Centenary Motorway Planning Study

Queensland Department of Transport and Main Roads

Summary Planning Report

IH111700-PE6-CR-RPT-0001 | Rev 4

28 November 2018

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Contents

Abbreviations

Term	Definition
AEP	Annual exceedance probability
ASC	Alternative specific constraints
AT	Active transport
AWE	Average weekly earnings
BC	Business Case
BCC	Brisbane City Council
BQ	Building Queensland
BSTM-MM	Brisbane Strategic Transport Model: Multi-Modal
CBD	Central business district
CCIS	Centenary Cycleway Investment Strategy
CMPS	Centenary Motorway Planning Study
CPI	Consumer Price Index
DBYD	Dial Before You Dig
DC	Design and Construct
DE	Design exceptions
E&T	Engineering & Technology
EAR	Environmental Assessment Report
EDD	Extended Design Domain
GA	General arrangement
IA	Infrastructure Australia
ICT	Information Communication Technology
IIC	Infrastructure Investment Committee
IS	Infrastructure Sustainability
ISCA	Infrastructure Sustainability Council of Australia
KBCMIOA	Kenmore Bypass Centenary Motorway Interchange Options Analysis
MCA	Multi-criteria analysis
MTO	Medium term option
NB	Northbound
NDD	Normal Design Domain
NOF	Network Optimisation Framework
NOS	Network Optimisation Solutions
PAF	Project Assessment Framework
PE	Preliminary Evaluation
PEAR	Preliminary Environmental Assessment Report
PHT	Passenger-hours travelled
PKT	Passenger-kilometres travelled
PSC	Project Steering Committee
PT	Public transport
PUA	Public Utilities Authority

Term	Definition
PUP	Public utility plant
QGSO	Queensland Government Statistician's Office
QTRIP	Queensland Transport and Roads Investment Program
RCP	Risk Context Profile
RCP	Reinforced concrete pipe
RPCG	Regional Planning Coordination Group
SASR	Strategic Assessment of Service Requirements
SB	Southbound
SEA	Supplementary Environmental Assessment
SEQ	South East Queensland
SRIU	Sumners Road Interchange Upgrade
STO	Short term option
TIC	Transport Infrastructure Contract
TMR	Department of Transport and Main Roads
VHT	Vehicle-hours travelled
VKT	Vehicle-kilometres travelled
WBTNS	Western Bridge Transport Network Strategy

Executive Summary

TMR commissioned the Jacobs+Aurecon team to deliver the Centenary Motorway Planning Study in 2017. This planning study would build on previous planning studies, including the 2010 SASR and 2013 CMPS (PE Lite), to focus on the short- to medium-term functionality and capacity issues in the Centenary Motorway corridor that need to be addressed as a priority, whilst giving due consideration to a staged delivery of the longer term vision.

The Project Team sought to investigate and develop realistic, affordable and viable short term and medium term solutions to address the Project Objectives for the Centenary Motorway that can, if required, lead to the staged delivery of a longer term upgrade. There has been a strong focus on maximising the use and residual life of existing assets, considering the needs for all transport modes and users, leading to the identification of options that test design considerations but reduce the negative impacts to the community and environment.

A Project Steering Committee (PSC) was established to oversee the development of the Project and has been intrinsic to the options identification and analysis process. A long list of Non-infrastructure, Existing Asset and New infrastructure options were developed to address the Project Objectives through an OnQ Business Case (BC) phase for the short term options, and Project Assessment Framework (PAF) Preliminary Evaluation (PE) for the medium term options. The Project Team undertook initial preliminary technical investigations, involving engineering, structural and traffic analysis, to identify a long list of potential project options. A comparative assessment was undertaken to reduce the long list to a more manageable shortlist of options, which was presented to the PSC (Table 1-1).

Table 1-1 : Shortlisted Centenary Motorway: Medium Staged Upgrades options

Category	Project number	Project description
Better use (non-infrastructure)	STO 1	Fig Tree Pocket Road and Moggill Road entry ramp signalisation and geometry improvements
	STO 2	Sinnamon Road entry ramp signalisation and new Dandenong Road entry ramp
	STO H	AT – Separation of pedestrian and cycling facilities along the motorway
	STO I	AT – Additional cycleway access points from minor streets
Improve existing	STO J	AT – Cycleway connection between Centenary Bikeway and Bicentennial Bikeway
	STO K	AT – Improved cycle facilities at Dean Street and Miskin Street
	STO L	AT – Improved at-grade crossing at Fig Tree Pocket Road southbound ramps
	STO M	AT – Improved at-grade crossing at Sinnamon Road northbound ramps
	STO N	AT – Improved at-grade crossing at Dandenong Road roundabout
	MTO D	AT – Cycle crossing at Sumners Road northbound ramps roundabout
	STO 3	PT – Southbound bus hard shoulder running, Moggill Road to Kenmore Road overpass
	STO 4	PT – Northbound bus hard shoulder running, Dandenong Road to Sinnamon Road
New infrastructure	STO 5	New three-lane northbound bridge over the Brisbane River
	MTO 1	Six lanes off existing alignment (unconstrained) between Moggill Road and Sumners Road (Normal Design Domain)
	MTO 2	Six lanes on existing alignment between Moggill Road and Sumners Road (Extended Design Domain)

Further preliminary technical investigations were presented to the PSC, which informed the following recommendations regarding the preferred project options that best addressed Project Objectives:

- New three-lane northbound bridge over Brisbane River to be further investigated and developed to inform an OnQ BC
- Six lane surface upgrade, largely to be widening of the existing alignment (using extended design parameters (EDD)) to be further investigated and developed to inform an updated PAF PE report, which would incorporate any identified active transport and managed motorway options.

Importantly, the preliminary investigations of the new bridge revealed that the capital cost would likely exceed $100 million. As this capital value exceeds the threshold requirements for the OnQ BC requirements, the decision was made to by the PSC to undertake further investigations and develop this project option as a separate investigation under a PAF PE.

The preliminary investigations of the six lanes surface upgrade focussed on further technical, traffic, risk and costs analysis, and understanding the potential for staging the delivery of the motorway upgrade. The outcomes of the preliminary investigations were brought to the PSC in Control Point 3 paper, where the following was endorsed:

Design elements

- Recommended option is to widen the existing motorway to accommodate six lanes from the Moggill Road southbound entry ramp to the Sumners Road southbound entry ramp. The concept has been developed to deliver improved motorway capacity, performance and safety for a reduced cost and fewer impacts upon property, environment and community compared to the previous study's recommended design.

Traffic modelling

- In 2036, the Centenary Motorway upgrade (Stages 1-5) is expected to increase daily traffic volumes across the Centenary Bridge by 23% northbound and 25% southbound. The upgrade will also deliver over 25,000 vehicle-kilometres travelled per day and a reduction of almost 18,000 vehicle-hours travelled per day across the metropolitan network.
- The additional traffic directed to the Centenary Bridge by 2036 also reduces traffic on other routes, including the Ipswich Motorway and Indooroopilly Bridge, with some smaller effects as far as the Gateway Bridge and Brisbane Airport.
- Modelled traffic growth primarily driven by key growth areas to the south-west (around Ipswich), the Australia Trade Coast and the CBD. Sensitivity testing will be undertaken on these demographic as part of the economic analysis.

Risk analysis

- The Risk Context Profile (RCP) Summary shows that Stakeholders have the highest risk profile with a rating of 82%. Human Resources and Finalisation have the lowest at 20%, and the remaining RCP items are all between 50% and 70%.

Cost estimates

The total whole-of-life project costs (out-turn $) are:

- Option 1 (Full Delivery)
  - Medium confidence: $1,080,967,542
  - High confidence: $1,251,238,350
- Option 2 (Staged Delivery)
  - Medium confidence: $1,164,054,430
  - High confidence: $1,345,194,016

The outcomes of this analysis informed subsequent detailed analysis in the remainder of the PAF PE.

1. Introduction

1.1 Background

This Summary Planning Report details work undertaken for the Preliminary Evaluation for the Centenary Motorway, undertaken as part of the Centenary Motorway Upgrade Project (the Project). The Preliminary Evaluation has been prepared to document the medium term upgrade solution and seek approval to proceed to Business Case stage.

The study area extends from the Ipswich Motorway in the south to Legacy Way and Mt Coot-tha Road in the north, including the Centenary Bridge and interchanges at Sumners Road, Dandenong Road and Sinnamon Road (south of the river) and at Fig Tree Pocket Road and Moggill Road (north of the river).

The Centenary Motorway has developed from a two-lane local arterial to an urban motorway that now provides the primary link between the western corridor and the inner and northern suburbs of Brisbane. This progressive development has led to a number of operational and road design limitations. Continued strong growth in traffic demand is expected on the corridor, driven by growth in key catchment areas including the Western Corridor and Australia Trade Coast, and reinforced by infrastructure improvements at the northern and southern ends of the corridor, including the Ipswich Motorway and Legacy Way. Additionally, the lack of alternative bridge crossings in the western suburbs will continue the need for local use of the corridor. Average weekday traffic demands crossing the Centenary Bridge were around 92,000 vehicles per day in 2016, with this expecting to increase to around 110,000 vehicles per day by 2026.

1.2 Review of previous work

In response to identified needs for the Centenary Motorway, TMR commissioned the Preliminary Evaluation which was to be delivered under the Queensland Government's Project Assessment Framework (PAF).

The recommendations of the Strategic Assessment of Service Requirements (SASR) report brought together a range of options considered as part of various planning studies, including recommendations from the Western Brisbane Transport Network Strategy (WBTNS). The SASR, approved by TMR's Infrastructure Investment Committee (IIC) in November 2010, identified various key issues which it considered were affecting the performance, safety and utility of the Centenary Motorway corridor. The SASR recommended that further consideration be given to a suite of 5 non-asset and asset based options. As part of this approval, the IIC requested the project return to the committee to seek endorsement of the Integrated Network Strategy and the resultant options prior to progression into a detailed options assessment as part of the PE stage. The Network Strategy identified two scenarios as being preferred options to use for the long term corridor options development for the PE phase.

In December 2011, IIC approved the Integrated Network Strategy and 2031 Masterplan Options (four Masterplan options) as a suitable base on which to proceed to further detailed options analysis as required in the PE.

The Centenary Motorway–Ipswich Motorway to Toowong Preliminary Evaluation Report (PE 'lite') is the culmination of previous planning work undertaken by the department. The bulk of the PE analysis was completed prior to October 2012 and should be recognised in that context – that is, the time required to complete stepped planning (from 'long term' 2031 planning, options development and analysis, to 'medium term' 2021 options development and analysis, down to short term 2015/16 options), consultants activities and other detailed PE activities have occurred over an extended timeframe extending across the change in State Government as a result of the March 2012 election.

In May 2013, IIC determined that the PE 'lite' Report, should be completed to the greatest extent possible, and was subsequently suspended in May 2013. In April 2013, to ensure value for money and to manage the upcoming potential traffic issues arising from the opening of Legacy Way, planning focus shifted to the preliminary design and cost estimates required for the first 'Tranche' of Stage 1 works north of the Centenary Bridge (for additional lane works on the Moggill Road to Mt-Coot-tha Road section of the Centenary Motorway and an assessment of southbound ramp metering at Mt Coot-tha, Moggill Road and Fig Tree Pocket Road). This 'Tranche 1' project fit under the umbrella of the long and medium term options assessed in the 'PE lite'.

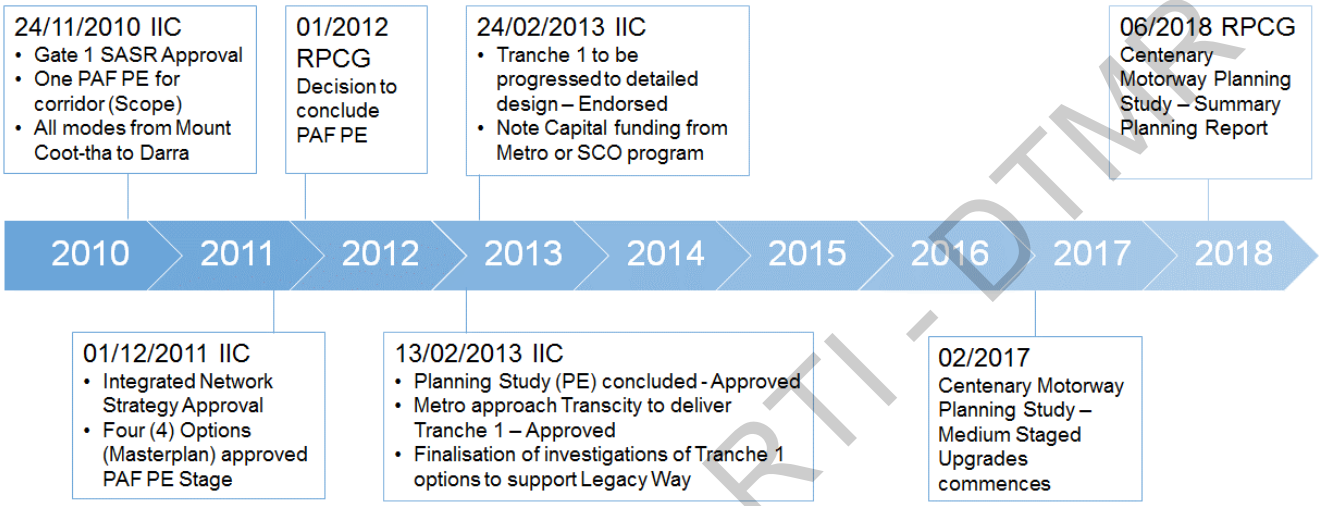


Figure 1-1: Previous planning timeline

1.3 Service requirements

A review of the outcomes from the previous planning was undertaken to reconfirm the validity and currency of the project's objectives and service requirements meet the priority needs, and ensure the outcomes are aligned with achieving Queensland Government and Departmental objectives. A review of the SASR service requirements and revised project objectives are detailed in Table 1-1.

Table 1-1: Service Requirements and revised Project Objectives

SASR Service Requirements	Revised Project Objectives
Address geometric deficiencies at ramps and the mainline alignment, thereby improving road safety	Improve safety along the corridor for all users
Facilitate the sustainable economic growth objectives of the Queensland government with a particular emphasis on the Western Corridor	Provide a roadway of sufficient standard, capacity and flexibility to meet future road user requirements.
Improve reliability of travel for forecast commercial, freight and inter-regional trips	Improve travel time and reliability for all road users.
Reduce travel times between Toowong and Darra	Provide an efficient roadway that integrates with the existing road network and is consistent with network priority requirements.
Improve availability of more appropriate route and mode alternatives (promotion of public transport)	Minimise disruption through closures and delay by adhering to acceptable flood immunity standards to enhance network resilience.
Improve lifecycle asset management effectives to meet required performance levels	Provide enhanced local connectivity and accessibility to support social inclusion within the local community.
	Maximise freight efficiency and allow adequate capacity for freight.

The service requirements for the project were identified in the context of addressing key issues / problems observed on the Centenary Motorway, with an initial identification of potential benefits. These Project service requirements were then aligned to TMR Strategic Objectives as detailed in Table 1-2.

Table 1-2: Project Objectives aligned with TMR Strategic Objectives

TMR Objective:	**An integrated transport system that supports the efficient and reliable movement of people and goods**	
TMR Strategies:	• **Plan to meet demand associated with growth** • **Invest to optimise operation and expansion of the network**	
Issues / problems	**Service requirements**	**Potential benefits**
• Existing motorway cannot cope with Western corridor growth • High levels of traffic congestion during peak traffic flows and unreliable travel times • Lack of river crossing capacity • High mix of regional and local traffic on the motorway increasing congestion and decreasing road safety • Motorway subject to flooding – motorway at risk of future time closures	• A motorway which provides adequate supply capacity to cater for 2041 (and beyond) predicted traffic volumes • A motorway that supports travel time reliability • A motorway that ensures reliable access for regional traffic • A motorway with minimised local traffic movements to the regional road network • A motorway with improved flood immunity	• Maximised economic growth potential of the western corridor • Reduced road user and vehicle operating costs through travel time savings and reliability • Enhanced connectivity between economic centres • Improved freight efficiency • More efficient incident management • Reduced time of motorway closure due to increased flooding risk
TMR Objective:	**Sustainable, cost-effective transport network accessible to all**	
TMR Strategies:	• **Travel reliability and efficiency** • **Balanced and integrated service**	
Issues / problems	**Service requirements**	**Potential benefits**
• Shorter trips use motorway • Lack of river crossing capacity to meet local trip demand	• Range of sustainable travel options in corridor • Network priority in line with transport task	• Effective transport services for all modes • People choose to shift to sustainable transport modes
TMR Objective:	**An integrated passenger transport system that is safe and accessible**	
TMR Strategies:	• **Safety, security of transport users** • **Connect people and communities**	
Issues / problems	**Service requirements**	**Potential benefits**
• Failure to meet contemporary design and operational standards • High number of crashes • Bus services not an attractive alternative to car	• A safe motorway that complies with contemporary design and operational standards • A safer road network through separation of regional and local traffic • Facilities that support safe movement for pedestrians and cyclists	• Reduced rate of crashes and severity of crashes for all road users • Safer travel for public transport users, cyclists and pedestrians • Optimise customer travel experience

Identifying the strategic needs and service requirements, along with the potential benefits of addressing the issues / problems, was a critical step in confirming the study objectives.

1.4 Study objectives

This current planning study has sought to develop a range of short and medium term responses to address a raft of network issues associated with the Centenary Motorway corridor. Given the urgency of the issues facing the Centenary Motorway, it was determined that the planning study would be undertaken with two concurrent streams of work progressing along the OnQ Business Case (BC) and Project Assessment Framework (PAF) Preliminary Evaluation (PE) Streams.

The work order objectives are as follows:

OnQ BC objectives:

- To progress a 'Tranche 1' suite of works to a series of completed Business Case Lite reports.

Overarching work objectives:

- enhancing network performance across all transport modes
- consider and address safety issues within the corridor and ramp locations
- providing upgrade solutions that can be packaged and delivered in stages, and which do not compromise or preclude delivery of the ultimate vision
- maximising affordability and economic viability
- maximising public & active transport networks to assist with the task of moving people in the corridor
- considering community needs and environmental and cultural heritage values (where relevant)
- incorporating innovation and sustainability in design.

PAF PE objectives

- To review the existing 'PE Lite report' that confirms the short and medium term stages using the PAF process.
- The short term and medium suite of projects that are considered to be:
  - Part of a logical first stage of upgrading the motorway in the medium term
  - Sequenced to provide the greatest performance benefit, whilst remaining affordable
  - The programme of works is to propose short (0-5year) and short/medium (5-10year and 10-15year) projects.
- To report the findings of the updated 'PE Lite report' to IIC and to seek further advice.

2. Available data

The datasets shown in Table 2-1 were provided/acquired and used as key inputs to the study.

Table 2-1: Available data

Dataset	Provided by	Date	Comments
Topographic survey data	TMR	Mar 2017	• Photogrammetric data captured by Schlenker Mapping, Dec 2016. • Stated accuracy ±0.12m
Aerial photography	TMR	Aug 2017	• Based upon data provided by DERM, dated 2016
TMR held properties	TMR	Mar 2017	• Provided in ACAD format, stated currency Feb 2017
Crash history data	TMR	Mar 2017	• TMR RoadCrash 2 data 2010-2016 • Trends in crash data pre-2010 were summarised from the previous 2012 study
Pile and borehole data from construction of Centenary Bridge	TMR	Aug 2017	• Scans of historic Rex Hooker drawings from construction of original Centenary Bridge, dated 1964
Drainage drawings	TMR	Aug 2017	• Scans of a selection of historic drainage drawings made available. • Age, status and currency of the drawings varies.
As-constructed bridge GA drawings	TMR	Circa 2009	• Data provided for previous study
Geotechnical data at bridge locations	TMR	Circa 2009	• Data provided for previous study
Kenmore Bypass Centenary Motorway Interchange Options Analysis	TMR	Mar 2018	• Draft Summary Planning Report and associated layout drawings

2.1 Crash data

A crash analysis has been prepared to investigate crash patterns on the Centenary Motorway from the Sumners Road interchange to the Moggill Road interchange, to support decisions regarding the upgrade of sections of the motorway including the Brisbane River Bridge and its approaches. Trends in crash data from 2010 to 2016 have been analysed for 14 segments of the motorway (refer to Appendix A). Key inputs to the analysis include:

- TMR RoadCrash 2 data 2010-2016;
- High level trends in crash data pre-2010 as noted from the previous 2012 CMPS.

There were 192 recorded crashes on the Centenary Motorway between 2010 and 2016. Key points to note are:

- Of the 14 segments, the worst crash records were observed for:
  - Segment 5 (Mt Ommaney Centre to Oldfield Road and including the Mt Ommaney Interchange)
  - Segment 8 (over the Brisbane River Bridge to Quinty Street);
  - Segment 9 (Quinty Street to Warunder Street including the tight curve just north of the river); and
  - Segment 11 (Fig Tree Pocket northbound entry ramp to Jerrang Street, mainly northbound on the approach to the Moggill Road off-ramp).

