



Transport
Roads & Maritime
Services



Additional crossing of the Clarence River at Grafton

Route Options Development Report
Volume 1 – Main Report

SEPTEMBER 2012





Transport
Roads & Maritime
Services

Main Road 83 Summerland Way Additional Crossing of the Clarence River at Grafton

Route Options Development Report

September 2012

Volume 1 – Main Report

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 220422

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Executive summary

Project purpose and objectives

Roads and Maritime Services (RMS) is currently undertaking investigations and community consultation to identify an additional crossing of the Clarence River at Grafton to address short-term and long-term transport needs. The key objectives for the additional crossing are to:

- Enhance road safety for all road users over the length of the project
- Improve traffic efficiency between and within Grafton and South Grafton
- Support regional and local economic development
- Involve all stakeholders and consider their interests
- Provide value for money
- Minimise impact on the environment.

Background

Planning for an additional crossing of the Clarence River at Grafton was initially funded by the NSW Government, starting from 2002. Investigations were deferred in September 2005 and restarted in 2009.

In December 2010 RMS (formerly Roads and Traffic Authority (RTA)) announced a revised approach to engage more effectively with the community and stakeholders in identifying a preferred route for an additional crossing. A community update issued in December 2010 identified 13 preliminary route options and invited community comment via a postal survey. Subsequent phone and business surveys were also carried out.

In June 2011, RMS published the *Feasibility Assessment Report* which describes the assessment undertaken on the 41 suggestions identified following the December 2010 to March 2011 community consultation period. Twenty-five preliminary route options in five corridors were identified for engineering and environmental investigation.

In January 2012, six route options were announced for further investigation. The short-listed options and short-listing process are documented in the *Preliminary Route Options Report – Final* (RMS, January 2012).

Since the announcement of the six short-listed options in January 2012, design refinements have been undertaken on the six route options and further field and technical investigations undertaken. The refined route options are presented in Figure 1.

This report

The purpose of this report (*Route Options Development Report*) is to provide the outcomes of the technical and environmental investigations on the six short-listed route options for community comment, to assist the assessment process for the identification of a recommended preferred route option.

The report documents the investigations and assessment of the six route options against the project objectives. This report comprises three volumes:

- **Volume 1: Main Report** – The Main Report introduces the project, its strategic context and justification, and summarises the community involvement and feedback received since the announcement of the short-list of route options. It provides a detailed description of the six route options and the methodology used for the assessment. The results of the option

assessments are presented and the next steps to be followed in the process to identify a preferred location for the additional crossing are provided.

- **Volumes 2 and 3: Technical Papers** – Volumes 2 and 3 contain technical papers that document the investigations undertaken for the assessment of the six route options, including traffic, social and economic, strategic cost estimates, economic evaluation, noise, Aboriginal heritage, non-Aboriginal heritage, ecology, landscape and urban character, flooding and geotechnical issues.

Summary of short-listed options

Table 1 is a summary comparison of the route options. This snapshot considers some key themes raised by the community. It does not include all assessment results. For more information and full details of the assessment results please refer to Chapter 6.

Table 1: Summary comparison of the route options

Item	Option E	Option A	Option C	Option 11	Option 14	Option 15
<p>Traffic – bridge utilisation</p> <p>Traffic volumes for 2 hour AM peak period (7-9am) (both ways):</p> <p>Number of vehicles using the additional crossing (approximate % of total vehicles crossing the river)⁽¹⁾</p> <ul style="list-style-type: none"> • 2019 • 2049 	<p>2697 (66%)</p> <p>5231 (65%)</p>	<p>3188 (78%)</p> <p>5919 (74%)</p>	<p>2808 (67%)</p> <p>5431 (68%)</p>	<p>1296 (32%)</p> <p>3515 (45%)</p>	<p>936 (23%)</p> <p>2673 (36%)</p>	<p>921 (22%)</p> <p>2578 (35%)</p>
<p>Traffic – reducing delays</p> <p>Average travel time between the Bent St/Gwydir Hwy intersection, South Grafton and Prince St/Pound St intersection, Grafton using the existing bridge, 30 years after opening (2049) in morning (AM) peak period (minutes)⁽²⁾</p>	7	8	7	8	14	14
<p>Heavy vehicles</p> <p>Travel between the Pacific Hwy/Tyson St intersection, South Grafton and Summerland Way/Butterfactory Lane intersection, Grafton using the additional crossing.</p> <ul style="list-style-type: none"> • Travel distance (km) • Travel time 30 years after opening (2049) in morning (AM) peak period (minutes) 	<p>9.1</p> <p>15</p>	<p>8.7</p> <p>14</p>	<p>8.4</p> <p>13</p>	<p>10.0</p> <p>11</p>	<p>10.5</p> <p>10</p>	<p>10.3</p> <p>10</p>
<p>Road safety</p> <p>Number of issues identified in road safety audit:</p> <ul style="list-style-type: none"> • High priority • Medium priority • Low priority 	<p>2</p> <p>9</p> <p>7</p>	<p>3</p> <p>13</p> <p>7</p>	<p>1</p> <p>10</p> <p>4</p>	<p>3</p> <p>8</p> <p>4</p>	<p>2</p> <p>7</p> <p>5</p>	<p>2</p> <p>7</p> <p>5</p>
<p>Property impacts</p> <p>Number of potentially directly affected properties:</p> <ul style="list-style-type: none"> • Residential • Businesses • Rural • Community • Total 	<p>16</p> <p>7</p> <p>0</p> <p>8</p> <p>31</p>	<p>21</p> <p>21</p> <p>0</p> <p>15</p> <p>57</p>	<p>24</p> <p>4</p> <p>2</p> <p>12</p> <p>42</p>	<p>22</p> <p>1</p> <p>2</p> <p>5</p> <p>30</p>	<p>6</p> <p>2</p> <p>7</p> <p>5</p> <p>20</p>	<p>1</p> <p>1</p> <p>14</p> <p>6</p> <p>22</p>
<p>Noise impacts</p> <p>10 years after opening (2029) (without mitigation measures)</p> <p>Number of residential properties where noise levels⁽³⁾:</p> <ul style="list-style-type: none"> • Are more than 50 dBA at night⁽⁴⁾ • Increase by 12 dB or more at night 	<p>461</p> <p>11</p>	<p>448</p> <p>0</p>	<p>462</p> <p>1</p>	<p>505</p> <p>51</p>	<p>477</p> <p>30</p>	<p>415</p> <p>21</p>

Item	Option E	Option A	Option C	Option 11	Option 14	Option 15
Aboriginal cultural heritage Impact on areas of Aboriginal cultural heritage	None	None	Impact on the aesthetic value of 1 site - Golden Eel	None	Direct impact on 1 site - Great Marlow	Direct impact on 1 site - Great Marlow
Non-Aboriginal heritage Direct impact on non-Aboriginal heritage items and archaeological sites: • Items of State heritage significance (No.) • Other items (No.)	0 21	2 25	0 24	0 12	0 10	0 10
Environmental Potential direct impact on identified Endangered Ecological Communities (EEC) (m ²)	100	550	1450	14,250	22,000	37,500
Landscape and urban character	Maintains visual integrity of existing bridge. Would not fragment existing urban settlement patterns.	Impacts on views to, and visual character of, existing bridge. Would fragment existing urban settlement patterns.	Impacts on views to, and visual character of, existing bridge. Would significantly fragment existing urban settlement patterns.	Maintains visual integrity of existing bridge. Would significantly fragment existing urban settlement patterns.	Maintains visual integrity of existing bridge. Would fragment existing urban settlement patterns.	Maintains visual integrity of existing bridge. Would fragment existing urban settlement patterns.
Flooding Length of levees upstream of additional crossing that will need to be raised to retain existing flood protection ⁽⁵⁾ (km)	11.75	16.70	18.10	19.50	16.50	16.50
Cost • Route option strategic cost estimates (\$m) (all upgrades at 2012) • Benefit-cost ratio (BCR) over 30 years from 2019 based on strategic cost estimates ⁽⁶⁾	215 1.6	231 1.3	231 1.6	210 1.7	304 1.0	340 0.9

- (1) For Option A the new bridge will be two lanes northbound and one lane southbound, and the existing bridge will become one lane southbound only. For the other five options, the new bridge will be one lane northbound and one lane southbound, and the existing bridge will remain as one lane northbound and one lane southbound.
- (2) Typical recorded travel times between the Bent Street/Gwydir Highway intersection, South Grafton and Prince Street/Pound Street intersection, Grafton in the morning (AM) peak earlier in 2012 were between eight and 10 minutes.
- (3) Only includes receivers identified in the *Technical Paper: Noise Assessment*.
- (4) Includes 468 properties that would exceed 50 dBA at night if no additional crossing was built.
- (5) Maximum height of increase for all options is less than or equal to 0.1 metre. For Option C, drainage mitigation measures would be required to provide the required flood immunity for the underpass of the railway viaduct between Kent Street and Clarence Street.
- (6) A BCR that is greater than one indicates that the road user benefits exceed the cost.

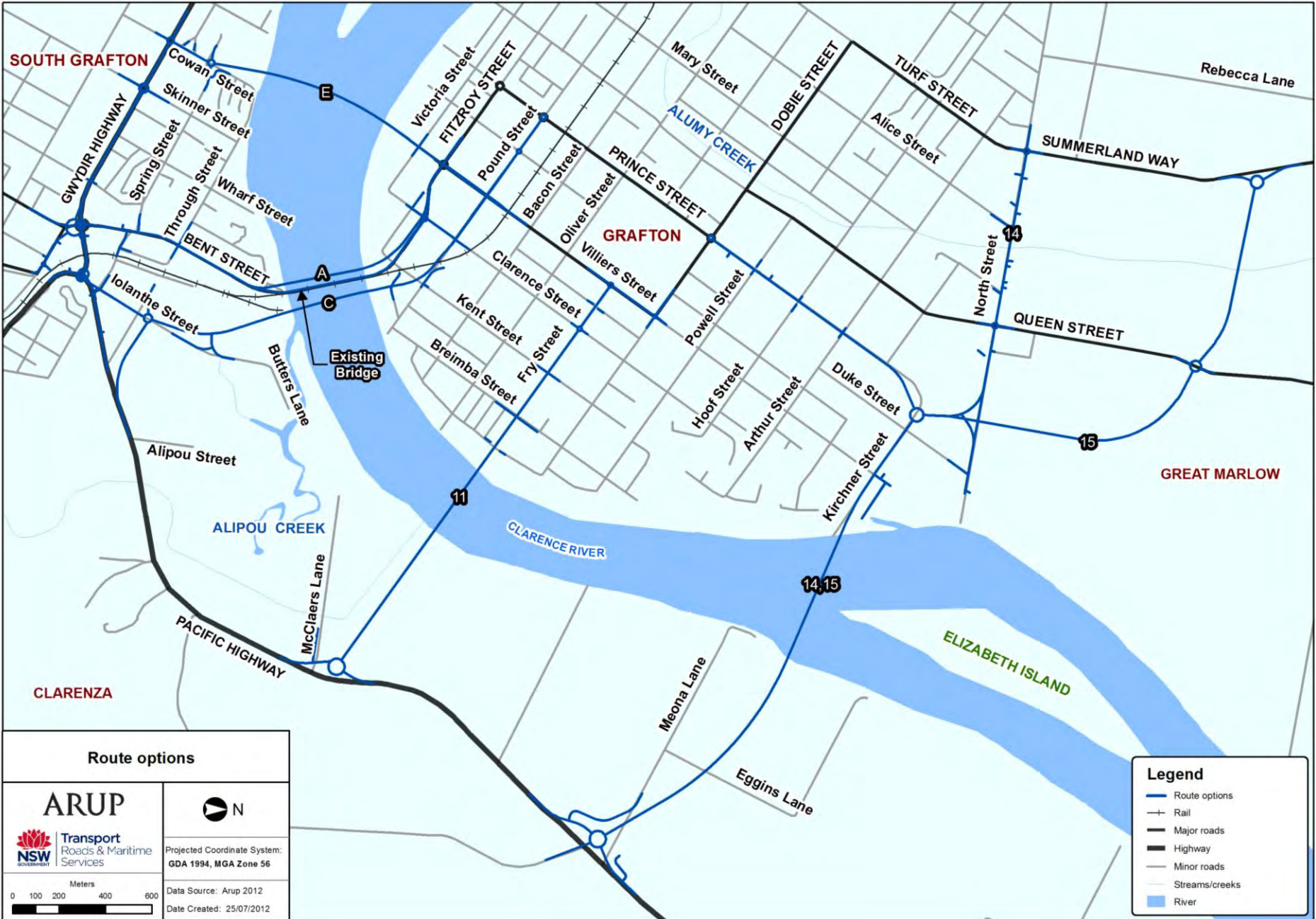


Figure 1: Route options for an additional crossing of the Clarence River at Grafton

Invitation to comment

This report is being displayed for community comment. Please provide comments by:

- Writing to Chris Clark, RMS Project Manager, PO Box 546, Grafton NSW 2460
- Emailing graftonbridge@rms.nsw.gov.au.

Further details are available on the project website www.rms.nsw.gov.au/graftonbridge.

What happens next

Community comments received on the six options, the investigations undertaken and the outcomes of the value management workshop will input into a decision on the recommended preferred route option.

RMS is targeting to identify the recommended preferred option by the end of 2012.

Feedback on the recommended preferred route option will be considered before a final decision is made on the preferred route option for an additional crossing of the Clarence River at Grafton.

The process to identify a preferred route option is shown in the flow chart in Figure 2 below.



Figure 2: Process to identify a preferred route option as of September 2012

Glossary of terms and abbreviations

AM peak	Morning traffic peak period in Grafton. The three hour period between 7-10am was modelled and showed that the most critical hour is 8-9am.
ARI	Average recurrence interval (measured in years) is a term used to describe flood frequency. It is the long-term average number of years between floods of a certain magnitude. For example, a 100-year ARI flood is a flood that occurs or is exceeded on average once every 100 years.
ARTC	Australian Rail Track Corporation.
AHD	Australian Height Datum, a common national plane of level approximately equivalent to the height above sea level.
Austroroads	Austroroads is the association of Australian and New Zealand road transport and traffic authorities. Austroroads classifies motor vehicles into 12 classes as follows: Light Vehicles: class 1 (eg sedan, 4WD) and class 2 (eg caravan). Buses: class 3 (2 axle bus) and class 4 (3 axle bus). Heavy Vehicles (rigid): class 3 (2 axle truck), class 4 (3 axle truck) and class 5 (4 axle truck). Heavy Vehicles (articulated): class 6 (3 axle articulated truck), class 7 (4 axle articulated truck), class 8 (5 axle articulated truck) and class 9 (6 axle articulated truck). Heavy Vehicles (B-double): class 10 (B-double truck), class 11 (double road train) and class 12 (triple road train).
Base case	This is the scenario if no additional crossing was built. The base case scenario includes some additional roadworks that would be necessary to address localised congestion and capacity constraints as they arise to reasonably cater for expected demand in 2019. Base case is the standard terminology used for economic evaluations. The base case is also referred to as the „do minimum“ scenario in traffic assessments or the „no build“ in noise assessments.
Base year	2011 „do nothing“ (no upgrades assumed) traffic model.
CBD	Central business district.
Contributory item	Contributory items are buildings in Grafton and South Grafton which are considered by the project’s non-Aboriginal heritage specialist to contribute to the significance and character of Grafton and South Grafton urban conservation areas. Contributory items have been identified in this report as areas of non- Aboriginal heritage archaeological sensitivity.
CVC	Clarence Valley Council.
dB	Decibel, a logarithmic unit of sound intensity.
dB(A)	A-weighted sound pressure level in decibels. The weighting is based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds. The frequency of a sound affects its perceived loudness. Human hearing is less sensitive at low and very high frequencies, the A-weighting is used to account for this effect. An A-weighted decibel level is written as dB(A). An increase of approximately 10 dB corresponds to a subjective doubling of the loudness of a noise. The minimum increase or decrease in noise level that can be noticed is typically 2 to 3 dB. Some typical dB(A) levels are shown below.

Noise Level dB(A)	Example
130	Human threshold of pain
120	Jet aircraft take-off at 100 m
110	Chain saw at 1 m
100	Inside nightclub
90	Heavy trucks at 5 m
80	Kerbside of busy street

70	Loud stereo in living room
60	Office or restaurant with people present
50	Domestic fan heater at 1 m
40	Living room (without TV, stereo, etc)
30	Background noise in a theatre
20	Remote rural area on still night
10	Acoustic laboratory test chamber
0	Threshold of hearing

Directly affected property	A directly affected property is where a route option is likely to require full or partial acquisition of the property.
„Do minimum“	This is the scenario if no additional crossing was built. The „do minimum“ scenario includes some additional roadworks that would be necessary to address localised congestion and capacity constraints as they arise to reasonably cater for expected demand in 2019. „Do minimum“ is the standard terminology used for traffic assessments. The „do minimum“ scenario is also referred to as the „no build“ scenario in noise assessments or the base case in economic evaluations.
DP&I	NSW Department of Planning and Infrastructure (former Department of Planning).
EEC	Endangered Ecological Community.
EP&A Act	NSW Environmental Planning and Assessment Act 1979.
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999.
Freeboard	The height of a ship"s side between the waterline and the deck.
GIS	Geographic Information System.
GNLALC	Grafton-Ngerrie Local Aboriginal Land Council.
Key stakeholder	The key stakeholders are groups who are proactively engaged during the project.
LEP	Local environmental plan.
Level of service	A measure of the quality of road operating conditions, including speed, travel time, freedom to manoeuvre, traffic interruptions, and comfort and convenience.
m	Million.
MHWS	Mean High Water Springs is the highest level to which spring tides reach on average over a period of time. This level is generally close to being the "high water mark" where debris accumulates on the shore annually.
Microsimulation traffic model	Computer software package that has the ability to individually model each vehicle, including heavy vehicles within a road network. It enables a realistic representation of driver behaviour such as overtaking and lane changing and can also illustrate network performance. It is a particularly useful tool in modelling congested road networks and for predicting the likely impact of changes in traffic patterns resulting from changes to traffic flow (demand) and/or changes to the physical environment (road network).
„No build“	This is the scenario if no additional crossing was built. The „no build“ scenario includes some additional roadworks that would be necessary to address localised congestion and capacity constraints as they arise to reasonably cater for expected demand in 2019. „No build“ is the standard terminology used for noise assessments. The „no build“ scenario is also referred to as the „do minimum“ scenario in traffic assessments or the base case in economic evaluations.
NSW	New South Wales.
OEH	NSW Office of Environment and Heritage (formerly known as Department of Environment and Climate Change and Water).
PM Peak	Afternoon traffic peak period in Grafton. The three hour period between 4-7pm was modelled and showed that the most critical hour is 4-5pm.
Project	Additional crossing of the Clarence River at Grafton.

Project team	The team, comprising representatives of RMS, Arup (as the lead technical consultant) and other technical specialists, that is working on the project.
PROR	Preliminary Route Options Report – Final (RMS, January 2012).
Reduced level	The vertical distance between a survey point and the Australian Height Datum (AHD).
RMS	Roads and Maritime Services (formerly known as RTA: Roads and Traffic Authority).
RMS (Maritime)	The maritime services division of Roads and Maritime Services (RMS).
RODR	Route Options Development Report (this report).
SES	State Emergency Services.
Strategic model	A tool for forecasting the implications of proposed transport infrastructure improvements by providing an understanding of likely travel patterns and network performance for different options. A strategic model was used to analyse the overall road network performance of the 25 preliminary route options that were assessed in the <i>PROR</i> . It is used for comparison of the likely network performance rather than for providing a detailed assessment of every individual component of the network. These aspects are better assessed by a microsimulation model.
TfNSW	Transport for New South Wales.
TRAIN	Trans Regional Amalgamated Infrastructure Network.
VHT	Vehicle hours travelled.
VKT	Vehicle kilometres travelled.

