Town Road at its intersection with Windsor Road and would travel along Pitt Town Road onto Bathurst Street and Punt Road. A new viaduct or low embankment would be provided to extend Punt Road across Bardenarang Creek and the adjacent

Hawkesbury River flood plain. On the northern bank of the Hawkesbury River, the bridge would intersect with King Road at a T-intersection. Traffic would turn left (westbound) into King Road and intersect with Wilberforce/Singleton Road at the existing T-intersection at Wilberforce. The new bridge would not provide pedestrian access given the isolation of the crossing from populated areas.

Option 8 meets some of the project objectives and criteria, including providing improved flood immunity and minimizing impacts on historic heritage in Windsor. This option does not meet some key project objectives and criteria including:

- Providing an efficient connection for local traffic – This option would remove the historical direct link between the southern and northern sides of the river at Windsor and result in a nine kilometre detour of the Windsor township. This would have adverse effects on local residents and businesses, as well as significantly changing the character of Windsor.
- Impacts on recreational areas – Establishment of new in-water structures (bridge pylons) in a part of the river used extensively by recreational boaters for high speed water skiing activities.
- Impacts on heritage – heritage vistas and historic heritage items in the Pitt Town area would be impacted. The location also has significance as place of contact between the Aboriginal community and European explorers.
- Cost effective and affordable outcomes – This would be the most expensive option with a capital cost of about three times that of options 1 and 2. It would far exceed the budget allocated to the project and would not provide value for money.

A major disadvantage of this downstream proposal would be that it would be subject to the full stream flow forces, being downstream from where the “Breakaway” rejoins the river.

A more convenient crossing of the river downstream, as proposed by some locals, is illustrated in **Attachment K**. This crossing would be located about 1.8 km from the historic bridge at a bend in the Wilberforce Road, but upstream from the effects of the “Breakaway”. It could link with Pitt Town Bottoms Road (south) and Pitt Town Road to carry traffic to McGraths Hill. The advantage of this road over RMS Option 8 is that it does not require another bridge crossing of Bardenarang Creek.

We believe that the existing bridge at Windsor should be retained for local traffic if this crossing is considered as an alternative to the RMS Wilberforce crossing.

Any new crossing of the Hawkesbury River would be subject to the requirements of the *Roads Act 1993*, the pertinent section of which states:

Roads authorities may construct bridges and tunnels
78. (1) A roads authority may construct bridges and tunnels across navigable waters.
(2) A bridge or tunnel that is constructed across navigable waters is taken to be a lawful obstruction to these waters.
(3) Subsection (2) does not limit any person’s right of action with respect to loss or damage arising from the construction of the bridge or tunnel, but any such right of action is subject to the other provisions of the Division.

> **Notice of proposal to be given**
> **79. (1)** Before constructing a bridge or tunnel across navigable waters, the roads authority may cause notice of the proposal to be published in a local newspaper.

In effect, a road authority cannot construct a bridge across a navigable waterway that would hinder or prevent the continuing entitlement and enjoyment of vessels already using the waterway. This requirement could result in a long clear bridge span for the river downstream from Windsor.

RMS action

The next move by RMS was to announce that their Approved Option 1 is to build a new two lane bridge (but wide enough for three lanes eventually) approximately 35m downstream of the existing historic bridge, followed by demolition of the existing bridge. Not only would the community lose its much-loved historic bridge but its even more historic Thompson Square – the oldest town square in Australia – would be ruined by the construction of a three lane approach road passing through one corner.

The community dispatched a petition with 11,000 signatures in protest to the State Government. The result was negative. The Government was adamant – the project would proceed with the RMS scheme. In the writers' view, the remaining eight proposals from RMS appeared to be a planned diversionary tactic.

Not only will RMS be eliminating two of the principal heritage components of Windsor – a Macquarie town – but it will direct 26,000 vehicles a day through the town, ultimately destroying the town.

> *Andrew Thompson* (1773 - 1810)
>
> *"CONVICT, ENTREPRENEUR, ADMINISTRATOR, CONSTABLE, FARMER, SHIP BUILDER, BREWER, PUBLICAN, INVENTOR, SMUGGLER, FLOOD HERO, BRIDGE BUILDER, SALT MANUFACTURER, MAGISTRATE & PHILANTHROPIST"*
>
> Source: CAWB Website: http://www.cawb.com.au/andrew-thompson.html

4. THE WRITERS' PROPOSAL – RETAIN THE EXISTING BRIDGE WITH UPSTREAM BY-PASS

A. Existing Bridge

The writers' proposal is to retain the historic bridge but with a load limit to control the number of vehicles entering the town to about 10,000 per day. Such a load limit would be determined by a traffic expert; we believe it would be about 15 -20 tonnes to allow essential vehicles, such as police vehicles, ambulances, fire trucks and school buses for instance.

Remaining vehicles up to the legal limit would use the by-pass route. This would be particularly useful in times of flood in the river of sufficient height to overtop the existing historic bridge but not the by-pass route.

During our site visits we had the opportunity to inspect the existing bridge from water level and to note specific treatments required to restore the bridge to "as new" condition while under traffic as outlined hereunder.

The greater portion of cosmetic repairs proposed for the historic bridge could be undertaken under traffic because they are required below deck level. One or two repairs/improvements could await the construction of the by-pass, which would then allow the closure of the historic bridge for the purpose of, say, adding an upstream footway and collapsible railing. With a longer closure, if required, it would be possible to raise the deck of the existing bridge to a similar level to RMS Option 1. The mass of a span is about 100 tonnes.

All parties have agreed on the repair work required on the historic bridge, including Mr Peter Stuart, a well-known structural engineer engaged by NSW Department of Planning and Infrastructure. The main areas requiring attention are:

1. the bottom outer corners and soffits of the upstream and downstream outer girders have small areas of exposed reinforcement;
2. the diaphragms installed during the raising of the deck by 8 feet have areas of exposed reinforcement and damaged concrete. (For both items 1 and 2, repairs can be effected by high pressure water blasting to clean the concrete followed by replacement of concrete);
3. the piers' cast iron cylinders are exhibiting a small degree of graphitization, as described in the consultant CTI's report of July 2011 (graphitization is a phenomenon that occurs in cast iron sewer pipes at elevated temperatures); and
4. the piers show some cracking of welds.

We propose that these matters receive attention as noted hereunder from barges located beneath the deck, to minimise disruption to traffic on the bridge deck.

Apply high pressure water blasting to the deteriorated concrete from the underside of the superstructure, inspecting, cleaning and replacing reinforcement where required, replacing the removed concrete by a shot-creting process and sealing with a sealant to enhance the impermeability of the concrete. When a similar process was carried out for the Swansea Bridge at the Entrance to Lake Macquarie it is understood that the working area was enclosed by drop sheets hanging from the sides of the girders with a lower heavy duty sheet to catch the blasted concrete by-products.