Segments 8, 9 and 11 are considered to be most important in terms of future corridor upgrades due to the overall numbers of crashes occurring in these areas, coupled with factors inherently related to road geometry and environment.

- The majority of the crashes (61%) resulted in injuries which required medical treatment and 26% required hospitalisation. The number of crashes resulting in hospitalisation gradually increased except in 2013 and 2014 where the number of hospitalisation crashes was found to drop slightly.
- A reduction in crashes occurred over 2014-2015 on the motorway mainline. The Legacy Way Tunnel opened in 2015 and this, coupled with the six-laning of the motorway between Moggill Road and the northbound portal, may have influenced this reduction.
- The least number of crashes was recorded in 2015 and this may be due to the traffic management program during the preceding construction periods. During the construction period, traffic speeds were controlled at to 60km/hr, and numerous traffic switches took place which would have improved driver alertness.
- From the 2012 CMPS crash study, approximately 267 crashes including several fatalities were recorded on segments 1-14 of the Centenary Motorway between 1999 and 2009 (11 years).
- On a pro-rata basis over a 7-year period (the period examined in this crash study) crash rates for the 2010-2016 period have increased slightly (170 to 192 crashes).
- A significant proportion of total crashes were recorded at the Brisbane River Bridge, the sub-standard curve to the north of the bridge, the Fig Tree Pocket and Moggill Road interchanges. The locational trend established in the 2012 CMPS for these areas appears to be ongoing based on the findings in this update to 2016.

The full crash analysis report is included in Appendix A.

3. Consultation

3.1 Needs Workshop

A Needs Workshop was held on Friday 17 February 2017 to inform stakeholders of the study (including TMR and Brisbane City Council), outline the previously recommended short to medium term staging, seek feedback on current conditions, issues and needs in the corridor, identify other studies and projects in or near the study area, and develop a common understanding of constraints, options and study objectives.

The key issues and needs identified along the corridor include:

- Conflict points between cyclists and pedestrians
- Southbound congestion propagates back from Fig Tree Pocket Road entry ramp
- Northbound congestion propagates back from Sinnamon Road entry ramp
- Centenary Motorway is not a freight route – B-doubles cannot access Legacy Way
- Bus travel time – buses are delayed due to general traffic congestion
- Rat-running occurs as people choose to use local streets rather than the motorway
- Sumners Road interchange was identified as one of the most pressing south-side congestion points
- Substandard geometry throughout the corridor poses safety issues – particularly just north of the bridge
- Geometry of ramps and merge points contributes to traffic congestion
- Flooding issues
- Centenary Bridge nearing the end of its design life

Some of the potential actions identified from the workshop include:

- Extend and improve cycle and pedestrian facilities, including safer crossings, more access points and separation of cyclists and pedestrians
- Install ramp metering at interchanges and increase entry ramp storage lengths
- Signalise Sumners Road interchange roundabouts
- Improve geometry and drainage along the corridor
- Investigate VMS opportunities along the corridor
- Conduct review of posted speed limits
- Install HOV lanes

Meeting minutes are included in Appendix B.

3.2 Steering Committee meetings

Three Steering Committee meetings have been held throughout the study. A summary of each meeting is shown in Table 3-1. Meeting minutes are included in Appendix B. The Control Point Papers prepared for each meeting are included in Appendix C.

Table 3-1: Summary of Steering Committee meetings

Steering Committee #1 – Friday 16 June 2017
Purpose of meeting / endorsement sought
Approval for further investigation and development of the following short term options to inform an OnQ Business Case: • STO 5: New 3 lane northbound bridge over Brisbane River • STO 3: Southbound bus hard shoulder running, Moggill Road to Kenmore Road overpass • STO 4: Northbound bus hard shoulder running, Dandenong Road to Sinnamon Road • STO 1: Fig Tree Pocket Road and Moggill Road entry ramp signalisation and geometry improvements • STO 2: Sinnamon Road entry ramp signalisation and new Dandenong Road entry ramp Approval for further investigation and development to inform an updated PAF Preliminary Evaluation: • MTO 1: Six lane, unconstrained surface upgrade, using normal design parameters (NDD) • MTO 2: Six lane surface upgrade, largely to be widening of the existing alignment, using extended design parameters (EDD)
Outcomes
• Approval to proceed with an OnQ Business Case for a new Centenary Bridge. • An OnQ Business Case for the upgrade of the Sumners Road interchange is also required. • Approval to progress MTO 2 (six lanes largely to be widening of the existing alignment) as the preferred option for upgrading the motorway and to prepare a Preliminary Evaluation for this option, which should include a staging implementation plan.
Steering Committee #2 – Friday 18 August 2017
Purpose of meeting / endorsement sought
• Seeking approval of either Option 1 (extend life of existing bridge) or Option 2 (expedite full-width new bridge), Option 3 (full six lane upgrade with Private Sector Investment) and the OnQ Business Case Options, including their associated issues • If a qualitative Value for Money assessment indicates a favourable opportunity, approval to assess a PE option involving express lanes and private sector investment.
Outcomes
• Endorsement of Option 2 (expedite full-width new bridge) as it has a shorter afflux risk than Option 1, the cost to upgrade the existing bridge will become redundant as the bridge will eventually be demolished, and Option 2 is versatile such that TMR can revert to Option 1 if the funds to construct the new bridge become unavailable. • Value for Money assessment would be beneficial for TMR, and the project team is to make a high level modelling assessment of tolling potential on the motorway.
Steering Committee #3 – Friday 18 May 2018
Purpose of meeting / endorsement sought

Presentation of the following key outcomes / changes since previous Steering Committee:
• Centenary Motorway / Kenmore Bypass interface, particularly Kenmore Road bridge / new Centenary Bridge interface
• Preferred Dandenong Road northbound entry ramp configuration is modification/extension of existing ramp
• Design changes south of river (reduction in design speed and new auxiliary lanes and two-lane exit ramps)
• Interim active transport arrangement – cantilevered steel structure on east of existing southbound bridge
• Traffic initial modelling results – upgrade results in increase to 2036 weekday traffic volumes over Bridge by 23% northbound and 25% southbound, and in the order of 40% more capacity in the peak hours. Traffic growth primarily driven by growth in the Western Corridor, Australia Trade Coast and CBD.
• Stakeholders have highest risk profile with rating of 82%. The remaining risk items sit between 50-70%, with Human Resources and Finalisation the lowest at 20%.
• Total whole-of-life out-turn project costs were as at 18 May 2018:
  • Medium confidence: $992,442,969 (full upgrade) / $1,065,485,525 (staged upgrade)
  • High confidence: $1,148,858,263 (full upgrade) / $1,231,380,700 (staged upgrade)

Steering Committee #1 – Friday 16 June 2017
• Current planning is based on Centenary Bridge configuration with cost limitation of $100 million. Outcomes of Centenary Bridge Preliminary Evaluation & Business Case will be different from previous work as cost limitation has been removed from scope.
Outcomes
• Agreement of new design south of river with posted speed reduction from 100km/h to 90km/h – consent to be sought from TMR Engineering and Technology (E&T) • Agreement of preferred Dandenong Road northbound entry ramp configuration – E&T will be consulted • Recommendation for future-proofing the design to provide eight 'skinny' lanes – investigate what is required in the design to allow this (e.g. set-back structures, land acquisition for future widening, minimising costs) • Recommendation to consider Managed Motorways and engage with ITS team

3.3 TMR internal stakeholder meetings

Internal technical TMR stakeholders were consulted at key points though the course of the study. These interactions are summarised in Table 3-2.

Table 3-2: Summary of meetings with TMR internal technical stakeholders

Date	TMR stakeholder	Subject matter	Key outcomes
27/07/17	TMR Bridge Branch	Structural options for Centenary Bridge that would satisfy project objectives and budgetary constraints ($95 million)	• UMax or SuperT configurations would be acceptable to TMR • Piers misaligned with existing bridge would be acceptable, subject to hydraulic impacts and acceptance by Harbour Master • 5m spacing between new and old bridges would be acceptable to TMR, provided construction approach is carefully managed and suitable allowances made in cost estimates
01/08/17	TMR Principal Hydraulics	Hydraulic assessment of Centenary Bridge upgrade options	• Hydraulic analysis approach applied to date is acceptable • Hydraulic impact predictions presented (+50mm under 1% AEP event) are a significant issue and would not be technically preferred as a long term scenario
25/08/17	E&T	EDD and DE items for northern section	• Acceptance in principle of the treatments of the EDD and DE elements identified for the section of motorway north of the Brisbane River

03/03/18	E&T	EDD and DE items for southern section	• Numerous EDD and DE elements were identified for 110 km/h design speed for the section of motorway south of the Brisbane River
			• E&T recommended that:
			  • 100 km/h design speed (90 km/h posted) is analysed
			  • auxiliary lanes and 2-lane exit ramps are provided for the sections where entry and exit ramps are closely

22/05/18	E&T	EDD and DE items for southern section	• Acceptance in principle of the treatments of the identified EDD and DE elements south of the Brisbane River, subject to Metro RD acceptance of the 90 km/h posted speed

3.4 Harbour Master meetings

Meetings held with the Harbour Master during the study are summarised in Table 3-3.

Table 3-3: Summary of meetings with Harbour Master

Date	Stakeholder	Subject matter	Key outcomes

03/08/17	Harbour Master	Centenary Bridge pier spacings and staged delivery options	• U/S bridge lighting would need to be relocated to new bridge
			• Substructure lighting and warning signs may be required for river traffic – particularly for piers offset from existing
			• If spans reduced compared to existing, maintaining central span is a priority
			• Design to consider adjacent property pontoons
			• Order of preference for Centenary Bridge solutions:
			  • Spans and piers aligned with existing
			  • Central span/piers aligned with existing
			  • Offset piers not preferred but would be considered

4. Options identification and assessment

4.1 Project options development process

In accordance with the study objectives, the Project Team undertook a review of the projects documented in the SASR (2010), PE 'Lite', previous planning studies (circa 2013) and options identified by stakeholders in the Needs Workshop (17 February 2017) to develop a list of potential options to be investigated as part of this study for general traffic, public transport and active transport, comprising of non-infrastructure and asset based options.

Preliminary investigation of these potential options was completed, resulting in a long list of potential options, classified as short term options (STOs) and medium term options (MTOs) for all modes (refer Control Point Paper 1 in Appendix C.1).

The assessment was undertaken for both the medium term and short term options. The MTOs were comparatively assessed to determine which MTO provided the highest benefit to the identified service requirements and project objectives, with a separate exercise undertaken for the STOs. The criteria were consistently used in the comparative assessments and were built on the Service Requirements from the SASR with a refined set of Project Objectives to align in the early phases of this planning study. The shortlisted options that were presented to the Project Steering Committee (PSC) is outlined in Table 4-1.

Table 4-1 : Shortlisted Centenary Motorway: Medium Staged Upgrades options

Category	Project number	Project description
Better use (non-infrastructure)	STO 1	Fig Tree Pocket Road and Moggill Road entry ramp signalisation and geometry improvements
	STO 2	Sinnamon Road entry ramp signalisation and new Dandenong Road entry ramp
	STO H	AT – Separation of pedestrian and cycling facilities along the motorway
	STO I	AT – Additional cycleway access points from minor streets
Improve existing	STO J	AT – Cycleway connection between Centenary Bikeway and Bicentennial Bikeway
	STO K	AT – Improved cycle facilities at Dean Street and Miskin Street
	STO L	AT – Improved at-grade crossing at Fig Tree Pocket Road southbound ramps
	STO M	AT – Improved at-grade crossing at Sinnamon Road northbound ramps
	STO N	AT – Improved at-grade crossing at Dandenong Road roundabout
	MTO D	AT – Cycle crossing at Sumners Road northbound ramps roundabout
	STO 3	PT – Southbound bus hard shoulder running, Moggill Road to Kenmore Road overpass
	STO 4	PT – Northbound bus hard shoulder running, Dandenong Road to Sinnamon Road
New infrastructure	STO 5	New three-lane northbound bridge over the Brisbane River
	MTO 1	Six lanes off existing alignment (unconstrained design) between Moggill Road and Sumners Road (Normal Design Domain)
	MTO 2	Six lanes on existing alignment between Moggill Road and Sumners Road (Extended Design Domain)

The outcomes of this comparative assessment were presented to the PSC in June 2017 (refer Control Point 1 paper), where the following recommendations were sought:

- Five STOs (1 to 5) would be further investigated and developed to inform an OnQ Business Case (BC) and the two MTOs (1and 2) would be further investigated and developed to inform an updated PAF Preliminary Evaluation (PE) report.

The Steering Committee endorsed the approach to concurrently develop the PAF PE and OnQ BC activities as part of this study. The six lane options would be progressed further to refine the concept design (traffic, geometric and EDD considerations) and understand the potential for staging and compare alternative delivery methods. The STOs, in particular STO 5 (Centenary Bridge), would undergo further design to understand the potential configuration, structural limitations and afflux issues associated with the identified options.

These refinements and further analysis were presented to the Steering Committee in August 2017, where the following recommendations were sought:

- Approve the presented PAF PE options (Six lanes on existing alignment (staged delivery), consideration of six lanes on existing alignment (full delivery), and the OnQ BC Options to be further progressed.

Part Refuse Sch.4 Part 4 s.4(1)(a) Opinion/advice/recommendation for deliberative processes of government as part of the six lanes on existing alignment, and endorsed the approach to expedite a full-width new (northbound) Centenary Bridge as part of a separate investigation under a PAF PE.

The Centenary Motorway PE continued to be progressed, refining the staged, six lane (on-line) upgrade of the Centenary Motorway between Moggill Road and Sumners Road in terms of the concept design, traffic analysis, cost estimates and risk analysis.

The outcomes of the refinements to the concept design, traffic analysis, cost estimates and risk analysis were presented to the Steering Committee in May 2018, in addition to further analysis of non-infrastructure options, where the Steering Committee was to note the status of key technical streams, including design elements, traffic modelling, risk analysis and cost estimates.

A summary of the development process is shown in Figure 4-1 overleaf.

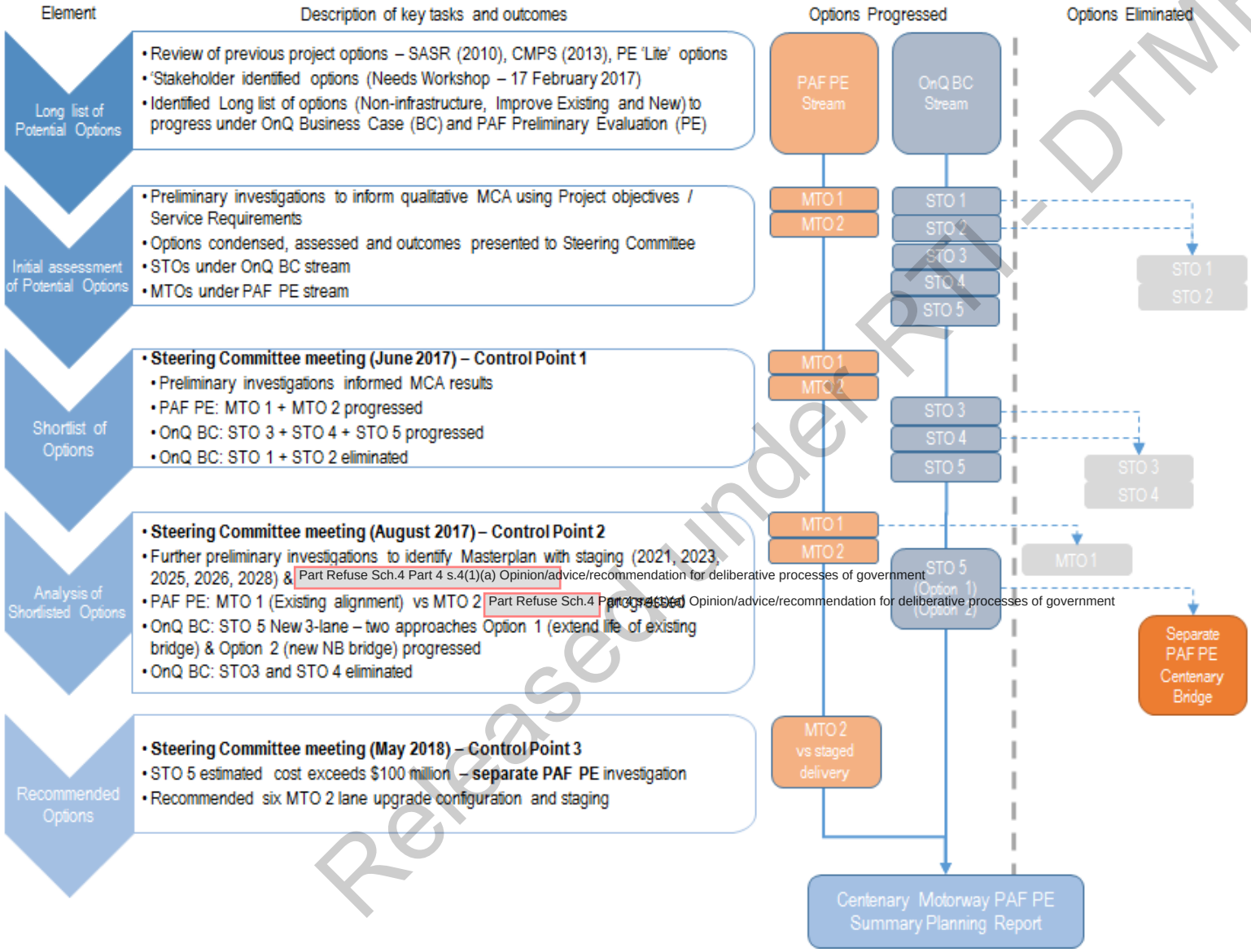


Figure 4-1: Project options development framework

4.2 Base Case: 'Do minimum'

The Base Case provides a common point of reference against which to measure the incremental costs and benefits of the various options. The Base Case can simply be defined as the business as usual scenario, which practically equates to an ongoing requirement to maintain the existing asset over the project assessment period.

The Base Case includes routine and programmed maintenance and rehabilitation that the department would necessarily undertake in the absence of any project option proceeding.

The 'Do minimum' is the most realistic scenario that would be implemented by TMR in the absence of the Project. The 'Do minimum' case will be treated as an alternative interim scenario to the delivery of any 'Non-infrastructure' or 'New Asset' options. The 'Do minimum' option would require:

- routine, periodic and rehabilitation activities on the Centenary Motorway
- rehabilitation activities on the Centenary Bridge to address current critical defects and to prolong its useful life, which was informed by a level 3 inspection of the existing northbound Centenary Bridge completed on 17 July 2017.

In addition to condition and design life issues for the Centenary Bridge, it is important to note the following:

- The existing northbound bridge was not designed to cater for heavy vehicle design loads. Given its structural form, it is not considered practical to upgrade the bridge's structural capacity.
- The existing northbound and southbound bridges both have traffic barriers which are not compliant with current design standards. The structural modifications that would be required for the bridges to adequately support compliant barriers would be considerable.
- Each of the existing bridges is only wide enough for two general purpose lanes. Given the limitations of their structural forms, neither of the structures are considered suitable for widening.
- There are structural issues and risks associated with the existing halving joints and drop-in central span. These joints are not fully accessible or able to be fully inspected. The existing bearings are damaged and are not able to be replaced without closing the bridge and lifting the central girders. Failure mechanisms for this type of joint can be brittle and catastrophic with little warning.

The 'Do minimum' option would require continued acceptance of the load- and traffic-carrying limitations and the risk profile associated with the critical structural elements.

4.3 Non-infrastructure options

It is important to consider the potential for low-cost and non-infrastructure solutions to optimise existing assets as part of a comprehensive assessment of potential options to address the project needs and meet the service requirements. Low-cost or non-infrastructure options have the potential to provide benefits to users and reduce the need for significant capital expenditure, helping TMR to "sweat existing assets", achieving more with less.

A number of short term, non-infrastructure options were identified in the early phases of this Project shown in Table 4-2.

Table 4-2: Non-infrastructure options

Category	Project number	Project description
Better use (non-infrastructure)	STO 1	Fig Tree Pocket Road and Moggill Road entry ramp signalisation and geometry improvements
	STO 2	Sinnamon Road entry ramp signalisation and new Dandenong Road entry ramp

STO 1 and STO 2 were both eliminated in the comparative assessment as these options were ineffective in addressing the project objectives and service requirements. Whilst these options provided some benefit to motorway users as local traffic movements on the motorway were reduced, they were less effective in meeting the project objectives and service requirements as both options negatively impacted the supporting road network as local traffic sought to access the motorway ramps, reducing connectivity and accessibility on the network. These options were also less effective in addressing the project objectives and service requirements relating to motorway safety as they had little effect in reducing motorway volumes.