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Economic Evaluation

Noise Assessment

Aboriginal Heritage

Non-Aboriginal Heritage

Volume 3 – Technical Papers

Ecology

Landscape and Urban Character

Flooding

Geotechnical Assessment for Route Options

1 Introduction

1.1 Background

Roads and Maritime Services (RMS) is currently undertaking investigations and community consultation to identify an additional crossing of the Clarence River at Grafton to address short-term and long-term transport needs.

Since the early 1970s there have been various discussions and studies into an additional crossing of the Clarence River at Grafton. A number of these studies have been carried out during the past 10 years and provide the background to the current investigation. A timeline depicting the evolution of discussions and studies into an additional crossing of the Clarence River since the current bridge opened in 1932 is shown in Figure 3 below.

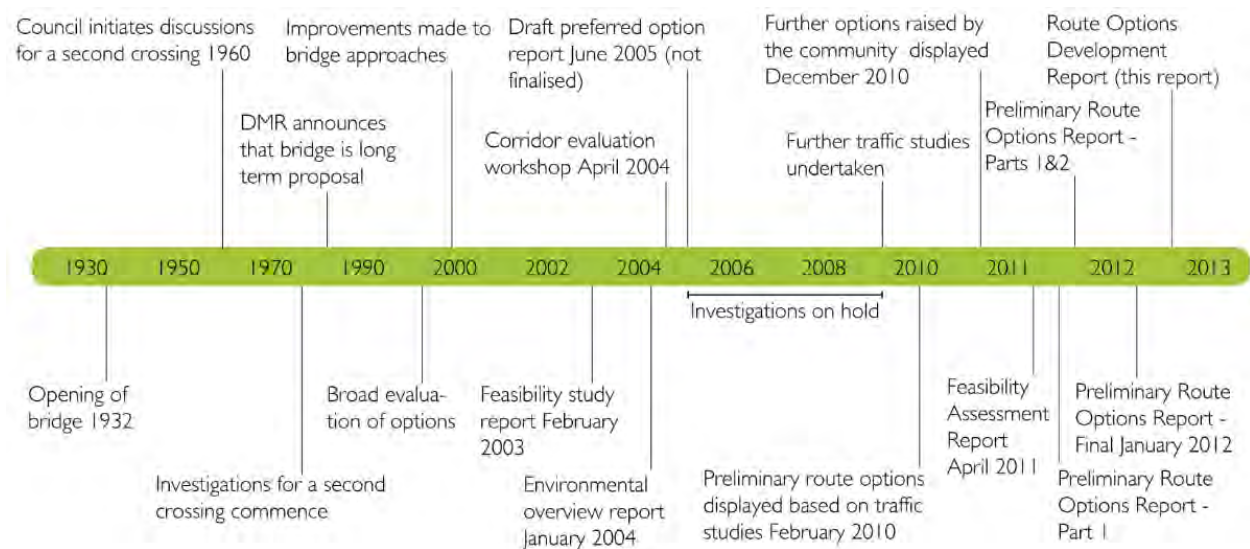


Figure 3: Timeline of discussions and studies into an additional crossing of the Clarence River

A revised approach to engage more effectively with the community and stakeholders to identify a preferred route for an additional crossing was announced in December 2010.

The revised approach was developed in response to sections of the community asking the then Minister for Roads and RMS to reconsider options for a second crossing as well as raising concerns about the basis and justification for identifying the four preliminary route options announced in February 2010.

Clarence Valley Council wrote to the Minister for Roads in September 2010 to ask that RMS survey the people of Grafton and surrounds about the location of a second crossing.

In December 2010, RMS made a commitment to undertake a process that would be transparent, involve all residents and stakeholders and make information available at the appropriate times, and not afterwards. The December 2010 community update also identified 13 preliminary options, including the additional nine options suggested by the community since the announcement of the four preliminary route options in February 2010.

RMS undertook three community surveys to gauge the views of residents and businesses regarding the additional crossing of the Clarence River at Grafton.

The responses to the surveys helped the project team to identify the key community issues for the project and the values held by the community. The responses also identified an additional 28

community suggestions for the location of the crossing, bringing the total number of suggestions to 41. At community forums in March 2011, RMS advised that the 41 suggested locations would be assessed for their feasibility, to identify those options that would be further considered and investigated.

In June 2011, RMS issued a community update and the *Feasibility Assessment Report* which identified 25 preliminary route options within five strategic corridors to go forward for further engineering and environmental investigations. Following consideration of community input, including the outcomes of a stakeholder evaluation workshop attended by members of the community, six short-listed options to go forward for further investigation were identified in January 2012. Four of the six short-listed options are based on suggestions received from the community. The short-listing process is documented in the *Preliminary Route Options Report – Final* (RMS, January 2012).

Since the announcement of the six short-listed options in January 2012, further investigations have been carried out. These include technical and field investigations, traffic, flood and noise modelling and further design refinements to the six route options. The refined route options are presented in Figure 1.

This report (*Route Options Development Report*), documents the investigations and assessment of the six short-listed route options against the project objectives. These six short-listed route options are referred to throughout this report as the route options.

1.2 Project purpose and objectives

1.2.1 Project purpose

To identify an additional crossing of the Clarence River at Grafton to address short-term and long-term transport needs.

1.2.2 Project objectives

The key objectives for the additional crossing of the Clarence River at Grafton are:

- Enhance road safety for all road users over the length of the project
- Improve traffic efficiency between and within Grafton and South Grafton
- Support regional and local economic development
- Involve all stakeholders and consider their interests
- Provide value for money
- Minimise impact on the environment.

1.2.3 Supporting objectives

The following supporting objectives assist in achieving the project objectives.

Enhance road safety for all road users over the length of the project

- Reduce the potential for road crashes and injuries on the bridge and approaches, including any intersections and connecting roads
- Provide safe facilities for pedestrians and cyclists.

Improve traffic efficiency between and within Grafton and South Grafton

- Provide efficient access for a second crossing of the Clarence River and for the State road network
- Provide a traffic management network which reduces delays between Grafton and South Grafton in peak periods to an acceptable level of service for 30 years after opening
- Provide adequate vertical clearance for heavy vehicles
- Consider demand management strategies to minimise delays to local and through traffic.

Support regional and local economic development

- Provide transport solutions that complement existing and future land uses and support development opportunities
- Provide improved opportunities for economic and tourist development for Grafton
- Provide for commercial transport including B-doubles where required
- Provide flood immunity for the bridge for a one in 100-year flood event, and for the approach roads for a one in 20-year flood event, where economically justified
- Provide navigational clearance from the additional crossing for river users.

Involve all stakeholders and consider their interests

- Develop solutions that consider community expectations for the project
- Satisfy the technical and procedural requirements of RMS with respect to the planning and design of the project
- Integrate input from the community into the development of the project through the implementation of a comprehensive program of community consultation and participation.

Provide value for money

- Achieve a justifiable benefit-cost ratio at an affordable cost
- Develop a strategy to integrate future upgrades into the project.

Minimise impact on the environment

- Minimise the impact on the social and economic environment, including property impacts
- Minimise the impact on residential amenity, including noise, vibration, air quality etc
- Minimise the impact on heritage
- Minimise impact on the natural environment
- Provide a project that fits sensitively into the built, natural and community context
- Minimise flooding impact caused by the project.

1.3 Purpose of this report

The purpose of this report (*Route Options Development Report*) is to provide the outcomes of the technical and environmental investigations on the route options for community comment, to assist the assessment process for the identification of a recommended preferred route option.

This report:

- Identifies the strategic context and need for the additional crossing
- Summarises the community involvement activities and feedback received since the announcement of the short-list of route options
- Presents the route options and the methodology used to assess these options against the project objectives
- Documents the results of the assessment of the route options
- Outlines the next steps for identifying the recommended preferred route option.

1.4 Structure of this report

As discussed below, this *Route Options Development Report* comprises three volumes:

- Volume 1 – Main Report
- Volume 2 – Technical Papers
- Volume 3 – Technical Papers.

Route Options Development Report, Volume 1 – Main Report

Volume 1 was developed from desktop studies (ie review and analysis of existing published information such as reports, mapping, government policy and planning documents), preliminary site visits undertaken during 2010 and 2011 and detailed field investigations undertaken in 2012. Volume 1 also considers previous investigations into an additional crossing of the Clarence River at Grafton undertaken over the past 10 years.

Route Options Development Report, Volumes 2 and 3 – Technical Papers

Volumes 2 and 3 contain technical papers that were prepared by technical specialists in the areas of traffic, social and economic, strategic cost estimates, economic evaluation, noise, Aboriginal heritage, non-Aboriginal heritage, ecology, landscape and urban character, flooding and geotechnical issues. These technical papers provide information on the detailed investigations undertaken for the six route options.

1.5 Assumptions and suitability of assessment

This report has been developed from desktop studies (ie review and analysis of existing published information such as reports, mapping, government policy and planning documents), preliminary site investigations undertaken during 2010 and 2011, detailed site investigations undertaken in 2012, and assessment of the route options including traffic, flooding and noise modelling.

This report builds upon the previous investigations into an additional crossing of the Clarence River at Grafton that have been undertaken over the past 10 years, including the 2011 investigations documented in the *Preliminary Route Options Report – Final* (RMS, January 2012).

Assumptions and limitations specifically related to the various specialist studies carried out for this report are identified in the technical papers in Volumes 2 and 3 of this report.

The project team have exercised all reasonable skill and care in preparing this report and have taken reasonable steps to ensure that the information contained in this report is accurate and up to date.

The information contained in this report is for the purpose of conducting a comparative assessment of the six route options. This will assist in identifying a recommended preferred route option.

The designs presented in this report are preliminary concept designs for the six route options. These designs may be further refined during the concept design phase based on further investigations and feedback from the community.

Key assumptions for the comparative assessment of the six route options are:

- The assumed date of opening of the additional crossing to traffic is 2019. Note that the actual year of opening will be subject to funding and may vary from this date.
- It is assumed that the Glenugie to Tyndale upgrade of the Pacific Highway (which bypasses South Grafton) will be open to traffic by the assumed date of opening of the additional crossing (2019).
- All options have been designed to operate with an adequate level of service 30 years after the assumed date of opening of the additional crossing, ie in 2049. It should be noted that the option layouts identify the works required to achieve sufficient capacity for the option to function adequately in 2049. Construction of the road network upgrades, eg intersection upgrades or widening of existing roads, may be staged over time following construction of the new bridge, as traffic demands increase.
- Large heavy vehicles (semi-trailers and B-doubles) will be required to use the additional crossing in preference to the existing bridge.
- Traffic patterns remain proportionally the same between the existing Pacific Highway and Centenary Drive.
- The Pacific Highway will continue to be the priority designated freight route for heavy vehicles travelling between Sydney and Brisbane. It is not the intention of the additional crossing to provide an additional freight corridor or to attract more heavy vehicles onto the Summerland Way.
- Population growth and development forecasts are consistent with those identified in the *Mid North Coast Regional Strategy* (DP&I, 2009). The forecasts consider land capacity and have been developed in consultation with Clarence Valley Council and the Department of Planning and Infrastructure.

Volumes 2 and 3 of this report contain technical papers prepared by technical specialists. The technical papers identify the key assumptions adopted by the technical specialists for their investigations into and assessment of the six route options.

2 Strategic context and project need

2.1 Strategic context

The overarching policies and strategic documents relevant to an additional crossing and to the Clarence Valley local government area are:

- *NSW 2021: A Plan to Make NSW Number One* (NSW Government, 2011)
- *NSW Long Term Transport Master Plan: Discussion paper* (TfNSW, 2012)
- *Mid North Coast Regional Strategy* (DP&I, 2009)
- *Far North Coast Regional Strategy* (DP&I, 2006)
- *Mid North Coast Farmland Mapping Project Final Recommendations Report* (DP&I, 2008)
- *Northern Rivers Regional Plan 2011* (Regional Development Australia – Northern Rivers, 2011)
- *Clarence Valley Settlement Strategy* (Grafton Council et al, 1999)
- *Clarence River Way Masterplan* (CVC and Clouston Associates, 2009)
- *Grafton Waterfront Precinct Masterplan* (CVC and Clouston Associates, 2011)
- *Bike Plan and Pedestrian Access and Mobility Plan* (CVC and QED, 2008)
- *Clarenza Cycleway Options Study* (CVC and Lewis Ford & Associates Consulting Engineers, 2012)
- *South Grafton Heights Precinct - A Strategy for the Future* (CVC, 2007)
- *Upgrading the Pacific Highway: Technical Review of Inland Corridor (via Summerland Way)* (RTA, 2006)
- Trans Regional Amalgamated Infrastructure Network (TRAIN), proposal submitted by Nation Building Australia TRAIN to Infrastructure Australia, 2008
- Ecologically sustainable development principles. Schedule 2, numeral 7 of the NSW *Environmental Planning and Assessment Regulation 2000*.

These documents are discussed below.

2.1.1 NSW 2021: A Plan to Make NSW Number One

NSW 2021: A Plan to Make NSW Number One (NSW Government, 2011) presents the NSW Government's strategy to move the State forward over the next 10 years. It is based on five principal strategies with underlying goals. The five strategies are to:

- Rebuild the economy – restore economic growth and establish NSW as the „first place in Australia to do business“
- Return quality services – provide the best transport, health, education, policing, justice and family services, with a focus on the customer
- Renovate infrastructure – build the infrastructure that makes a difference to both our economy and people's lives

- Strengthen our local environment and communities – improve people’s lives by protecting natural environments and building a strong sense of community
- Restore accountability to Government – talk honestly with the community, return planning powers to the community and give people a say on decisions that affect them.

The NSW 2021 goals relevant to transport under the plan are to reduce travel times, grow patronage on public transport by making it a more attractive choice, improve customer experience with transport services and improve road safety.

An additional crossing of the Clarence River at Grafton will support the NSW 2021 plan transport goals by reducing travel times between Grafton and South Grafton and improving road safety.

2.1.2 NSW Long Term Transport Master Plan

Transport for NSW (TfNSW) is in the process of drafting the *NSW Long Term Transport Master Plan* to address key transport challenges that face the State over the next 20 years and put the customer at the centre of everything NSW does in transport.

The draft plan is scheduled to be released for public comment mid-2012, with the final plan due for completion in November 2012.

Subsequent stages of the project will need to examine how the additional crossing will take into consideration the *NSW Long Term Transport Master Plan*.

2.1.3 Mid North Coast Regional Strategy

The *Mid North Coast Regional Strategy* (DP&I, 2009) provides a strategy to ensure that adequate land is available to accommodate the projected housing and employment needs of the NSW Mid North Coast region’s population over the next 25 years.

Grafton is identified in the strategy as a major regional centre and also has the greatest capacity for commercial redevelopment. It is expected to take the majority of future commercial development in the Clarence subregion. Other major regional centres in the Mid North Coast region are Coffs Harbour, Port Macquarie and Taree.

The strategy also identifies Junction Hill and Clarenza as „proposed urban release areas“.

An additional crossing of the Clarence River at Grafton would support the implementation of the *Mid North Coast Regional Strategy* (DP&I, 2009) as it would enhance the ability of Grafton to meet its functions as a major regional centre.

2.1.4 Far North Coast Regional Strategy

The *Far North Coast Regional Strategy* (DP&I, 2006) provides a strategy to manage the region’s expected high growth rate in a sustainable manner.

The strategy identifies the Pacific Highway and the Summerland Way as „two major north–south corridors“. It identifies Casino and Kyogle as towns providing levels of services and employment to support the surrounding villages and rural settlements. The strategy notes Casino and Kyogle are located on major transport routes with access to interstate road and rail networks.

An additional crossing of the Clarence River at Grafton acknowledges the *Far North Coast Regional Strategy* (DP&I, 2006) and the towns of Casino and Kyogle as settlements connected to Grafton via the Summerland Way.

2.1.5 Mid North Coast Farmland Mapping Project Final Recommendations Report

The *Mid North Coast Farmland Mapping Project Final Recommendations Report* (DP&I, 2008) aims to identify and protect regionally significant farmland from urban and rural residential encroachment and land use conflict with the aim of keeping the best agricultural land in the Mid North Coast region available for food production for the benefit of current and future generations.

Regionally significant farmland is defined as “land capable of sustained use for agricultural production with a reasonable level of inputs and which has the potential to contribute substantially to the ongoing productivity and prosperity of a region” (DP&I, 2008).

The process of identifying a preferred route option will consider the regionally significant farmland in the Grafton area as identified on maps in the *Mid North Coast Farmland Mapping Project Final Recommendations Report* (DP&I, 2008). See *Technical Paper: Social and Economic Issues* in Volume 2 for further details.

2.1.6 Northern Rivers Regional Plan 2011

The *Northern Rivers Regional Plan 2011* (Regional Development Australia – Northern Rivers, 2011) identifies regional issues, priorities and opportunities for the Northern Rivers region of NSW. The plan’s 2020 vision for the Northern Rivers region is “a healthy, prosperous and sustainable future for the communities of the Northern Rivers region” (Regional Development Australia – Northern Rivers, 2011).

One of the priority issues identified in the plan is transport and the need to increase investment in transport infrastructure to enhance economic development.

An additional crossing of the Clarence River at Grafton is consistent with the plan’s vision and would support the economic development in Grafton, South Grafton and surrounds.

2.1.7 Clarence Valley Settlement Strategy

The *Clarence Valley Settlement Strategy* (Grafton Council *et al*, 1999) provides a vision for how the Clarence Valley can grow sustainably over the next 20 years. It seeks to locate population growth in areas where it would have the least environmental, social and economic costs.

The strategy forecasts that most of the new growth in the Clarence Valley would be within the towns of Grafton and Maclean. The strategy recognises that such growth would increase traffic pressures over the existing bridge at Grafton.

An additional crossing of the Clarence River at Grafton would respond to the traffic demands of the existing population and forecast growth areas of Grafton and South Grafton while alleviating the traffic pressure over the existing bridge.

2.1.8 Clarence River Way Masterplan

The *Clarence River Way Masterplan* (CVC and Clouston Associates, 2009) is a tourism and infrastructure investment program aiming to position the Clarence River as one of the nation’s great river experiences.

One of the masterplan strategies is to reposition Grafton as a „River City“ tourist destination by completing the following projects:

- Re-orient the city to the river, including both Grafton and South Grafton.
- Create a sense of arrival with a gateway statement that enhances first impressions of Grafton from the Pacific Highway and simplifies decision-making.
- Improve the cityscape through investment in a main street program for the CBD, but primarily Prince Street for its waterfront linkage and Fitzroy Street for its role in providing a gateway to the town and creating positive first impressions for visitors.
- Promote the development of a waterfront precinct adjacent to the town centre. Focus on the redevelopment and vitalisation of the core river edge from Queen Street to below the Grafton Bridge.
- Improve the presentation of retail and commercial areas for tourism.
- Encourage extended trading hours for restaurants and cafes.
- Facilitate investment in new infrastructure and improve accommodation presentation levels to meet expectations of target markets.
- Investigate options for development of the State Rail Authority land on the river“s edge on both sides of the river as public parkland.
- Through negotiation with private landholders, investigate options to provide safe public waterfront access or easements that respect privacy and security.
- Improve public access to the waterfront through existing public open space.