If it is required that additional reinforcement be added to the cross section for increased strength and rigidity, this can be achieved by bonding carbon fibre strips to the repaired concrete face.

Supplement the deteriorated cast iron cylinders by attaching pairs of semi-circular steel plates around the existing cylinders and by bolting against packing rings to achieve a friction connection between the new steel plates and the cast iron cylinders over the depth of the cast iron deterioration.

The cracks in the cast iron cylinders can be held by placing steel bands around the cylinders enclosing the cracks.

When repaired with respect to the above items the Windsor Bridge will be capable of withstanding the Bending Moment and Shear effects from various actual and design truck loads as follows (checked independently by the authors):

TABLE: Stresses caused by various load combinations and design philosophies

Loading	Max Bending Moment Stresses Reinforcement $\mathbf{f_s}$ psi (lb/sqin)	Max Bending Moment Stresses Concrete $\mathbf{f_c}$ psi (lb/sqin)	Max Shear Reinforcement Stresses $\mathbf{f_s}$ psi (lb/sqin)
Windsor Bridge allowable stresses	**18,000**	**900**	**18,000**
MS18 design load (pre-1992 design Code)	**16,350**	**736**	**17,200**
44.5 tonne semi-trailer (legal)	**16,860**	**759**	**18,500** (3% over)
62.5 tonne B-Double (legal)	**15,159**	**682**	**16,390**
T44 design load (1992 – 2004 Code)	**19,125** (6% over)	**861**	**20,599** (14% over)
M1600 (post 2004 Code)	**21,711** (20% over)	**977** (9% over)	**25,701** (43% over)

The above stresses have been calculated using Working Stress Design Principles as would have been used at the time of design in the 1920s. However, current Design Codes allow Limits States Design Principles to be used, which results in lower design forces and stresses because of a rationalisation of safety factors for Dead Loads and Live Loads, as follows:

Loading	Max Bending Moment Stresses Reinforcement f_s psi (lb/sqin)	Max Bending Moment Stresses Concrete f_c psi (lb/sqin)	Max Shear Reinforcement Stresses f_s psi (lb/sqin)
T44 design load (1992-2004 Code)	**14,930**	**672**	**17,626**
M1600 (post 2004 Code)	**17,258**	**777**	**22,090** (23% over)

Notes: For the above Table f_s means stress in steel reinforcement, f_c means stress in concrete.
The effects of a B-Double Truck are less than the effects from a semi-trailer because of the short span of 13m.
The B-Double effects become dominant above 26m spans (for simply supported spans).

The scheduled figures above demonstrate that the reinforced concrete superstructure of the existing Windsor Bridge, when repaired, will have more than adequate capacity to continue to carry legal loads well into the future. Even for the M1600 load, for which modern bridges are now being designed to allow for a future increase in legal load, the over stress will not be catastrophic.

In summary, our proposed renovation of Windsor Bridge would:

- see the bridge able to safely carry full loads well into the future;
- continue to allow for its use as a Higher Mass Limit Vehicle RAV Route; and
- could be achieved for the same cost as for its demolition.

Despite this, proponents in favour of RMS Option 1 continue to make uninformed noise about the width of Windsor Bridge. Once again this is an issue that does not withstand reasonable scrutiny and the following lane width comparisons are enlightening:

Windsor Bridge	**3.0m**
Victoria Road	**2.6 - 2.9m**
Buttsworth Crk Bridge (next bridge on Putty Rd after Windsor)	**2.7m**
Sydney Harbour Bridge	**2.8m**
Parramatta Road	**2.8m**
Anzac Bridge	**3.0m**
Gladesville Bridge	**3.0m**
F3 Hawkesbury Bridge	**3.0m**
Windsor Road	**3.0m**

Whilst Windsor Bridge, like sections of Parramatta Road and Victoria Road, has no median strip, the Bridge has wider lanes than either of these roads. It is also worth noting that with a width of 2.8m Parramatta Road is a Class 2 Heavy Vehicle Route, carrying four times as much traffic as Windsor Bridge on a road with smaller lanes, no shoulders and no median strip.

Curiously, all Class 2 heavy vehicles that cross Windsor Bridge heading north towards Putty must then cross a second bridge over Butterworth Creek, which is not scheduled for demolition despite its lanes being 10% narrower than those of Windsor Bridge and, while all these roads and bridges are 'functioning' on a daily basis, not one achieves the Australian Standard, which calls for a lane width of 3.5 metres.

The RMS also promotes demolition and replacement of this historic bridge on the basis of engineering and road safety standards (EIS Volume 1, page xii), a position that also fails to withstand reasonable scrutiny.

This argument deliberately confuses technical standards with functionality and reeks of applied discrimination. Whilst the RMS can create increasingly demanding and stringent new 'standards' to apply to the entire NSW road network and thus, Windsor Bridge, *there is a functional reality that calls into question the validity of, or need, to apply such new and demanding 'standards' to one historic bridge.*

The RMS approach to improving the structural capacity of the existing bridge was to incorporate additional steel girders between each concrete girder to share some of the increased loading on the deck (SM 1600 Load). The installation and support of these steel girders would be quite complicated, although not so complicated as to justify the $18.5M estimate of cost.

In fact, elsewhere in the EIS the Standards argument is challenged by the RMS' own project Alternatives (EIS Vol 1, page 30), which includes an option to refurbish the Bridge, "... to meet current design standards where possible". So, “where possible” is an acceptable measure for the RMS to apply, should it choose to.

In March 2008, with RTA Officers in attendance, a test was conducted on the functionality of the Bridge. A bus and a B-Double truck passed each other on the bridge. Clearances were noted. The RTA Officer stated:

> *Both vehicles passed without incident and the B-Double was able to remain within its lane during the crossing. Windsor Bridge was constructed in 1874 and although it represents an ageing asset, it continues to perform adequately* (Gazette, page 1, March 19, 2008, see Attachment C)

In the last 4-5 years nothing has changed; heavy vehicles can still pass each other on the bridge without incident and B-Double trucks continue to be able to cross the bridge while remaining wholly within their lane.

More importantly and more recently, Windsor Bridge in its existing current condition is cleared to carry unrestricted loads. (Duncan Gay, 2012 Budget Estimates Transcript Page 19). The Minister's statement is supported by relevant RMS documents including the RMS Travel Restriction Vehicle Routes, Sydney , Map A; Class 2 B-Double Notice App 1; RMS Interactive RAV. (http://www.rta.nsw.gov.au/heavyvehicles/ravmap/).

So Windsor Bridge can carry the loads, meaning unrestricted access for all legal vehicles. This is no different from many other RMS assets across NSW that are accepted as functional and fit for purpose. In fact nothing has physically changed that warrants the demolition of Windsor Bridge:

- The heavy vehicles that use Windsor Bridge have not increased in width (ADR 43/04, 2006).
- It is reasonably evident that Windsor Bridge has not become more narrow.
- Classification 9 semi-trailers have been passing each other while crossing Windsor Bridge for 40 odd years.