4.4 Public and active transport

As part of the previous SASR in 2010 and the Centenary Motorway Planning Studies completed in 2013 (Summary Planning Report and Tranche 1 Design Development Report), a number of active and public transport options were documented and considered as part of this Project in terms of potential short and medium term options.

These options were identified in the Needs Workshop with stakeholders held on Friday 17 February 2017 to identify issues and potential responses along the Centenary Motorway. It is noted that no specific public transport options were identified in the workshop.

Subsequently, the project team held a meeting on Thursday 9 March 2017 to discuss the options from the previous studies and the options identified in the Needs Workshop. Additional options were identified by the project team and a condensed list of options were developed as shown in Table 4-3, with the options to be continued for investigation as marked.

Table 4-3: Active and public transport options

Category	Project number	Project description
Better use (non-infrastructure)	STO H	AT – Separation of pedestrian and cycling facilities along the motorway
	STO I	AT – Additional cycleway access points from minor streets
Improve existing	STO J	AT – Cycleway connection between Centenary Bikeway and Bicentennial Bikeway
	STO K	AT – Improved cycle facilities at Dean Street and Miskin Street
	STO L	AT – Improved at-grade crossing at Fig Tree Pocket Road southbound ramps
	STO M	AT – Improved at-grade crossing at Sinnamon Road northbound ramps
	STO N	AT – Improved at-grade crossing at Dandenong Road roundabout
	MTO D	AT – Cycle crossing at Sumners Road northbound ramps roundabout
	STO 3	PT – Southbound bus hard shoulder running, Moggill Road to Kenmore Road overpass
	STO 4	PT – Northbound bus hard shoulder running, Dandenong Road to Sinnamon Road

Importantly, it should be noted that no active transport specific options were recommended to be taken forward as standalone options. The active transport options were consolidated and developed as part of the STOs and MTOs that were recommended for the OnQ BC and PE phase respectively.

The two public transport options taken forward for further analysis as part of the OnQ BC are discussed in further detail in the following sections.

4.4.1 STO 3 – southbound bus hard shoulder running (Moggill Road to Kenmore Road overpass)

STO 3 provides priority to buses on the southbound carriageway in the PM peak period (2pm to 7pm). The option involves:

- Hard shoulder running southbound from Moggill Road to just north of the Kenmore Road overpass

The desired outcome of the option is to reduce travel time for bus passengers between Moggill Road and the Centenary Bridge during the PM peak period (2pm to 7pm) by allowing buses to bypass the congested traffic on the motorway and ramps south of Moggill Road.

Preliminary traffic assessment considerations for this option include:

- A total of 51 bus services (9 bus routes) would benefit from this option during the PM peak (2pm to 7pm). Based on preliminary assessment, this option would give an average time saving of around one minute per bus service (up to six minutes in peak conditions), with a total saving of 103 passenger hours during the PM peak (assuming 40 passengers per bus).

Engineering considerations for this option include:

- At this stage, a 3.3m wide shoulder / bus lane (with provision for curve widening where required) has been assumed beyond the existing traffic lane edge. This requires a widened formation along much of the alignment and may require retaining walls in some locations to minimise footprint
- Operations and interfaces with entry and exit ramps and emergency stopping bays would need to be carefully considered
- In a number of locations, the widening would require re-alignment of the bikeway. In some locations, new bikeway crossings of existing roads would be required.

4.4.2 STO 4 – Northbound bus hard shoulder running, Dandenong Road to Sinnamon Road

STO 4 provides priority to buses on the northbound carriageway in the AM peak period (6am to 9am). The option involves:

- Hard shoulder running northbound from Dandenong Road to Sinnamon Road
- Bus jumps at the Sinnamon Road and Dandenong Road northbound entry ramps

The desired outcome of the option is to reduce travel time for bus passengers between Dandenong Road and Sinnamon Road during the AM peak period (6am to 10am) by allowing buses to bypass the congested traffic on the motorway and ramps north of Dandenong Road.

Preliminary traffic assessment considerations for this option include:

- A total of 31 bus services (4 bus routes) would benefit from this option during the AM peak (6am to 10am). Based on preliminary assessment, this option would give an average time saving of around 0.7 minutes per bus service (up to 5 minutes in peak conditions), with a total saving of 58 passenger hours during the AM peak (assuming 40 passengers per bus).

Engineering considerations for this option include:

- At this stage, a 3.3m wide shoulder / bus lane (with provision for curve widening where required) has been assumed beyond the existing traffic lane edge. This requires a widened formation along much of the alignment and may require retaining walls in some locations to minimise footprint
- Operations and interfaces with entry and exit ramps and emergency stopping bays would need to be carefully considered
- In a number of locations, the widening would require re-alignment of the bikeway. In some locations, new bikeway crossings of existing roads would be required.

STO 3 and STO 4 were both eliminated in the comparative assessment as these options were ineffective in fully addressing the project objectives and service requirements. Whilst these options provided some benefit to motorway users as public transport movements were given priority on motorway, giving some very marginal capacity improvements to general purpose traffic, which supported more sustainable modes of transport, these options were less ineffective in meeting the project objectives and service requirements relating to motorway travel time reliability, which further impacted connectivity and accessibility on the supporting network. These options were also less effective in addressing the project objectives and service requirements relating to motorway safety as they had little effect in reducing motorway volumes.

4.5 New infrastructure options

The previous Centenary Motorway study developed and assessed a range of new infrastructure options, consistent with a six lane design of the Centenary Motorway that could be implemented in the medium term (2021), as a step towards a potential eight-lane configuration that is expected to be required in the longer term (2031 and beyond). As part of these developments, it was recognised that a new Brisbane River crossing would be required to accommodate expected traffic growth over the planning horizon. Upgrading the Centenary Motorway progressively from north to south was considered to be the most effective staging approach from the traffic performance and constructability perspectives, providing downstream benefits from the upgraded sections. Accordingly, STO 5, MTO 1 and MTO 2 have been identified to achieve a six lane arrangement between Moggill Road and Sumners Road. At a high-level, these can be described in Table 4-4, with further detail provided in the following sections.

Table 4-4: New infrastructure options

Category	Project number	Project description
New infrastructure	STO 5	New three-lane northbound bridge over the Brisbane River
	MTO 1	Six lanes off existing alignment (unconstrained) between Moggill Road and Sumners Road (Normal Design Domain)
	MTO 2	Six lanes on existing alignment between Moggill Road and Sumners Road (Extended Design Domain)

The full implications and staging potential of STO 5, MTO 1 and MTO 2, alongside a full delivery scenario, is discussed in Section 6.2.

4.5.1 STO 5 – New three-lane northbound bridge over Brisbane River

The existing Centenary Bridges over the Brisbane River are known to have a number of issues/risks, including:

- Northbound bridge is not able to cater for heavy vehicle loads (southbound bridge design vehicle is T44)
- Northbound bridge is known to be in a poor condition and approaching the end of its effective life. Remediation works will be required to address the critical issues.
- Both bridges incorporate halving joints and drop-in central spans. This structural concept has known issues (accessibility and maintainability of joints and bearings) and risks (associated with the failure mechanism).
- Neither bridge is readily able to be widened.
- Barriers on both bridges are not compliant with current design standards and could not be readily upgraded to comply.

To increase the traffic-carrying capacity of the River crossing and to facilitate heavy vehicles in the northbound direction, a new bridge would be required. STO 5 provides a new northbound three lane bridge, designed for heavy vehicle loads. It is envisaged that this would be located upstream from the existing bridges. During the previous study, it was specified that the new bridge would need to be located 29m upstream of the existing bridge in order to manage risks during construction. Investigations as part of the Centenary Bridge OnQ BC phase indicated that this constraint does not need to apply, with the separation being reduced to only 5m.

It was determined that the most cost-effective structural form be adopted for the bridge. Whilst a detailed assessment has not yet been undertaken, it is expected that the most cost-effective form would be a standard Super T arrangement. This would support spans of approximately 35m and the new piers would not line up with the existing bridge piers. Such an arrangement would adversely affect upstream flood levels until the downstream bridges are removed/ replaced in the future.

It is envisaged that the new bridge would initially be constructed to accommodate three lanes of traffic, and would be designed to facilitate future widening to provide for additional lanes to support MTO 1 and MTO 2. Staging and future expansions were given consideration as part of subsequent investigations as part of the OnQ BC.

STO 5 includes three general purpose lanes on the southern and northern approaches to the bridge. This would effectively provide an additional lane above the existing from the Sinnamon Road entry ramp to the Kenmore Road overpass. There is insufficient room to provide an additional lane beneath the existing Kenmore Road overpass, so it is proposed that the three lanes will merge into two prior to reaching the overpass.

The provision of an added lane from the Sinnamon Road entry ramp across the bridge and relocation of the merge point to north of the river would provide an improved merge condition at the critical Sinnamon Road entry ramp to better manage the entry flows. This is expected to deliver a marginal uplift in the hourly traffic capacity of the northbound carriageway, recognising the two lane constraint still remaining beneath the existing Kenmore Road overpass.

As part of the PE, two staging options were considered to achieve the upgrade of the Centenary Motorway to six lanes between Sumners Road and Moggill Road, which will be discussed in the below sections. To support the development of the two motorway staging options, two alternative bridge upgrade options were also developed:

- Option 1 – Extend the life of the existing bridge by upgrading the superstructure to accommodate three southbound lanes with heavy vehicle capacity (such that it would be suitable as a 25 m B-Double route). This would require TMR to accept adverse upstream hydraulic impacts and the technical risks inherent with the existing structure over that extended life (likely approx. 27 years from 2017).
- Option 2 – Expedite delivery of six lanes and active transport (AT) by widening the new structure and removing the existing structure. This would remove the adverse hydraulic impacts and technical risks as soon as possible.

The key differences between these two bridge options relate to project need and staging, discussed in Section 6.2, and key technical specifications, discussed in more detail in Section 6.6.1. For the purposes of the comparative analysis, given the Centenary Bridge in either form did not materially affect the functionality of the bridge with respect to traffic impacts and performance, it was not a determining factor at this stage.

STO 5 (in either form) performed relatively well in the comparative assessment. This option provided some benefit to motorway users, giving some very marginal capacity improvements, albeit over a relatively short distance with respect to the full motorway corridor. Accordingly, this option was more effective in meeting the project objectives and service requirements relating to supporting more sustainable modes of transport, and addressing connectivity and accessibility on the supporting network, and motorway safety. The analysis indicated that this was a physical constraint on the motorway and addressing this as an initial stage of works would enable the future upgrades to achieve the project objectives and service requirements relating to travel time reliability, capacity and safety.

4.5.2 MTO 1 – Six lanes off existing alignment (unconstrained design), Moggill Road to Sumners Road

The six lane unconstrained design was developed during the previous study to be fully compliant with all current design standards without requiring extended design domain (EDD) parameters. North of the river, a design speed of 100 km/h was adopted (posted 90 km/h). South of the river, a design speed of 110 km/h was adopted (posted 100 km/h).

The proposed vertical geometry would provide flood immunity to the 100 year ARI event and the 2011 historical flood event at the critical locations (Moggill Road, Fig Tree Pocket Road and Jindalee). To achieve this outcome, embankment heights at these locations would be significantly higher than the existing formation.

To accommodate the widened formation and the revised alignment, significant upgrades to the existing interchanges and structures would be required, including:

- New interchanges at Moggill Road, Fig Tree Pocket Road, Sinnamon Road / Seventeen Mile Rocks Road, Dandenong Road and Sumners Road
- New bridges over the Brisbane River and at Witton Road
- New overpasses at Jerrang Street and Kenmore Road

4.5.3 MTO 2 – Six lanes on existing alignment, Moggill Road to Sumners Road

MTO 2 has been identified as a potential lower-cost, lower-impact medium term option as an alternative to MTO 1. In essence, MTO 2 involves widening of the existing formation to provide six lanes. Existing geometry limitations would be largely accepted. Current posted speeds would be maintained where possible. Extended design domain parameters would be required.

Existing flood immunity issues at Moggill Road, Fig Tree Pocket Road and Jindalee would remain unchanged.

It is recognised that in some locations, the widened formation would not be consistent with the ultimate master plan. To accommodate the widened formation, some upgrades to existing interchanges and structures would be required, including:

- Widened bridges at Witton Road
- New bridges over the Brisbane River
- New overpasses at Jerrang Street, Kenmore Road, Seventeen Mile Rocks Road and Sumners Road
- Upgraded ramps at Fig Tree Pocket Road, Sinnamon Road / Seventeen Mile Rocks Road and Dandenong Road
- New ramp at Dandenong Road
- Relocated bikeway at Fig Tree Pocket Road interchange

The comparative assessment of MTO 1 and MTO 2 indicated that whilst MTO 1 comparatively met the project objectives and service requirements to a greater degree over MTO 2, these outcomes would only be realised at a considerably high capital expense, with considerable community and property impacts. Therefore, in comparative terms, MTO 2 outperformed MTO 1.

4.6 Project options assessment

4.6.1 Project options assessment criteria

The options assessment criteria were established from the Project Objectives, the Project Service Requirements and a set of Technical criteria. The project objectives and project service requirements were informed by a review of outcomes from the previous planning that has been completed and confirms that the project's objectives and service requirements meet the priority needs and are aligned with State Government and Departmental objectives. The assessment criteria are set out in Table 4-5, with further explanations provided in Table 4-6.

Table 4-5: Project options assessment criteria

Objectives and Service Requirements
TMR objective: An integrated transport system that supports the efficient and reliable movement of people and goods
Project objectives • Provide a roadway of sufficient standard, capacity and flexibility to meet future road user requirements • Improve travel time and reliability for all road users • Minimise disruption through closures and delay by adhering to acceptable flood immunity standards to enhance network resilience • Maximise freight efficiency and allow adequate capacity for freight
Service requirements • A motorway which provides adequate supply capacity to cater for 2041 (and beyond) predicted traffic volumes • A motorway that supports travel time reliability • A motorway that ensures reliable access for regional traffic • A motorway with minimised local traffic movements to the regional road network • A motorway with improved flood immunity
TMR objective: Sustainable, cost-effective transport network accessible to all
Project objectives • Provide an efficient roadway that integrates with the existing road network and is consistent with network priority requirements • Provide enhanced local connectivity and accessibility to support social inclusion within the local community
Service requirements • Range of sustainable travel options in corridor • Network priority in line with transport task
TMR objective: An integrated passenger transport system that is safe and accessible
Project objectives • Improve safety along the corridor for all users
Service requirements • A safe motorway that complies with contemporary design and operational standards • A safer road network through separation of regional and local traffic • Facilities that support safe movement for pedestrians and cyclists
Technical criteria
• Estimated cost • Constructability • Stageability • Community impacts / property resumptions

Table 4-6: Explanation of assessment criteria ratings

Assessment type	Rating	Description
Project objective / service requirement assessment	★	*Does not meet outcomes sought*
	★★	*Some contribution to outcomes sought*
	★★★	*Significant contribution to outcomes sought*
	★★★★	*Fully meets outcomes sought*
Estimated cost	Low	*<$100 million*
	Med	*$100-$500 million*
	High	*$500-$1000 million*
	Very high	*>$1000 million*
Constructability	Low	*Not easily constructible, with interruptions to traffic operations*
	Med	*Reasonably constructible, with some interruptions to traffic operations*
	High	*Easily constructible, with no interruption to traffic operations*
Stageability	Low	*Unable to be staged / no contribution to staging of future works*
	Med	*Some works able to be staged / some contribution to staging of future works*
	High	*Easily staged / fully contributes to staging of future works*
Community impacts / property resumptions	Low	*None or low number / area of property resumptions*
	Med	*Medium number / area of property resumptions*
	High	*High number / area of property resumptions*
OVERALL SCORE	★	*Does not meet outcomes sought*
	★★	*Some contribution to outcomes sought*
	★★★	*Significant contribution to outcomes sought*
	★★★★	*Fully meets outcomes sought*

4.6.2 Project options assessment summary

The STOs and MTOs were qualitatively assessed against the Do Minimum scenario according to the project objectives and service requirements, as well as additional technical considerations. This assessment is detailed in Table 4-7.

The following key considerations had particular influence on the qualitative assessments documented in table:

- Options assessed independently (exclusive of each other)
- The Do-Minimum option has minimal contribution to the project objectives and service requirements
- STO 1 and 2 have similar benefits southbound and northbound respectively, with travel time savings for both general purpose traffic and public transport
- STO 3 and 4 have similar benefits southbound and northbound respectively, with travel time savings for public transport
- STO 5 improves safety of the river crossing via improved lane widths, barrier standards, structural form/ structural capacity
- STO 5 provides some improvement in capacity and travel time, but primarily is a key staging step towards the medium term six-lane configuration
- Both MTO 1 and MTO 2 provide increased traffic-carrying capacity and improve travel times, but MTO 1 allows for better design standards (e.g. higher posted speed)
- MTO 1 provides improved flood immunity, whilst MTO 2 does not

- MTO 1 has significant property impacts, which is a significant issue, whilst these would be minimised in MTO 2
- Crash likelihood for MTO 2 is expected to be higher than for MTO 1 (due to geometry compromises)

On the basis of the preliminary investigations undertaken to date, and the qualitative assessment documented herein, the following recommendations were made:

- STO 5: New 3 lane northbound bridge over Brisbane River be further investigated and developed to inform an OnQ BC
- MTO 2: Six lane surface upgrade, largely to be widening of the existing alignment (using extended design parameters (EDD)) be further investigated and developed to inform an updated PAF PE report.

The following STOs and MTO were not progressed in further detail in either the OnQ BC or PAF PE:

- STO 3: Southbound bus hard shoulder running, Moggill Road to Kenmore Road overpass
- STO 4: Northbound bus hard shoulder running, Dandenong Road to Sinnamon Road
- STO 1: Fig Tree Pocket Road and Moggill Road entry ramp signalisation and geometry improvements
- STO 2: Sinnamon Road entry ramp signalisation and new Dandenong Road entry ramp
- MTO 1: Six lane, unconstrained surface upgrade (using normal design parameters (NDD))

As outlined in previous sections of this report, the options that were eliminated were deemed to be less effective in meeting the project objectives and service requirements, particularly around the need to address motorway reliability and capacity, but importantly, the ability to manage growth that is anticipated on the motorway and subsequent impacts on the supporting network.

All active transport options were to be captured into any subsequent new infrastructure options, recognising that standalone active transport options would have little impact on the project outcomes, but incorporating them reflected the strategic importance of the need to ensure the Centenary Bikeway connectivity is maintained regardless of which project option is progressed.

In a similar context, whilst the STOs relating to ramp metering were ineffective in fully addressing the project objectives and service requirements, the decision was made to provide an assessment of managed motorways requirements irrespective of any project option progressed based on the requirements as outlined by TMR's Engineering and Technology Branch (E&T). Refer to Sections 4.7.3 and 6.11 for more detail.

Table 4-7: Centenary Motorway Upgrade Project Options Assessment Summary

Criteria	Do-Min	STO 1	STO 2	STO 3	STO 4	STO 5	MTO 1	MTO 2
TMR Objective: An integrated transport system that supports the efficient and reliable movement of people and goods								
Project Objectives								
Provide a roadway of sufficient standard, capacity and flexibility to meet future road user requirements	★	★★	★★	★★	★★	★★★★	★★★★	★★★★
Improve travel time and reliability for all road users	★	★★★	★★★	★★★	★★★	★★	★★★★	★★★★
Minimise disruption through closures and delay by adhering to acceptable flood immunity standards to enhance network resilience	★	★	★	★	★	★★	★★★★	★
Maximise freight efficiency and allow adequate capacity for freight	★	★	★	★	★	★★★★	★★★	★★★
Service Requirements								
A motorway which provides adequate supply capacity to cater for 2041 (and beyond) predicted traffic volumes	★	★★	★★	★★	★★	★★★★	★★★★	★★★★
A motorway that supports travel time reliability	★	★★★	★★★	★★★★	★★★★	★★	★★★★	★★★
A motorway that ensures reliable access for regional traffic	★	★	★	★	★	★★★	★★★	★★★
A motorway with minimised local traffic movements to the regional road network	★	★★	★★	★	★	★	★★	★★
A motorway with improved flood immunity	★	★	★	★	★	★	★★★★	★
TMR Objective: Sustainable, cost-effective transport network accessible to all								
Project Objectives								
Provide an efficient roadway that integrates with the existing road network and is consistent with network priority requirements	★	★	★	★★	★★	★★★	★★★★	★★★★
Provide enhanced local connectivity and accessibility to support social inclusion within the local community	★	★	★	★	★	★★★	★★	★★
Service Requirements								
Range of sustainable travel options in corridor	★	★	★	★★★	★★★	★	★★★	★★★
Network priority in line with transport task	★	★	★	★★	★★	★	★★★★	★★★★
TMR Objective: An integrated passenger transport system that is safe and accessible								
Project Objectives								
Improve safety along the corridor for all users	★	★	★	★	★	★★★★	★★★★	★★
Service Requirements								
A safe motorway that complies with contemporary design and operational standards	★	★	★	★	★	★★★★	★★★★	★★
A safer road network through separation of regional and local traffic	★	★	★	★	★	★	★★	★★
Facilities that support safe movement for pedestrians and cyclists	★	★★	★★	★	★	★★	★★★	★★★
Estimated cost	Low	Low	Low	Low	Low	Low	Very high	High
Constructability	N/A	High	High	Med	Med	High	High	Med
Stageability	N/A	Low	High	High	High	High	Med	High
Community impacts / property resumptions	Low	Low	Low	Low	Low	Med	High	Low
Summary / overall	★	★★	★★	★★	★★	★★★	★★	★★★

4.6.3 TMR Network Optimisation Framework

TMR has developed the Network Optimisation Framework (NOF) to assist in the prioritisation and consideration of low-cost and non-infrastructure solutions, or Network Optimisation Solutions (NOS), within the planning and investment processes.