The masterplan also identifies the potential for a marina integrated with the redevelopment of the Kemp Street bowling club and a jetty/pontoon immediately downstream of the existing bridge in Grafton.

The process of identifying a preferred route option will consider the *Clarence River Way Masterplan*.

2.1.9 Grafton Waterfront Precinct Masterplan

The *Grafton Waterfront Precinct Masterplan* (CVC and Clouston Associates, 2011) proposes a revitalisation program for the river edge area between Queen Street and the Grafton Bridge, Grafton. This area covers the existing rowing club, sailing club, Memorial Park and a substantial portion of privately owned land in front of residential and church properties.

The process of identifying a preferred route option will consider the masterplan.

2.1.10 Bike Plan and Pedestrian Access and Mobility Plan

Clarence Valley Council“s *Bike Plan and Pedestrian Access and Mobility Plan* (CVC and QED, 2008) is a comprehensive strategic approach to identifying a cycling and pedestrian network. The plan“s objectives are to:

- Increase use of the bike and pedestrian network for short trips
- Reduce the number of missing links and severance within the bike and pedestrian network

- Reduce the number of bike and pedestrian accidents
- Improve connectivity with other transport modes, particularly bus, car and train
- Provide pedestrian facilities that cater for the needs of all pedestrians including people with disabilities, commuters, children, seniors and recreational walkers
- Meet obligations under the *Commonwealth Disability Discrimination Act 1996* and Disability Standards for Accessible Public Transport
- Link with Safer Routes to Schools projects
- Allow the bike and pedestrian networks to complement each other (both existing and planned networks).

An additional crossing of the Clarence River at Grafton has the potential to complement the *Bike Plan and Pedestrian Access and Mobility Plan* (CVC and QED, 2008) by providing an additional pedestrian and cyclist connection over the Clarence River.

2.1.11 Clarenza Cycleway Options Study

The *Clarenza Cycleway Options Study* (CVC and Lewis Ford & Associates Consulting Engineers, 2012) identifies and assesses route options for the construction of a shared footpath/cycleway facility between the existing shared path north of the South Grafton Railway Station and the McAuley Catholic College in Hennessy Drive, off the Pacific Highway at Clarenza.

The study presents a route between South Grafton Railway Station and the Pacific Highway (near Bunnings Warehouse), four route options between the Pacific Highway (near Bunnings Warehouse) and the South Grafton Levee Crossing and two route options between the levee crossing and the McAuley Catholic College.

At its meeting in June 2012, Council adopted an alignment for the cycleway and decided to commence discussions with RMS on the options of a bridge or tunnel crossing of the existing Pacific Highway.

An additional crossing over the Clarence River would complement any footpath/cycleway to Clarenza by providing a footpath/cycleway on the new bridge which would have the potential to be linked to the Clarenza cycleway.

2.1.12 South Grafton Heights Precinct - A Strategy for the Future

The *South Grafton Heights Precinct - A Strategy for the Future* (CVC, 2007) aims to:

- Identify areas in South Grafton for future residential development
- Ensure that future residential development is compatible with local character and amenity
- Ensure that future residential development and planning provisions have regard to relevant legislation and contemporary guidelines
- Provide strategic planning input into the Clarence Valley local growth management strategy.

The strategy provides for over 700 lots for residential development to about the year 2030 in the South Grafton Heights Precinct located on Bent Street, South Grafton.

Clarence Valley Council updated the strategy in November 2011 to enable a change of zoning on part of the Grafton and District Golf Course site. The proposed zone is Rural (Residential) or

similar with the intention to enable development of large residential lots consistent with the rural-residential allotments on the opposite side of Bent Street. The amended strategy was placed on public exhibition between February and March 2012. The *Clarence Valley Local Environmental Plan 2011* (CVLEP, December 2011) includes an update of the zoning around the golf course. Part of the RE2 (Private Recreation) has been rezoned to R5 (Large Lot Residential).

An additional river crossing has the potential to provide an additional transport link over the Clarence River that would meet the future transport demands generated by the *South Grafton Heights Precinct - A Strategy for the Future* (CVC, 2007) development.

2.1.13 Upgrading the Pacific Highway: Technical Review of Inland Corridor (via Summerland Way)

Upgrading the Pacific Highway: Technical Review of Inland Corridor (via Summerland Way) (RTA, 2006) is a strategic document that reviews an inland transport corridor as an alternative to the Pacific Highway between Grafton and Tyagarah/Ewingsdale. The technical review consists of an assessment of two alternative inland routes and compares the outcomes of the assessment against the outcomes of planning investigations for upgrading the Pacific Highway between Grafton and Tyagarah/Ewingsdale.

The technical review concludes that the inland corridor is not a viable alternative to upgrading the Pacific Highway because:

- It would not take significant traffic off the Pacific Highway
- The traffic that would use the Summerland Way would not justify the cost of the upgrade
- It would cost more than the Pacific Highway upgrade
- The Pacific Highway would require upgrading even if the Summerland Way were upgraded
- The majority of traffic remaining on the Pacific Highway would require continuing investment to upgrade the highway even if the inland corridor were built
- It would have to be completed in one stage, which means that other sections of the Pacific Highway identified for upgrade would be delayed.

While the report does not identify the Summerland Way as the preferred transport corridor, it remains a State road. The additional crossing of the Clarence River at Grafton has the potential to improve access to the State road network as well as addressing local traffic issues by responding to the existing and future local transport demands between Grafton and South Grafton.

2.1.14 Trans Regional Amalgamated Infrastructure Network (TRAIN)

The Trans Regional Amalgamated Infrastructure Network (TRAIN) proposal is for a network of road, rail and water infrastructure covering a large area of north-eastern NSW and south-eastern Queensland.

The TRAIN proposal was one of 59 projects submitted in 2011 to Infrastructure Australia for consideration and assessment, as noted in *Communicating the Imperative for Action* report to the Council of Australian Governments (Infrastructure Australia, June 2011). However, the TRAIN proposal was not one of the 47 projects that were included in the 2011 Infrastructure priority list in Appendix C of the report. Six of the projects on the priority list (including the upgrade of the Pacific Highway) were identified as „Ready to Proceed“ projects while another seven projects were recommended for project development funding.

The TRAIN proposal is not included in the 42 project submissions listed in the 2012 report *Infrastructure Australia Progress and Action* (Infrastructure Australia, June 2012), and is not included in the 2012 Infrastructure priority list in Appendix D of the report. The Pacific Highway upgrades remain on the 2012 Infrastructure priority list under the „Ready to Proceed“ category.

2.1.15 Ecologically sustainable development principles

Application of the ecologically sustainable development principles began through the identification of constraints relevant to the additional crossing. These constraints guided the development of preliminary route options and the selection of the short-list of route options. Social, environmental, economic and engineering design evaluation criteria used in the project also reflect the ecologically sustainable development principles outlined below.

Schedule 2, numeral 7 of the NSW *Environmental Planning and Assessment Regulation 2000* defines the ecologically sustainable development principles as follows:

- a) **The precautionary principle**, namely, that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:
 - i. careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment
 - ii. an assessment of the risk-weighted consequences of various options
- b) **Inter-generational equity**, namely, that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations
- c) **Conservation of biological diversity and ecological integrity**, namely, that conservation of biological diversity and ecological integrity should be a fundamental consideration
- d) **Improved valuation, pricing and incentive mechanisms**, namely, that environmental factors should be included in the valuation of assets and services, such as:
 - i. polluter pays, that is, those who generate pollution and waste should bear the cost of containment, avoidance or abatement
 - ii. the users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste
 - iii. environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms, that enable those best placed to maximise benefits or minimise costs to develop their own solutions and responses to environmental problems.

Further, under Section 3A of the *Environment Protection Biodiversity Conservation Act 1999*, the principles of ecologically sustainable development require:

- Decision-making processes to effectively integrate both long-term and short-term environmental, economic, social and equitable considerations
- Consideration of the precautionary principle
- Consideration of inter-generational equity

- Conservation of biological diversity and ecological integrity
- Improved valuation, pricing and incentive mechanisms to be considered.

The ecologically sustainable development principles have also been used during the assessment of the route options as documented in this report and will continue to be considered during the concept and detailed design, construction, operation and decommissioning stages of the project.

2.2 The need for an additional crossing

Investigations into the traffic situation in the Grafton area show congestion and traffic delays over the existing bridge and approach roads, particularly during morning and afternoon peak hours. Traffic studies presented in this report show that the majority of traffic that causes congestion and traffic delays is traffic with an origin and/or destination in Grafton or South Grafton. This situation is discussed in detail in the *Preliminary Route Options Report – Final* (RMS, January 2012).

It is likely that future traffic growth will add to the existing congestion in peak hours, which in turn will decrease the average travel speed and increase travel times. This scenario will result in a reduced level of service on the existing bridge.

Microsimulation traffic modelling carried out as part of the route options assessment (detailed in *Technical Paper: Traffic Assessment* in Volume 2) has shown that future year traffic demands would exceed the capacity of the existing bridge by 2029 and beyond.

The need for an additional crossing of the Clarence River at Grafton is largely due to:

- Traffic counts undertaken in August 2010 indicate that the bridge was carrying 1360 vehicles per hour in the northbound direction for the AM peak and 1330 vehicles per hour in the southbound direction for the PM peak. *Guide to Traffic Management Part 3: Traffic studies and analysis* (Austroads, 2009) indicates that the theoretical capacity of the bridge could be considered to be in the range of 900 to 1400 vehicles per lane per hour. Based on the traffic flows recorded on the bridge and the information set out in the Austroads guide, it is apparent that the peak hour traffic flows across the bridge are at, or very close to, the practical capacity of the bridge.
- Existing traffic congestion associated with the existing bridge and the resultant flow affecting the Grafton community. Observed travel times of trips undertaken in surveys in 2008 and 2011 from the intersection of Bent Street and Gwydir Highway in South Grafton and the intersection of Fitzroy Street and Villiers Street in Grafton are shown in Table 2 below. These travel times are also reported in the *Technical Paper: Traffic Assessment* in Volume 2 for use in calibration of the microsimulation model.

Table 2: Average travel time and speed between Bent Street/Gwydir Highway and Fitzroy Street/Villiers Street (based on surveys in 2008 and 2011)

Direction	AM peak period (8-9am)		PM peak period (4-5pm)	
	Average travel time (seconds)	Average speed (km/h)	Average travel time (seconds)	Average speed (km/h)
Southbound	172 ⁽¹⁾	40.1	303 ⁽²⁾	22.8
Northbound	355 ⁽¹⁾	19.4	204 ⁽³⁾	33.8

(1) Average travel time based on 2011 survey

(2) Due to minimal travel time data recorded for the southbound route in the PM peak, a combination of the 2008 and 2011 travel time data has been used to determine the average observed travel time.

(3) 2011 travel time data was not observed on the northbound route in the PM peak and as such 2008 travel time data has been used to validate the route in the PM peak.

Note: Additional travel time surveys were undertaken by RMS in February and March 2012 when a vehicle was driven through the traffic stream. Typical recorded travel times between the Bent Street/Gwydir Highway intersection, South Grafton and Prince Street/Pound Street intersection, Grafton in the morning (AM) peak were between eight and 10 minutes.

- This is the only crossing of the Clarence River for the Summerland Way and in the Grafton area. All trips between Grafton and South Grafton including local and through trips use the existing bridge as there is no practical alternative. This problem is currently exacerbated when the Pacific Highway is closed due to road traffic accidents or flooding.
- Growth and development in the Grafton area. Population forecasts over the next 30 years indicate substantial growth in both the Grafton area (50 per cent increase) and surrounding areas (109 per cent increase) as reported in the *Preliminary Route Options Report – Final* (RMS, January 2012). The population growth forecasts are presented in Table 3 below. This is expected to increase the demand for the bridge crossing and contribute to further congestion. Current traffic delays in peak periods potentially affect people's travel behaviour and daily activity patterns and as a result may be constraining development.

Table 3: Forecast population growth in Grafton and surrounds

Location	Year			
	2010	2021	2031	2041
Grafton	10,761	11,255	11,255	11,255
Junction Hill	1015	2250	3455	3455
South Grafton	6065	6806	7601	7601
Clarenza	684	1610	2514	5418
Total	18,525	21,921	24,825	27,729
Other areas				
Townsend, Maclean, James Creek, Gulmarrad	4800	6800	8800	8800
Coutts Crossing	613	786	955	955
Waterview Heights	769	1974	3150	3150
Total other areas	6182	9560	12,905	12,905

Source: CVC 2011.

Note: CVC advised projections up to year 2031. The 2041 projections are extrapolations based on the trends up to year 2031.

- The geometry of the existing bridge and resultant traffic constraints and safety issues. Significant queuing and delays occur on the bridge approaches as the two lanes of traffic (in each direction) approaching the bridge, Fitzroy Street southbound and Bent Street northbound, must merge into a single lane on the bridge. The configuration of the bridge also introduces conflict with heavy vehicles. The safety implications of the shape of the existing bridge (the “kinks”) and the traffic delays and congestion that the kinks create, also impact on the need for an additional crossing. Long, heavy vehicles cannot negotiate the kinks without crossing the centrelines. This creates a risk of traffic crashes and also causes traffic in either direction to slow, which increases congestion and delays.
- The current B-double ban on the existing bridge during peak periods, restricts freight movement.
- The existing bridge and approach roads do not facilitate the economic viability of the South Grafton business area (Skinner Street).
- Deterioration in network performance increases the economic cost of travel. Significant increases in trip costs can change travel behaviour, particularly for commercial trips.

3 Community involvement and feedback

This chapter summarises the community involvement and feedback activities undertaken to date and upcoming activities for the project.

A revised approach to engage more effectively with the community and stakeholders in identifying a preferred route for an additional crossing was announced in December 2010.

The revised approach was developed in response to sections of the community asking the then Minister for Roads and RMS to reconsider options for a second bridge as well as raising concerns about the basis and justification for identifying the four preliminary route options announced in February 2010.

Clarence Valley Council wrote to the Minister for Roads in September 2010 to ask that RMS survey the people of Grafton and surrounds about the location of a second crossing.

In December 2010, RMS made a commitment to undertake a process that would be transparent, involve all residents and stakeholders and make information available at the appropriate times, and not afterwards. The community update also identified 13 preliminary options, including the additional nine options suggested by the community since the announcement of the four preliminary route options in February 2010.

Following the announcement of the revised approach in December 2010, RMS undertook three community surveys to gauge the views of residents and businesses regarding the additional crossing of the Clarence River at Grafton.

Key issues that came out of these surveys as important to the community included:

- Improving traffic efficiency
- Reducing heavy vehicle movements
- Considering the impact on residential areas
- Minimising impacts on the environment, including the heritage and amenity of Grafton
- Enhancing safety for all road users
- Catering for additional commuter and heavy vehicle traffic in the future
- Resolving the traffic congestion currently being experienced
- Supporting the role of Grafton CBD as Clarence Valley's prime retail and service centre
- Improving efficiencies between manufacturers/processors and their suppliers
- Increased ease of access for delivery vehicles into the CBD
- Facilitating the development of new employment lands or business hubs
- Reduction of business-related travel times.

A summary of the community surveys was provided in the June 2011 community update. The postal, phone and business survey reports are available on the project website or by contacting the project team.

The surveys included an additional 28 community suggestions for the location of the additional crossing, bringing the total number of suggestions to 41. At community forums in March 2011,

RMS advised that the 41 suggested locations would be assessed for their feasibility, to identify those options that would be further considered and investigated.

In June 2011, RMS issued a community update and the *Feasibility Assessment Report* which identified 25 preliminary route options within five strategic corridors to go forward for further engineering and environmental investigations.

The *Preliminary Route Options Report* was issued in three parts:

- Part 1, issued in August 2011, describes the existing environment in the Grafton area and potential issues and constraints relevant to an additional crossing of the river
- Part 2, issued in October 2011, assesses the 25 preliminary route options against the issues and constraints in the Grafton area
- Part 3, issued in January 2012, identifies the six short-listed options and the process to identify the options, including community consultation activities and the stakeholder evaluation workshop.

Four of the six short-listed options have been developed from suggestions received from the community. Option E was suggested following the identification of the four preliminary route options in February 2010 and Options 11, 14 and 15 were included in the 28 suggestions in the surveys undertaken following the announcement of the revised approach in December 2010.

Community feedback and issues have been considered at each stage of the project process.

Letters, emails and phone calls received by the project team that raise issues and questions relevant to an additional crossing of the Clarence River are considered by the project team and responded to individually. Consultation is also captured in the project's consultation database.

Community feedback received will assist the project team in gaining an understanding of the community's views on key issues regarding the preferred location for an additional river crossing.

3.1 Community involvement activities prior to the announcement of the short-list of route options

Between December 2010 and December 2011, the following community involvement and feedback activities were carried out for the selection of the short-list of route options:

- December 2010 – community update and associated staffed displays
- December 2010 to May 2011 – community surveys (postal, telephone and business surveys)
- March 2011 – community forums
- June 2011 – community update and forums
- August 2011 – *Preliminary Route Options Report - Part 1*, for comment
- August 2011 – information and feedback sessions
- October 2011 – *Preliminary Route Options Report - Parts 1 and 2*, for comment
- October 2011 – community update
- November 2011 – information and feedback sessions
- November 2011 – community and stakeholder evaluation workshop.

The outcomes of the surveys and the feedback received from these activities have been documented and are available on the project website and as part of the *Preliminary Route Options Report - Final* which was released in January 2012.

3.2 Community and stakeholder consultation since the announcement of the short-list of route options

The six route options as discussed in Chapter 4 were announced in January 2012. Community and stakeholder consultation undertaken since this announcement has included:

- January 2012 – community update
- February 2012 – staffed displays
- Consultation with stakeholders and community members.

These activities are outlined below.

3.2.1 January 2012 community update

A community update was posted to Grafton area residents in January 2012 to announce the six route options for further investigation.

The update also announced the release of the *Preliminary Route Options Report – Final* (RMS, January 2012) and informed the public that field investigations were to be undertaken on the short-listed options including survey work, geotechnical investigations, flora and fauna studies, traffic surveys, and examination of Aboriginal and non-Aboriginal heritage.

3.2.2 Staffed displays

The project team attended displays of the six route options on Tuesday 7 February 2012 at:

- Grafton Shopping World (10am to 5pm)
- Bi-Lo Shopping Complex (2pm to 5pm).

Members of the community had the opportunity to speak with members of the project team. About 80 community members attended the displays.

3.2.3 Stakeholder consultation

RMS carried out consultation with a number of stakeholders within the project area as summarised in Table 4.

A register of all meetings undertaken as part of the project is provided on the project website www.rms.nsw.gov.au/grafonbridge.