Disingenuous rhetoric seems to abound in RMS documents. In justifying the demolition of the existing asset the EIS (Vol 1, Table 11.2, page 458) states that:

> *The replacement bridge would have a load capacity to meet current load* ***standards.***

However, the statement can be seen for the meaningless verbiage it is when one considers the existing bridge is currently carrying unrestricted loads, regardless of standards. The NSW Roads Minister confirmed this himself in response to a question asked by the Hon Penny Sharpe in the 2012 Estimates Hearings (2012 Budget Estimates Transcript page 19).

The question that remains unanswered is, if the bridge is in such poor condition, why are there no load limits currently imposed? More to the point: why has the load limit actually increased since the bridge condition assessment was formally updated on the *Heritage Register* to 'poor' in 2009?[3]

In fact, in 2008 the load on the bridge was **50t** (a 19m B-Double)[4]. Despite the condition assessment being updated to 'poor' in 2009, in 2011 the maximum load on the bridge was **62t** (25m B-Double)[5]. In 2012 the maximum load on the bridge was **68t** (25m B-Double, Livestock)[6].

These loadings would appear consistent with advice contained in the Inspection and Structural Assessment Report – Windsor Bridge (15 April 2011, Access UTS), (Vol 1, Appendix C, UTS Report, page 6), which says, in part, "*the bridge in its present condition and loading will be safe for some time".*

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[3] http://www.environment.nsw.gov.au/heritageapp/ViewHeritageItemDetails.aspx?ID=4309589

[4] Operating Conditions: Specific Permits for Oversize and Overmass Vehicles" RTA, ISBN 9781921242045, page 27

[5] Class 2 B-Double Notice, Appendix 1, 20-5-2011, page 2

[6] Duncan Gay media release 10 October 2012

It is quite clear that despite the hysterical rhetoric from a small group of pro-Option 1 commentators, Windsor Bridge is not in danger of collapse. It has no load limit applied to it. Indeed even in its current 'poor' condition, testing shows it is strong enough to be a recognized Restricted Access Vehicle Route.

As shown in the analysis of the bridge deck by Brian Pearson and Ray Wedgwood the existing bridge, when renovated, will have a load capacity capable of exceeding the requirements of the T44 Design Load (1992 Austroads Bridge Design Code). It will be able to carry legal loads well into the future.

Photographs showing exposed and corroded reinforcement in outer girders and diaphragm blemishes (Items 1 and 2 above) are shown at **Attachment B**.

B. Upstream by-pass

We identified two possible upstream routes that would feed traffic to Hawkesbury Valley Way (The Flood Evacuation Route) (see **Attachment L**). These two upstream routes require a main bridge crossing of the river upstream from the junction with Rickabys Creek along the western edge of Deerubbin Park, with a possible bridge over Cornwallis Road and bridge crossing of Rickabys Creek, with a line connecting to Richmond Road skirting the Barracks Golf Course (either at the eastern or western extremity). For the eastern extremity route, adjacent to the motel car park, access to the motel golf course would be provided by a low clearance structure.

At the northern end either line would commence from the intersection of Wilberforce Road and Freemans Reach Road, with one alternative going through Macquarie Park, behind the kiosk and toilets; the other would go back up Freemans Reach Road for approximately 300m before turning south and going through the paddocks to meet at a the same main bridge site as for the first alternative.

This bridge site has the shortest water crossing length.

We propose a deck level for the bridge spanning the river of RL 11.0 AHD with the approaches to be lower at the same level as the level of the low points on Wilberforce and Freemans Reach Roads (about RL 9.8 AHD). The opportunity exists to subsequently raise the approaches to RL 11.0 AHD. This level represents a flood frequency of once in five years. This bridge will have a two lane carriageway and a downstream footway provided.

For both these options it is suggested that traffic modeling be carried out to see whether extra lanes will be required between the intersection with Hawkesbury Valley Way and George St during flood evacuations.

This additional local road would be a further welcome addition to meet the requirements of Outcome 8 of the Infrastructure NSW report *Resilient Valley,* *Resilient Communities: Hawkesbury-Nepean Valley Flood Risk Management Strategy:* January 2017.

After detailed consideration of all aspects, our strong recommendations are to:

a) restore the existing bridge under traffic; and
b) construct an upstream bypass as described above.

Extract from CAWB website
"In the beginning – From a Bridge Street Point of View"

Thompson's Store must have been a Mecca for all the inhabitants of Windsor and the surrounding Hawkesbury. Just as many now-days make their way to Bunnings at McGrath's Hill to get "just about everything useful", so they made their way to Bell Post Square for the same reason. They came by boat or horse or on foot for the necessary things to make their farm work and house keeping more efficient and comfortable.

About 10 months before his death, Thompson had so many ventures and interests in hand, that he found it too difficult to run his store. Also, his health was failing badly. So, he appears to have handed over the running, at least in part, of his store to his trusted clerk, John Howe. The following Advertisement in the Sydney Gazette, Dec. 3rd, 1809 gives us a peak into a "Bunnings"/department store of the early Hawkesbury...even some of the language is the same.......

"John Howe begs leave to inform the public that he keeps and carries on the extension house and business of Mr Andrew Thompson, at the Green Hills Hawkesbury, with every respectful attention, and has now on sale a valuable assortment of Woollen and Linen Drapery, Haberdashery, Hosiery, Stationery, Grocery, Drugs, Cutlery, Ironmongery, Saddlery, Chaise, Cart and other harness in sets or otherwise, Men and Women's Shoes, Shoemaker's Tools, Dressed Leather of all kinds, Salt, Pitch and Tar, Large Brass locks, Copper, Copper Pump Works, Leaden Pipes, and other Brewing Utensils, with a variety of other Goods of the best quality and at the most reduced prices, for ready payment only. All persons indebted to A. Thompson are requested to make good their payments without delay."

5. TRAFFIC FLOW AND BY-PASS PROPOSAL

A traffic report of 14 December 2012 by Christopher Hallam and Associates provides the following information:

Benefit-Cost Ratio

The question of the benefit-cost ratio of the bridge proposal appears to be a movable feast. The August 2011 report *Windsor Bridge over the Hawkesbury River – Traffic modeling and evaluation of options – preliminary report* quotes a benefit-cost ratio of Option 1 of 4.5, assuming a capital cost of $45.4M. However on page 26 of the EIS, for a capital cost of $46.36M, the benefit-cost ratio is stated to be 14.6. In the earlier assessment, the benefits were reduced travel costs (travel time and vehicle operating costs). The EIS assessment included "external savings" and "safety benefits". However looking at Table 3.5, these make up less than 1% of the total benefits, and hence do not explain the difference.