To support the comparative evaluation, the NOS and New infrastructure options were assessed using the TMR "Smarter solutions multi-criteria analysis (MCA)" tool. The Project Team incorporated this analysis using the smarter solutions MCA tool to confirm the outcomes of the assessment criteria, and demonstrate consistency and transparency in analysis, improving the robustness of the analysis informing investment decision-making. The MCA tool applies a standardised consideration of Network Optimisation Strategies relative to large capital infrastructure, ensuring TMR is delivering the right infrastructure at the right time and aligning with government policy direction for investment.

A NOS workshop was facilitated by TMR as part of one of the outcomes from the PSC meeting in May 2018 (refer Control Point 3 paper in Appendix C.3). The MCA tool was utilised to test the 'performance' of the NOS against the New-infrastructure options, ensuring these lower cost and non-infrastructure solutions are given due consideration using an outcomes-based approach.

The options assessed are outlined in Table 4-8, with two new options being developed for this NOS assessment, being NOS Option 2 and NOS Option 3.

Table 4-8: Network Optimisation Solutions and New Infrastructure Options

NOS Reference	Option	Description
NOS Option 1	Hard shoulder running (PT only)	STO 3 and STO 4 – targeted as PT priority
NOS Option 2	Smarter motorways	*Newly Developed as a STO* – Smarter Motorways entire length of Centenary Motorway
NOS Option 3	Hard shoulder running (PT + HOV)	*Newly Developed as a STO* – targeted at PT and higher occupancy vehicle priority.
NOS Option 4	Selected ramp metering	STO 1 and STO 2
Infra 1	Six-lane, unconstrained surface upgrade (NDD)	MTO 1 (accommodate 'skinny eight' to align with Masterplan)
Infra 2	Six-lane, that largely follows existing alignment (EDD)	MTO 2 (accommodate 'skinny eight' to align with Masterplan)
Infra 3	Three-lane NB bridge	STO 5 – New northbound Centenary Bridge

Underpinning the NOF MCA tool are a consistent set of predetermined criterion from which to choose, relating to performance, economic, technical, social or environmental outcomes areas. The TMR Project Evaluation Unit facilitated the workshop, selecting 19 criteria due to the relevance to the Project Objectives, Service Requirements and Technical Criteria previously adopted. Criteria weights and scores were agreed upon at the workshop. The assessment criteria selected for the MCA is outlined in Appendix D, and a summary of the scoring and ranking is in Table 4-9.

Despite incorporating two new NOS, which were aimed at providing lower cost solutions to address the Project Objectives and service needs, the New Infrastructure options outperformed the NOS in almost all of the selected criteria. This would suggest that the project needs are more effectively addressed by increases to motorway capacity when comparatively assessed against demand management or PT specific measures.

Table 4-9: NOS and New Infrastructure summary score and rank

Summary of Option Scoring	Base Case (do minimum)	NOS Option 1 Hard shoulder running (PT only)	NOS Option 2 Smarter motorways	NOS Option 3 Hard shoulder running (PT & HOV)	NOS Option 4 Selected ramp metering	Infra 1 Six-lane, unconstrained surface upgrade (NDD)	Infra 2 Six-lanes largely on existing alignment (EDD)	Infra 3 Three-lane northbound bridge
Economic data	15%	0.44	0.42	0.36	0.44	0.40	0.40	0.36
Traffic performance and integration	47%	1.42	1.56	1.42	1.42	2.29	2.29	1.74
Construction and constructability	11%	0.32	0.23	0.27	0.27	0.24	0.25	0.22
Environmental impact	7%	0.21	0.21	0.21	0.21	0.07	0.14	0.17
Social factors	21%	0.62	0.72	0.56	0.56	0.76	0.81	0.66
Score	**3.00**	**3.13**	**2.82**	**3.13**	**2.90**	**3.75**	**3.88**	**3.15**
Rank	**6**	**4**	**8**	**4**	**7**	**2**	**1**	**3**

Similar outcomes from the NOF MCA process and the initial MCA processes can be observed, with the new infrastructure options generally outperforming the non-infrastructure options, suggesting that the conditions experienced on the Centenary Motorway warrant improvements that primarily address capacity constraints to alleviate congestion and improve travel times.

4.6.4 Options analysis conclusions

A broad and objective options identification and assessment process was undertaken to progress a number of short and medium term options to address the performance, design and structural issues experienced on the Centenary Motorway. Preliminary investigation of these potential options informed the assessment, reducing an initial long list of potential options to generate a shortlist of options that best met the Project service requirements and objectives. The PSC was critical in the development and assessment of options identification and assessment process for the Project, which has resulted in the identification of the following:

- A **short term option (STO 5)** comprising of a New 3 lane northbound bridge over Brisbane River be further investigated and developed.
- A **medium term option (MTO 2)** comprising of a six lane surface upgrade, largely to be widening of the existing alignment (using extended design parameters (EDD)) be further investigated and developed.

The preliminary investigations allowed the PSC to make well-informed decisions that have key to the development of this planning study. The key considerations are outlined below:

- Preliminary engineering, traffic and cost investigations of a new 3-lane northbound bridge over the Brisbane River (**STO 5**) indicated that the capital cost would **likely exceed $100 million**. As this capital value exceeds the threshold requirements for the OnQ BC requirements, the decision was made to undertake further investigations and develop this project as a **separate investigation under a PAF PE**. Refer to Control Point Paper 2 in Appendix C and the Centenary Bridge Business Case Summary Report in Appendix J.
- Preliminary engineering and traffic analysis allowed the PSC to consider the EDD, safety, potential realignment and property requirements, to make the necessary recommendations for a medium term Centenary Motorway upgrade option (MTO 2) be further investigated and developed as part of the remaining PAF PE reporting requirements.
- The decision was made not treat a number of active transport and managed motorway options as standalone treatments and incorporate them (where appropriate) into the preferred medium term option, to ensure the project service requirements were able to be effectively met.

Outcomes of the preliminary investigations and further detail around the Preferred option will be discussed in the following sections.

4.7 Preferred option

4.7.1 Six lanes on existing

The options identification and qualitative assessment, informed by quantitative analysis and preliminary technical investigations, determined that the Preferred Option to upgrade the Centenary Motorway was an approach involving a six lane configuration along the length of the motorway largely by widening the existing alignment (MTO 2 – six lanes on existing alignment, Moggill Road to Summers Road). This would create a consistent six-lane facility along the whole study corridor (from Frederick Street to the Ipswich Motorway), as six lanes already exist north of Moggill Road and south of Sumners Road, with the exception of the section between the Moggill Road northbound off ramp and on ramp, which would remain four-lanes.

There are several design considerations, with exceptions, that have to be considered as part of a staged strategy to upgrade the Centenary Motorway over the next 10 years. These considerations support a lower cost motorway upgrade concept, which avoids or minimises extensive local road upgrade and large scale property resumption, whilst meeting the Project service requirements and objectives.

These considerations are provided in further detail below and in Section 6.

4.7.2 Future eight laning

The long term vision of the Centenary Motorway, established in the 2013 Planning Study (PE Lite), broadly allowed for an eight-lane configuration of the existing motorway. Whilst the focus of this study has been to identify medium term staged options, the geometric and structural elements of this planning study have been cognisant of the need to consider an ultimate configuration for the Centenary Motorway. To that end, future proofing, reducing or limiting redundant investments, and consideration of adopting a 'skinny eight-lane' configuration within the existing alignment, was given due consideration as part of this planning study.

To avoid considerable costs as part of future upgrades, sufficient set-back allowances will need to be considered in the design of any new structures. Similarly, property acquisitions will need to have sufficient allowances for future widening of the motorway for requirements for general purpose or public transport lanes, or active transport facilities.

The lane and shoulder widths allowed for in the recommended six lane design are presented in Section 6.4. In combination with full managed motorway infrastructure (including monitoring and lane control), additional emergency stopping bays and median U-turn facilities, it is considered that these lane and shoulder widths could be reduced to facilitate a 'skinny 8' configuration.

4.7.3 Future Managed Motorways

The potential for incorporating managed motorways technologies within the recommended option has not been precluded, however these measures have not been specifically proposed for the recommended option. Further discussion on the potential future implementation of managed motorways measures is provided in Section 6.11.

5. Transport modelling

5.1 Introduction

The Centenary Motorway corridor experiences significant peak period congestion at present, with delays of over 15 minutes northbound in the morning peak and both northbound and southbound in the evening peak. These issues are expected to grow over time as a result of growth in key catchment areas, infrastructure improvements at either end of the corridor and the lack of alternative bridge crossings.

The Planning Study has identified a package of realistic and viable short to medium term improvement measures to address this. Taken together these would upgrade the Motorway to a six lane cross-section between Moggill Road and Sumners Road, duplicate the Centenary Bridge, and replace the two roundabouts on Mount Coot-tha Road with upgraded signalised intersections. Two delivery strategies for these works have been examined, identified as PE1 and PE2. In PE1, the full package of works is constructed by 2024, while in PE2 the works are staged between 2024 and 2031. This is described in further detail in Section 6.2.

5.2 Methodology and approach

Traffic and transport modelling undertaken as part of the Planning Study included strategic transport modelling to identify the benefits and wider network effects of the project options and to inform economic analysis, and update of the microsimulation traffic model of the corridor (developed in the previous study in 2012) to reflect current traffic conditions.

The full Transport Modelling Report is attached in Appendix E.

5.3 Base model

The transport model used for this analysis was the Version 2.0 Brisbane Strategic Transport Model: Multi Modal (BSTM-MMv2.0). The base year model supplied by TMR was reviewed to assess its validation, both overall (using the 2016 screenline spreadsheet provided by TMR) and along the study corridor (using 2017 count data), which identified a need for targeted updates and refinements to improve the model's forecasting accuracy for the corridor, connections and competing routes.

The BSTM-MM is a four-step strategic transport model that extends from Elimbah (north of Caboolture) in the north to Jimboomba and Ormeau in the south, and to the west beyond Ipswich and Rosewood. The model area includes 1,543 internal transport zones and 28 external cordon locations. In calculating trip generation from each of these zones, eight travel purposes are considered (classified into home based and non-home based trips). These trips choose between seven transport modes (including car, public transport and active modes). Commercial vehicle demand matrices are calculated separately and not subject to mode choice. Thus, eight transport modes are modelled in total.

The model represents a full typical weekday subdivided into four time periods, including a two-hour AM peak (7am to 9am), a two-hour PM peak (4pm to 6pm), a seven-hour daytime off peak period (9am to 4pm) and an 'evening' period capturing the rest of the day (6pm to 7am).

Key inputs to the BSTM-MM include demographic and land use data for each zone, a representation of the road and public transport networks for each time period, cost information (such as parking charges, fares, tolls, vehicle operating costs and value of time) and external demands.

5.3.1 2016 model update

After reviewing the performance of the base year BSTM-MM against contemporary count data, it was identified that targeted updates and revalidation of the strategic model would be appropriate for this project. The following updates were undertaken in consultation with TMR:

- Demographic and land use updates – based on the latest Queensland Government Statistician's Office (QGSO) medium series projections (2015 edition), with an updated version provided by TMR (QGSOv05)

- Network updates – review of base year networks to confirm inclusion of appropriate recently completed upgrade projects and the coding of the corridor and key congestion points
- User costs and tolling parameters – updated using the latest available information including:
  - Consumer Price Index (CPI) and Average Weekly Earnings (AWE), based on published historical data
  - Public transport fares, based on TransLink published rates
  - Toll road charges, from operator websites
  - Alternative specific constants (ASCs) for toll roads, based on updated toll charges and test runs
- Matrix estimation – approach adopted to improve the fit of modelled to observed commercial and private vehicles across the network, as party of revalidation process
- Other calibration and validation adjustments, including changes to k-factor distribution weights, time period factors and special generators.

The performance of the base year model has been measured both across the overall BSTM-MM area, using observed count data from the 2016 model validation screenline spreadsheet provided by TMR, as well as in more detail along the study corridor, using 2017 count data collected for this study.

Statistics for the original and updated models shows a substantial improvement resulting from the revalidation process, particularly for peak period totals, and show that the update process has substantially improved the goodness of fit at interchanges along the study corridor for all vehicle classes. Overall, the screenline and study corridor results indicate that the final updated base year model is appropriately validated and suitable for use in the current work.

5.3.2 Future transport demands – without project

Future year base case BSTM-MM models have been developed in consultation with TMR's Transport Analysis Unit to provide a sound basis for analysing the impact of the Centenary Motorway Upgrade Project. The general approach to future year modelling has been to adopt a 'do minimum' base scenario, including only committed works, consistent with the requirements of Building Queensland (BQ) and Infrastructure Australia (IA).

5.3.2.1 Demographics assumptions

The demographic and land use inputs used for the future year modelling (both with and without the project) are from the data set supplied by TMR, based on the 'medium' series from the latest (2015 edition) QGSO population projections. The key sectors of interest surrounding the Centenary Motorway are the Local North (Toowong, Indooroopilly, Kenmore, Fig Tree Pocket) and Local South (Jindalee, Mt Ommaney, Sumners, Corinda, Chelmer). Modest population growth is forecast for these areas along with moderate employment growth. Forecast growth in the South-West (Ipswich and surrounding areas), Australia Trade Coast (Brisbane Airport, Port of Brisbane) and parts of the North (particularly the CBD) is higher than the local catchment of the motorway and will have a large influence on the traffic growth in this corridor.

5.3.2.2 Network assumptions

A detailed review of the project inclusions was carried out for the modelled network, in consultation with TMR, as the existing scheme list was not up-to-date. Firstly, the scheme list and coding was updated to reflect the latest Queensland Transport and Roads Investment Program (QTRIP) four-year plan. The recent BNE model development (separate to this project) conducted detailed review of future year network coding, including discussions with affected local governments to identify planned and committed infrastructure improvement projects on the roads under their control. In the BSTM-MM, the 2021 and 2026 schemes from the BNE model were taken as 'committed' projects, while all upgrade projects beyond 2026 were considered 'not committed' and not included in the base case.

Any schemes related to or involving upgrades along the Centenary Motorway corridor were also excluded from the base case in all years, except for the Sumners Road interchange upgrade, which was required to prevent unrealistic congestion and is presently in detailed design planning expecting to be delivered before 2021.

In order to ensure model stability and avoid the arising convergence issues in later forecast years, additional 'not committed' network schemes were added to provide more realistic connections from the high growth zones to the surrounding road network and to address unrealistic bottlenecks in those areas.

The 2036 networks also have a modest level of capacity uplift on higher order roads to reflect trends of more efficient road space use through vehicle/network management technology, which also helps to ensure model stability.

5.3.2.3 Public transport services assumptions

Due to the exclusion of non-committed projects, several public transport infrastructure projects were not included. Therefore, modifications to public transport routes in response to these infrastructure changes were minimised and timetables were not altered. In the case where changes were made to suit project coding, the routes were kept as close as possible to the original path.

5.3.2.4 Forecast traffic volumes – without project

Key indicators of transport demand and network performance for the base year and future year base case models are summarised in Table 5-1. The results indicate that:

- Private vehicle demand across the network grows by more than a third across the forecast period. Growth in demand on the Centenary Bridge is faster than the network average and overall cross river demand, due to its strategic position linking growth areas in the south-west to the CBD and northern suburbs.
- There is increasing trip lengths and congestion in the network. VKT grows significantly faster than vehicle trips and VHT grows much faster than VKT. There is a declining overall average speed, falling by over 10% in the forecast period.
- Public transport usage grows significantly faster than private vehicles, caused by major projects such as Cross River Rail, and more road network congestion increasing the attractiveness of rail/bus services. The average trip length increases in later years (PKT increases faster than number of passenger trips), while the average travel speed increases (PHT grows slightly slower than PKT).

Table 5-1: Network demand and performance measures, base case models

Data	2016	2021	2026	2031	2036	2036 vs 2016
Daily private vehicle trips	4,782,000	5,160,000	5,591,000	6,061,000	6,544,000	+37%
Daily private vehicle person trips	6,724,000	7,255,000	7,859,000	8,498,000	9,149,000	+36%
Daily commercial vehicle trips	185,000	209,000	230,000	253,000	278,000	+50%
Daily VKT (km)	65,605,000	72,308,000	80,442,000	89,227,000	98,868,000	+51%
Daily VHT (hours)	1,165,000	1,285,000	1,454,000	1,682,000	1,960,000	+68%
Average network speed	56.3	56.3	55.3	53.0	50.4	-10%
River Crossing Screenline Total	607,614	663,945	725,868	787,787	858,176	+41%
Centenary Bridge Total	100,749	115,226	130,331	139,631	152,756	+52%
Daily PT trips	693,000	833,000	930,000	1,037,000	1,166,000	+68%
Daily PKT (km)	10,192,000	12,587,000	14,228,000	16,099,000	18,519,000	+82%
Daily PHT (hours)	276,000	336,000	379,000	428,000	491,000	+78%

As shown in Figure 5-1, the Centenary Motorway bridge increasingly acts as bottleneck, despite stronger than average growth, growing more slowly than the northern and southern ends of the corridor. Growth on the bridge visibly drops off in 2031 and 2036.

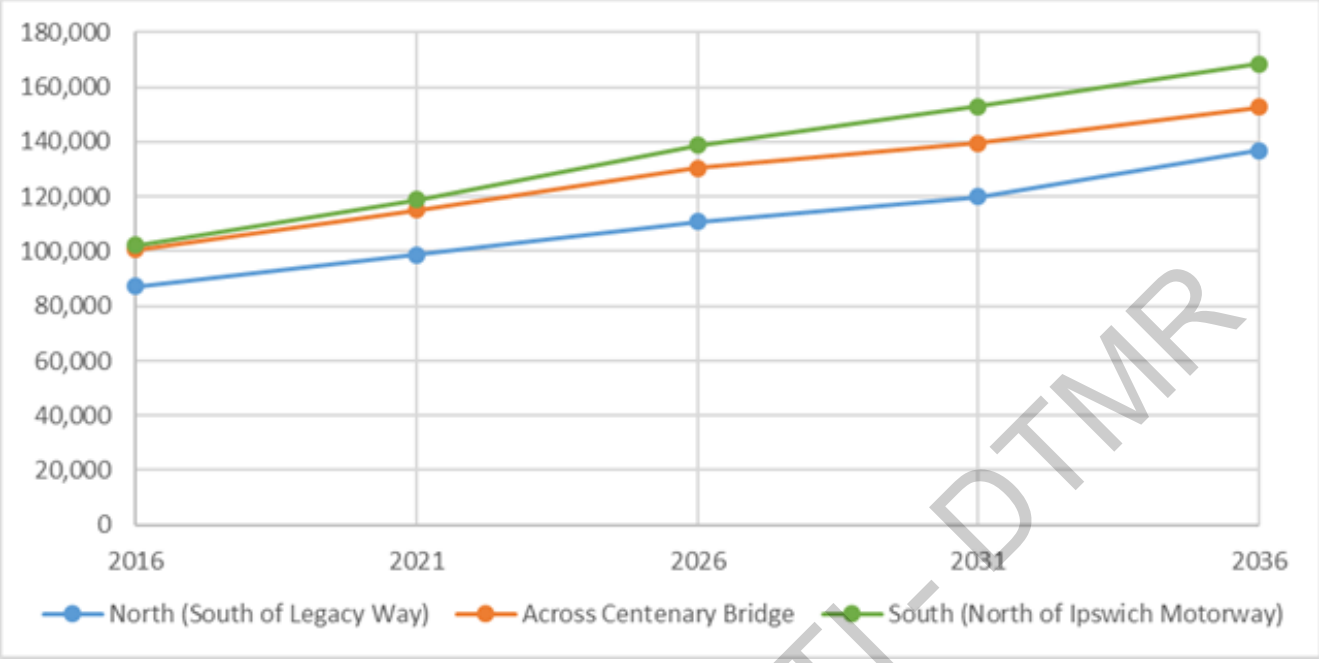


Figure 5-1: Weekday two-way modelled volumes on key segments of the Centenary Motorway, base case

5.4 Modelling outcomes

5.4.1 Forecast transport demands – with project

The project consists of a package of works which, taken together, expand the Centenary Motorway to three lanes in each direction between Moggill Road and Sumners Road, duplicate the Centenary Bridge, and upgrade and signalise the two roundabouts on Mt Coot-tha Road. The two delivery strategies modelled in the study are:

- PE1 – full upgrade of the Centenary Motorway upgrade to six lanes delivered by 2024
- PE2 – staged delivery of the Centenary Motorway upgrade to six lanes between 2024 and 2031
- Nine project case and four base case models were run to test the performance and benefits under the PE1 and PE2 delivery strategies, summarised in Table 5-2.