Table 4: Stakeholder consultation summary

Stakeholder	Consultation date	Topics discussed
Grafton Concerned Citizens Group	January 2012	The Grafton Concerned Citizens Group raised their concerns about the following: <ul style="list-style-type: none"> • Technical assessments and studies • Short-listing process and next steps • Consultation process • Project objectives
RMS (Maritime), Clarence River Sailing Club, Big River Sky Club, Bridge to Bridge ski race, Clarence River Yacht Club and Clarence Valley Council	January 2012	<ul style="list-style-type: none"> • Short-list of route options • Horizontal and vertical clearances for the navigable channel • Piers must be aligned with the existing bridge wherever feasible and reasonable • Minimum span recommended for horizontal clearance for each option • Sufficient vertical clearance for downstream options • Potential safety issues for options in close proximity to the existing bridge • Impacts on Corcoran Park
Aboriginal Community	February 2012	<ul style="list-style-type: none"> • Project status • Geotechnical investigations • Upcoming site inspections to inform the preparation of this report • GNLALC requested to inspect the ARTC land between the existing bridge and Iolanthe St and the route followed by Options 11, 14 and 15 in South Grafton
	February 2012 site inspections along route options	Representatives provided feedback on the Aboriginal cultural heritage value of the areas crossed by the route options and information about Tracker Robinson.
	April 2012 two site inspections covering ARTC land between the existing bridge and Iolanthe St and Tracker Robinson site	Representatives provided further feedback on the Aboriginal cultural heritage value of the lands inspected.
Clarence Valley Council	February 2012	Council reviewed the short-list of route options and provided advice about issues to consider for design refinements.
State Emergency Service	March 2012	A second crossing in any of the six route option locations would bring improvements to the emergency service function as all options assist with moving people out of Grafton faster by providing an opportunity to increase vehicle flows out of town.
Summerland Way Promotional Committee	June 2012	The project team provided an update on the project, including traffic data, the announcement of the six short-listed options and the next steps in the process to identify a recommended preferred route option.
Potentially affected residents	Various	<ul style="list-style-type: none"> • Concerns and queries regarding the options selection process • The process to select the short-list of route options • Traffic demand management • Property impacts • Amenity impacts • Property acquisition

Note: Aboriginal consultation is being carried out in accordance with RMS Procedure for Aboriginal Cultural Heritage Consultation and Investigation (PACHCI). A detailed description of the Aboriginal community consultation activities undertaken since the announcement of the short-list of route options is presented in the *Technical Paper: Aboriginal Heritage* in Volume 2.

3.2.4 Feedback received between January and June 2012

A summary of the feedback received between January and June 2012 is provided in Appendix 1. The main issues raised by the community since the announcement of the six short-listed options include:

- Traffic – traffic congestion in the CBD and Grafton area
- Planning – concerns about avoiding impacts in residential areas, avoiding flood-prone areas, and removing heavy vehicles from the centre of town
- Social impacts – concerns about property acquisitions and amenity
- Economic impacts – concerns about property devaluation
- Design – the need to design for flood protection
- Community consultation – concerns about the process
- Environment – concerns about flooding, mature trees and heritage buildings.

These issues along with further community feedback received on the short-listed options will be considered before a decision is made on a recommended preferred route option.

3.3 Future community and stakeholder involvement activities

Upcoming community involvement activities include:

- Display of this report and associated technical papers for community comment
- Staffed displays and information sessions
- Public forum
- Talk-back radio discussion.

Community comments are encouraged. These can be provided by email to graftonbridge@rms.nsw.gov.au, write to Grafton Bridge project, PO Box 546, Grafton NSW 2460, phone 1800 633 332 (free toll) or visit the shop front at the Pacific Highway office on 21 Prince Street, Grafton.

A value management workshop (a facilitated workshop with participants from the project team, Council, government agencies, other key stakeholders and the community) will be held following the display of this report. The workshop will assess the six route options based on the outcomes of the technical and environmental investigations summarised in this report and the issues raised in the submissions received from the display of the report.

The investigations undertaken, community comments received on the route options, and the outcomes of the value management workshop will input into a decision on the recommended preferred route option.

Community feedback on the recommended preferred route option will be considered before a final decision is made on the preferred option for an additional crossing of the Clarence River at Grafton. Community involvement will continue.

4 Route options

This chapter describes the existing bridge and its required maintenance. It also summarises the process followed for selection of the six route options and then describes the further design development and refinement of these route options.

4.1 Existing bridge

Approval for the design and construction of the existing bridge was granted in 1915. The bridge was originally intended to carry a railway and a footway. It was designed to accommodate two rail tracks, but only one was installed. The design included a moveable span („bascule“) to allow clearance for river navigation. In 1922, when design was well advanced, the then Minister for Works requested that the design be amended to include vehicular traffic in addition to the railway and pedestrian traffic. The addition of the upper roadway deck resulted in kinks at each end of the main bridge where the roadway diverts away from the railway. The bridge was completed and opened to traffic in 1932.

The Grafton Rail and Road Bridge over the Clarence River, shown in Figure 4, is listed on the State Heritage Register (SHR). The listing boundary for the item includes the structure, the piers, abutment and track formation for a distance of 10 metres in all directions from those elements (SHR No. 01036). As noted in the *Statement of Heritage Impact* (RTA, March 2005) the bridge exhibits significant technical characteristics. The bascule span of the bridge is of an unusual type in Australia and although no longer in use, is the largest railway bascule built in Australia. The bridge is the second to last steel truss rail bridge built in NSW and was constructed at the height of popularity of this type of bridge. The bridge is the only one in NSW to carry road and rail traffic on two separate levels and is unique in that rail signals were originally used to control road traffic.

The bridge is an important icon for both the local and regional communities. The bridge retains an important role for the present day community both in a functional sense and as a strong reminder of the history of the area.

The visual relationship between Grafton and the Clarence River is also fundamental to the urban experience of the town. As the dominant visual feature on the river, the bridge is a key urban landmark that contributes significantly to the identity of the town.



Figure 4: Grafton Bridge from Fitzroy Street

4.2 Bridge maintenance

Inspections, maintenance, repairs and rehabilitation of the existing bridge are carried out by Australian Rail Track Corporation Ltd (ARTC) and RMS via a partnership agreement signed in August 2010. This agreement is scheduled to be reviewed in 2016. The bridge inspections program can be summarised as follows:

- Visual inspections: Detailed inspections every two years by trained bridge inspectors
- Engineering inspections: Undertaken by bridge engineers and inspection teams every six years and includes detailed structural analysis
- Approach spans inspections: Undertaken every six years as per engineering inspections
- Underwater dive inspection: Undertaken by professional dive teams every four years to assess the underwater structural condition of the bridge piers.

The bridge structure maintenance work is carried out by ARTC, and maintenance of the road deck, road surface, approach spans and the footway is carried out by RMS. RMS mechanically sweeps the bridge road surface fortnightly, and undertakes maintenance inspections every six months with minor bridge maintenance works occurring regularly. Both RMS and ARTC have agreed the scope and methodology for maintenance, repairs and rehabilitation works for the bridge.

4.3 Identification of the short-list of route options

As outlined earlier, in December 2010 RMS announced a revised approach to engage more effectively with the community and stakeholders in identifying a preferred route for an additional crossing. A community update issued in December 2010 identified 13 preliminary route options, including options suggested by the community, and invited community comment via a postal survey. Subsequent phone and business surveys were also carried out.

A total of 437 responses to the postal survey were received between 6 December 2010 and 8 March 2011. Respondents to the postal survey identified a total of 28 additional suggestions for the additional crossing. These, together with the 13 identified in the December 2010 community update, brought the total number of suggestions for an additional crossing to 41.

In June 2011, RMS published the *Feasibility Assessment Report* which describes the assessment undertaken on the 41 suggestions identified following the December 2010 to March 2011 community consultation period. Twenty-five preliminary route options in five corridors were identified for engineering and environmental investigation.

Following the release of the June 2011 *Feasibility Assessment Report*, the project team undertook engineering refinements on the 25 preliminary route options. A comparative assessment process was also undertaken to identify the best option or options within each corridor. The outcomes of the technical investigations, community feedback, and the community and stakeholder evaluation workshop provided the inputs to the short-listing process.

In January 2012, six route options were announced for further investigation. The short-listing process is documented in the *Preliminary Route Options Report – Final* (RMS, January 2012).

4.4 Development of route options

Since the announcement of the six short-listed route options in January 2012, further design development and refinement of the route options has been carried out. The purpose was to develop the design of each option ensuring that the layouts would meet the broad project

objectives in terms of traffic capacity, functionality, and compliance with RMS technical requirements while also addressing to the extent possible the constraints and opportunities identified in the earlier investigations and feedback from the *Preliminary Route Options Report - Final* (RMS, January 2012).

The intent was to develop the design and layout of each option in sufficient detail to allow further investigations to be carried out as described in Chapter 5, and subsequently to allow the comparative assessment of the route options as described in Chapter 6.

The development of the route options was informed by input from the traffic modelling, RMS design guidelines, geotechnical surveys, safety assessments and the locations of major public utilities. The traffic modelling was the critical input since it defined the extent of layout improvements and upgrades necessary for each option to meet the key project objective and supporting objective related to traffic efficiency:

Project Objective: Improve traffic efficiency between and within Grafton and South Grafton.

Supporting objective: Provide a traffic management network which reduces delays between Grafton and South Grafton in peak periods to an acceptable level of service for 30 years after opening.

The key features of the six route options are summarised in Table 5 and descriptions of the options are presented in the following chapters (ordered from upstream to downstream). Where design refinements have been made since the announcement of the six short-listed route options, the refinements have been described.

Table 5: Route options

Option	Summary of the location in relation to existing bridge	Connection	River bridge length (m)	Viaduct length (including minor waterway structures) (m)	Traffic lane arrangement for new bridge	Traffic lanes arrangement for existing bridge	Pedestrian/ cyclist shared path location	Minimum maritime clearance for the navigable channel (m) as agreed with NSW Maritime (now part of RMS)*	
								Horizontal	Vertical
E	Upstream	Cowan St, South Grafton to Villiers St, Grafton	618	68	1 northbound lane and 1 southbound lane	1 northbound lane and 1 southbound lane	Downstream side of bridge	2 clear channels of 35 m each	9.1
A	Upstream	New bridge parallel to and immediately upstream of the existing bridge connecting Bent St, South Grafton and Fitzroy St, Grafton	471	145	2 northbound lanes and 1 southbound lane	1 southbound lane	Upstream side of bridge	2 clear channels of 35 m each	9.1
C	Downstream	Junction of the Pacific Hwy and the Gwydir Hwy, South Grafton to Pound St, Grafton	458	122	1 northbound lane and 1 southbound lane	1 northbound lane and 1 southbound lane	Upstream side of bridge	2 clear channels of 35 m each	9.1
11	Downstream	The existing Pacific Hwy north of South Grafton to Fry St, Grafton	387	450	1 northbound lane and 1 southbound lane	1 northbound lane and 1 southbound lane	Upstream side of bridge	2 clear channels of 35 m each	17
14	Downstream	The existing Pacific Hwy north of South Grafton to North St, Grafton, via Kirchner St	617	1068	1 northbound lane and 1 southbound lane	1 northbound lane and 1 southbound lane	Upstream side of bridge	2 clear channels of 35 m each	17
15	Downstream	The existing Pacific Hwy north of South Grafton to the Summerland Way north of Grafton, via Kirchner St	617	1128	1 northbound lane and 1 southbound lane	1 northbound lane and 1 southbound lane	Upstream side of bridge	2 clear channels of 35 m each	17

* As agreed with NSW Maritime (now part of RMS), refer to Chapter 4.5.

4.4.1 Traffic modelling

The objective of the traffic modelling was to allow an understanding of the road network performance of the route options on initial opening as well as their ability to cater for future traffic growth. It involved the development of a microsimulation traffic model to individually model vehicles within the road network for each route option. Base year 2011 AM and PM peak period models were prepared for each option along with AM and PM peak period models for 2019, 2029, 2039, 2049. The three hour periods between 7-10am and 4-7pm were modelled and showed that the most critical hour is 8-9am in the AM and 4-5pm in the PM.

The microsimulation traffic model covers the Grafton and South Grafton areas. It enables a realistic representation of driver behaviour such as overtaking and lane changing and can also illustrate network performance. As such, microsimulation enables a more detailed investigation of traffic conditions than the strategic model.

Key inputs used to set up the model were:

- Growth forecasts as developed by Clarence Valley Council and the Department of Planning and Infrastructure (as documented in the *Mid North Coast Regional Strategy* (DP&I, 2009))
- Traffic counts and travel time surveys
- Road network characteristics (lanes, speeds, intersection types etc).

The key assumptions inherent in the modelling are as described in Chapter 1.5 and in the *Technical Paper: Traffic Assessment*. They include for example the assumption for modelling purposes of opening the additional crossing in 2019 and also that the Glenugie to Tyndale upgrade of the Pacific Highway (which bypasses South Grafton) will be open to traffic by 2019.

The approach used was to firstly model each option in 2049 to determine the extent of road network upgrades and intersection improvements that would be necessary to provide an acceptable level of service for 30 years after opening. Once these network improvements were established, the road layouts corresponding to the required improvements were developed as described in Chapter 4.4.5. Using these developed layouts, the traffic models were then run for the years 2019, 2029, 2039 and 2049 to assess the performance of the network for each option in the corresponding year.

In addition, it was necessary to establish base year (2011) and „do minimum“ models. There are several reasons for needing to establish these models:

- To allow a comparison of the traffic model of the base year (2011) model with existing road layouts and existing traffic volumes against the observed traffic conditions. It allows calibration and validation of the traffic model to ensure that it reasonably reflects the actual network performance.
- To allow modelling of traffic growth on the existing road network without an additional crossing, as a means of confirming the need and justification of an additional crossing.
- To allow the comparison of options to take into account the effects of any other road network improvements that are committed and expected to be built whether or not an additional river crossing goes ahead. In this case committed works include the Glenugie to Tyndale upgrade of the Pacific Highway, which has been assumed to be in operation by 2019.
- To provide a baseline for the economic evaluation of the route options, allowing the road user benefits of building each option to be estimated.

The base year (2011) model was developed to accurately reflect the current operating conditions of the network. It was calibrated and validated to industry standard guidelines that compare modelled and observed traffic data as well as a visual assessment of operating conditions, including vehicle queues. Traditionally a „do minimum“ model would be established for all forecast years, in this case 2019, 2029, 2039 and 2049. However, modelling of the „do minimum“ identified that the cross-river traffic demand exceeded the capacity of a single bridge by 2029, and only a 2019 „do minimum“ model was able to be established. The approach to the economic evaluation has been adapted to suit, as discussed in the *Technical Paper: Economic Evaluation* in Volume 2.

The „do minimum“ modelling also identified several localised network improvements that would be required to meet the 2019 traffic demands. The four network improvements required for the „do minimum“ base case are described below. These improvements are also required as part of the infrastructure improvements needed for the route options to function in 2049.

- Upgrading Pound Street to two traffic lanes in each direction between Villiers Street and Prince Street
- Upgrading of Gwydir Highway to two traffic lanes in each direction between the Pacific Highway and Bent Street
- Upgrading of the Villiers Street and Dobie Street roundabout to improve turning movements for heavy vehicles
- Upgrading of the Gwydir Highway and Skinner Street roundabout from a single lane roundabout to a two lane roundabout.

The microsimulation model established the „do minimum“ model through to 2019 and determined the traffic performance for each of the route options in 2019, 2029, 2039 and 2049. The traffic microsimulation modelling results are documented in the *Technical Paper: Traffic Assessment* in Volume 2. The outcomes of the traffic modelling are discussed in Chapter 6.1.

4.4.2 Geotechnical investigations

Geotechnical investigations included:

- A review of information on existing ground conditions available and relevant to the route options.
- Borehole drilling at six locations and laboratory testing analysis to supplement existing data.
- Gravity survey for Options 11, 14 and 15. A gravity survey explores the gravitational field at a series of different locations along each route option to associate variations with differences in the distribution of densities and, hence, rock types. The survey helps the project team to understand the likely ground conditions along each route option.
- Ground conditions characterisation at each borehole location and along the lines of the gravity surveys.

The findings of the geotechnical investigations have been considered in the engineering design and costing of each option.

The geotechnical investigations undertaken for the route options are documented in the *Technical Paper: Geotechnical Assessment for Route Options* in Volume 3.

4.4.3 Preliminary flooding investigations

One of the supporting objectives for the project is to provide flood immunity for the proposed bridge for a 100-year Average Recurrence Interval (ARI) design flood event, and for the approach roads for a 20-year ARI design flood event, where economically justified.

Preliminary flooding investigations were carried out in order to identify for each option the waterway opening requirements necessary to meet this supporting objective and to minimise any adverse impacts on the existing flooding regime.

Waterway opening widths, waterway area requirements and approximate flood levels were identified for the main river crossing, viaducts across the flood plains and the minor creek crossings. These requirements were informed by the flooding investigations and are documented in the *Technical Paper: Flooding Assessment* in Volume 3.

Identification of these requirements allowed the approach road levels and bridge and viaduct soffit levels to be set. It also allowed the minimum lengths of the main river bridge, the approach viaducts and the minor creek crossing to be better defined.

4.4.4 Public utilities

Existing public utilities and services within or close to the route options were identified and mapped. Public utility providers were also consulted to identify any future utility infrastructure development that could potentially impact on the route options.

The 132 kilovolt crossing at Elizabeth Island, which forms part of TransGrid's infrastructure, provides clearance for a maximum allowable vessel height of 17 metres on the western arm and 21 metres on the eastern arm of Elizabeth Island in accordance with *Crossings of NSW Navigable Waters: Electricity Industry Code* (NSW Maritime, 2011) and AS6947-2009.

Information gathered has been considered in the engineering design of the options and in the strategic cost estimates.

4.4.5 Design development

As described in Chapter 4.4.1, the traffic modelling identified the extent of road network upgrades and intersection improvements that would be required for 2049. Using the intersection upgrades and lane configurations identified by the modelling to meet the 2049 traffic demands, the design of each option was then developed. This design development process was informed by a number of other design inputs and the designs were refined by an iterative process as they were developed to best address the other design constraints and opportunities including:

- Engineering and environmental investigations carried out as part of the *Preliminary Route Options Report - Final* (RMS, January 2012).
- Community feedback before and after issue of the *Preliminary Route Options Report - Final* (RMS, January 2012).
- RMS design guidelines.
- Geotechnical investigations as described in Chapter 4.4.2.
- Preliminary flooding investigations as described in Chapter 4.4.3.
- The horizontal and vertical clearance requirements over the navigable channel. This involved investigating existing and likely future maritime uses taking into consideration the feedback

received from RMS (Maritime) and river users. The identified clearance requirements are listed in Table 7 in Chapter 4.5 and shown in the engineering drawings in Chapter 4.12.

- Bridge span spacing and pier alignment. The pier alignment and span spacing for each route option was developed taking into consideration clearance requirements over the navigable channel, flood modelling and the visual and heritage constraints identified for the existing bridge.
- Bridge and viaduct construction methods. The design development of the layouts of the bridges and viaducts took into consideration construction methods likely to be utilised for each route option, as described in Appendix 2.
- Locations of major public utilities as described in Chapter 4.4.4.
- Drainage issues. Investigations into the drainage required for each option were conducted. Identified drainage strategies are described in Chapters 4.6.4, 4.7.4, 4.8.4, 4.9.4, 4.10.4 and 4.11.4.
- Shared path. All options incorporate a shared path (walkway/cycleway) on one side of the proposed bridge and viaducts with a clear width of 3.1 metres. The shared path would be separated from the roadway by a vehicle barrier. Off the structures, the proposed shared path would continue as a 2.5 metre wide off-road path extending alongside the approach roads to where they connect back to the existing arterial road network.

4.4.6 Construction staging opportunities

As described in Chapter 4.4.1, the design development of the route options has identified the extent of road network upgrades and intersection improvements that would be necessary to provide an acceptable level of service in 2049, 30 years after the assumed year of opening in 2019.