Returning to the economic analysis results set out in Table 3.5 of the EIS, almost all of the benefits would also accrue if the ancillary intersection works at Bridge Street/George Street and Bridge Street/Freemans Reach Road/Wilberforce Road were constructed without the new bridge. The resulting benefit-cost ratio from the above noted actions would be very substantial. Without a cost breakdown of the elements of the project, the actual figure is difficult to calculate. Funds could also be put aside for repairs to the existing Windsor Bridge, and the benefit-cost ratio would still be significantly higher than any figure for Option1.

Rickabys Line Option

While previous studies identified Option 1 as the preferred option, are there any other options that could achieve the road network objectives and at the same time preserve and improve the heritage importance of Thompson Square? The community group Community Action for Windsor Bridge [CAWB] has identified an alternative route option that travels through Macquarie Park, over the river and Rickabys Creek and joins Hawkesbury Valley Way between the Sebel Resort and the RAAF Base. This option is briefly reviewed on page 46 of the EIS. The EIS comments:

> *While this third Hawkesbury Valley Way option would meet project objectives for heritage and safety, it is anticipated to only partially meet the traffic objectives unless a number of additional significant improvements were made to the surrounding traffic network.*

The CAWB option was developed as a heavy vehicle bypass of Windsor town centre, and would proceed in association with the retention of the existing Windsor Bridge, with the latter restricted to light traffic only, with a load limit. If remedial works were required, even with this weight restriction, then that would be a cost to the project. As a light traffic route, the accessibility of Windsor town centre is retained for local businesses, and pedestrian and cycle routes are maintained.

Benefits of Rickabys Line Option
The primary benefit is the reduced traffic impact on Thompson Square, which is very important from a heritage perspective. Other benefits include:

- Regional traffic is directed onto Hawkesbury Valley Way and hence onto the flood free route across South Creek (Jim Anderson Bridge), or to Macquarie Street West;
- An additional bridge over the Hawkesbury River would be provided;
- The reduction in traffic using Windsor Bridge would reduce traffic delays through the Bridge Street/George Street and Bridge Street/Macquarie Street intersections. The latter intersection was identified in the EIS as an intersection of concern;
- Reduced traffic along Macquarie Street would reduce traffic delays along its intersections and reduce traffic noise;
- The EIS identified traffic noise concerns at some properties fronting Thompson Square. The removal of heavy traffic would provide significant reductions in traffic noise. While the EIS was deficient in not addressing traffic noise at all properties on Thompson Square, ignoring non-residential properties, impacts at commercial buildings are also relevant, particularly "commercial" buildings with residential uses. With residential properties R1-R4 on Figure 7.30 of the EIS, the removal of heavy vehicles might achieve compliance with Road Noise Policy criteria.
- The Rickabys Line would provide improved access to recreational areas between Wilberforce Road and Hawkesbury Valley Way;
- Should the RAAF Base be redeveloped for civil aviation, road traffic would significantly increase. The new route would provide additional road network capacity where it was needed.

Road Network Connections to Rickabys Line Option
At the eastern end, a form of roundabout would provide an appropriate connection, with the four roundabout arms comprising the Bridge approach, Wilberforce Road, Freemans Reach Road and Rickabys Line. The layout would be different from the Option 1 roundabout layout, but there is sufficient land to allow a satisfactory design to be achieved.

At the western end, the route would intersect with Hawkesbury Valley Way. This could either be a roundabout or a traffic signal controlled intersection. The latter could more easily fit into the road reserve. Such a junction has been modeled, based on current traffic distributions found in surveys undertaken as part of the *Windsor Town Centre Traffic Study* (June 2011) by Christopher Hallam & Associates Pty Ltd, plus a sensitivity factor. The SIDRA modeling found a morning peak hour level of service of A and an afternoon peak hour level of service of B, for current traffic levels. These results suggest spare capacity for traffic growth.

The intersection of Hawkesbury Valley Way and Macquarie Street is, and will, remain the busiest intersection in Windsor. It currently operates close to capacity in peak periods. The Rickabys Line option will channel additional southbound and northbound traffic along Hawkesbury Valley Way, being traffic that currently uses Bridge Street and thence Windsor Road. Traffic from Windsor Bridge with destinations towards South Windsor and Penrith will have their routes altered, from travelling straight through along each direction of Macquarie Street, to either a left turn from Macquarie Street West or a right turn into Macquarie Street West. The proportions of traffic between Windsor Bridge and Windsor Road, and Macquarie Street have again been derived from the traffic surveys undertaken for the *Windsor Town Centre Traffic Study.*

The intersection of Hawkesbury Valley Way and Macquarie Street has been modeled using the SIDRA program. As with any intersection close to capacity, the results are sensitive to how the traffic signals operate. For the 8.00 – 9.00am peak hour, with a fixed signal cycle time, the impact of the Line is to improve the level of service and reduce delays. Under vehicle-actuated control, the modeled delays are higher, but the impact of the Line still improves the level of service and reduces delays. The 4.00-5.00pm peak hour sees higher traffic flows. Under vehicle-actuated control, the operation remains little different with traffic redistribution. A 3% increase in average intersection delay is indicated, although the degree of saturation of the intersection reduces. Looking at both peak periods, the impact of Rickabys Line is neutral.

Summary of Traffic Studies

1. Windsor Bridge does not currently have a load limit imposed. There is no need for immediate action to construct a new bridge. Trucks have not increased in width in recent years. The percentage of heavy vehicles using the bridge (around 7 to 8%) is relatively modest and less than what is typically found on an arterial road.
2. The current bridge does not substantially reduce the capacity of the route of Bridge Street between Macquarie Street and Wilberforce Road. The capacity of this route is controlled by the capacity of the intersections at each end, and also at the nearby intersection of Bridge Street/Macquarie Street.
3. Virtually all of the claimed benefits for travel time savings and vehicle operating cost savings could be achieved by simply undertaking the intersection upgrading works without the new bridge. Even after allowing for repairs to the existing bridge, the benefit-cost ratio of undertaking the intersection works plus the bridge repair works would be likely to substantially exceed the benefit-cost ratio of Option 1. The claimed benefit-cost ratio of Option 1 of 14.6 appears to be unsubstantiated and significantly more than the BCR of 4.5 stated in the August 2011 Assessment of Options.

The Rickabys Line is a valid alternative bypass of Windsor for heavy vehicles and for light traffic finding it more convenient route, while retaining the current Windsor Bridge for light traffic only. There would be substantial benefits from this option.

Royal Australian Historical Society website
https://www.rahs.org.au/wp-content/uploads/2016/05/The-Battle-for-Windsor-Bridge-Personal-Stories.pdf
pp123.4 by Helen Mackay:

Governor Macquarie would have preferred the centre of Windsor to be more towards the location of St Matthews but he quickly recognised the importance and significance of Thompson Square to the people of the Hawkesbury and encouraged its formalisation as the commercial and civic heart of Windsor. Governor Macquarie named the Square after Andrew Thompson, changing its name from Bell Post Square. Macquarie wanted to commemorate the contribution Andrew Thompson, an emancipist, had made both the Hawkesbury Community and the Sydney Colony. He was a symbol of the successful outcome of giving a person a second chance and a fair go.