Table 5-2: Summary of modelling scenarios and years

Model year	Base Case	Stage 1	Stages 1-4	Stages 1-5
2021	✓	✓		✓
2026	✓	✓	✓	✓
2031	✓	✓	✓	✓
2036	✓			✓

5.4.2 Forecast traffic volumes – with project

The full medium term upgrade is expected to increase daily traffic volumes by 23% northbound and 25% southbound across the Centenary Bridge in 2036. The upgrade will also be able to deliver an additional 16% to and from Legacy Way / Mt Coot-tha Road per day, and deliver around 18-19% more to and from the Ipswich Motorway and further south per day.

The growth in two-way total daily volumes at these points on the Centenary Motorway, over time and for the three staging configurations modelled, is shown in Figure 5-2, Figure 5-3 and Figure 5-4. These graphs indicate that in isolation, Stage 1 has little impact on daily traffic on the motorway, however Stages 1-4 and Stages 1-5 have strong growth in throughput and capacity along the corridor over time.

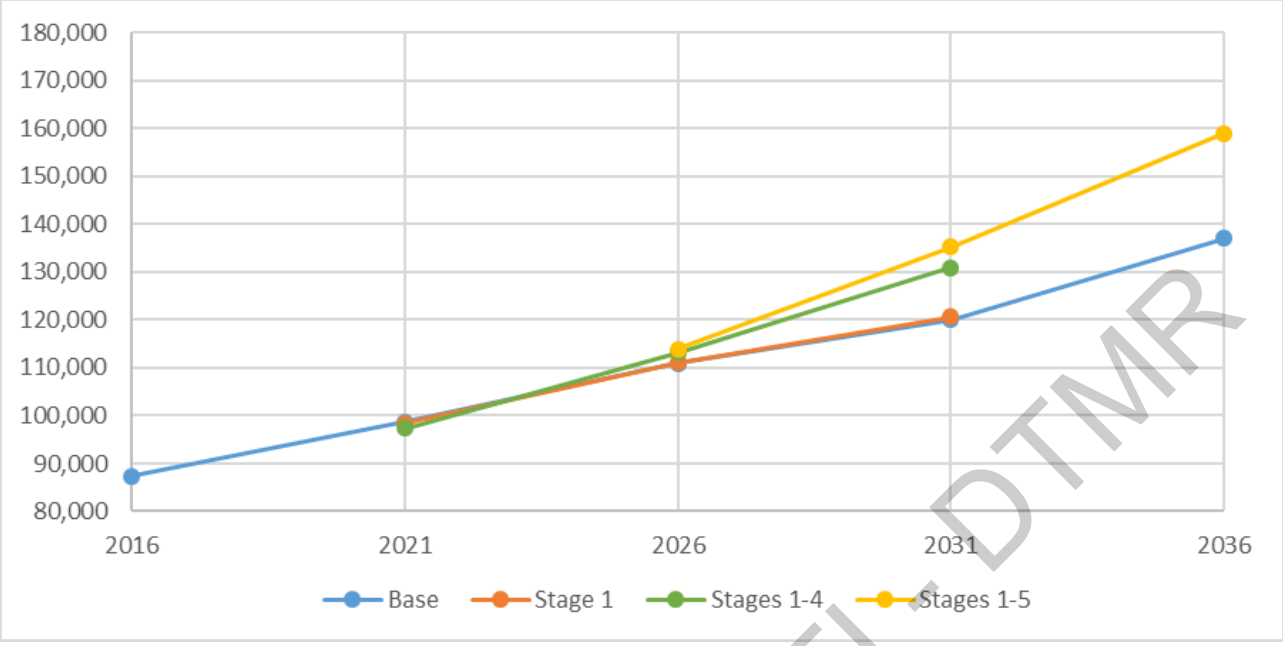


Figure 5-2: Weekday two-way modelled volumes on northern Centenary Motorway (south of Legacy Way)

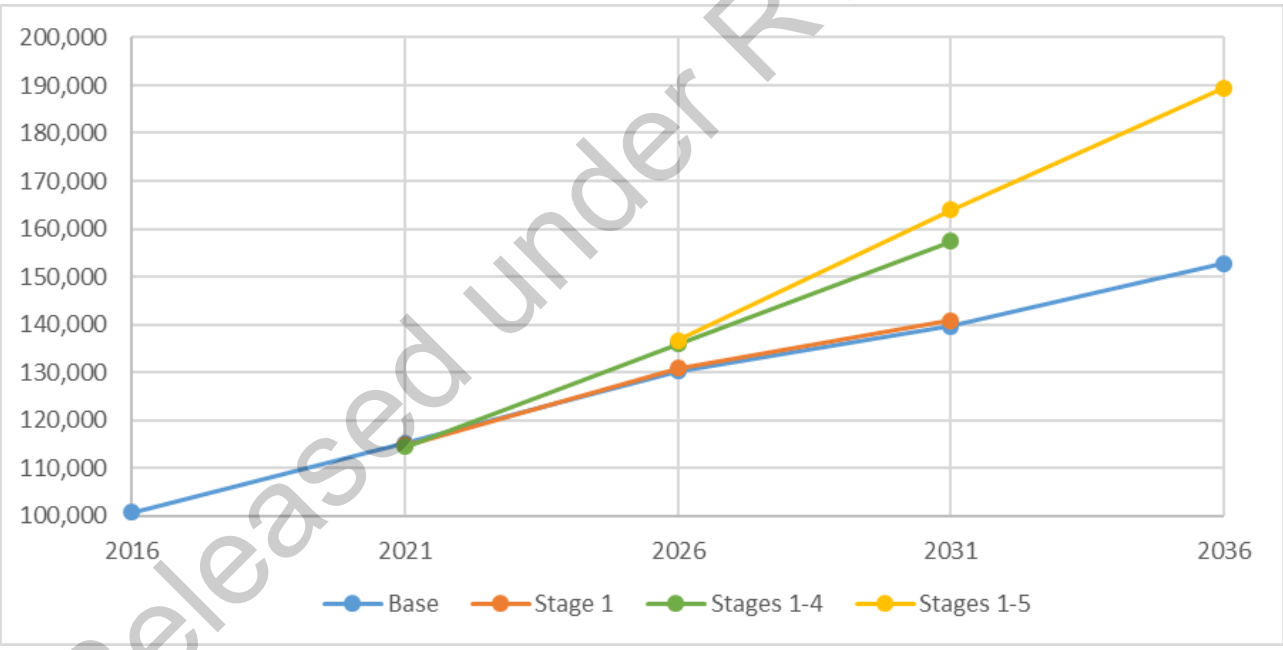


Figure 5-3: Weekday two-way modelled volumes across Centenary Bridge

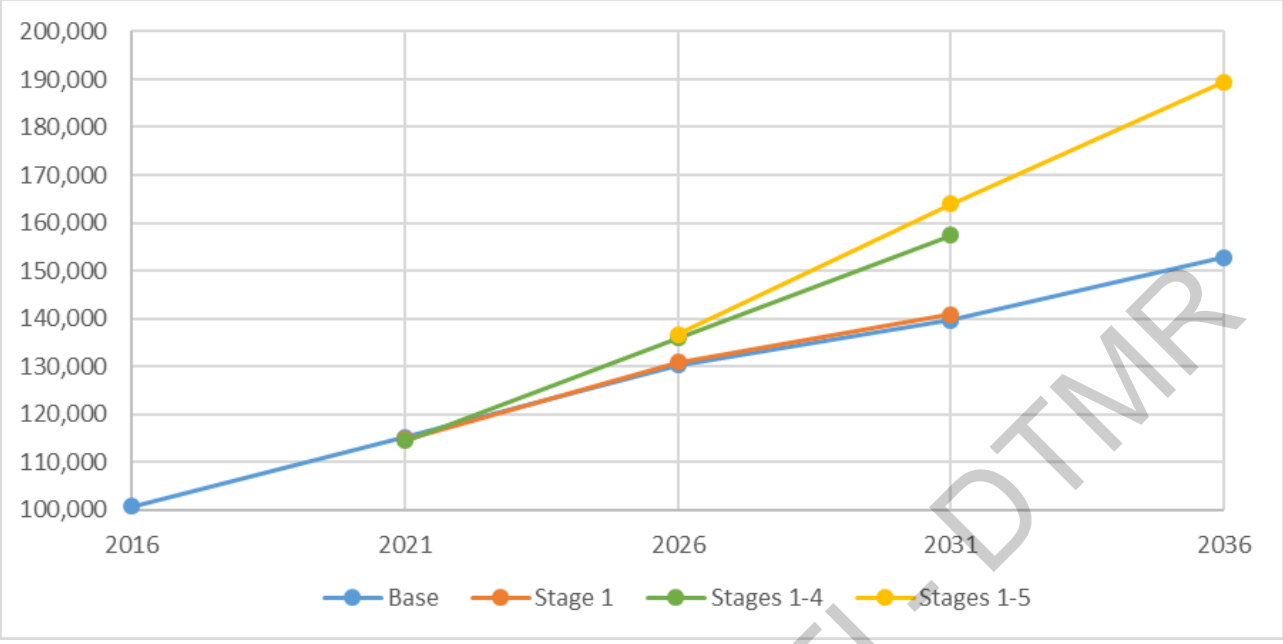
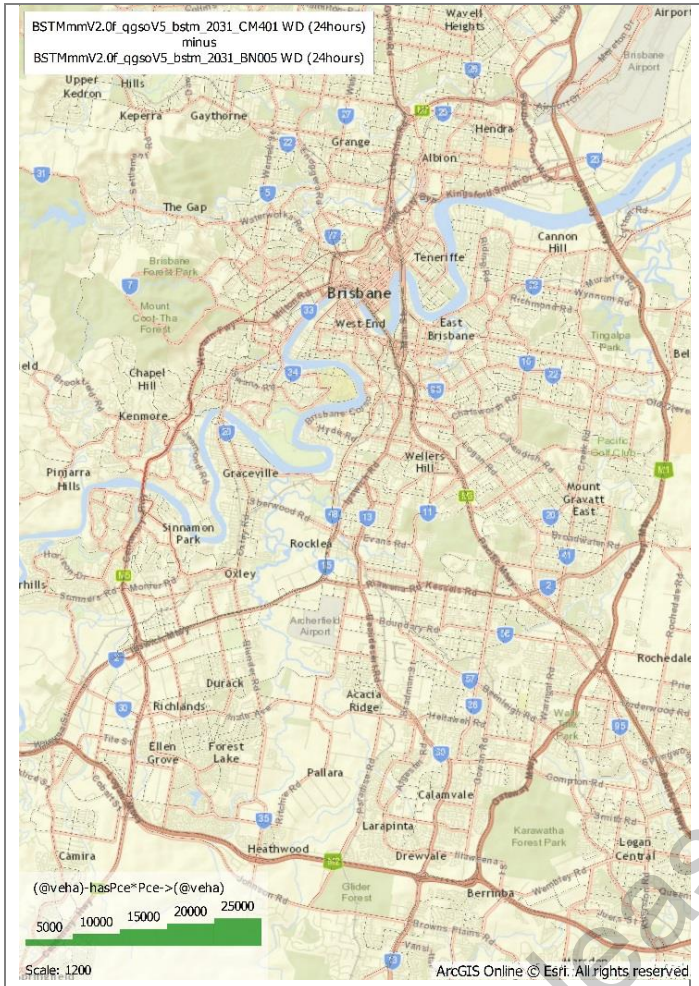


Figure 5-4: Weekday two-way modelled volumes on southern Centenary Motorway (north of Ipswich Motorway)

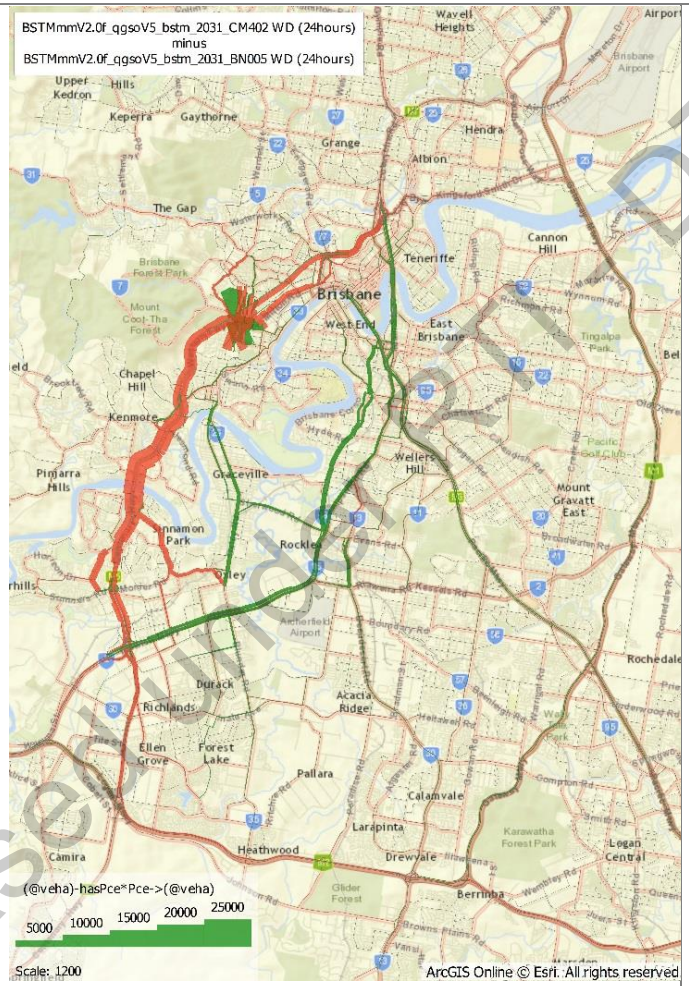
The project also has an effect on the wider metropolitan road network, as shown in Figure 5-5. Again, the impact of Stage 1 alone is modest with very little change on the surrounding roads. With Stages 2 to 4 added, the project has wide ranging effects, with longer distance traffic drawn to the Centenary Motorway away from the Ipswich Motorway, which reduces traffic on other routes into the CBD. There are also smaller effects as far as the Gateway Bridge and Brisbane Airport. Locally, traffic is also diverted away from the Indooroopilly Bridge to the Centenary Bridge via Seventeen Mile Rocks Road.

The addition of Stage 5 generally strengthens the effects from Stages 1-4, with traffic able to access the Centenary Motorway more easily from the south rather than from Seventeen Mile Rocks Road.

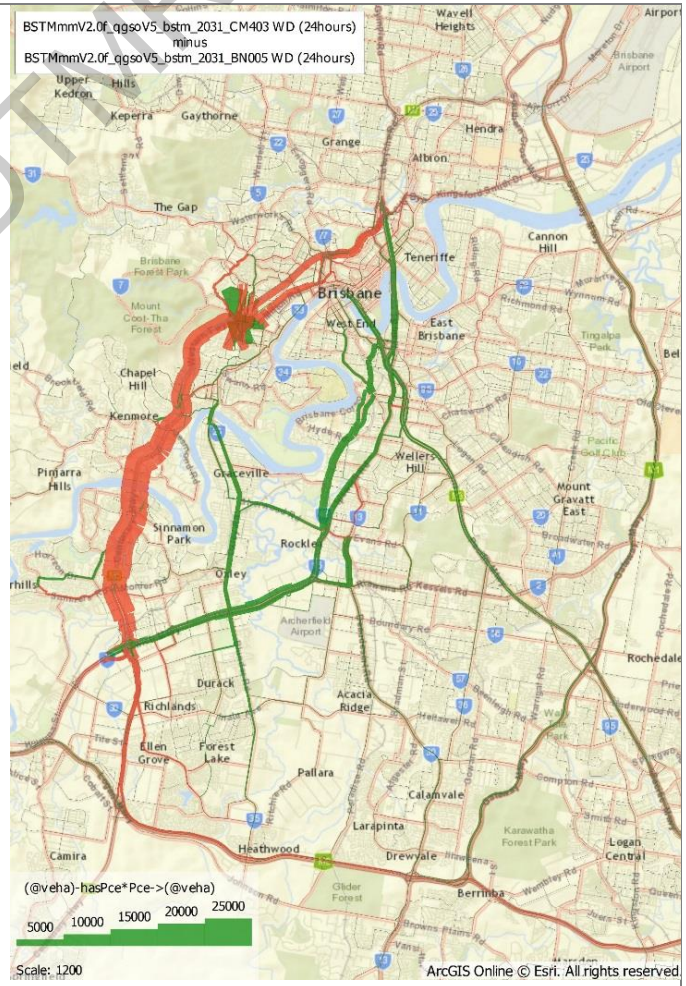
By 2036, the project attracts almost 25% more traffic to the Centenary Bridge, compared to the base case, and removes more than one in eight trips from the Indooroopilly Bridge.



Stage 1



Stages 1-4



Stages 1-5

Figure 5-5: Effect of Centenary Motorway Upgrade Project on metropolitan traffic patterns – Daily modelled volume changes, 2031

5.5 Transport user benefits

The impact of the Centenary Motorway project on transport users as forecast by the BSTM-MM was used to derive inputs to the economic analysis, and was separated into private vehicles, commercial vehicles and public transport.

The results show that the project delivers significant reductions in travel time for private and commercial vehicles in the later modelled years, with a modest increase in travel distance, which occurs when drivers are attracted to a less direct route that has travel time savings, likely from the diversion of traffic from the Captain Cook Bridge / M3 and CLEM7. By 2036, the full upgrade delivers over 25,000 additional vehicle-kilometres travelled per day and a reduction of almost 18,000 vehicle-hours travelled per day across the metropolitan network. A summary of the VKT and VHT results in shown in Table 5-3 for all vehicles, with the change in average travel time shown in Table 5-4 for private and commercial vehicles separately.

Table 5-3: Total daily private and commercial VKT, VHT (whole network)

Year	Vehicle-kilometres travelled (VKT)			Vehicle-hours travelled (VHT)		
	Base	Project	Change	Base	Project	Change
2021	72,308,000	72,304,000	-3,900 (-0.01%)	1,285,000	1,285,000	+400 (+0.03%)
2026	80,442,000	80,442,000	-300 (0.00%)	1,454,000	1,452,000	-2,400 (-0.16%)
2031	89,227,000	89,255,000	+28,000 (+0.03%)	1,682,000	1,670,000	-12,000 (-0.70%)
2036	98,868,000	98,894,000	+25,000 (+0.03%)	1,960,000	1,942,000	-18,000 (-0.90%)

Table 5-4: Average travel time per private trip and commercial trip (whole network)

Year	Avg travel time per trip (mins) – private vehicles			Avg travel time per trip (mins) – commercial vehicles		
	Base	Project	Change	Base	Project	Change
2021	13.85	13.86	0.01 (0.05%)	26.97	26.97	0.00 (0.01%)
2026	14.47	14.45	-0.02 (-0.15%)	27.49	27.46	-0.03 (-0.10%)
2031	15.45	15.35	-0.10 (-0.66%)	28.66	28.53	-0.13 (-0.45%)
2036	16.69	16.54	-0.15 (-0.89%)	30.06	29.90	-0.16 (-0.52%)

The project has no significant effect on public transport service provision. However, changes in peak period travel times on the road network will also benefit buses, and may also affect the choice of park ‘n’ ride or kiss ‘n’ ride locations, affecting public transport trip lengths. The results suggest a small shift away from public transport use, particularly with the more complete project stages. With the increase in road capacity from the project and the overall improvement in traffic conditions, such a mode shift is understandable. The project also delivers user benefits to the passengers who do not change modes. A summary of the results is shown in Table 5-5.

Table 5-5: Public transport PKT, PHT and average travel time

Year	Passenger-kilometres travelled (PKT)		Passenger-hours travelled (PHT)		Average travel time per trip (mins)		
	Base	Project	Base	Project	Base	Project	Change
2021	12,586,784	12,589,795	335,802	335,847	24.18	24.18	0.00 (0.01%)
2026	14,227,501	14,205,179	378,790	377,926	24.43	24.40	-0.03 (-0.14%)
2031	16,099,372	16,071,238	428,115	426,409	24.78	24.71	-0.07 (-0.26%)
2036	18,519,120	18,477,856	491,019	488,679	25.27	25.18	-0.08 (-0.32%)

5.6 Microsimulation model update

The Centenary Motorway Full Corridor Paramics Model is a detailed representation of the full study corridor from Toowong to the Ipswich Motorway, including all interchanges and ramp terminal intersections as well as the two roundabouts on Mount Coot-tha Road and Goggs Road and Sinnamon Road in Jindalee.