While the traffic modelling and assessment of the route options has been based on the infrastructure improvements that would be likely to be required by 2049, new road projects would not normally be constructed initially to provide 30 years of capacity. More commonly, and with other projects competing for available funding, initial construction works would be limited to those works required to provide sufficient capacity for about 10 years after opening. The remaining infrastructure improvements would be staged over time, responding to actual traffic growth.

For this project it would be necessary for the initial construction stage to include, as a minimum, the main bridge, approach viaducts and connections back to the existing arterial road network on either side of the river. Other works necessary to meet traffic demands through to 2049 would be added as part of later construction stages.

While traffic modelling of staged construction has not been carried out, a preliminary assessment of traffic staging opportunities has been carried out for each option; as described in Chapters 4.6 to 4.11. The purpose of the preliminary assessment was to identify the indicative scope of works that would be constructed initially, and was broadly aimed at identifying those works likely to be necessary to provide an acceptable level of service for around 10 years after opening of the new bridge to traffic.

Further detailed investigations of the construction staging options will be carried out following selection of the preferred route option.

4.5 Key features – common to all route options

As described in Chapter 4.4.1, the traffic modelling for each option in 2049 defined the extent of road network upgrades and intersection improvements that would be necessary to provide an acceptable level of service for 30 years after opening. Once these network improvements were established, the road layouts corresponding to the required improvements were developed as described in Chapter 4.4.5.

The design development incorporated a number of engineering design features that apply to all route options:

- Posted speed limit of 60 kilometres per hour for approach roads within urban areas and 80 kilometres per hour for approach roads outside urban areas
- Minimum traffic lane widths of 3.5 metres
- Pedestrian/cyclist shared path width of 3.1 metres clear on structures, continuing as a 2.5 metre wide shared path alongside the main approach roads
- Bridge structural elements designed and detailed for a design life of at least 100 years
- Waterway structures to be of sufficient height to maintain acceptable freeboard during a 100-year ARI design flood event
- Bridge approach embankments and viaducts to be flood immune during a 100-year ARI design flood event
- Main roads accessing the bridge approaches to be flood immune during a 20-year ARI design flood event
- Route options should not adversely impact the flood immunity in Grafton and South Grafton. Where impacts are identified, design mitigation measures would be implemented to maintain the current level of flood immunity
- To reasonably cater for expected demand in 2019 for the „do minimum“ scenario, it is likely that some additional roadworks would be necessary to address localised congestion and capacity constraints as they arise. Localised network upgrades found necessary for the model to operate reasonably in 2019 include:
 - Upgrading Pound Street to two traffic lanes in each direction between Villiers Street and Prince Street
 - Upgrading of Gwydir Highway to two traffic lanes in each direction between the Pacific Highway and Bent Street
 - Upgrading of the Villiers Street and Dobie Street roundabout to improve turning movements for heavy vehicles
 - Upgrading of the Gwydir Highway and Skinner Street roundabout from a single lane roundabout to a two-lane roundabout.
- Drainage infrastructure must meet the criteria in Table 6.

Table 6: Drainage infrastructure – basis of design

Element	ARI
Open drains (surface drains including table drains, bench drains, catch drains, contour banks, drop downs, basin inflows and basin outflows)	5 years
Piped system (including pits)	10 years
Culverts where surcharge is allowable	50 years
Structures where surcharge is undesirable	100 years
Gross pollutant traps	1 year
Shared path	1 year

- NSW Maritime (now part of RMS) advised that an additional crossing over the Clarence River at Grafton requires the minimum clearances shown in Table 7.

Table 7: Minimum required clearances for an additional crossing over the Clarence River at Grafton

Location	Minimum clearance (metres above Mean High Water Springs (MHWS))	
Options E, A and C	Vertical clearance	9.1 m
	Horizontal clearance	2 x 35 m
Options 11, 14 and 15	Vertical clearance	17 m
	Horizontal clearance	2 x 35 m

The vertical clearance to the soffit of the existing bridge above Mean High Water Springs is approximately 7.9 metres. The vertical clearance requirements stated above indicate that the soffit level of an additional bridge will be required to be higher than the soffit of the existing bridge lower rail deck.

Chapters 4.6 to 4.11 below outline the key features of the current preliminary concept designs for each of the six route options. Further design refinements may be made once a preferred route option is selected.

4.6 Key features – Option E

A plan and longitudinal section for Option E is presented in Chapter 4.12, Drawing 1. For illustrative purposes, artist impressions of the likely appearance of the additional crossing are shown in Figure 7 and Figure 8. Photos comparing the current views with artist impressions of the additional crossing can be found in the *Technical Paper: Landscape and Urban Character* in Volume 3.

4.6.1 Location

For Option E, the additional crossing would be located west (upstream) of the existing bridge and southeast (downstream) of Susan Island.

4.6.2 Road network upgrades

This option would connect to the Gwydir Highway at Cowan Street in South Grafton and to Villiers Street in Grafton, with upgraded connections to/from the Gwydir Highway and the Pacific Highway.

The route would extend along Villiers Street beneath the existing railway viaduct (between Pound Street and Bacon Street); Villiers Street would be lowered to increase the vertical clearance to 5.3 metres.

The southern connection introduces two new roundabouts to replace existing minor four-way priority controlled intersections. The properties fronting Cowan Street, south of Spring Street maintain direct access, while the properties north of Spring Street would access the network via Spring Street, to the east of the upgraded Cowan Street.

In Grafton, the two major intersections of Villiers Street with Fitzroy Street and Pound Street would be upgraded from roundabouts to signalised intersections. Pound Street would be upgraded to four lanes with provision for turning movements at intersections. Parking facilities on Pound Street and Clarence Street would also be upgraded.

The existing bridge would remain with one northbound lane and one southbound lane.

All options have been designed to operate with an adequate level of service 30 years after the assumed year of opening of the additional crossing, ie in 2049. It should be noted that the option layouts identify the works required to achieve sufficient capacity for the option to function adequately in 2049. Construction of the road network upgrades, eg intersection upgrades or widening of existing roads, may be staged over time following construction of the new bridge, as traffic demands increase. Refer to Chapter 4.6.7.

A summary of the road network upgrades required for Option E in 2049 is shown in Table 8.

Table 8: Road network upgrades for Option E (2049)

Item		Description	
New connection		• Between Gwydir Hwy/Cowan St in South Grafton and Villiers St in Grafton	
Road upgrades		Pacific Hwy	• Upgrade to 4 lanes in the vicinity of Gwydir Hwy and Iolanthe St
		Ryan St (Gwydir Hwy)	• Upgrade to 4 lanes from the Pacific Hwy to Cowan St
		Villiers St	• Upgrade to 4 lanes between proposed bridge and Pound St • To be lowered beneath railway
		Pound St	• Upgrade to 4 lanes between Villiers St and Prince St • Upgrade parking between Villiers St and Clarence St
		Clarence St	• Upgrade parking between Craig St and Pound St
Intersections	New signalised intersections	Villiers St/Fitzroy St	• Replace existing roundabout with traffic signals
		Villiers St/Pound St	• Replace existing roundabout with traffic signals
	New roundabouts	• Gwydir Hwy/Cowan St • Cowan St/Spring St • Craig St/Clarence St	
		Upgraded roundabouts (and approach roads)	• Gwydir Hwy/Bent St • Gwydir Hwy/Skinner St • Pound St/Duke St • Villiers St/Dobie St

4.6.3 Proposed bridge

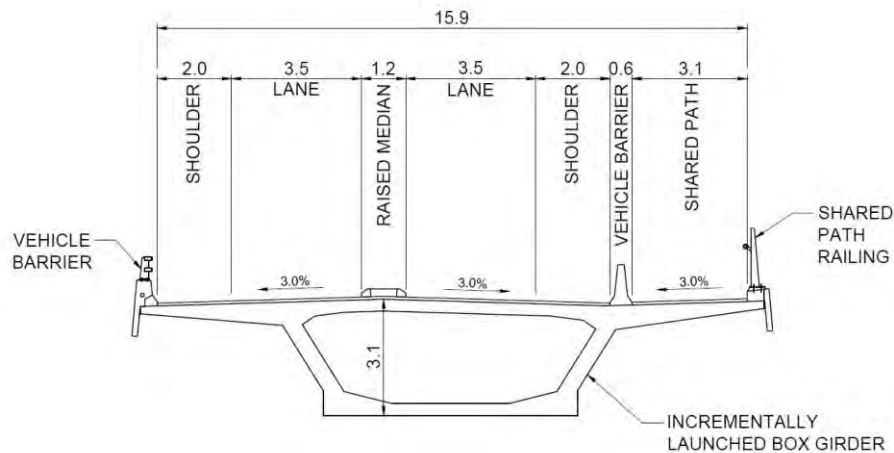
The proposed bridge would be 618 metres long and 15.9 metres wide and would be on a constant large radius horizontal curve (1400 metres radius) over the Clarence River for the majority of its length; with a horizontal curve on the last two spans on the Grafton side.

The bridge would include one northbound lane and one southbound lane for vehicles and a shared path 3.1 metres wide on the eastern (downstream) side of the bridge.

Beneath the bridge, there would be two clear navigable channels 35 metres wide and with a minimum vertical clearance of 9.1 metres.

The current preliminary concept design for the bridge would provide a 39.5 metre span on the South Grafton side, followed by 11 spans of 49 metres across the river, and another 39.5 metre span on the Grafton side. There would also be a 68 metre long approach viaduct (with two 34 metre long spans) on the Grafton side.

A typical bridge cross section for Option E is shown in Figure 5.



(ALL DIMENSIONS ARE IN METRES - NOT TO SCALE)

Figure 5: Option E – typical bridge cross section

4.6.4 Drainage

The bridge would be on a crest vertical curve. Drainage networks with pits and longitudinal pipes within the bridge superstructure would collect runoff and direct it to collection points on each side of the river. On the northern side the drainage network would extend along the viaduct structure.

4.6.5 Geotechnical issues

Based on the available geotechnical data, the approximate reduced levels (RL) for the pile toe for the approach viaducts and river crossings for Option E would be RL -18 m AHD for the southern approach, RL -18 m AHD to RL -33 m AHD for the river crossing piers and RL -33 m AHD for the northern approach viaduct. These pile toe levels assume a three-metre rock socket. The pile size and length will be refined once bridge loadings and a detailed design have been completed. The pile toe levels are indicative and subject to further geotechnical investigation to confirm the ground conditions assumed.

No major embankment issues were identified for Option E.

4.6.6 Bridge construction method

The bridge would probably be constructed using a combination of incremental launching (from South Grafton) for the longer spans and prestressed beam-and-slab construction methods for the viaduct spans. Refer to Appendix 2 for a description of these construction methods.

4.6.7 Indicative Stage 1 construction

As noted in Chapter 4.4.6, a preliminary assessment has been carried out to identify the indicative extent of road network upgrades and intersection improvements that might be constructed initially.

For Option E this indicative Stage 1 upgrade would provide a connection from the Gwydir Highway at Cowan Street in South Grafton to Villiers Street in Grafton. It includes construction of the new bridge and upgrades to approach roads and key intersections to provide an acceptable level of service for around 10 years after opening. These upgrades include:

- The bridge and approach roads between the Gwydir Highway and Fitzroy Street
- Gwydir Highway between the Pacific Highway and Bent Street
- Gwydir Highway/Cowan Street roundabout
- Gwydir Highway/Bent Street roundabout
- Victoria Street/Villiers Street intersection.

The indicative extent of the Stage 1 works is shown in Figure 6 below. The strategic cost estimate for the Option E Stage 1 upgrade is \$146 million. The 2049 road network upgrades cost estimate for Option E is \$215 million.

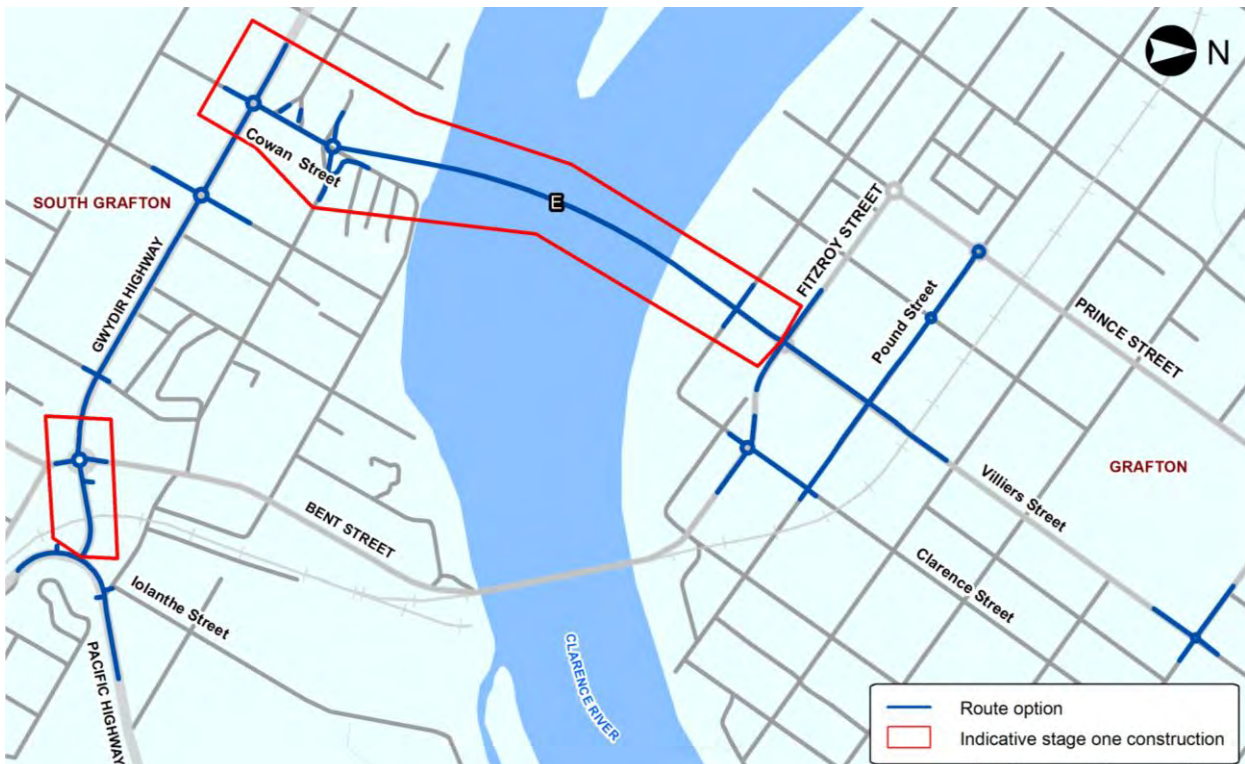


Figure 6: Indicative extent of the Stage 1 works for Option E



This artist's impression is for indicative purposes only and provides an indication of the bulk and scale of the current preliminary concept design for the option. The preliminary concept design may be refined with further development of the option.

Figure 7: Aerial perspective artist impression of Option E looking northwest



This artist's impression is for indicative purposes only and provides an indication of the bulk and scale of the current preliminary concept design for the option. The preliminary concept design may be refined with further development of the option.

Figure 8: Eye-level perspective artist impression of Option E looking northwest

4.7 Key features – Option A

A plan and longitudinal section for Option A is presented in Chapter 4.12, Drawing 2. For illustrative purposes, artist impressions of the likely appearance of the additional crossing are shown in Figure 11 and Figure 12. Photos comparing the current views with artist impressions of the additional crossing can be found in the *Technical Paper: Landscape and Urban Character* in Volume 3.

4.7.1 Location

For Option A, the additional crossing would be located parallel and immediately west (upstream) of the existing bridge.

4.7.2 Road network upgrades

This option would connect to the existing road network on Bent Street in South Grafton and on Fitzroy Street in Grafton. Upgraded connections are proposed to/from the Gwydir Highway and the Pacific Highway via Bent Street.

The proposed route generally follows the existing route with upgrades including signalisation of the Fitzroy Street/Villiers Street and Villiers Street/Pound Street intersections. Signalisation would also be implemented at Through Street, the first intersection at the southern bridge connection. The two major highway intersections on the south side would both operate as roundabouts with no significant alteration to routes.

In Grafton, the route would extend along Villiers Street beneath the existing railway viaduct (between Pound Street and Bacon Street); Villiers Street would be lowered to increase the vertical clearance to 5.3 metres.

The two major intersections of Villiers Street with Fitzroy Street and Pound Street would be upgraded from roundabouts to signalised intersections. Fitzroy Street and Pound Street would be upgraded to four lanes with provision for turning movements at intersections. Parking facilities on Pound Street and Clarence Street would also be upgraded.

The existing bridge would become a one-lane southbound bridge, with adjustments to line marking to reduce the severity of the kinks.

All options have been designed to operate with an adequate level of service 30 years after the assumed year of opening of the additional crossing, ie in 2049. It should be noted that the option layouts identify the works required to achieve sufficient capacity for the option to function adequately in 2049. Construction of the road network upgrades, eg intersection upgrades or widening of existing roads, may be staged over time following construction of the new bridge, as traffic demands increase. Refer to Chapter 4.7.7.

A summary of the road network upgrades required for Option A in 2049 is shown in Table 9.

Table 9: Road network upgrades for Option A (2049)

Item		Description
New connection		• Between Bent St in South Grafton and Fitzroy St in Grafton with new bridge, just upstream of existing bridge
Road upgrades		Pacific Hwy/Gwydir Hwy • Upgrade to 4 lanes in the vicinity of Bent St, Ryan St and Iolanthe St
		Bent St • Upgrade to 4 lanes with additional turning lanes at intersections
		Fitzroy St • Upgrade with additional turning lanes at intersections
		Villiers St • Upgrade to 4 lanes between Fitzroy St and Pound St • To be lowered beneath railway viaduct
		Pound St • Upgrade to 4 lanes between Villiers St and Prince St • Upgrade parking between Prince St and Clarence St
		Clarence St • Upgrade parking between Craig St and Pound St
		• General modifications to road markings • New left-in/left-out accesses at New St, Spring St west, Riverside Dr • Closure of Fitzroy St south of Villiers St
Intersections	New signalised intersections	Bent St/Spring St east (partial)
		Bent St/Through St • Replace existing roundabout with traffic signals
		Villiers St/Fitzroy St • Replace existing roundabout with traffic signals
		Villiers St/Pound St • Replace existing roundabout with traffic signals
	New roundabouts	• Pacific Hwy/Gwydir Hwy
	Upgraded roundabouts (and approach roads)	• Gwydir Hwy/Bent St/Ryan St • Gwydir Hwy/Skinner St • Pound St/Duke St • Villiers St/Dobie St

4.7.3 Proposed bridge

The proposed bridge would be approximately 471 metres long and 17.7 metres wide, and would be a straight crossing of the Clarence River.

The bridge would include two northbound lanes and one southbound lane for vehicles and a 3.1 metre wide shared path on the western (upstream) side of the bridge.

Beneath the bridge, there would be two clear navigable channels 35 metres wide and with a minimum vertical clearance of 9.1 metres.

The current preliminary concept design for the bridge would provide five 74.6 metre long spans across the river to match the existing bridge, and another 61 metre span on the South Grafton side, followed by a 37.5 metre long span on the Grafton side. There would also be a 145 metre long approach viaduct (with five 29 metre long spans) on the Grafton side.

A typical bridge cross section for Option A is shown in Figure 9.