6. THE COMMUNITY'S BRIDGE

The principal measure of the value of a bridge to its community is that it will carry the community and its transport in complete safety for the life expectancy of the bridge. In this regard Australian Standard AS5100 requires a bridge to be designed for a minimum life expectancy of one hundred years.

We believe that with the cosmetic treatment recommended in Section 4 of this submission the existing Windsor Bridge will provide excellent service for at least another century. It has an impeccable safety record and hence its value to the community it serves is equal to that of a new bridge. In fact the community now values it at a higher level because it provides additional attributes – that of being a major heritage item in Macquarie's "five towns" (Windsor, Richmond, Wilberforce, Pitt Town and Castlereagh) and of being a National Treasure by virtue of its unique design.

In addition to the unique heritage values of Thompson Square, the existing bridge itself has at least two significant heritage features:

i. The cast iron piles were constructed using the caisson process to allow men to work inside the cylinder under air pressure to keep the water out – this requires an air lock to enable access for material and personnel. This is possibly a first for NSW; and
ii. To enable the replacement of the timber deck in half widths to provide limited traffic flow, it was advantageous to precast the reinforced concrete beams on the bank of the river, probably the first use of precasting in NSW or even Australia. The central split half beams are a feature of this procedure.

There are many Roman bridges still giving excellent service to their communities 2,000 years after construction. To destroy a healthy Windsor Bridge after only 100 years of service (as planned by the RMS) could only be described as an act of extreme vandalism created by political ignorance of basic heritage values. It must not be allowed to happen. On the financial side the destruction of this bridge would be equivalent to the loss of 60 million dollars of the community's funds, this being the value of a replacement bridge. Logic indicates that as the cost of demolishing this bridge equates to the cost of restoring the bridge to an "as new" condition, then why destroy this fine example of man's art and industry and replace it at great cost to the community?

It has been our practice to recognise that bridges in villages and towns are not the property of the government. They belong to the community they serve and who paid for their design and construction through taxation. The government is the servant of that community. This must continue to be our pattern of life, and the future of Windsor Bridge must remain the responsibility of its community. In our combined 80 years experience as bridge engineers, we have never encountered such government disregard of community wishes as at Windsor.

SCHEDULE OF ATTACHMENTS

ATTACHMENT A	Time line history of existing bridge alterations
ATTACHMENT B	Photographs of existing bridge
ATTACHMENT C	Hawkesbury basin – the bath tub effect[1]
ATTACHMENT D	Location of siltation and Sackville Gorge (Choke)
ATTACHMENT E	"The Breakaway" between Freemans Reach and Pitt Town
ATTACHMENT F	Flood evacuation routes[1]
ATTACHMENT G	Downstream Options considered for Flood Strategy[2]
ATTACHMENT H	Options considered for Flood Strategy[1]
ATTACHMENT I	Outcomes from Flood Strategy Report[1]
ATTACHMENT J	RMS Options for bridge replacement[3]
ATTACHMENT K	Alternative downstream Option by locals
ATTACHMENT L	Upstream Bypass routes

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1 From "Resilient Valley, Resilient Communities Hawkesbury-Nepean Valley Flood Risk Management Strategy, January 2017, through Infrastructure NSW"

2 From "Hawkesbury-Nepean Valley Flood Management Review Stage One — Review Report, March 2014, Published by the NSW Department of Primary Industries, Office of Water

3 From RTA brochure "Community Update – Windsor Bridge over the Hawkesbury River, July 2009"

ATTACHMENT A (From BIOSIS RESEARCH report of November 2012**)**

Table 4. Evolution of the bridge over time

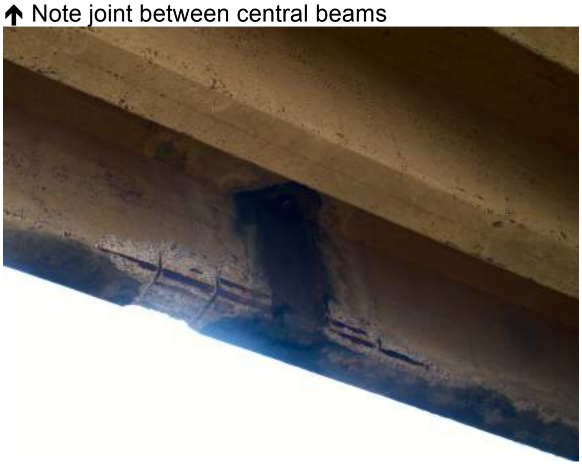
Year	Action	Form	Fabric removed	Fabric added
1874	Initial construction of bridge	Low level bridge on brick and concrete filled cast iron piers with wrought iron cross bracing with one timber pier with Timber Girders. Collapsible Handrail. Timber kerb logs	Nil	Brick and concrete filled cast iron piers with wrought iron cross bracing with one timber pier with Timber Girders. Collapsible Handrail. Timber kerb 'logs
1897	Raising of the bridge by eight feet using iron caissons to form piers.	High (mid) level bridge on iron and concrete piers with double iron cross bracing one timber pier with Timber Girders Collapsible handrail – updated design Abutment and approach raised higher to meet bridge height – and built up at both ends. Timber kerb logs	Deck replaced. Old version of Collapsible Handrail.	New cylinder extensions eight feet long. New bracing on top level. New handrails of updated design.
1922	Re-construction of the bridge superstructure with reinforced concrete girders, deck and pier crossheads	High (mid) level bridge on iron and concrete piers iron cross bracing and concrete cross girders with one Monier reinforced concrete pier. Concrete girder deck cast in two halves to facilitate traffic continuity. Collapsible Handrail. Retains timber kerb logs.	Metal cross bracing (not entirely clear if bracing remains within concrete girder) Timber deck components (with exception of kerb logs) Timber pier X *[sic]* replaced with Monier concrete pier Timber abutment at Wilberforce end.	Concrete decking: headstocks, girders, road deck. Concrete cross girder to replace top cross bracing Concrete pier. New concrete abutment at Wilberforce end.
1934	Change in approach through Thompson Square – Cutting	Bridge form unchanged though its associated approach from the south side is altered	Nil	Nil
1936	Replace-ment of timber kerb	Concrete kerbing replaces timber. Interesting that timber kerb is retained after deck is concreted. Possibly to facilitate	Timber kerb logs	Concrete kerb logs