As part of the study, the microsimulation model of the Centenary Motorway corridor originally developed for the 2012 study was updated to a 2017 base year and revalidated, ready for use in the Business Case phase of project delivery. The basic characteristics of the updated 2017 full corridor model remain the same as the original CMPS version, with the addition of a new zone 36 for Legacy Way.

The model update for the current study included:

- Detailed review and update of network coding, particularly around the Legacy Way connections and the Moggill Road interchange improvements which were completed after the previous work
- Update of signal phasing and timing using actual control data from March 2017
- Update of bus routes and timetables using contemporary TransLink information
- Adjustment of the demand matrices in line with 2017 count data

The updated model is very well calibrated. Of the 225 targets (five hourly measurements at 45 count locations), a GEH below 5.0 was achieved in 99.2% of cases in the AM period and 100% in the PM.

6. Recommended option

6.1 Description

As discussed above, the recommended option is to widen the existing motorway on the existing alignment to accommodate six lanes from the Moggill Road southbound entry ramp to the Sumners Road southbound entry ramp. The concept has been developed to deliver improved motorway capacity, performance and safety for a reduced cost and fewer impacts upon property, environment and community compared to the previous study's recommended design.

- Changes to the existing horizontal and vertical alignment have been avoided wherever possible to minimise cost and impact. Part Refuse Sch.4 Part 4 s.4(1)(a) Opinion/advice/recommendation for deliberative processes of government
Part Refuse Sch.4 Part 4 s.4(1)(a) Opinion/advice/recommendation for deliberative processes of government
- Wherever possible, existing interchanges and bridges have been retained and widened as necessary. The proposed works are discussed in Section 6.6 and presented in Table 6-3.

General Arrangement drawings and Typical Sections have been produced for the recommended option and included in Appendix F.

6.2 Staging

A staged approach to deliver the upgrade to six lanes has been developed, as discussed in Section 5. The proposed staging is shown in Figure 6-1, with the rationale outlined in Table 6-1. It is noted that this has been considered at a high level only in the design. Details for tie-in works required for each stage and sub-stage have not been developed, and will need to be considered in future phases of the project.

Table 6-1: Traffic considerations for staging

Stage	Year	Considerations
Stage 1	2024	• The new three-lane northbound bridge completed in 2024 will shift the merge point at Sinnamon Road further north and provide a longer merge lane length. This may have some minor benefits for traffic by slightly improving the merge condition at this point. • The existing structure will provide two southbound lanes only (i.e. two-lane northbound carriageway closed). A third southbound lane would not yet be required across the bridge as no traffic benefits would be realised until the southbound carriageway is also upgraded to three lanes (part of Stage 3). • The provision of a third southbound lane across the bridge was previously proposed as part of the Stage 1 scope but has now been included as part of Stage 3 following feedback from Bridge Branch that the proposed arrangement to facilitate the additional lane would be unlikely be accepted for an extended period of time.
Stage 2	2026	• Congestion currently occurs in the northbound direction in both the AM and PM peak periods at Dandenong Road and Sinnamon Road. Therefore, the northbound direction is the highest priority for widening to three lanes. • The benefits of the new three-lane northbound bridge (Stage 1) will be fully realised in this stage which delivers three northbound lanes between Dandenong Road and Moggill Road in 2026. • The Mt Coot-tha Road roundabouts require upgrade to signals in this stage to accommodate the additional northbound traffic that will be delivered from three lanes.
Stage 3	2028	• The next priority is the southbound congestion that occurs in the PM peak at Moggill Road and Fig Tree Pocket Road. Therefore, this stage will deliver three southbound lanes between Moggill Road and Dandenong Road in 2028. • Existing Centenary Bridge reconfigured to provide three southbound lanes (i.e. by utilising northbound carriageway in temporary arrangement) to fully realise the additional southbound capacity delivered by the road upgrade. The third lane however would be separated from the first two lanes across the bridge, subject to Bridge Branch approval.

Stage	Year	Considerations
Stage 4	2029	• This stage will complete the widening of the new bridge to six lanes to accommodate three northbound lanes and three southbound lanes in 2029. The existing Centenary Bridge would be demolished to minimise afflux impacts.
Stage 5	2031	• This stage will upgrade the remaining section of the motorway between Dandenong Road and Sumners Road to six lanes (three northbound lanes and three southbound lanes) in 2031.

During the Business Case phase, these stages could be refined, amalgamated or broken into sub-stages to suit budgetary constraints, priorities or economic drivers.

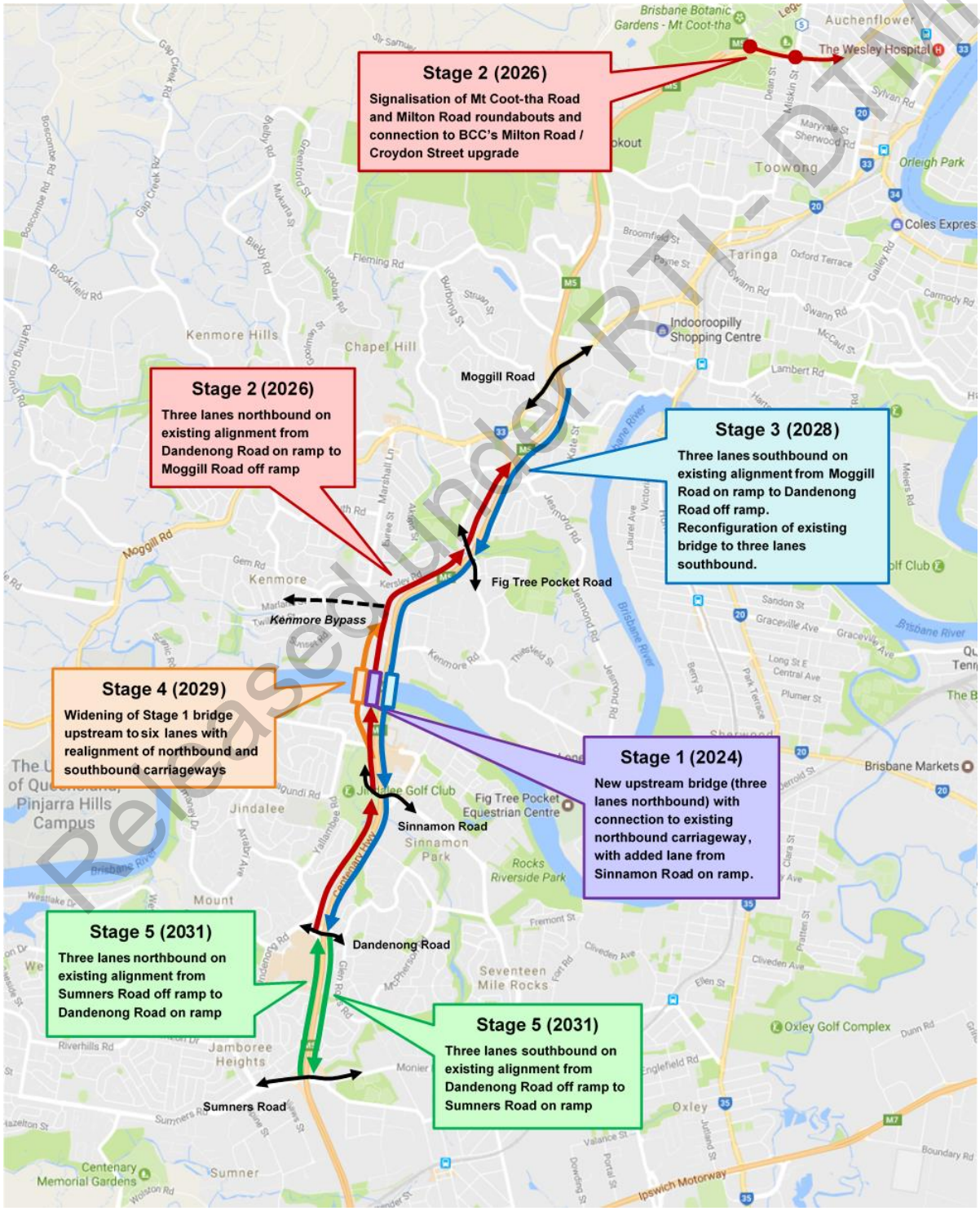


Figure 6-1: Six lane upgrade proposed staging

6.3 Design standards

As noted above, the recommended design solution is to provide three northbound (NB) lanes and three southbound (SB) lanes by widening the existing formation. The design illustrated in Appendix E has been developed using Austroads Guide to Road Design and the TMR supplements.

As discussed, the existing horizontal and vertical alignment will be retained wherever possible. Due to these constraints, application of Normal Design Domain (NDD) principles does not provide a viable design solution and TMR Guidelines for Road Design on Brownfield Sites have been used in the assessment of the geometry. Extended Design Domain (EDD) and Design Exception (DE) elements have been identified within the design. Refer to Section 6.4.

The following key geometric design parameters have been used in the design development for the design:

- Design vehicle – 25.0m B-double
- Reaction time – 2.0s
- Crossfall and superelevation – 3% normal

6.4 Geometric design

6.4.1 Motorway section north of Brisbane River

The upgraded motorway section north of the Brisbane River is proposed to be posted 80km/h as the alignment is constrained by the road corridor boundary and the existing sub-standard road geometry. The design speed for this section has been adopted as 90km/h.

The typical section adopted for the northern section provides:

- 3.0 m left hand shoulder
- 3.5 m left hand lane
- 3.7 m centre lane
- 3.5 m right hand lane
- 1.0 m right hand shoulder (0.5m absolute minimum width under existing bridge structures)

These lane widths and left hand shoulder widths are compliant with Austroads requirements and the TMR supplement. Reduced right hand shoulder widths have been accepted considering the brownfield nature of the project and the footprint of the works using EDD principles. Reduced right hand shoulder width below 1.0m (next to bridge piers) has been documented as a Design Exception due to the cost associated with bridge modifications.

Necessary curve widening has been applied to the lane widths to accommodate the design vehicle requirements as per the Austroads guidelines. Shoulder widening has been applied to the right-hand side to accommodate for sightline requirements where this approach is economically feasible.

The following EDD and DE element categories have been identified within this section:

- EDD categories
  - Vertical crest curves (stopping sight distance)
  - Sighting over barriers (stopping sight distance)
  - Median shoulder width
- DE categories
  - Central lane width under overpass bridges
  - Median shoulder width next to overpass bridge piers

- Sighting over barriers (stopping sight distance)
- Vertical crest curves (stopping sight distance)
- Aquaplaning
- Ramp sight distance (approach to the nose, merge taper and mutual visibility)
- Entry and exit ramp spacing

Due to the relatively low operating speed, EDD and DE elements for this section of the motorway have not been assessed for individual traffic lanes. Details of the identified EDD and DE items are provided in Technical Note 255310-0000-MEM-RR-0003, included in Appendix G.

6.4.2 Motorway section south of Brisbane River

The upgraded motorway section south of the Brisbane River is proposed to be posted 90km/h as the alignment is somewhat constrained by the road corridor boundary and the existing sub-standard road geometry. The design speed for this section has been adopted as 100km/h.

The typical section adopted for the southern section provides:

- 3.0 m left hand shoulder
- 3.5 m left hand lane
- 3.7 m centre lane
- 3.5 m right hand lane
- 2.0 m right hand shoulder (1.5m absolute minimum)

These lane widths and shoulder widths are compliant with Austroads requirements and the TMR supplement. Reduced right hand shoulder widths have been accepted considering the brownfield nature of the project and the footprint of the works using EDD principles.

The motorway section south of the Brisbane River was originally proposed to be posted 100km/h as per the current arrangement. The design speed for this section was adopted as 110km/h. Due to the higher operating speed within this section of the motorway, an individual lane assessment has been carried out in determining the EDD and DE elements. Details of the identified EDD and DE items are provided in Technical Note 255310-0000-MEM-RR-0003, included in Appendix G. The following EDD and DE element categories were identified within this section:

- EDD categories
  - Vertical crest curves (stopping sight distance)
  - Sighting over barriers (stopping sight distance)
- DE categories
  - Median shoulder width
  - Sighting over barriers (stopping sight distance)
  - Vertical crest curves (stopping sight distance)
  - Aquaplaning
  - Ramp sight distance (approach to the nose, merge taper and mutual visibility)
  - Entry and exit ramp spacing

A meeting was held with TMR E&T on 8 March 2018 to discuss the motorway section south of the Brisbane River. Given the number of EDD and DE elements identified for the 110km/h design speed, E&T requested that an assessment of EDD and DE elements be undertaken for a reduced posted speed of 90km/h (design speed of 100km/h). A considerable reduction of EDD and DE elements has been observed for the reduced design

speed, as summarised in the Technical Note. This reduced design (and posted) speed and the associated reduction in EDD and DE elements was accepted in principle by E&T.

In addition, it has also been suggested to undertake 85th percentile speed check for the section south of river in determining the appropriate design speed for this section of the highway. The outcome of this assessment will inform the justification of correct design speed that is to be adopted in the next stages of the project by taking into account the number of EDD and DE elements identified during the design.

Part Refuse Sch.4 Part 4 s.4(1)(a) Opinion/advice/recommendation for deliberative processes of government

6.6 Structures

Each of the existing motorway bridge structures and local road bridges over the motorway have been reviewed to determine the works required to support the upgrade. A high-level general arrangement drawing and a Technical Note has been produced for each to summarise the key issues and considerations (refer to Appendix I). Table 6-3 summarises the works planned for each structure.

Table 6-3: Summary of bridge upgrade works

Bridge structure	Description of planned works	Key issues, risks & considerations
Witton Road overpasses	The Bridges over Witton Road and the Bridges over the Ambrose Tracey Drainage Channel each consist of two single span bridges to carry separately a northbound and southbound carriageway of the Centenary Motorway. These are proposed to be widened to accommodate the additional motorway width.	Widening the Northbound Bridge at the same superelevation as the existing bridge may lower the clearance than what is currently provided. To limit the clearance reduction, deck units have been considered rather than super T girders. The deck unit depth for the widened structure was chosen as it gives a similar soffit level to the existing bridge however this deck unit depth is shallower than what would normally be considered for the span. The deck unit depth will need to be confirmed in the design phases to ensure it meets the bridge design code requirements. If a deeper deck unit is required and clearance is not going to be achieved then to meet the current clearance, Witton Road underneath may require regrading. Detailed structural analysis and design calculations have not been undertaken for this planning study to confirm member sizes.

Bridge structure	Description of planned works	Key issues, risks & considerations
Jerrang Street overpass	The existing Jerrang Street Overpass is proposed to be demolished due to it being unable to accommodate the horizontal extent of the medium term widening of the Centenary Motorway. The proposed Jerrang Street Overpass is a new two-span bridge carrying a road carriageway and two shared paths over the widened northbound and southbound Centenary Motorway carriageways.	Spill through abutments have been assumed for the bridges over the Centenary Motorway. Allowing for a spill through abutment which can be cut back without major modification allows greater flexibility for any future widening of the Centenary Motorway. Due to the above assumption, the design has not allowed for any abutment retaining works to any existing properties within the vicinity of the bridge abutments. Detailed structural analysis and design calculations have not been undertaken for this planning study to confirm member sizes.
Fig Tree Pocket Road interchange	To adequately fit the northbound and south bound carriages of the Centenary Motorway through the existing Fig Tree Pocket Road Overpass, the southern abutment spill through may have to be cut back at a steep angle and pinned with soil nails. Cubberla Creek Bridge 2 is intended to use the existing unused abutment headstock, with new deck units to widen the bridge.	The widened deck structure of Cubberla Creek Bridge 2 has been sized for SM1600 and HLP400 vehicle loads which are greater than the design loads used for the design of the existing deck. To use the existing unused abutment headstock, deck units of the same depth as the existing deck units have been proposed. The deck unit arrangement of the widened deck will need to be confirmed in the design phases to ensure it meets the bridge design code requirements. Detailed structural analysis and design calculations have not been undertaken for this planning study to confirm member sizes.
Kenmore Road overpass and pipe bridge	The existing Kenmore Road Overpass is proposed to be demolished due to it being unable to accommodate the horizontal extent of the medium term widening of the Centenary Motorway. The proposed Kenmore Road Overpass is a new two-span bridge carrying a road carriageway and two shared paths over the widened northbound and southbound Centenary Motorway carriageways. Included also in the design is steel truss structure provided to carry two watermains over the Motorway.	Spill through abutments have been assumed for the bridges over the Centenary Motorway. A spill through abutment can be cut back without major modification, and allows greater flexibility for any future widening of the Centenary Motorway. Due to the above assumption, the design has not allowed for any abutment retaining works to any existing properties within the vicinity of the bridge abutments. Detailed structural analysis and design calculations have not been undertaken for this planning study to confirm member sizes.
Centenary Bridge	See separate discussion in Section 6.6.1.	See separate discussion in Section 6.6.1.
Seventeen Mile Rocks Road overpass	The existing Seventeen Mile Rocks Road Overpass is proposed to be demolished due to it being unable to accommodate the horizontal extent of the medium term widening of the Centenary Motorway. The proposed Seventeen Mile Rocks Road Overpass is a new three-span bridge carrying a road carriageway and footway over the widened northbound and southbound Centenary Motorway carriageways.	Spill through abutments have been assumed for the bridges over the Centenary Motorway. A spill through abutment can be cut back without major modification allows greater flexibility for any future widening of the Centenary Motorway. Due to the above assumption, the design has not allowed for any abutment retaining works to any existing properties within the vicinity of the bridge abutments. Detailed structural analysis and design calculations have not been undertaken for this planning study to confirm member sizes.

Bridge structure	Description of planned works	Key issues, risks & considerations
Dandenong Road interchange	The Mount Ommaney Interchange Bridges consist of four single span bridges carrying the northbound and southbound carriageways of the Centenary Motorway over the Dandenong Road roundabout. The bridges are to be widened to accommodate the widened carriageways.	The widened deck structure has been sized for SM1600 and HLP400 vehicle loads which are greater than the design loads used for the design of the existing deck. Due to these greater vehicle loads, the depth of the widened deck is deeper than the original deck. This extra depth could decrease the traffic clearance over the Dandenong Road roundabout. To meet the current clearance, the road underneath may require regrading. The 400mm deep deck units (concept design) have been specified to minimise reduction in traffic clearance. The deck unit depth will need to be confirmed in the design phases to ensure the deck unit does not sag under the self-weight of the 400mm thick wet concrete deck slab. Detailed structural analysis and design calculations have not been undertaken for this planning study to confirm member sizes.
Sumners Road interchange	The existing Sumners Road Overpass is to be duplicated to the north under a separate project done by others. At this stage it is understood that the existing bridge would not be modified by that project. As part of the Project, the existing Sumners Road Overpass would be demolished as part of Stage 5 due to it being unable to accommodate the horizontal extent of the medium term widening of the Centenary Motorway. A new overpass is proposed to be constructed using a similar alignment to the existing. The new overpass would be a two-span bridge carrying a road carriageway and a single shared path over the widened northbound and southbound Centenary Motorway carriageways.	Spill through abutments have been assumed for the bridges over the Centenary Motorway. A spill through abutment can be cut back without major modification allows greater flexibility for any future widening of the Centenary Motorway. Due to the above assumption, the design has not allowed for any abutment retaining works to any existing properties within the vicinity of the bridge abutments. Detailed structural analysis and design calculations have not been undertaken for this planning study to confirm member sizes.

6.6.1 Centenary Bridge over Brisbane River

As noted above, upgrading the Centenary Bridge is stage 1 of the motorway upgrade. This upgrade is a complex challenge, and is complicated by several key factors, including:

- Budgetary constraints
- Limitations and risks associated with the existing structure
- Condition of the existing structure
- Afflux implications associated with the upgrade options.

Considerable engineering investigation has been undertaken to understand the key issues, identify and assess the feasible options. A summary report has been prepared to document the investigations, findings and recommendations. A copy is included in Appendix J with a summary of the key issues provided below.

6.6.1.1 Budgetary constraints

During the study, a budget of $100 million was specified for the stage 1 works, effectively limiting the structural options available to a Super T or U-Max girder arrangement. Neither of these options can achieve the existing span lengths (up to 48.4 m), so the piers would not be aligned with those of the existing structure. As discussed below, this introduced afflux challenges to the project.

6.6.1.2 Limitations and risks associated with the existing structure

The existing Centenary Bridge has a unique structural arrangement. Overall, the bridge has seven spans. Girders are continuous over piers 2 and 3; and 4 and 5. Halving joints are provided within spans 2, 4 (two of) and 6. At these locations, adjacent girders are supported on each other, some distance from the nearest pier.

TMR bridge branch has advised that this arrangement is non-preferred for the following reasons:

- An inability to effectively inspect and maintain the halving joints and their bearings
- High probability of water ingress to the joints and an increased risk of corrosion/ damage
- An inability to jack the spans that are supported on halving joints and replace their bearings without bridge closure and substantial falsework being constructed/ installed to jack against

It is also important to note that the existing bridge consists of two separate superstructures and piers, supported on a common pile cap. The piles, pile cap and northbound piers, headstocks, girders and deck were constructed in the 1960's by a private developer. The southbound piers, headstocks, girders and deck were added by TMR in the 1980's. The two super structures remain independent structures, separated by a 30 mm air gap. It is not known if the existing decks were constructed with the same level.