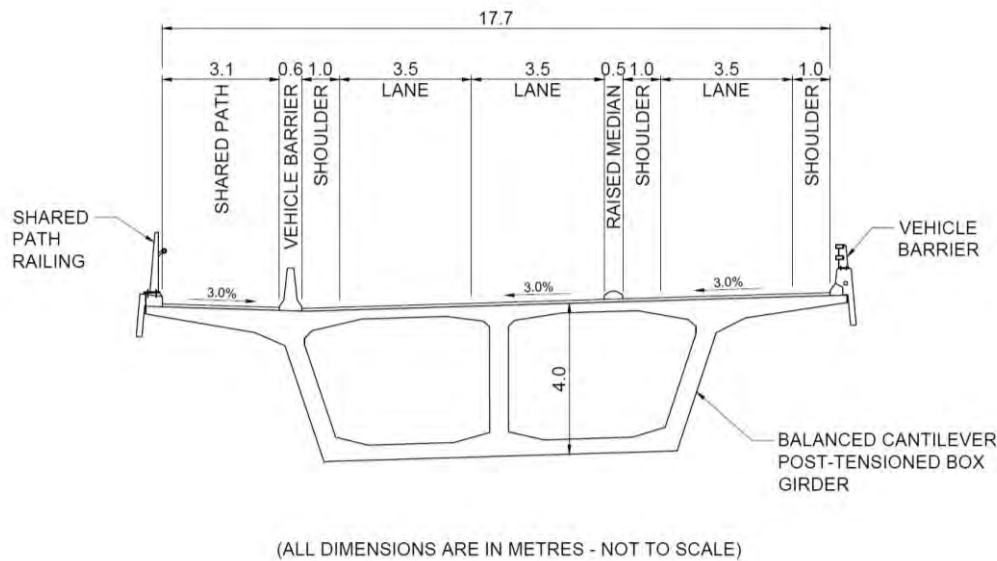


Figure 9: Option A – typical bridge cross section

4.7.4 Drainage

The bridge would be almost flat but with a slight longitudinal grade of 0.1% falling from the South Grafton to the Grafton side. A drainage network with closely spaced pits and longitudinal pipes within the bridge superstructure would collect runoff and direct it to a collection point on the northern side of the river. On the northern side the drainage network would extend along the viaduct structure.

4.7.5 Geotechnical issues

Based on the available geotechnical data, the approximate reduced levels (RL) for the pile toe for the approach viaducts and river crossings would be RL +5 m AHD to RL -18 m AHD for the southern approach, RL -18 m AHD to RL -26 m AHD for the river crossing piers and RL -26 m AHD for the northern approach viaduct. These pile toe levels assume a three-metre rock socket. The pile size and length will be refined once bridge loadings and a detailed design have been completed. The pile toe levels are indicative and subject to further geotechnical investigation to confirm the ground conditions assumed.

No major embankment issues were identified for Option A.

4.7.6 Bridge construction method

The bridge would probably be constructed using a combination of balanced cantilever spans for the river crossing and prestressed beam-and-slab construction methods for the viaduct. Refer to Appendix 2 for a description of these construction methods.

4.7.7 Indicative Stage 1 construction

As noted in Chapter 4.4.6, a preliminary assessment has been carried out to identify the indicative extent of road network upgrades and intersection improvements that might be constructed initially.

For Option A this indicative Stage 1 upgrade would provide a connection from Bent Street in South Grafton to Fitzroy Street in Grafton. It includes construction of the new bridge and upgrades to

approach roads and key intersections to provide an acceptable level of service for around 10 years after opening. These upgrades include:

- The bridge and approach roads on Bent Street/Craig Street between Through Street and Villiers Street
- Gwydir Highway between the Pacific Highway and Bent Street
- Fitzroy Street/Clarence Street intersection.

The indicative extent of the Stage 1 works is shown in Figure 10 below. The strategic cost estimate for the Option A Stage 1 upgrade is \$149 million. The 2049 road network upgrades cost estimate for Option A is \$231 million.

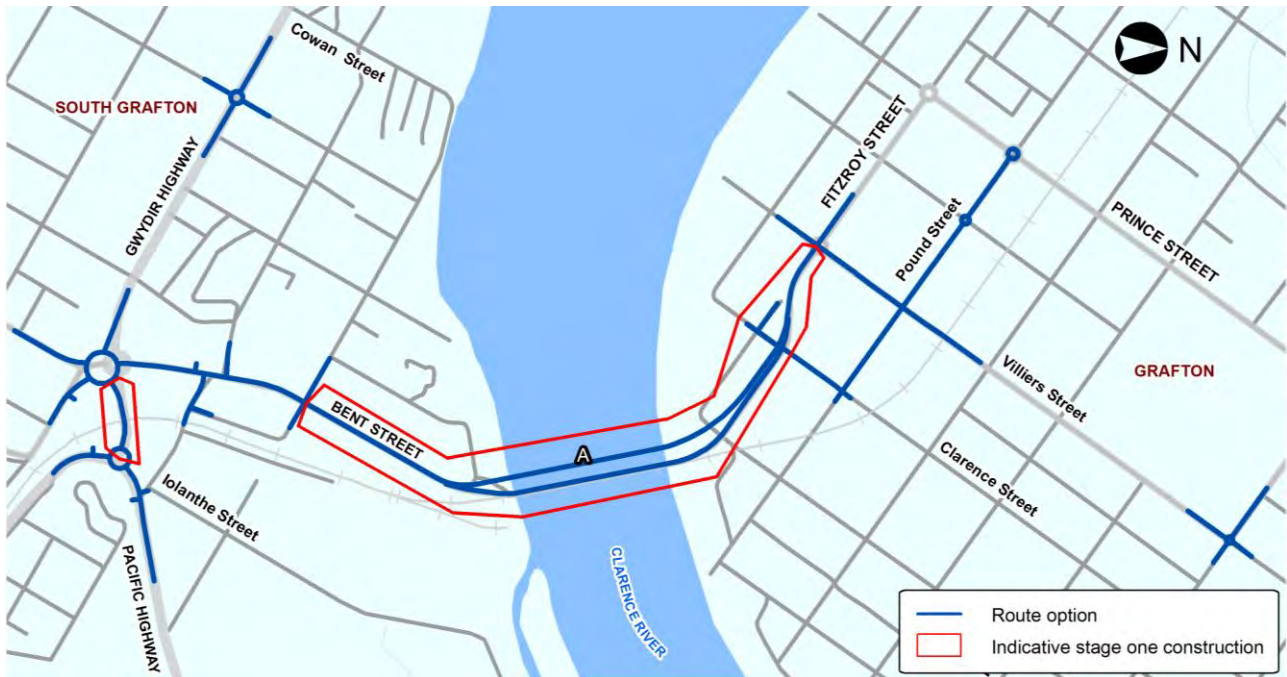


Figure 10: Indicative extent of the Stage 1 works for Option A



This artist's impression is for indicative purposes only and provides an indication of the bulk and scale of the current preliminary concept design for the option. The preliminary concept design may be refined with further development of the option.

Figure 11: Aerial perspective artist impression of Option A looking east

Note: Photo shows two-way traffic on existing bridge. With Option A, existing bridge would be altered to one southbound lane only.



This artist's impression is for indicative purposes only and provides an indication of the bulk and scale of the current preliminary concept design for the option. The preliminary concept design may be refined with further development of the option.

Figure 12: Eye-level perspective artist impression of Option A looking east

4.8 Key features – Option C

A plan and longitudinal section for Option C is presented in Chapter 4.12, Drawing 3. For illustrative purposes, artist impressions of the likely appearance of the additional crossing are shown in Figure 15 and Figure 16. Photos comparing the current views with artist impressions of the additional crossing can be found in the *Technical Paper: Landscape and Urban Character* in Volume 3.

4.8.1 Location

For Option C, the additional crossing would be located about 70 metres east (downstream) of the existing bridge.

4.8.2 Road network upgrades

This option would connect to the Pacific Highway at Iolanthe Street in South Grafton to Pound Street in Grafton.

It would include a new intersection with the Gwydir Highway and the Pacific Highway south-west of Bunnings Warehouse. The Pacific Highway to the north would be diverted to the north side of Bunnings Warehouse with a new roundabout where it connects to the bridge approaches. In South Grafton, just before the bridge abutment, the alignment would cross an abandoned rail spur.

The new northern approach would be lowered beneath the existing railway viaduct (between Kent Street and Clarence Street) to achieve a vertical clearance of 5.3 metres and would connect to the existing road network in Grafton at Pound Street.

The option would extend along Villiers Street beneath the existing railway viaduct (between Pound Street and Bacon Street) where the vertical clearance would be increased to 5.3 metres. Greaves Street would also be lowered to provide four metres clearance beneath the new viaduct.

The major intersection of Pound Street and Villiers Street would be upgraded from a roundabout to a signalised intersection. The intersection of Pound Street and Clarence Street would be upgraded to a signalised intersection. A new roundabout would be provided at the intersection of Clarence Street and Fitzroy Street. Pound Street would be upgraded to four lanes with provision for turning movements at intersections. Parking facilities on Pound Street and Clarence Street would also be upgraded.

The existing bridge would remain with one northbound lane and one southbound lane.

All options have been designed to operate with an adequate level of service 30 years after the assumed year of opening of the additional crossing, ie in 2049. It should be noted that the option layouts identify the works required to achieve sufficient capacity for the option to function adequately in 2049. Construction of the road network upgrades, eg intersection upgrades or widening of existing roads, may be staged over time following construction of the new bridge, as traffic demands increase. Refer to Chapter 4.8.7.

A summary of the road network upgrades required for Option C in 2049 is shown in Table 10.

Table 10: Road network upgrades for Option C (2049)

Item		Description		
New connection		<ul style="list-style-type: none"> • Between the Pacific Hwy/Gwydir Hwy in South Grafton and Clarence St/Pound St in Grafton, with new bridge just downstream of existing bridge • Realignment of the Pacific Hwy in the vicinity of Bunnings Warehouse to new link road on south side of new bridge 		
Road upgrades		Iolanthe St	• Upgrade to 4 lanes from the Pacific Hwy to new roundabout south of new bridge	
		Pacific Hwy/Gwydir Hwy	• Upgrade to 4 lanes in the vicinity of Bent St and Ryan St	
		Greaves St	• To be lowered beneath railway	
		Villiers St	<ul style="list-style-type: none"> • Upgrade to 4 lanes between Fitzroy St and Pound St • To be lowered beneath railway 	
		Pound St	<ul style="list-style-type: none"> • To be lowered beneath railway • Upgrade to 4 lanes between Clarence St and Prince St, with additional turning lanes at intersections • Upgrade parking between Villiers St and Prince St 	
		Clarence St	• Upgrade parking between Craig St and Pound St	
				<ul style="list-style-type: none"> • New left-in/left-out accesses at Iolanthe St, Spring St west, Clarence St north, New St • Closure of Kent St (at Pound St), Fitzroy St (south of Villiers St), Pound St (near Bridge St), Iolanthe St (north of Bunnings Warehouse), the Pacific Hwy (south of Bunnings Warehouse) • General modifications to road markings
Intersections	New signalised intersections	Pound St/Clarence St	• Upgrade existing intersection with traffic signals	
		Pound St/Villiers St	• Replace existing roundabout with traffic signals	
	New roundabouts	<ul style="list-style-type: none"> • Realigned Pacific Hwy/Iolanthe St/new bridge approach • Pacific Hwy/Gwydir Hwy • Ryan St/Viaduct Rd • Craig St/Clarence St 		
		Upgraded roundabouts (and approach roads)	<ul style="list-style-type: none"> • Gwydir Hwy/Skinner St • Pound St/Duke St • Villiers St/Dobie St 	

4.8.3 Proposed bridge

The proposed bridge would be approximately 458 metres long and 15.9 metres wide and would be on a constant very large radius horizontal curve (4500 metres radius) over the Clarence River.

The bridge would include one northbound lane and one southbound lane for vehicles and a shared path 3.1 metres wide on the western (upstream) side of the bridge.

Beneath the bridge, there would be two clear navigable channels 35 metres wide and with a minimum vertical clearance of 9.1 metres.

The current preliminary concept design for the bridge would provide a 44 metre span on the South Grafton side, followed by five 74 metre long spans across the river to match the existing bridge, and a 44 metre long span on the Grafton side. There would also be approach viaducts on either side of the bridge; 64 metres long (with two 32 metre long spans) on the South Grafton side, and 58 metres long (with two 29 metre long spans) on the Grafton side.

A typical bridge cross section for Option C is shown in Figure 13.

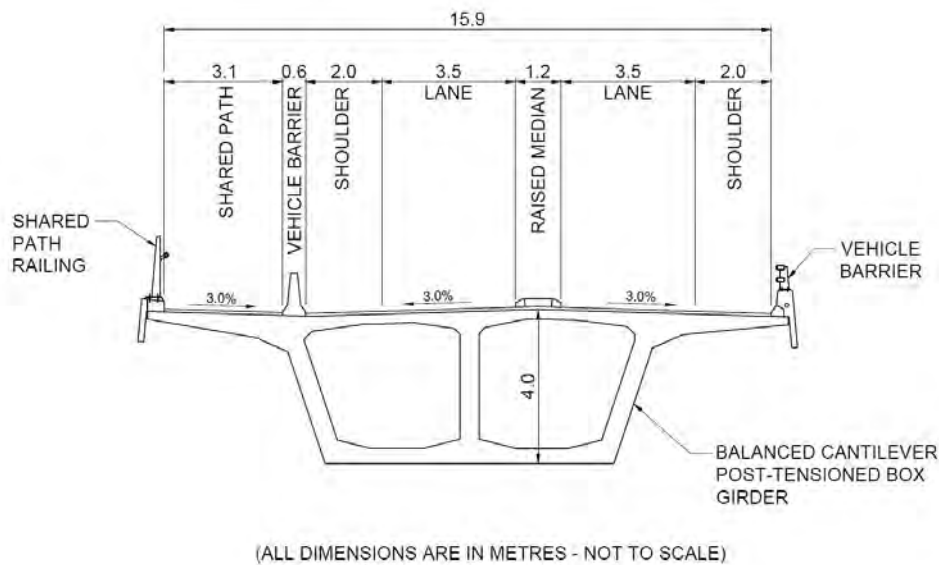


Figure 13: Option C – typical bridge cross section

4.8.4 Drainage

The bridge would be almost flat but with slight longitudinal grades of 0.1 per cent falling from a high point in the middle of the river back to the South Grafton and Grafton sides. A drainage network with closely spaced pits and longitudinal pipes within the bridge superstructure would collect runoff and direct it to collection points on each side of the river. On both sides of the river the drainage network would extend along the viaduct structures.

As noted above, under this option, the route would be lowered beneath the existing railway viaduct along Pound Street between Kent Street and Clarence Street. Drainage mitigation measures would be required to provide the required flood immunity during:

- Intense short duration storms, resulting in local drainage catchment runoff exceeding the capacity of the stormwater drainage network
- Long duration storms resulting in elevated flood levels within the Clarence River, reducing stormwater network outflow.

In order to achieve the required flood immunity during these 20-year ARI events, flood levels would need to be reduced. The following flood mitigation measures have been developed as one option which would allow flood free access to the new bridge in these 20-year ARI event floods:

- A catch drain north of Option C
- A detention basin south of Option C with a capacity of 560 cubic metres (about 2.8 metres by 20 metres by 10 metres) and a design bed level of 0.7 m AHD
- A pump station with capacity of two cubic metres per second to extract water from the detention basin
- Box culverts (with dimensions 8 metres by 0.5 metres by one metre) beneath Option C to provide connectivity between the catchment north of Option C and the proposed detention basin.

A more detailed assessment of flood mitigation would be undertaken once a recommended preferred route option has been selected.

4.8.5 Geotechnical issues

Based on the available geotechnical data, the approximate reduced levels (RL) for the pile toe for the approach viaducts and river crossings would be RL -18 m AHD for the southern approach, RL -18 m AHD to RL -26 m AHD for the river crossing piers and RL -26 m AHD for the northern approach viaduct. These pile toe levels assume a three-metre rock socket. The pile size and length will be refined once bridge loadings and a detailed design have been completed. The pile toe levels are indicative and subject to further geotechnical investigation to confirm the ground conditions assumed.

No major embankment issues were identified for Option C.

4.8.6 Bridge construction method

Option C would probably be constructed using a combination of balanced cantilever spans for the river crossing and prestressed beam-and-slab construction methods for the viaducts. Refer to Appendix 2 for a description of these construction methods.

4.8.7 Indicative Stage 1 construction

As noted in Chapter 4.4.6, a preliminary assessment has been carried out to identify the indicative extent of road network upgrades and intersection improvements that might be constructed initially.

For Option C this indicative Stage 1 upgrade would provide a connection from the existing Pacific Highway at Iolanthe Street in South Grafton to Pound Street in Grafton. It includes construction of the new bridge and upgrades to approach roads and key intersections to provide an acceptable level of service for around 10 years after opening. These upgrades include:

- The bridge and approach roads between the Pacific Highway and Villiers Street
- Gwydir Highway between the Pacific Highway and Bent Street
- Gwydir Highway/Pacific Highway roundabout
- Realignment of the Pacific Highway to connect to Iolanthe Street on the northern side of Bunnings Warehouse
- Clarence Street/Pound Street intersection
- Clarence Street between Craig Street and Pound Street.

The indicative extent of the Stage 1 works is shown in Figure 14 below. The strategic cost estimate for the Option C Stage 1 upgrade is \$182 million. The 2049 road network upgrades cost estimate for Option C is \$231 million.

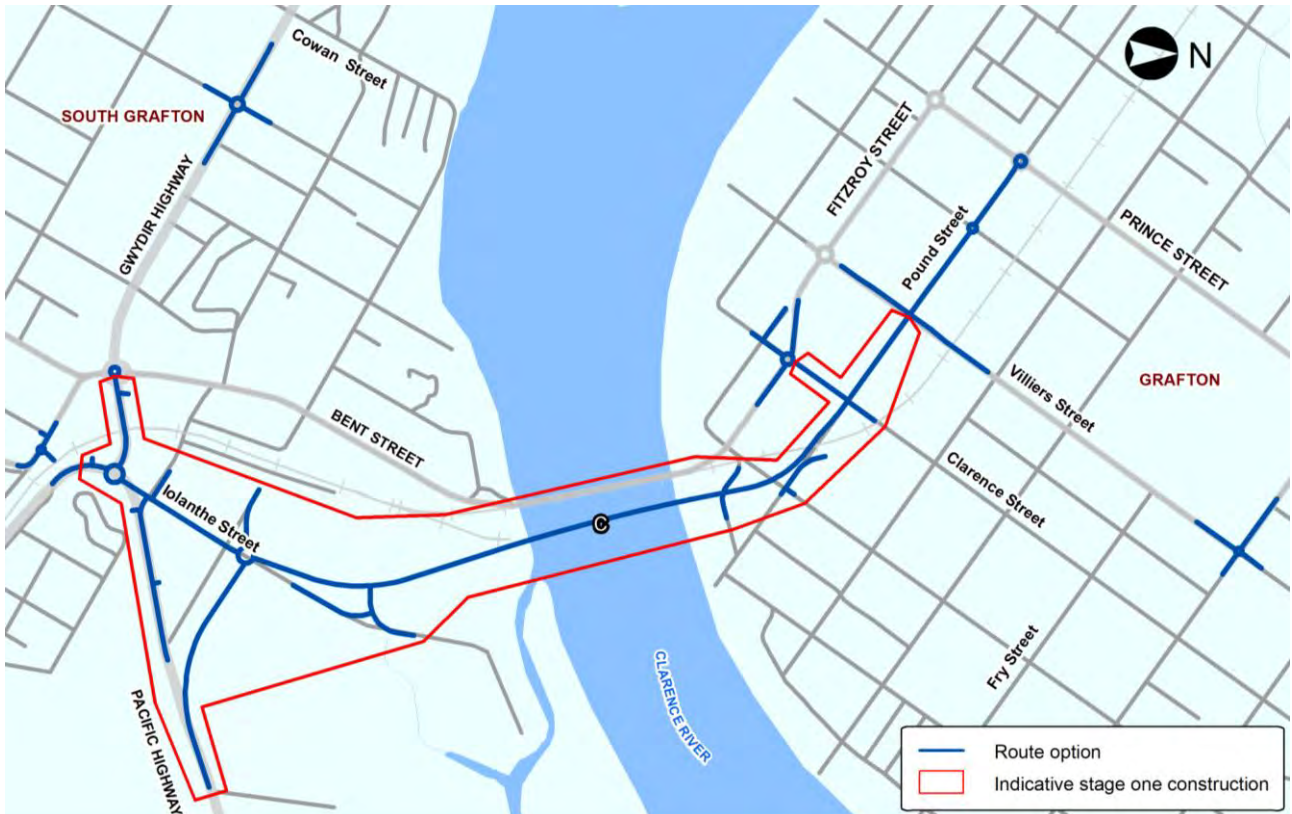


Figure 14: Indicative extent of the Stage 1 works for Option C



This artist's impression is for indicative purposes only and provides an indication of the bulk and scale of the current preliminary concept design for the option. The preliminary concept design may be refined with further development of the option.