Year	Action	Form	Fabric removed	Fabric added
	'logs'	collapsible handrail		
1941	Iron cross bracing renewed and replaced with steel.	New RSJ transom at base of bracing, and new steel channel section used for bracing. Note that in 1952 a diving inspection remarks that the RSJ transom is half its original thickness. It is likely that only some bracing was renewed	Original 'gussets' retained at top of bracing. Iron cross bracing and some componentry removed.	Steel cross bracing (only on some piers): New collars on bracing, RSJ used for transom, channel section used for bracing
1968	Addition of underslung cantilevered footway	Attachment of Steel and Concrete footway with service pipes below. Addition of tubular crash railing on top of concrete kerb (next to footway). Collapsible handrail retained on Footway and on upstream side of bridge. Services are attached to footway – power, water and telephone (this occurs over time and not at the exact time of installation. Water main is increased which changes the appearance of the bridge slightly).	Some drilling in concrete and piers results in minor removals.	Steel girders and concrete slabs for footway. Pipelines and conduits for services.
1980/ 1986	Replace-ment of collapsible handrails	Collapsible handrail replaced on footway (downstream side) and upstream side of bridge due to safety concerns (first aired in 1930s or earlier) – metal tubular crash railing installed on upstream side, new collapsible handrail installed downstream.	Removal of original collapsible handrail gets rid of the most visible 1874 element.	Metal and wire collapsible handrail, lowered inwards to be secured to the deck

ATTACHMENT B – Photographs of existing bridge

↑ Note joint between central beams

↑ Spalling of concrete due to corrosion of reinforcement



↑ Staining from drainage opening

↑ Edge beams display most of spalling

↑ Exposed reinforcement near drain

↑ Note good condition of interior beams

↑ Diaphragm at pier bracing

↑ Note interior beams in good condition

The Valley's 'bathtub' effect

The combination of large upstream catchments and narrow downstream sandstone gorges results in floodwaters backing up behind natural choke points in the Valley.

The Valley has been described as a bathtub, with five main taps (being the main tributaries) but only one plug hole, Sackville Gorge (Figure 3). As a result, floodwaters back up and rise rapidly, causing significant flooding both in terms of areas and depth. This bathtub effect is unusual as most river valleys tend to widen as they approach their mouths, which is not the case in the Valley.

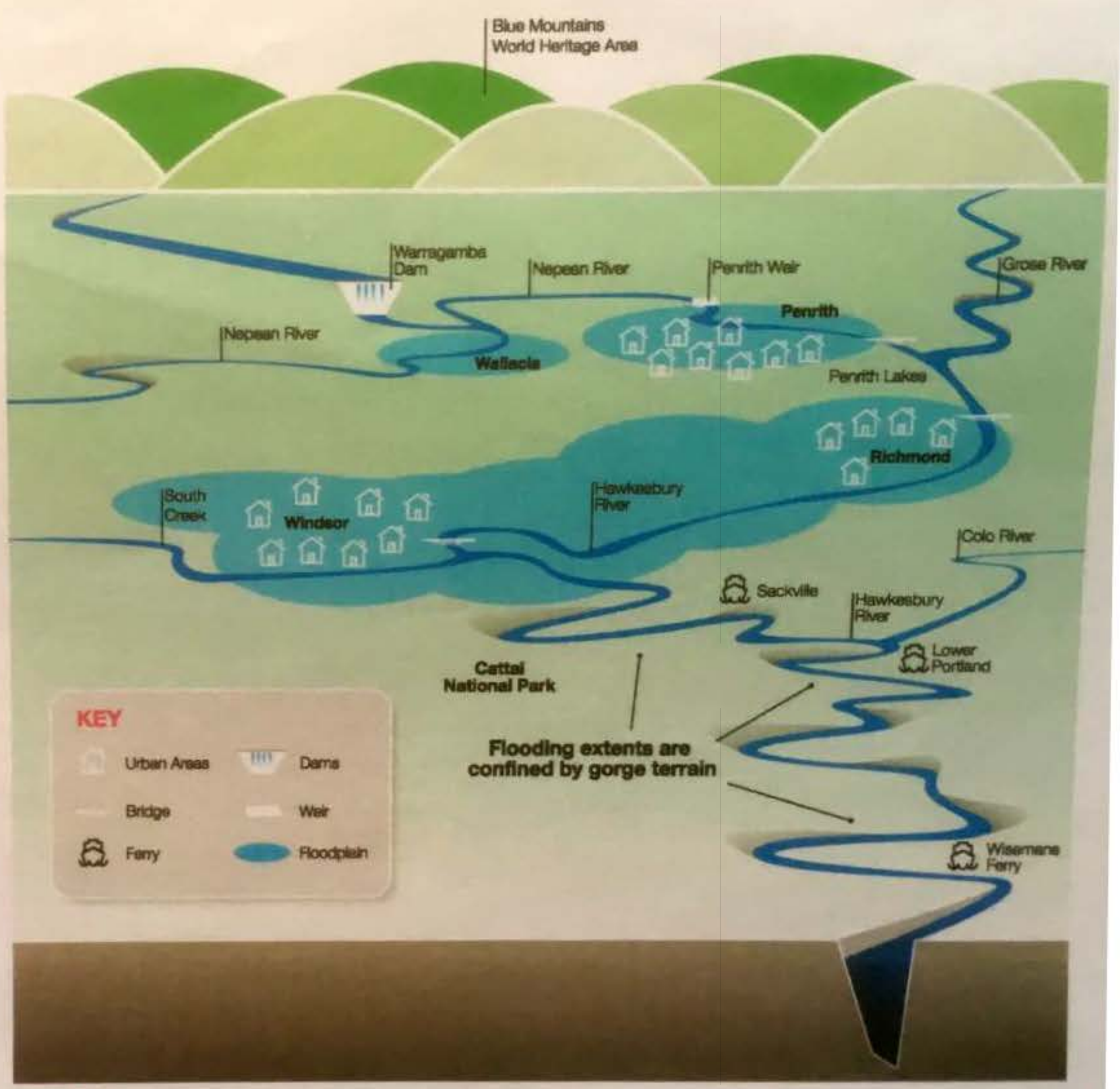
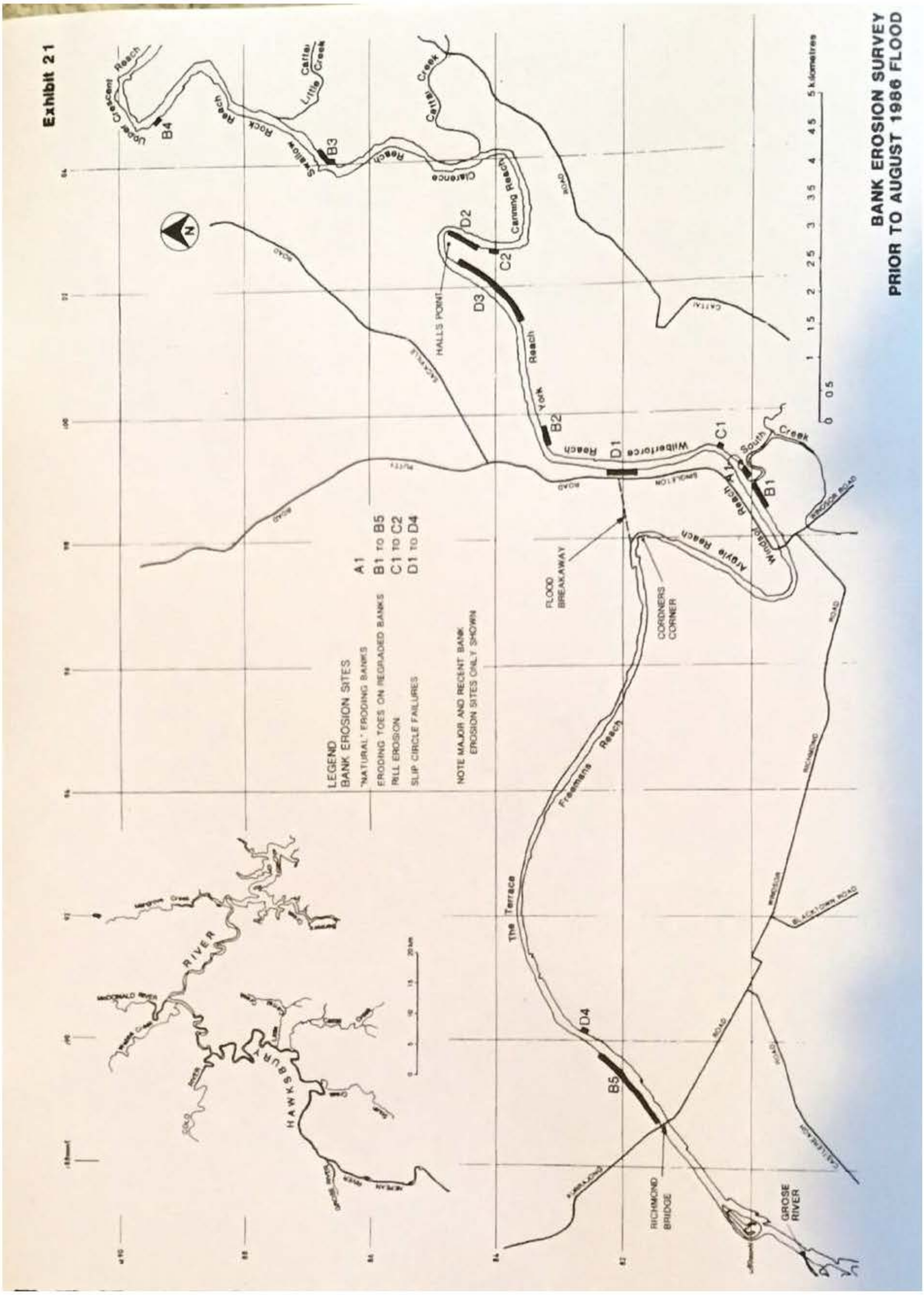