6.6.1.3 Load capacity of the existing structure

It is understood that the NB superstructure was designed for a H20-S16 loading (approximately 30% less than T44 loads), and the SB superstructure was designed for T44 loading. Furthermore, it should be noted that the NB girders have been reported to have insufficient shear capacity for these design loads. However, site inspections have not observed the extent of cracking that would be expected for this degree of overstress. At the time of writing this report, TMR is undertaking investigations to resolve this apparent anomaly.

6.6.1.4 Condition of the existing structure

Recent level 2 inspections identified that a number of the original structural elements of the existing NB bridge are in Condition State 4. Aurecon was subsequently engaged by TMR to undertake the following tasks:

- Complete a level 3 inspection of nominated NB bridge elements
- Estimate the residual life of the NB structure
- Identify measures that could be implemented to return the condition state 4 elements to Condition State 2

Irrespective of the adopted upgrade strategy, urgent remedial works have been recommended to return the critical structural elements to Condition State 2. These works could be undertaken as part of the overall upgrade project, or alternatively brought forward and delivered independently. The most urgent works are listed below. More details are available in the level 3 inspection report.

- Replace girder bearings and repair damaged components at piers 1 and 6 (original abutments) – immediate works
- Replace deck expansion joints at piers 1 and 6 and all halving joints to prevent water ingress – immediate works
- Clean out debris from bearing shelves and replace girder bearings at halving joints – in next 5 years
- Replace deck unit bearings at pier 1 – in next 5 years
- Repair and protect exposed post tensioning bars at pier 3 – in next 5 years
- Repair piles at pier 4 – in next 5 years

6.6.1.5 Hydraulic impacts (afflux)

For the period that the new stage 1 bridge and the existing bridge are both in place, the project will have a hydraulic impact due to their misaligned piers. Given the sensitivity of the region to flooding, it was critical to understand these upstream effects and how they would impact upon properties. For this reason, the hydraulic model developed for the Brisbane River Catchment Flood Study was used to assess hydraulic impacts.

Table 6-4 summarises the model-predicted extent of the impacts, and the number of flood-affected properties predicted to have afflux greater than 10 mm. At this stage three event magnitudes have been considered, including 1% AEP, 2% AEP and 5% AEP.

Table 6-4: Hydraulic impact whilst new bridge and existing bridge remain in place

Event Magnitude	Peak afflux upstream of bridge	Upstream extent of afflux >10mm		No. of properties affected by afflux in excess of 10mm
		Brisbane River (from bridge)	Bremer River (from confluence)	
1% AEP	50 mm	30 km	8 km	6,040
2% AEP	40 mm	30 km	3 km	2,280
5% AEP	40 mm	17 km	N/A	530

6.6.1.6 Upgrade staging

The recommended staging strategy discussed in Section 6.2 has been developed to expedite delivery of a new six lane bridge structure and removal of the existing bridges and has been heavily influenced by:

- the limitations and risks associated with the existing structure
- the condition of the existing structure
- the load limitations of the existing structure
- satisfy the $100 million upper limit budget for stage 1
- the hydraulic impacts associated with the stage 1 bridge – acknowledging that these are dictated by the structure form dictated by the specified $100M budget. If that budget limitation was removed, the staging strategy could be significantly affected.

6.6.1.7 Business Case study

At the time of writing this report, TMR is procuring a separate PAF PE and BC study for the Stage 1 works. More detailed investigations and design will be undertaken as part of that study to:

- inform a more detailed comparative analysis of bridge options; and
- confirm the configuration most likely to achieve the service requirements and provide best value for money.

It is understood that the $100 million budget constraint has been removed for stage 1. Importantly, this will allow alternate structural configurations to be considered. If a configuration with piers aligned to existing could be developed for an acceptable budget, afflux issues would be substantially reduced. This could influence not only the preferred structural solution, but the recommended staging approach also (because the motivation to remove the existing bridge would be reduced, provided the structural limitation/ risks can be accepted for a longer period).

6.7 Drainage

6.7.1 Transverse drainage

The project survey data does not provide details of the existing drainage structures, so the significant transverse culvert crossings were identified manually from scanned drawings provided by TMR. For planning purposes, it has been assumed that existing culverts will be extended as required to match the new formation width. Existing headwall structures will be demolished and re-constructed at the new end locations. Allowances for culverts 600mm in diameter and greater have been included in the estimate. Table 6-5 summarises the allowances made.

Table 6-5: Transverse drainage structure allowances

Motorway section	Affected drainage structure		
	Size	Location	Proposed mitigation
Dandenong Road to Seventeen Mile Rocks Road	7/1800 mm RCP	Ch 9650	Extend NB end by 6m and SB end by 10m
Seventeen Mile Rocks Road to Brisbane River	750 mm RCP	Ch 10060	Extend NB end by 5m and SB end by 30m
Kenmore Road overpass to northern extent of realignment	2/900 mm RCP	Ch 11575	Existing culvert to be removed and replaced by a new culvert. The length of the new culvert is approximately 30.5m at both NB and SB ends.
	900 mm RCP	Ch 11410	Existing culvert to be removed and replaced by a new culvert. The length of the new culvert is approximately 30m at both NB and SB ends.
	1050 mm RCP	Ch 11625	Existing culvert to be removed and replaced by a new culvert. The length of the new culvert is approximately 28m at both NB and SB ends.
Northern extent of realignment to Fig Tree Pocket Road	1800 mm RCP	Ch 12400	Extend NB by 10m. (SB extension is not required)
Fig Tree Pocket Road to Jerrang Street	1200 mm RCP	Ch 12525	Extend SB by 10m (NB extension is not required)
Jerrang Street to Moggill Road	3/3000 mm x 3000 mm RCBC	Ch 13825	Extend NB and SB ends by 10m
Fig Tree Pocket Entry Ramp SB	1200 mm X 1500 mm RCBC	Ch 12225	Extend by 25m
Fig Tree Pocket Exit Ramp SB	1800 mm RCP	Ch 12300	Existing culvert to be removed and replaced by a new culvert. The length of the new culvert is approximately 30m.

Additional survey data, site investigation and hydraulic analysis will be required in future project stages to refine these assumptions and allowances, and further develop the transverse drainage design.

6.7.2 Longitudinal drainage

As noted above, the project survey information does not provide details of drainage infrastructure. A quantitative assessment of existing longitudinal drainage capacity and the likely impacts has therefore not been undertaken at this stage. A qualitative assessment has been undertaken to identify areas where additional longitudinal drainage infrastructure is most likely to be required (e.g. areas where the road pavement drains towards the median barrier and the contributing catchment will be extended due to the formation widening). Notional allowances have been included in the estimate for each of these identified locations.

Additional survey data, site investigation and hydraulic analysis will be required in future project stages to refine these assumptions and allowances, and further develop the longitudinal drainage design.

6.7.3 Aquaplaning

Whilst it is noted that the project survey model accuracy is somewhat limited, preliminary aquaplaning checks have been undertaken for the recommended design in accordance with Austroads and TMR guidelines. This assessment identified several locations where recommended film depth was exceeded. Detailed ground survey will be required in future project stages to confirm these issues and to design mitigations (e.g. locally shifting superelevation rotations from sag areas, application of diagonal crossfall and/or additional local drainage infrastructure). For the purposes of the estimate, nominal allowances have been included for each of the identified locations.

6.7.4 Water quality

No water quality modelling or assessment has been undertaken in the planning to date. Analysis and design of measures will be undertaken in future project stages.

6.8 Pavement

At this stage, details and condition of the existing pavements and subgrade are not available. The assumptions and allowances that have been made for the purposes of the estimate are shown in Table 6-6. Additional investigation, analysis and design will be undertaken in future project stages.

Table 6-6: Pavement assumptions/allowance

Location	Assumed pavement details
New motorway pavement	• Surface - 60mm AC 14H • Base - 320mm AC20H • Working platform – 150mm Type 3.1
Existing motorway pavement	• 40mm mill and replace with SMA overlay
New local road pavement	• Surface - 50mm AC 14H • Base - 200mm Type 3.1
Shared paths	• 125mm concrete path

6.9 Public Utility Plant

A high-level assessment of the existing public utility plant (PUP) infrastructure along the Centenary Motorway has been undertaken using the data provided by service providers and DBYD. A service conflict table has been compiled to summarise this assessment in Appendix K. No site inspections or surveys have been undertaken to locate/ identify services or identify service conflicts. More detailed site investigations, pot holing to confirm service locations and detailed surveying will be required as the project progresses into more detailed design development.

For planning purposes and for the estimate, mitigation measures have been assumed for each identified service conflict (see Appendix K). No discussions with PUAs have been undertaken at this stage, and these mitigations are considered indicative only at this stage. Detailed negotiations with PUAs will be required in future project stages to confirm the mitigations required.

6.10 Active Transport

The formation widening required to accommodate the additional motorway lanes will impact upon existing active transport infrastructure. Wherever this occurs, the recommended option includes relocated/ realigned active transport facilities with the same functionality and capacity as provided by the existing infrastructure. Also, where new overpasses/bridges have been included in the recommended option, active transport provisions have been included. A summary of the active transport works included in the recommended design is provided in Table 6-7.

Table 6-7: Active transport provisions included in recommended design

Location	Active transport provisions included in recommended design
CH13520 – 13630	Provide realigned 3.5m wide concrete shared path, southern side of motorway
CH12070 – 13380	Provide realigned 3.5m wide concrete shared path, southern side of motorway, including new underpass beneath Fig Tree Pocket Road and bridge over Cubberla Creek
CH10900 – 11800	Provide realigned 3.5m wide concrete shared path, southern/eastern side of motorway, including connection to Musgrave Street.
CH10680 – 10900 (Centenary Bridge)	Stage 1 - Widen existing shared path, eastern side of SB bridge to 4m (total), using a retro-fitted cantilever steel structure Stage 4 – Provide new 4m shared path, western side of new bridge
CH10300 – 10680	Provide realigned 3.5m wide concrete shared path, western side of motorway
CH9000 – 9850	Provide realigned 3.5m wide concrete shared path, western side of motorway
CH8650 – 8750	Provide realigned 3.5m wide concrete shared path, western side of motorway
CH7250 – 8370	Provide realigned 3.5m wide concrete shared path, western side of motorway, including connections to Andaman Street and shopping centre
New Kenmore Road overpass	New 3.0m shared paths in each direction
New Seventeen Mile Rocks Road overpass	New 2.5m wide shared path
Jerrang Street overpass	New 2.5m shared path in each direction

The active transport provisions included in the recommended design, shown in Figure 6-2, have also been captured in the capital cost estimate, with an approximate provision of $19 million (high confidence), including an approximate $11 million lump sum allowance for an active transport facility on the new Centenary Bridge. These costs reflect the strategic need to ensure active transport connectivity and functionality remains on the Centenary Bikeway and facilitate the achievement of objectives within the SEQ Principal Cycle Network Plan.

It should be noted that the Centenary Cycleway Investment Strategy (CCIS) was being progressed in parallel with this Project. The CCIS identified upgrade cycleway facilities at several key locations along the motorway. In particular, upgrades were identified to improve connectivity at interchanges and local road crossings. Consistent with the objective of identifying a low-cost, low-footprint scope, the Project recommended option has avoided large-scale upgrades to interchanges, and has maintained existing structures and arrangements (including the associated cycleways and shared paths) wherever possible. If/when the interchange upgrades are considered in the future, it would be appropriate to incorporate the CCIS cycleway upgrades at that time.

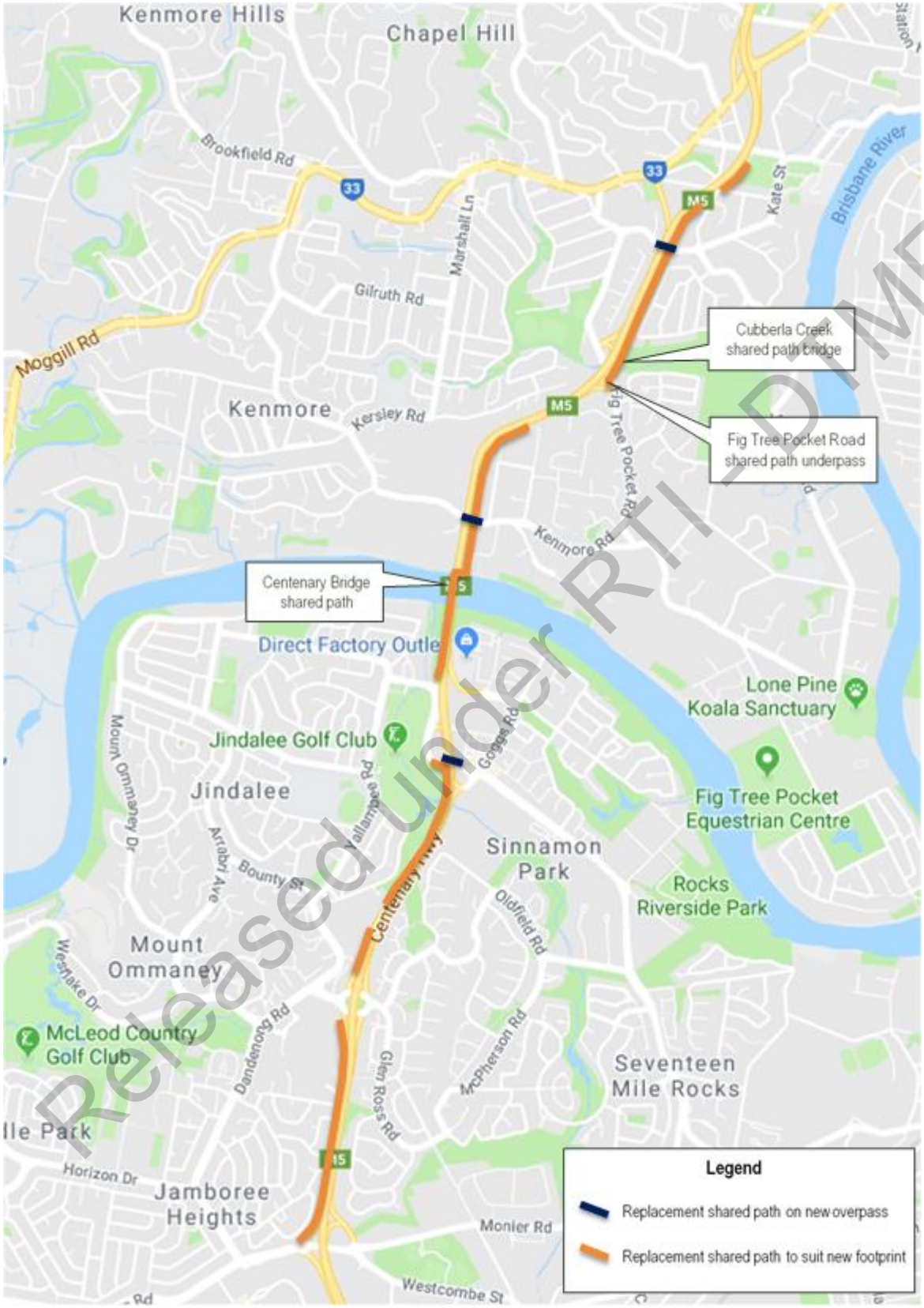


Figure 6-2: Active transport works included in recommended option

6.11 ICT / Managed Motorways

Utilising ramp signalling and Managed Motorways, infrastructure can improve motorway performance characteristics, however, for such works to be effective, the following conditions must be satisfied:

- All entry ramps must be metered
- Sufficient storage must be available on the entry ramps to suitably restrict access to the motorway without queuing onto the surrounding road network
- Entry ramp conditions and geometry must be suitable to allow vehicles to accelerate and merge with the motorway traffic

The potential for incorporating ramp metering within the recommended option has been considered. This investigation identified that potential ramp storage volumes are limited in several locations. For metering in these locations to have a meaningful impact on motorway performance, impacts on the local road network would be likely. Table 6-8 summarises the related opportunities, constraints and issues for each motorway entry.

Table 6-8: Ramp metering opportunities and constraints

Motorway entry	Metering opportunities, constraints and issues
Toowong entry southbound	Given the traffic volumes entering the motorway from Toowong, metering the entry (by signalising the roundabouts and/ or by adding signals adjacent to the Legacy Way portal) has the potential to increase congestion on the surrounding road network. It is envisaged that such measures would need to be implemented in conjunction with BCC's planned upgrade from Croydon Street to the Toowong roundabouts.
Legacy Way southbound	It is not envisaged that the Legacy Way tunnel could be metered
Moggill Road southbound	A two lane metered ramp with approximately 150m entry ramp storage could be provided, with potential for some minor additional storage on the Moggill Road westbound left turn approach to the ramp. It is understood that the existing bikeway bridge pier has been positioned to provide for future upgrade of the existing entry ramp. Detailed investigations would need to be undertaken to confirm that sufficient storage is available to have a meaningful impact upon motorway performance without adversely affecting Moggill Road eastbound.
Moggill Road northbound	It is understood that the existing northbound entry ramp was modified by the Legacy Way project with the required traffic lanes and some infrastructure (e.g. underground ducts and pits) provided for future ramp metering.
Fig Tree Pocket Road southbound	It was proposed in the Project that this ramp be metered via the phasing of the Fig Tree Pocket Road traffic signals, with additional storage provided on the Fig Tree Pocket Road northbound left turn approach to the ramp. There was no entry ramp storage. A two lane metered ramp with approximately 100m entry ramp storage could be provided, however the pedestrian crossing of the ramp associated with the existing bus stop would need to be closed, with an alternative route (e.g. underpass) provided.
Fig Tree Pocket Road northbound	A two lane metered ramp with approximately 100m entry ramp storage could be provided, however the pedestrian crossing of the ramp associated with the existing bus stop would need to be closed, with an alternative route (e.g. underpass) provided.
Seventeen Mile Rocks Road southbound	A two lane metered ramp metering with approximately 200m entry ramp storage could be provided. However, the Sinnamon Road roundabout may require signalisation to manage traffic flows through the roundabout and to the ramp
Sinnamon Road northbound	The concept design can accommodate future ramp metering.
Dandenong Road southbound	A two lane metered ramp with approximately 250m entry ramp storage could be provided. The roundabout may require signalisation to manage traffic flows through the roundabout and to the ramp

Motorway entry	Metering opportunities, constraints and issues
Dandenong Road northbound	A two lane metered ramp with approximately 100m entry ramp storage can be provided. The roundabout may require signalisation to manage traffic flows through the roundabout and to the ramp
Sumners Road southbound	A two lane metered ramp with approximately 200m entry ramp storage can be provided. However, the proposed Sumners Road bridges would need to be designed with sufficient width to accommodate the two lane entry ramp.
Sumners Road northbound	A two lane metered ramp with approximately 100m entry ramp storage can be provided but will require confirmation with the current Sumners Road project.

Considering the physical constraints at entry ramps (summarised in Table 6-9), the appetite for Managed Motorways as discussed at Steering Committee meetings (see minutes in Appendix B) and the outcomes of the options evaluation process (see Section 4), ramp metering has not been proposed for the recommended option. Sufficient allowance has not been included in the cost estimate to accommodate variable speed signs and an ICT backbone. Consideration of these elements will need to be considered in further detail in the BC phase.

As discussed in Section 5, traffic modelling predicts that the recommended option will provide a significant improvement in motorway capacity and performance over the modelled horizon (2021-2036). The recommended option could be upgraded during that time to include ramp metering and managed motorway infrastructure to further optimise motorway capacity and performance. TMR's Network Operations and Performance (NOP) team has reviewed the recommended option layouts and identified potential measures that could be incorporated at that time. For reference, high-level cost estimates have been prepared and suggest that those upgrades could cost in the order of $20 million. Whilst detailed analysis has not been undertaken at this stage, it is envisaged that such measures could improve motorway capacity by 5-10%.

6.12 Geotechnical investigations

A desktop geotechnical review was undertaken as part of the 2012 study. This document has been reviewed considering the current recommended option. Key geotechnical issues and risks for each of the project elements has been identified and summarised in Table 6-9. An updated Desktop Geotechnical Review has been produced and is included in Appendix M.

Table 6-9: Expected geology and geotechnical issues at key project elements

Project element	Expected geology & available geotech. info.	Geotechnical issues and risks
Sumners Road interchange	• Neogene age Darra Formation on the South-east • Triassic-Jurassic age Aberdare Conglomerate to the North-west • No existing geotechnical investigation information	• Excavation: Easy excavation in weathered materials • Erodibility: Variable with siltstones eroding readily to soil strength. Mudstones tend to be moderately erosion resistant and sandstones may fret • Slopes: Often deeply weathered, requires slope protection/low cut batter angles • Foundations: Suitable for driven piles. Bored piers often have installation difficulties, may require installation under polymer fluids/muds and/or casing.
Mount Ommaney Interchange and Seventeen Mile Rocks Road Bridges	• Triassic age Colleges Conglomerate and Mt Crosby Formation • No existing geotechnical investigation information at Mt Ommaney, minimal	• Excavation: Generally easy excavation in weathered materials and soils. Deeper excavation into conglomerate and sandstone beds will require rock breaking. The requirement for blasting is not expected. • Erodibility: Rill erosion develops with time on exposed weathered rock. Unprotected sandy soils susceptible to erosion.