Figure 15: Aerial perspective artist impression of Option C looking south



This artist's impression is for indicative purposes only and provides an indication of the bulk and scale of the current preliminary concept design for the option. The preliminary concept design may be refined with further development of the option.

Figure 16: Eye-level perspective artist impression of Option C looking west

4.9 Key features – Option 11

A plan and longitudinal section for Option 11 is presented in Chapter 4.12, Drawing 4. For illustrative purposes, artist impressions of the likely appearance of the additional crossing are shown in Figure 19 and Figure 20. Photos comparing the current views with artist impressions of the additional crossing can be found in the *Technical Paper: Landscape and Urban Character* in Volume 3.

4.9.1 Location

For Option 11, the additional crossing would be located northeast (downstream) of the existing bridge.

4.9.2 Road network upgrades

This option would provide a connection between the Pacific Highway, north-east of McClaers Lane, and Fry Street in Grafton. A new roundabout would provide access to and from the Pacific Highway. The Gwydir Highway and the Pacific Highway would also be upgraded to four lanes in the vicinity of Bent Street, Ryan Street and Iolanthe Street.

Fry Street would be upgraded with McHugh Street and Weiley Avenue intersections closed. Breimba Street and Kent Street intersections would maintain priority control and Clarence Street and Villiers Street intersections would be upgraded to roundabouts.

In addition, the route would extend along Villiers Street beneath the existing railway viaduct (between Pound Street and Bacon Street); Villiers Street would be lowered to increase the vertical clearance to 5.3 metres.

The existing bridge would remain with one northbound lane and one southbound lane.

All options have been designed to operate with an adequate level of service 30 years after the assumed year of opening of the additional crossing, ie in 2049. It should be noted that the option layouts identify the works required to achieve sufficient capacity for the option to function adequately in 2049. Construction of the road network upgrades, eg intersection upgrades or widening of existing roads, may be staged over time following construction of the new bridge, as traffic demands increase. Refer to Chapter 4.9.7.

A summary of the road network upgrades required for Option 11 in 2049 is shown in Table 11.

Table 11: Road network upgrades for Option 11 (2049)

Item		Description								
New connection		<ul style="list-style-type: none"> Between the Pacific Hwy north of McClaers Lane in South Grafton and Fry St in Grafton 								
Road upgrades		<table border="1"> <tr> <td>Pacific Hwy/Gwydir Hwy</td> <td> <ul style="list-style-type: none"> Upgrade to 4 lanes in the vicinity of Bent St, Ryan St and Iolanthe St </td> </tr> <tr> <td>Fry St</td> <td> <ul style="list-style-type: none"> From Breimba St to Villiers St, with additional turning lanes at intersections </td> </tr> <tr> <td>Breimba St</td> <td> <ul style="list-style-type: none"> Upgrade with additional turning lanes at its intersection with Fry St </td> </tr> <tr> <td>Villiers St</td> <td> <ul style="list-style-type: none"> From Fry St to Dobie St, with additional turning lanes To be lowered beneath railway </td> </tr> </table>	Pacific Hwy/Gwydir Hwy	<ul style="list-style-type: none"> Upgrade to 4 lanes in the vicinity of Bent St, Ryan St and Iolanthe St 	Fry St	<ul style="list-style-type: none"> From Breimba St to Villiers St, with additional turning lanes at intersections 	Breimba St	<ul style="list-style-type: none"> Upgrade with additional turning lanes at its intersection with Fry St 	Villiers St	<ul style="list-style-type: none"> From Fry St to Dobie St, with additional turning lanes To be lowered beneath railway
		Pacific Hwy/Gwydir Hwy	<ul style="list-style-type: none"> Upgrade to 4 lanes in the vicinity of Bent St, Ryan St and Iolanthe St 							
		Fry St	<ul style="list-style-type: none"> From Breimba St to Villiers St, with additional turning lanes at intersections 							
		Breimba St	<ul style="list-style-type: none"> Upgrade with additional turning lanes at its intersection with Fry St 							
		Villiers St	<ul style="list-style-type: none"> From Fry St to Dobie St, with additional turning lanes To be lowered beneath railway 							
<ul style="list-style-type: none"> New left-in/left-out accesses at New St, Kent St Closure of McHugh St and Weiley Ave at Fry St General modifications to road markings 										
Intersections	New signalised intersections	No new signalised intersections								
	New roundabouts	<ul style="list-style-type: none"> Pacific Hwy/new bridge approach Fry St/Clarence St Fry St/Villiers St 								
	Upgraded roundabouts (and approach roads)	<ul style="list-style-type: none"> Gwydir Hwy/Bent St Gwydir Hwy/Skinner St Villiers St/Dobie St 								

4.9.3 Proposed bridge

The proposed bridge would be approximately 387 metres long and 15.9 metres wide, and would be a straight crossing of the Clarence River.

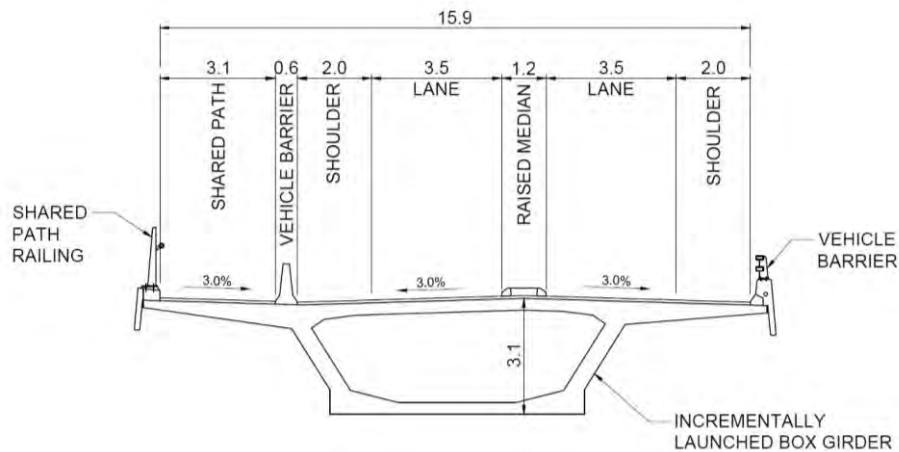
The bridge would include one northbound lane and one southbound lane for vehicles and a shared path 3.1 metres wide on the western (upstream) side of the bridge.

Beneath the bridge, there would be two clear navigable channels 35 metres wide and a minimum vertical clearance of 17 metres.

The current preliminary concept design for the bridge would provide eight spans of 48.4 metres across the river. There would also be a 340 metre long approach viaduct on the South Grafton side across the floodplain (with ten 34 metre long spans).

In addition to these structures, an additional shorter 110 metre long viaduct would be required to cross a small creek on the South Grafton side, near the Pacific Highway.

A typical bridge cross section for Option 11 is shown in Figure 17.



(ALL DIMENSIONS ARE IN METRES - NOT TO SCALE)

Figure 17: Option 11 – typical bridge cross section

4.9.4 Drainage

The bridge would be on a crest vertical curve. Drainage networks with pits and longitudinal pipes within the bridge superstructure would collect runoff and direct it to collection points on each side of the river. On the southern side the drainage network would extend along the viaduct structure.

4.9.5 Geotechnical issues

Based on the available geotechnical data, the approximate reduced levels (RL) for the pile toe for the approach viaducts and river crossings would be RL -15 m AHD to RL -21 m AHD for the southern approach viaduct and RL -21 m AHD to RL -23 m AHD for the river crossing piers. These pile toe levels assume a three-metre rock socket. The pile size and length will be refined once bridge loadings and a detailed design have been completed. The pile toe levels are indicative and subject to further geotechnical investigation to confirm the ground conditions assumed.

Ground settlement associated with embankments may be an issue with Option 11 and some ground improvement may be required. However, these issues are considered manageable and allowances have been included in the strategic cost estimates.

4.9.6 Bridge construction method

Option 11 would probably be constructed using incremental launching methods for the river crossing and prestressed beam-and-slab construction methods for the viaducts. Refer to Appendix 2 for a description of these construction methods.

4.9.7 Indicative Stage 1 construction

As noted in Chapter 4.4.6, a preliminary assessment has been carried out to identify the indicative extent of road network upgrades and intersection improvements that might be constructed initially.

For Option 11 this indicative Stage 1 upgrade would provide a connection from the existing Pacific Highway near McClaers Lane north of South Grafton to Fry Street in Grafton. It includes

construction of the new bridge and upgrades to approach roads and key intersections to provide an acceptable level of service for around 10 years after opening. These upgrades include:

- The bridge and approach roads between the Pacific Highway and Villiers Street
- Gwydir Highway between the Pacific Highway and Bent Street
- The Pacific Highway intersection for the approach road to the new bridge
- Fry Street intersections at Breimba Street, Kent Street, Clarence Street and Villiers Street.

The indicative extent of the Stage 1 works is shown in Figure 18 below. The strategic cost estimate for the Option 11 Stage 1 upgrade is \$167 million. The 2049 road network upgrades cost estimate for Option 11 is \$210 million.



Figure 18: Indicative extent of the Stage 1 works for Option 11



This artist's impression is for indicative purposes only and provides an indication of the bulk and scale of the current preliminary concept design for the option. The preliminary concept design may be refined with further development of the option.

Figure 19: Aerial perspective artist impression of Option 11 looking northeast



Figure 20: Eye-level perspective artist impression of Option 11 looking east

4.10 Key features – Option 14

A plan and longitudinal section for Option 14 is presented in Chapter 4.12, Drawing 5 and Drawing 6. For illustrative purposes, artist impressions of the likely appearance of the additional crossing are shown in Figure 23, Figure 24 and Figure 25. Photos comparing the current views with artist impressions of the additional crossing can be found in *Technical Paper: Landscape and Urban Character* in Volume 3.

4.10.1 Location

For Option 14, the additional crossing would be located northeast (downstream) of the existing bridge.

4.10.2 Road network upgrades

This option would create a new roundabout with Centenary Drive and the Pacific Highway in South Grafton and connect to Kirchner Street and North Street in Grafton.

The Gwydir Highway and the Pacific Highway would be upgraded to four lanes in the vicinity of Bent Street, Ryan Street and Iolanthe Street.

The southern connection crosses Eggins Lane, which would be provided with an alternative access to the new roundabout with the Pacific Highway and Centenary Drive.

The northern connection utilises Kirchner Street, which is upgraded to connect with the new roundabout at Prince Street. Prince Street would be upgraded for heavy vehicle access to the CBD. Powell Street, Hoof Street and Crown Street would be partly closed to Prince Street. North Street would become the main route north, connecting to the Summerland Way, with new roundabouts provided at its intersections with Queen Street/Grafton-Lawrence Road and Turf Street.

In addition, Villiers Street beneath the existing railway viaduct (between Pound Street and Bacon Street) would be lowered to increase the vertical clearance to 5.3 metres.

The existing bridge would remain with one northbound lane and one southbound lane.

All options have been designed to operate with an adequate level of service 30 years after the assumed year of opening of the additional crossing, ie in 2049. It should be noted that the option layouts identify the works required to achieve sufficient capacity for the option to function adequately in 2049. Construction of the road network upgrades, eg intersection upgrades or widening of existing roads, may be staged over time following construction of the new bridge, as traffic demands increase. Refer to Chapter 4.10.7.

A summary of the road network upgrades required for Option 14 in 2049 is shown in Table 12.

Table 12: Road network upgrades for Option 14 (2049)

Item		Description
New connection		<ul style="list-style-type: none"> • Between the Pacific Hwy/Centenary Dr in South Grafton and North St in Grafton • Realignment of Eggins lane west of new Pacific Hwy roundabout • Realignment of North St to meet new link road from Kirchner St/Prince St
Road upgrades		Pacific Hwy/Gwydir Hwy • Upgrade to 4 lanes in the vicinity of Bent St, Ryan St and Iolanthe St
		Kirchner St • Upgrade from new bridge to new roundabout at Prince St
		Prince St • Upgrade from new roundabout with Kirchner St to Dobie St
		North St • Upgrade from new roundabout at Kirchner St/Prince St to Turf St, with additional turning lanes at intersections
		Alice St • Upgrade at its intersection with North St
		Villiers St • To be lowered beneath railway
		<ul style="list-style-type: none"> • New left-in/left-out accesses at New St, Davey Ave east • Closure of Crown St, Hoof St and Powell St (all at Prince St); Duke St and Villiers St (at Kirchner St); Morrison St (at North St) • General modifications to road markings
Intersections	New signalised intersections	No new signalised intersections
	New roundabouts	<ul style="list-style-type: none"> • Pacific Hwy/Centenary Dr/new bridge approach • Kirchner St/Prince St • North St/Queen St • North St/Turf St
	Upgraded roundabouts (and approach roads)	<ul style="list-style-type: none"> • Gwydir Hwy/Bent St • Gwydir Hwy/Skinner St • Villiers St/Dobie St

4.10.3 Proposed bridge

The proposed bridge would be 617 metres long and 16.3 metres wide and would be a straight crossing of the Clarence River.

The bridge would include one northbound lane and one southbound lane for vehicles and a shared path 3.1 metres wide on the southern (upstream) side of the bridge.

Beneath the bridge, there would be two clear navigable channels 35 metres wide and with a minimum vertical clearance of 17 metres.

The current preliminary concept design for the bridge would provide eleven spans of 53 metres across the river, followed by a 34 metre long span on the Grafton side. There would also be a 782 metre long approach viaduct (with 23 spans of 34 metres) on the South Grafton side across the floodplain. On the Grafton side, there would be a 136 metre long approach viaduct (with four spans of 34 metres).

In addition to these structures, there would also be three other shorter bridges for creek crossings.

A typical bridge cross section for Option 14 is shown in Figure 21.

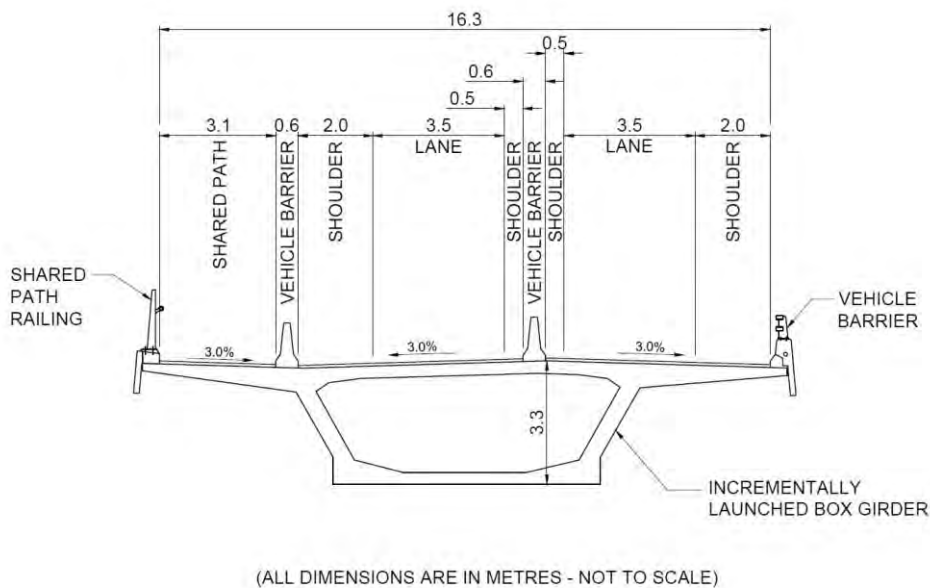


Figure 21: Option 14 – typical bridge cross section

4.10.4 Drainage

The bridge would be on a crest vertical curve. Drainage networks with pits and longitudinal pipes within the bridge superstructure would collect runoff and direct it to collection points on each side of the river. On both sides of the river the drainage network would extend along the viaduct structures.

4.10.5 Geotechnical issues

Based on the available geotechnical data, the approximate reduced levels (RL) for the pile toe for the approach viaducts and river crossings would be RL -15 m AHD to RL -23 m AHD for the southern approach, RL -23 m AHD for the river crossing piers and RL -23 m AHD for the northern approach. These pile toe levels assume a three-metre rock socket. The pile size and length will be refined once bridge loadings and a detailed design have been completed. The pile toe levels are indicative and subject to further geotechnical investigation to confirm the ground conditions assumed.

Ground settlement associated with embankments may be an issue with Option 14 and some ground improvement may be required. However, these issues are considered manageable and allowances have been included in the strategic cost estimates.

4.10.6 Bridge construction method

The bridge would probably be constructed using incremental launching methods for the river crossing and prestressed beam-and-slab construction methods for the viaducts. Refer to Appendix 2 for a description of the construction methods.

4.10.7 Indicative Stage 1 construction

As noted in Chapter 4.4.6, a preliminary assessment has been carried out to identify the indicative extent of road network upgrades and intersection improvements that might be constructed initially.

For Option 14 this indicative Stage 1 upgrade would provide a connection from the existing Pacific Highway at Centenary Drive north of South Grafton to North Street via Kirchner Street in Grafton. It includes the construction of the new bridge and upgrades to approach roads and key intersections to provide an acceptable level of service for around 10 years after opening. These upgrades include:

- The bridge and approach roads between the Pacific Highway and the North Street / Queen Street intersection
- Gwydir Highway between the Pacific Highway and Bent Street
- The Pacific Highway intersection at Centenary Drive for the approach road to the new bridge
- Prince Street construction from the Kirchner Street/Prince Street roundabout to Arthur Street
- Prince Street pavement widening and strengthening works from Arthur Street to Dobie Street
- Kirchner Street/Prince Street roundabout
- Realignment of North Street east
- North Street/Queen Street roundabout
- North Street/Turf Street roundabout.

The indicative extent of the Stage 1 works is shown in Figure 22 below. The strategic cost estimate for the Option 14 Stage 1 upgrade is \$262 million. The 2049 road network upgrades cost estimate for Option 14 is \$304 million.