Figure 3 **The 'bathtub' effect in the Hawkesbury-Nepean Valley**

ATTACHMENT D – Location of siltation and Sackville Gorge (Choke)

ATTACHMENT E – “The Breakaway” between Freemans Reach and Pitt Town



ATTACHMENT F – Flood evacuation routes

Evacuation constraints and complexity

Evacuating people away from flood affected areas is the primary method of reducing the risk to life during a flood. In the Valley, the NSW State Emergency Service identifies mass self-evacuation by private motor vehicles as the primary method for evacuation, as other transport options are highly vulnerable to floods or have limited capacity. The major regional evacuation road routes are shown in Figure 7.

Legend

- Castlereagh Road route
- Great Western Highway
- Hawkesbury Valley Way
- Llandilo Road route
- Londonderry Road route
- M4 Motorway
- Old Northern Road route
- Park Road route
- Pitt Town route
- Richmond Road route
- The Northern Road route
- Wallacia alternate route
- Windsor Road route
- Westlink M7

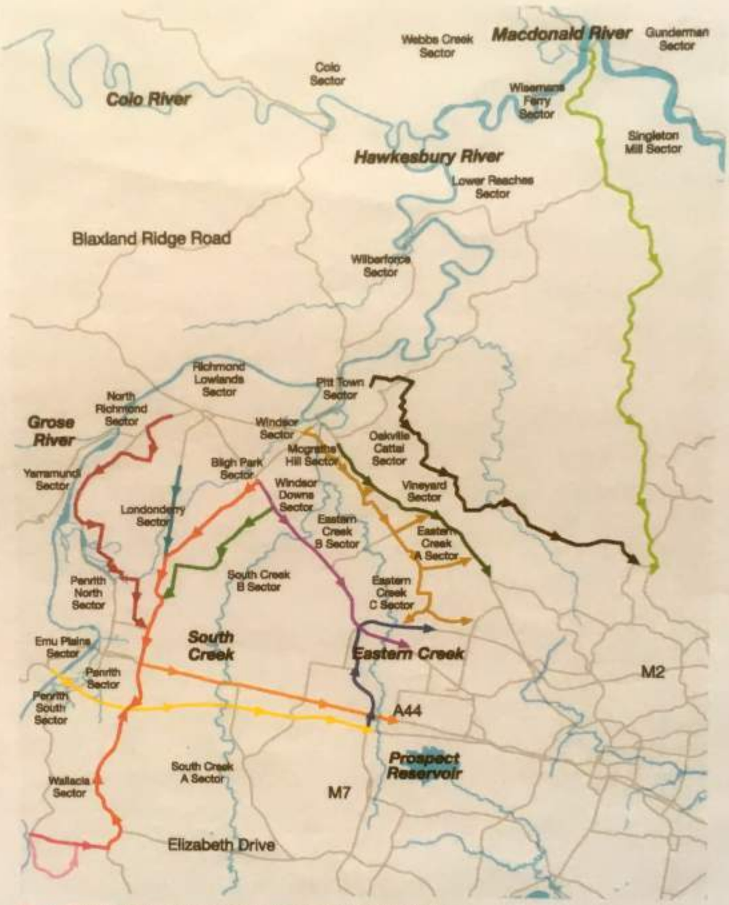


Figure 7 Major regional evacuation road routes out of the Valley

Infrastructure NSW | Hawkesbury-Nepean Valley Flood Risk Management Strategy Summary report 21

ATTACHMENT G – Downstream Options considered for Flood Strategy

ATTACHMENT H – Options considered for Flood Strategy

Results of the cost benefit analysis of infrastructure options

Each infrastructure option was evaluated in terms of its net benefits, defined as its discounted benefits less its discounted costs.

Discounting reduced the projected costs and benefits of an option to a current value for 2015 to allow for comparison. These costs and benefits have been discounted by 7% per year as per NSW Treasury Policy.

Based on the results of the evaluation, raising Warragamba Dam by 14 metres was selected as the preferred infrastructure option as it provided the largest net benefits of around $200 million (Figure 11).

While raising Warragamba Dam wall is the infrastructure option with the highest net benefit, no combination of infrastructure options can eliminate the risk. Regardless of any infrastructure option, non-infrastructure options must be part of the solution for managing ongoing flood risk.

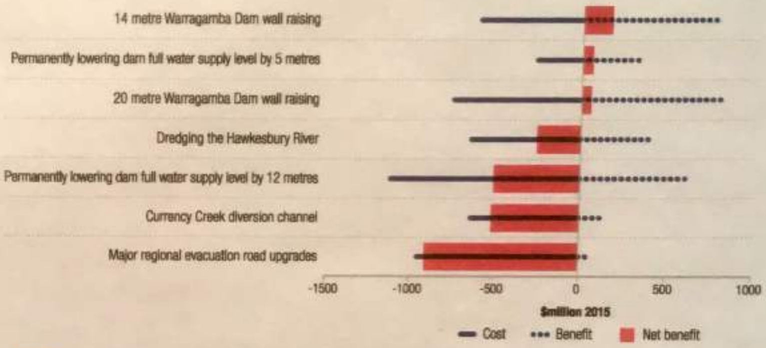


Figure 11 **Net benefits, costs and benefits of infrastructure options in order of decreasing net benefits ($millions)**

ATTACHMENT I – Outcomes from Flood Strategy Report

Delivering results

The Flood Strategy is designed to deliver nine key outcomes:

Outcome 1
Coordinated flood risk management across the Valley now and in the future

Outcome 2
Reduced flood risk in the Valley by raising Warragamba Dam wall

Outcome 3
Strategic and integrated land use and road planning

Outcome 4
Accessible contemporary flood risk information

Outcome 5
An aware, prepared and responsive community

Outcome 6
Improved weather and flood predictions

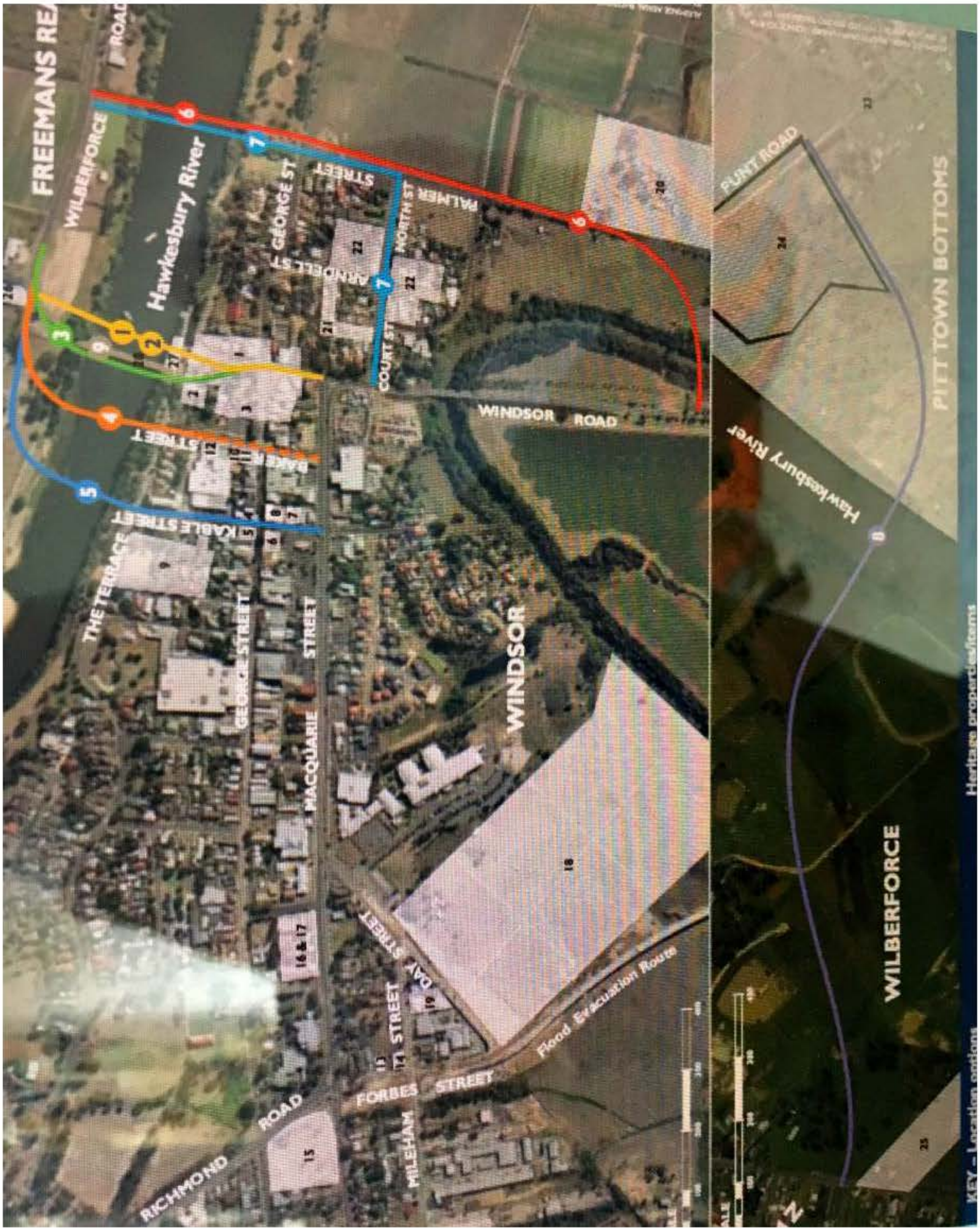
Outcome 7
Best practice emergency response and recovery

Outcome 8
Adequate local roads for evacuation

Outcome 9
Ongoing monitoring and evaluation, reporting and improvement of the Flood Strategy

ATTACHMENT J – RMS Options for bridge replacement

Eight of the RMS proposals (all at Windsor) are shown on the large aerial photograph of Windsor. Proposals 1 to 5 and 7 result in traffic being directed into Macquarie Street. Proposal 6 requires another crossing of South Creek. Proposal 9 is restoration (strengthening and widening) of the existing bridge. The eighth proposal is shown on the smaller photograph of Wilberforce and Pitt Town.



ATTACHMENT K – Alternative downstream Option by locals

The downstream proposal, 1.8km downstream from the historic bridge at Windsor is shown by dashed lines, just downstream of the junction with South Creek (A). The flood relief viaduct (Jim Anderson Bridge) linking to Hawkesbury Valley Way is also shown (B).

ATTACHMENT L – Upstream Bypass routes

Shows a choice of two northern ends from the intersection of Wilberforce Road and Freemans Reach Road meeting at a common site for the new Bridge over the Hawkesbury River with two southern ends either side of the motel golf course.