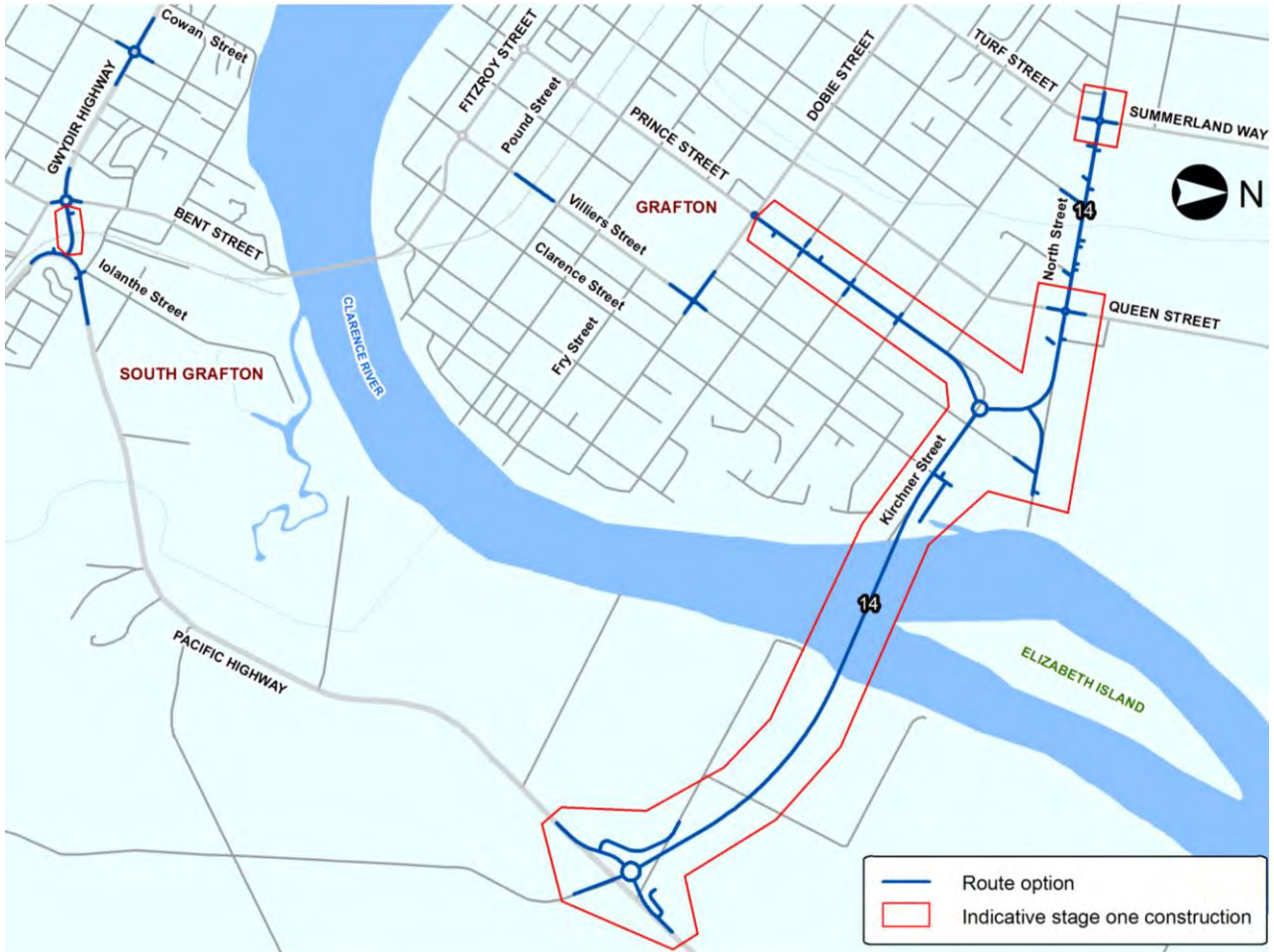


Figure 22: Indicative extent of the Stage 1 works for Option 14



This artist's impression is for indicative purposes only and provides an indication of the bulk and scale of the current preliminary concept design for the option. The preliminary concept design may be refined with further development of the option.

Figure 23: Aerial perspective artist impression of Option 14 looking northeast



Figure 24: Eye-level perspective artist impression of Option 14 looking southeast

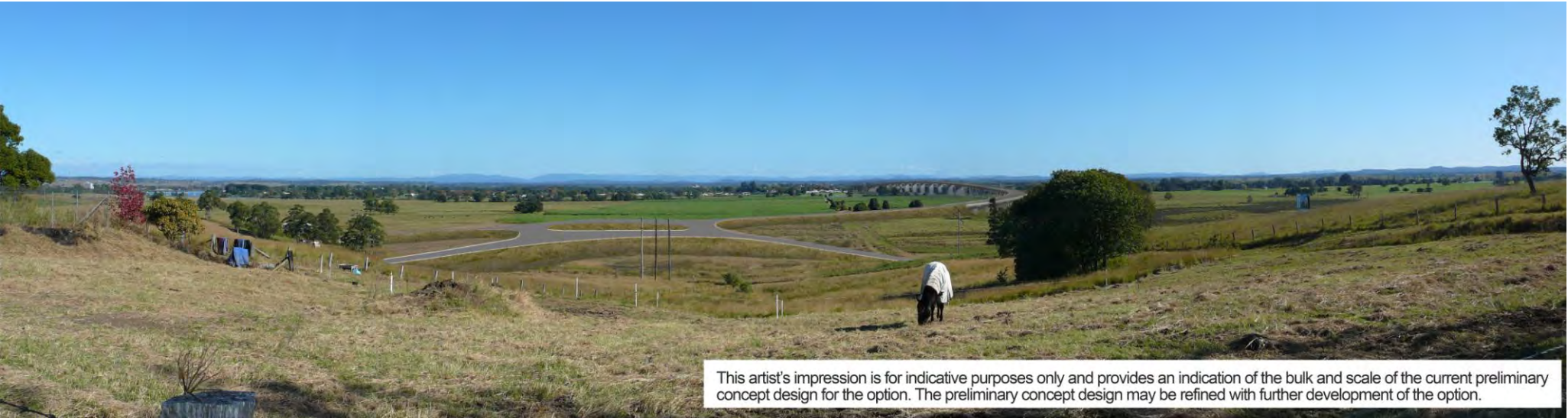


Figure 25: Eye-level perspective artist impression of Option 14 looking northwest

4.11 Key features – Option 15

A plan and longitudinal section for Option 15 is presented in Chapter 4.12, Drawing 7, Drawing 8 and Drawing 9. For illustrative purposes, artist impressions of the likely appearance of the additional crossing are shown in Figure 28, Figure 29 and Figure 30. Photos comparing the current views with artist impressions of the additional crossing can be found in the *Technical Paper: Landscape and Urban Character* in Volume 3.

4.11.1 Location

For Option 15, the additional crossing would be located northeast (downstream) of the existing bridge.

4.11.2 Road network upgrades

This option would create a new roundabout with Centenary Drive and the Pacific Highway in South Grafton and connect to Kirchner Street, and then to a new roundabout at the Summerland Way about 400 metres south of Butterfactory Lane in Grafton.

The southern connection crosses Eggins Lane, which would be provided with an alternative access to the new roundabout with the Pacific Highway and Centenary Drive.

Kirchner Street would be upgraded to connect with the new roundabout at Prince Street. The new route from Kirchner Street to the Summerland Way, intersecting with Queen Street/Grafton-Lawrence Road with a new roundabout, would become the main route north.

Prince Street would be upgraded for heavy vehicle access to the CBD. Powell Street, Hoof Street and Crown Street would be partly closed to Prince Street.

In addition, Villiers Street beneath the existing railway viaduct (between Pound Street and Bacon Street) would be lowered to increase the vertical clearance to 5.3 metres.

The existing bridge would remain as one northbound lane and one southbound lane.

All options have been designed to operate with an adequate level of service 30 years after the assumed year of opening of the additional crossing, ie in 2049. It should be noted that the option layouts identify the works required to achieve sufficient capacity for the option to function adequately in 2049. Construction of the road network upgrades, eg intersection upgrades or widening of existing roads, may be staged over time following construction of the new bridge, as traffic demands increase. Refer to Chapter 4.11.7.

A summary of the road network upgrades required for Option 15 in 2049 is shown in Table 13.

Table 13: Road network upgrades for Option 15 (2049)

Item		Description
New connection		<ul style="list-style-type: none"> Between the Pacific Hwy/Centenary Dr in South Grafton and North St in Grafton Realignment of Eggins lane west of new Pacific Hwy roundabout New link road from North St to Queen St/Grafton-Lawrence Rd and to the Summerland Way
Road upgrades		Pacific Hwy/Gwydir Hwy • Upgrade to 4 lanes in the vicinity of Bent St, Ryan St and Iolanthe St
		Kirchner St • Upgrade from new bridge to new roundabout at Prince St
		Prince St • Upgrade from new roundabout with Kirchner St to Dobie St
		North St • Upgrade from just south of Duke St to just south of Morrison St
		Villiers St • To be lowered beneath railway
		<ul style="list-style-type: none"> New left-in/left-out access at New St Closure of Crown St, Hoof St, Powell St (all at Prince St); Duke St and Villiers St (at Kirchner St) General modifications to road markings
Intersections	New signalised intersections	No new signalised intersections
	New roundabouts	<ul style="list-style-type: none"> Pacific Hwy/Centenary Dr/new bridge approach Kirchner St/Prince St New link road/Grafton-Lawrence Rd New link road/Summerland Way
	Upgraded roundabouts (and approach roads)	<ul style="list-style-type: none"> Gwydir Hwy/Bent St Gwydir Hwy/Skinner St Villiers St/Dobie St

4.11.3 Proposed bridge

The proposed river bridge would be the same as in Option 14 (617 metres long and 16.3 metres wide and would be a straight crossing of the Clarence River).

The bridge would include one northbound lane and one southbound lane for vehicles and a shared path 3.1 metres wide on the southern (upstream) side of the bridge.

Beneath the bridge, there would be two clear navigable channels 35 metres wide and with a minimum vertical clearance of 17 metres.

The current preliminary concept design for the bridge would also be the same as Option 14; with eleven spans of 53 metres across the river, followed by a 34 metre long span on the Grafton side. The approach viaducts would also be the same as Option 14; with a 782 metre long approach viaduct (with 23 spans of 34 metres) on the South Grafton side across the floodplain, and a 136 metre long approach viaduct (with four spans of 34 metres) on the Grafton side.

In addition to these structures, there would also be four other shorter bridges for creek crossings.

A typical bridge cross section for Option 15 is shown in Figure 26.

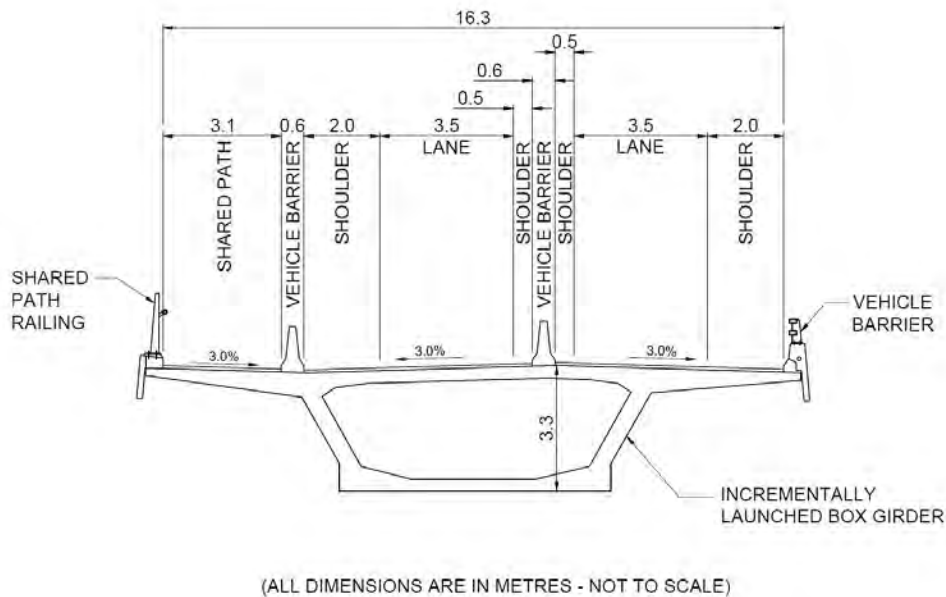


Figure 26: Option 15 – typical bridge cross section

4.11.4 Drainage

The bridge would be on a crest vertical curve. Drainage networks with pits and longitudinal pipes within the bridge superstructure would collect runoff and direct it to collection points on each side of the river. On both sides of the river the drainage network would extend along the viaduct structures.

4.11.5 Geotechnical issues

Based on the available geotechnical data, the approximate reduced levels (RL) for the pile toe for the approach viaducts and river crossings would be RL -15 m AHD to RL -23 m AHD for the southern approach, RL -23 m AHD for the river crossing piers and RL -23 m AHD for the northern approach. These pile toe levels assume a three-metre rock socket. The pile size and length will be refined once bridge loadings and a detailed design have been completed. The pile toe levels are indicative and subject to further geotechnical investigation to confirm the ground conditions assumed.

Ground settlement associated with embankments may be an issue at Options 15 where some ground improvement may be required. However, these issues are considered manageable and allowances have been included in the strategic cost estimates.

4.11.6 Bridge construction method

The bridge would probably be constructed using incremental launching methods for the river crossing and prestressed beam-and-slab construction methods for the viaducts. Refer to Appendix 2 for a description of these construction methods.

4.11.7 Indicative Stage 1 construction

As noted in Chapter 4.4.6, a preliminary assessment has been carried out to identify the indicative extent of road network upgrades and intersection improvements that might be constructed initially.

For Option 15 this indicative Stage 1 upgrade would be the same as proposed for Option 14. If Option 15 is selected as the preferred option then the construction of the new roadway connection to the Summerland Way could be added at a later stage.

As with Option 14, the indicative Stage 1 upgrade for Option 15 provides a connection from the existing Pacific Highway at Centenary Drive north of South Grafton to North Street via Kirchner Street in Grafton. It includes the construction of the new bridge and upgrades to approach roads and key intersections to provide an acceptable level of service for around 10 years after opening. These upgrades include:

- The bridge and approach roads between the Pacific Highway and the North Street/Queen Street intersection
- Gwydir Highway between the Pacific Highway and Bent Street
- The Pacific Highway intersection at Centenary Drive for the approach road to the new bridge
- Prince Street construction from the Kirchner Street/Prince Street roundabout to Arthur Street
- Prince Street pavement widening and strengthening works from Arthur Street to Dobie Street
- Kirchner Street/Prince Street roundabout
- Realignment of North Street east
- North Street/Queen Street roundabout
- North Street/Turf Street roundabout.

The indicative extent of the Stage 1 works is shown in Figure 27 below. The strategic cost estimate for the Option 15 Stage 1 upgrade is \$262 million. The 2049 road network upgrades cost estimate for Option 15 is \$340 million.

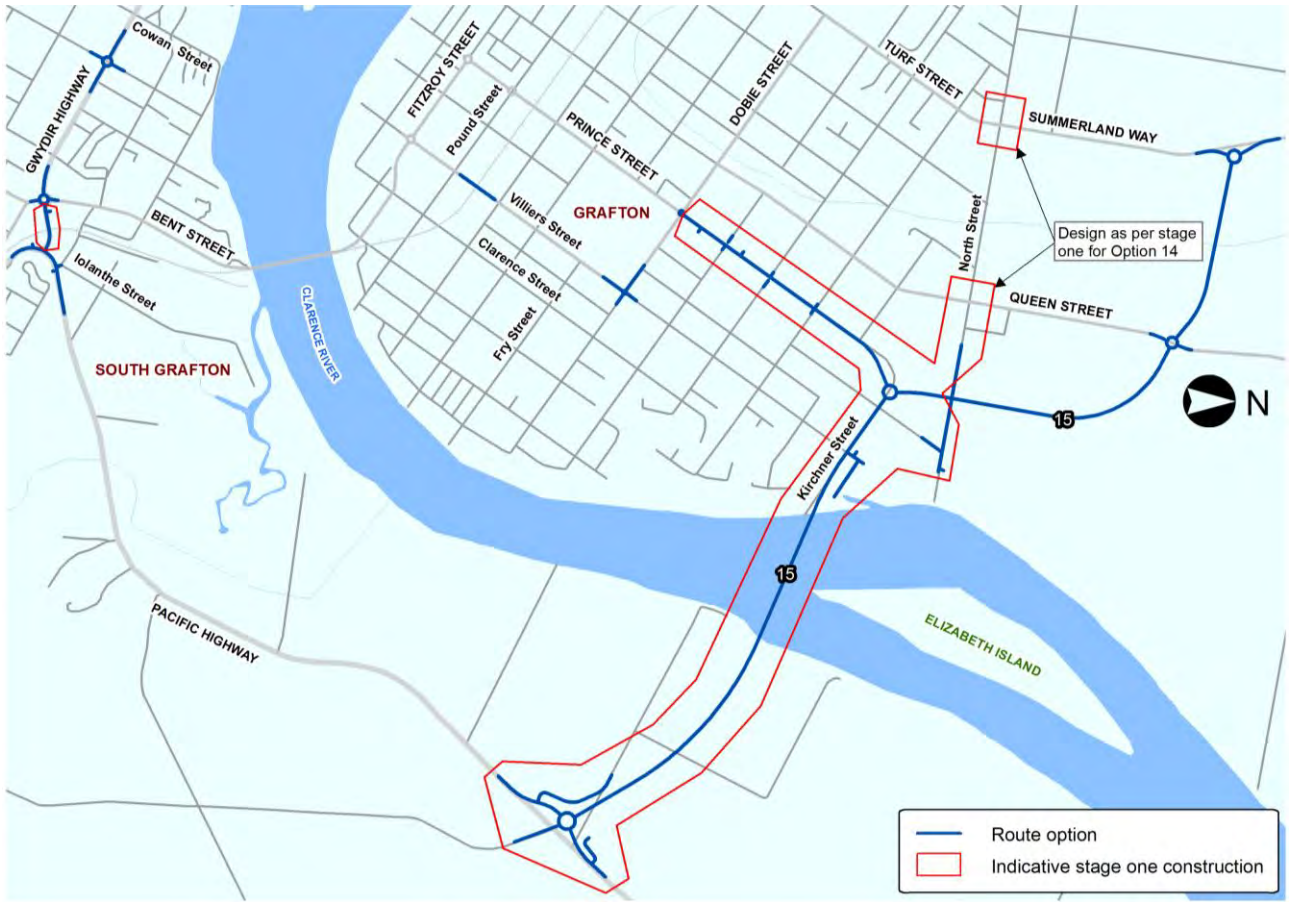


Figure 27: Indicative extent of the Stage 1 works for Option 15



This artist's impression is for indicative purposes only and provides an indication of the bulk and scale of the current preliminary concept design for the option. The preliminary concept design may be refined with further development of the option.

Figure 28: Aerial perspective artist impression of Option 15 looking northeast



Figure 29: Eye-level perspective artist impression of Option 15 looking southeast



Figure 30: Eye-level perspective artist impression of Option 15 looking northwest

4.12 Engineering plans and longitudinal section drawings

Engineering plans and longitudinal section drawings of the refined short-list of route options are on the following pages.