Project element	Expected geology & available geotech. info.	Geotechnical issues and risks
	information available for Seventeen Mile Rocks Road.	• Slopes: Often deeply weathered, requires slope protection/low cut batter angles • Foundations: Suitable for driven piles in places. High level footings suitable when less weathered. Large diameter bored piers easy to drill but may be prone to collapse, requiring support.
Centenary Bridge over Brisbane River	• Alluvium overlying Devonian age Neranleigh-Fernvale Beds in the river and southern abutment • Shallow alluvium overlying Neranleigh-Fernvale Beds and Brisbane Tuff at the northern abutment • Some geotechnical investigation information available as well as construction records for the existing bridge piling	• Excavation: Moderately weathered or better rock requires heavy ripping, rock-breaking or even blasting. • Erodibility: Erosion resistant • Slopes: Existing slope stability issues at the northern abutment with a long history of problems. Likely that all cut and fill slopes will require full retention. • Foundations: Deep bored piers. Piers at the northern abutment should be founded through the Tuff into the Neranleigh-Fernvale Beds due to the presence of a weak unconformity between the two. • Settlements: New embankment on the southern abutment will need to be designed for consolidation of the underlying alluvial soils. Pre-loading is recommended.
Kenmore Road Overpass	• Triassic age Brisbane Tuff however some Tuffaceous Agglomerate is expected. • Minimal geotechnical investigation information available.	• Excavation: Variable. Difficult excavation in fresh Tuff however easy excavation in tuffaceous agglomerate. • Erodibility: Variable. Stratified tuff tends to fret. Welded tuff highly resistant to erosion. • Slopes: Likely to be stratified and will require retention. • Foundations: Suitable for bored piers where stratified. High level footings suitable when less weathered.
Fig Tree Pocket Road	• Alluvium at the bridge and to the North-east. • High Level Neranleigh-Fernvale Beds to the South west • Limited geotechnical investigation information is available	• Excavation: Moderately weathered or better rock requires heavy ripping, rock breaking or even blasting. Easy excavation in the alluvium but excavations will be unstable (even in the short term) and will require support, particularly if groundwater inflows occur. • Erodibility: Erosion resistant in the Neranleigh-Fernvale Beds. Alluvium is susceptible to erosion. • Slopes: Alluvium is unstable, the Neranleigh-Fernvale Beds are stable when less weathered. • Foundations: Suitable for bored piers. The alluvium will create installation difficulties. Likely that full casing will be required for installation.
Jerrang Street and Witton Road Bridges	• Bunya Phyllite bedrock present below approximately 5m of residual soil. • Some geotechnical investigation information is available.	• Excavation: Moderately weathered or better rock requires heavy ripping, rock breaking or even blasting. Easy excavation in the alluvium but excavations will be unstable (even in the short term) and will require support, particularly if groundwater inflows occur. • Erodibility: Erosion resistant in the Bunya Phyllite • Slopes: The Bunya Phyllite Beds are stable when less weathered. • Foundations: Suitable for bored piers. Difficult drilling in moderately weathered or less weathered rock.

6.13 Environment and Cultural Heritage assessment

A preliminary Environmental Assessment Report (EAR) and Supplementary Environmental Assessment (SEA) were completed in 2012 and 2013 respectively as part of the previous study. Both the PEAR and SEA have been reviewed and an addendum report prepared to present the key changes/updates that relate to the current proposed Project alignment in relation to:

- Legislative requirements
- Existing environment (existing planning and environmental opportunities, constraints and potential impacts)
- Management measures and recommendations

In presenting the key changes/updates, consideration has been given to:

- Identifying potential gaps in existing environmental data and information, and making recommendations regarding additional investigations and studies that are required to inform future reporting and Project decision-making
- Reviewing the original key conclusions and management measures, identifying any potential new project risks

The key findings and recommendations from the environmental review have been identified and summarised in Table 6-10. The PEAR is attached in Appendix N.

Table 6-10: Environmental addendum report key findings and recommendations

Aspect	Key findings and recommendations
Legislation	• A review of current legislative requirements has been undertaken for the Project alignment and has identified a number of key changes since the preliminary EAR and SEA were prepared. • The Project still has the potential to trigger a number of approvals under Commonwealth and State legislation. In most instances, confirmation of these approvals is dependent upon the completion of further field investigations and the progression and refinement of the Project design. • It is recommended that the likely approval requirements continue to be reviewed as the design progresses to minimise Project delivery risks and ensure legislative compliance.
Water quality	• The Project alignment crosses Jindalee Creek, Brisbane River, Cubberla Creek (Fig Tree Pocket) and Witton Creek. It no longer crosses Bullock Head Creek, Wolston Creek, Mount Ommaney Creek or Toowong Creek as identified within the preliminary EAR for the original study area. • The preliminary EAR identified 16 registered groundwater bores within the original study area. The number of registered groundwater bores lots based on the current Project alignment has now been reduced to three. • It is recommended that a Site Based Stormwater Management Plan and an Erosion and Sediment Control Plan (in accordance with MRTS52 – Erosion and Sediment Control) are developed and implemented for the Project alignment • It is recommended that a surface water quality monitoring programme is established prior to and during construction to ensure the preferred option contributes to achieving applicable WQOs and to assist with the identification of potential issues for the Project alignment. As part of the monitoring programme, it is recommended that the desktop review of available water quality data conducted in the preliminary EAR is updated for the Project alignment • Undertake groundwater investigations/monitoring prior to and during construction to determine actual water levels, seasonal fluctuations, hydraulic parameters and water quality
Hydrology and hydraulics	• It is recommended that the hydrology and hydraulics assessment and associated models for the original study area which were conducted for the preliminary EAR are updated for the reduced scope and current Project alignment

Aspect	Key findings and recommendations
Flora and fauna	• A review of vegetation community mapping, predictive species mapping and species occurrence data has identified a number of key changes that have occurred since the preliminary EAR and SEA were prepared. The addendum report identified a number of vegetation communities, flora species and fauna species that are protected under the Commonwealth and State legislation that have the potential to occur in the Project alignment • Essential habitat for the following threatened species is mapped within or adjacent to the Project alignment; *Lilaeopsis brisbanica* (Brisbane River Grasswort), Koala (*Phascolarctos cinereus*), Tusked frog (*Adelotus brevis*), Swift parrot (*Lathamus discolour*) and Common death adder (*Acanthophis antarcticus*) • The following biodiversity corridors remain mapped within the Project alignment; regional significance corridor in Kenmore and the state significance corridor associated with the Brisbane River. The Project alignment no longer directly impacts the regional significance biodiversity corridor associated with Brisbane Forest Park • The Project alignment is now located within the South-east Queensland 'Koala District A', as listed under the provisions of the *Nature Conservation (Koala) Conservation Plan 2017.* This triggers the requirement for sequential clearing and the presence of a suitably qualified koala spotter catcher during clearing works within areas of potential Koala habitat • It is recommended that fauna and flora surveys and updated reviews of desktop database sources such as, regulated vegetation mapping, protected plant mapping, species occurrence records etc. are undertaken at future stages of the Project • A number of mapped waterways for waterway barrier works are mapped within and adjacent to the Project alignment. Ensure design and construction works within mapped waterways for waterway barrier works comply with the relevant self-assessable code or approval conditions
Soils, topography and geomorphology	• Following review of the preliminary EAR and soils mapping, the addendum report did not identify any change in soil types potentially impacted by the Project alignment. Some changes in geology types affected by the Project alignment were noted • The preliminary EAR identified 37 lots within the Study area located on the Environmental Management Register (EMR). The number of lots listed on the EMR within the Project alignment has been reduced to seven. Updated searches of the EMR and CLR are recommended for the Project alignment. Undertake a Stage 1 Contaminated Land Investigation for any lots registered on either the EMR or the Contaminated Land Register (CLR) and would be impacted by the Project alignment • Since the preliminary EAR was prepared, Red Imported Fire Ant (RIFA) biosecurity zones have been replaced by RIFA restricted areas. The majority of the Project alignment is situated within a 'Low risk restricted area [orange zone]'. A small portion at the southern extent of the Project alignment is situated within a 'High risk restricted area [red zone]'. Restrictions apply to the movement of potential fire ant carriers (i.e. soils, mulch, quarry material) from the Project alignment • Future stages of the Project should undertake an Acid Sulfate Soils (ASS) investigation for the Project alignment and if required, prepare an ASS management plan
Noise	• The Project alignment has the potential to result in noise related impacts during the construction and operational phases • In the time since the preliminary EAR was prepared, changes have occurred to the TMR Road Traffic Noise Measurement Code of Practice (TMR Code of Practice) which should be considered as part of future Project stages (for design and construction) • The preliminary EAR presented noise monitoring and modelling undertaken for the CMPS by SLR Consulting in 2011-12. Revised noise monitoring and modelling should be undertaken as part of future stages for the Project to reflect the current Project alignment and account for changes to sensitive receptors that have likely occurred in the time since 2011-12.

Aspect	Key findings and recommendations
Air quality and climate	• The Project alignment has the potential to result in air quality related impacts during the construction and operational phases, although the majority of these impacts are likely to be contained to the construction phase. • The Project should consider the need to undertake road traffic air quality assessment during the Project's detailed design phase, and ensure compliance with the TMR Road Traffic Air Quality Management Manual (June 2014 or later version)
Planning and land use	• The Project alignment is situated within a portion of the original study area and therefore land use patterns remain largely associated with urban areas; predominately comprising residential, commercial and industrial land uses, with some recreational and community use areas • A number of the State and regional land use planning instruments have been revised and updated in the time since the preliminary EAR was prepared, however the Project alignment is considered to be generally consistent with the intent of these instruments. • The Project alignment remains wholly located within the Brisbane City Council (BCC) local government area, with development in the BCC LGA regulated under the new Brisbane City Plan 2014 (replacing the previous City Plan 2000). Applicability of the Brisbane City Plan 2014 should be confirmed as design progresses given the potential for State exemptions to apply to the Project. Part Refuse Sch.4 Part 4 s.4(1)(a) Opinion/advice/recommendation for deliberative processes of government
Landscape and visual amenity	• Since the landscape and visual amenity assessment was conducted for the preliminary EAR, the TMR Road Landscape Manual, on which the assessment was based (TMR 1997), has been updated (TMR 2013). It is recommended that the assessment is updated to reflect changes in the TMR Road Landscape Manual • The Project alignment will no longer have a direct impact on the existing landscape feature of Mt Coot-tha or on Industrial land south of the Sumners Road interchange
Social and economic issues	• The Addendum report did not include an update of social and economic statistics presented in the preliminary EAR to reflect new available data from the 2016 Australian Bureau of Statistics (ABS) census. It recommended that this update is conducted in future project stages • It is not anticipated that significant changes in the community and demographic profiles, social infrastructure or economic profile of the Project alignment area have occurred since the preliminary EAR assessment • The Project alignment no longer includes the suburbs of Toowong, Taringa or Darra. No new suburbs, which were not previously assessed in the Preliminary EAR, are affected by the Project alignment. As Toowong and Taringa no longer occur within the Project alignment, potential impacts on more mobile populations are considered to be reduced • With the removal of Darra from the Project alignment, potential impacts on less affluent areas and industrial precincts is considered to be reduced, and Part Refuse Sch.4 Part 4 s.4(1)(a) Opinion/advice/recommendation for deliberative processes of government
Native Title, Aboriginal and Torres Strait Islander and European cultural heritage	• Updated desktop searches of the Native Title Register have identified that the previous Native Title claim that applied to the study area presented in the preliminary EAR was subject to a determination in March 2015 that Native Title did not exist. There are currently no registered Native Title claims in the area of the Project alignment. • Updated desktop searches of the Aboriginal and Torres Strait Islander cultural heritage database have identified no recorded sites within the area of the Project alignment. Cultural heritage assessments and consultation with the registered Aboriginal cultural heritage parties and body is recommended as part of future Project stages. • Updated searches of State and local European heritage registers have been undertaken and identified two BCC local heritage sites adjacent to the Project alignment.

Aspect	Key findings and recommendations
Waste management	• Generation of wastes during the construction and operation of the Project have the potential to result in potential impacts to the environment if appropriate waste management practices are not implemented. • During construction, waste will be required to be managed in accordance with relevant legislation and policies, including the waste management hierarchy (avoid, reuse, recycle). • A Waste Management Plan will still be required to be developed and implemented for the Project and be incorporated into the detailed design and construction phases of the Project.

6.14 Sustainability

A preliminary sustainability assessment has been undertaken using the Infrastructure Sustainability (IS) Rating tool. The project is targeting a Leading Rating which would mean that the Centenary Motorway upgrades will represent leadership in sustainable infrastructure in Australia. Sustainability is evaluated across a broad range of categories and aims to address environmental, social, economic and heritage issues associated with the development; and to enhance outcomes in these areas.

The first step in developing this sustainability strategy was to undertake a weightings analysis, which tailors the scoring system to address the local conditions, so that initiatives to address the most significant local sustainability issues are weighted and therefore rewarded more heavily. This analysis resulted in the prioritisation of sustainability categories to be addressed, including Discharges, Energy, Water, Materials and Climate.

Other categories that were identified to be of lower priority, but will still addressed and form an important part of the Centenary Motorway Upgrade sustainability strategy include Stakeholders, Urban Environment, Ecology, Heritage, Land use, Health, Procurement and Management.

Following the weightings assessment, a preliminary IS Rating points pathway was created through team discussion on what is possible for this type of project. Through consultation with TMR, it was agreed to target a “leading” rating, and updated IS Rating Scorecard and IS Rating Pathway documents were issued. Copies are included in Appendix O. Some of the key sustainability initiatives that may be included in the project are:

- Management of water discharges during construction to prevent contamination
- Reduction of noise and vibration effecting the local community
- Monitoring and modelling of whole of life greenhouse gas emissions
- Preservation of heritage value through consultation with community groups throughout the course of the upgrade project
- Reduction of whole of life energy intensity of materials through material selections

The scorecard and rating pathway documents set a framework that can be further developed through subsequent phases of the upgrade project.

6.14.1 Issues to consider in next phase

TMR is committed to sustainability planning and construction of major infrastructure projects. The ISCA Scorecard and Rating Pathway activities will be further explored in next phase will focus on the following:

- Stakeholder engagement – incorporating the ISCA stakeholder engagement credits into the communication and engagement strategies.
- Innovation / use of emerging materials and technology – early identification and consideration of possible innovations in planning phases to allow E&T to investigate the feasibility of the use of innovative materials and technology in the project.
- Procurement – early identification and consideration of sustainable procurement credits and involvement with the start the TMR Project Leadership Team.

6.15 Interfaces with other projects

The Centenary Motorway is a pivotal element within the overarching transport network of south-east Queensland, and the upgrade planning needs to fit within the strategic context spelled out in the Western Brisbane Transport Network Strategy. As noted in the strategy, the Centenary Motorway upgrade will:

- Complete a future North South Motorway in conjunction with the proposed North West Motorway and Inner Orbital tunnel
- Form an early motorway-standard connection from the west to the Gateway Motorway and Australia Trade Coast, in conjunction with Airport Link.

Specifically, the upgrade planning has considered the following adjacent projects to provide consistency and integration between the relevant elements:

- Kenmore Bypass Centenary Motorway Interchange Options Analysis
- Centenary Motorway Active Transport Gap Analysis
- Sumners Road Interchange Upgrade

6.15.1 Kenmore Bypass Centenary Motorway Interchange Options Analysis

During the course of the study, the Kenmore Bypass Centenary Motorway Interchange Options Analysis (KBCMIOA) has been completed by others. The KBCMIOA was developed with full visibility of the Centenary Motorway upgrade planning and the two studies are consistent with each other. Particular points of note include:

- The KBCMIOA proposes a northbound exit ramp to Kenmore Bypass just north of Centenary Bridge, without an auxiliary northbound lane over the bridge. Previous studies have considered that the proximity of this exit to the Sinnamon Road entry ramp would necessitate an auxiliary lane over the bridge. The ultimate width planned for the Centenary Bridge makes allowance for this auxiliary lane if required (shoulder widths would be reduced and traffic lanes would be slightly narrowed).
- The Kenmore Road overpass and adjacent pipe bridge constructed as part of the Centenary Motorway upgrade will need to accommodate future northbound exit and southbound entry ramps from Kenmore Bypass. The planned overpass bridges are suitable for this, but would need to be constructed with retaining abutments rather than spill through batters. The retaining wall alignments leading to the abutments would also need to suit the future ramp alignments. It would be prudent for these retaining walls and associated earthworks to be constructed as part of the Centenary Motorway upgrade.
- The KBCMIOA identifies a new bridge structure for the Kenmore Bypass over the re-aligned section of Centenary Motorway. The KBCMIOA sketches do not include bridge details, but it is noted that if a central pier is required for the Kenmore Bypass bridge, it is likely that some widening of the Centenary Motorway median shoulders would be required at that time to address sight distance issues.

6.15.2 Centenary Cycleway Investment Strategy

The Centenary Cycleway Investment Strategy (CCIS) has been ongoing throughout the course of the study. The CCIS concluded the existing shared path on the Centenary Bridge does not provide sufficient functionality. An upgraded/ replacement facility will be included in Stage 1 of the motorway upgrade, and suitable provisions will need to be maintained throughout each of the subsequent upgrade stages.

As presented to the Steering Committee, the recommended option and associated cost estimate has allowed for a cantilevered widening of the existing shared path, to provide an overall 4m width. However, it has recently been advised that a separate, bicycle-only facility on the proposed Stage 1 bridge may be preferred. Such an arrangement would need to address connectivity with the existing shared paths to the northern and southern sections, and would need to include a crossing of the motorway at the northern abutment (the shared path to the north is on the eastern side of the existing motorway.

Details of the shared path or separated cycleway will need to be developed as part of the Stage 1 Centenary Bridge Preliminary Evaluation and Business Case project being procured at the time of writing this report.

6.15.3 Sumners Road Interchange Upgrade

The Sumners Road interchange upgrade (SRIU) project commenced during the course of the study. At this stage, it is understood that the SRIU project will be constructing a new bridge over the motorway to provide two eastbound lanes. Bridge spans and soffit levels will be selected by that project to accommodate the upgraded motorway configuration. The Centenary Motorway Upgrade Project design files have been provided to the SRIU project to facilitate this integration.

It is understood that the SRIU project scope may grow to also include replacement of the existing bridge structure. At the time of writing, this decision has not been confirmed/ finalised, so the recommended option includes allowance for replacement of that structure.

7. Cost estimates

7.1 Methodology and approach

Cost estimates were prepared for the following three options:

- Base case: no capital work, maintenance costs only
- Option 1 (Full Delivery): continuous work as one project
- Option 2 (Staged Delivery): staged work as a five-stage project

The construction estimate was based on a schedule of quantities that were produced from an options analysis design, with a level of detail for the purposes of options comparison. More sub-items and further quantity breakdown were populated as part of the cost estimating process. The majority of the scheduled items costs have been calculated from First Principles based on this schedule of quantities.

Some cost elements rely on details in documents that are currently unavailable, therefore recent experience from similar projects has been used to generate First Principles costings for these elements.

The risk percentage was determined using the Deterministic Method. This approach has been confirmed with Infrastructure Delivery Services (TMR) and all assumptions have been agreed progressively with TMR. The construction contingency, or risk allowance for issues to be address by the Contractor, was also determined during this process. The “High confidence” output has been used.

The key assumptions of the construction estimate include:

- The project will be delivered as a TMR TIC-DC (Design and Construct) project.
- In the absence of available geotechnical data, all material was assumed rippable based on the following assumptions. Within the volume of excavation required, 50% of the material is assumed to be excavated, approximately 25% may hard ripping, and the remaining 25% requiring blasting.
- Excavated material from the site is not suitable for embankment construction.
- The design details for the bridges have been assumed based on similar structures from other projects for estimating purposes.
- The allowances for traffic management have been valued at 12.33% of the total construction job costs.
- The allowance for environmental management is 2.5% of direct construction job costs.
- The available details are concept plan details.
- The detail and requirement are based on Concept Phase Category 2 Estimate, which consists of:
  - Direct Job Costs: these cover the costs of material, plant, labour and subcontractors for the construction of the physical works
  - Indirect Costs: this estimate is at a category 2 level, so a general percentage has been adopted for indirect/overhead costs with reference to total construction cost – the allowance of overhead cost is 20% of the Direct Job Costs less the allowance for contractor site facilities included within the cost schedule
- Based on the "High confidence” approach, a profit margin of 10% on the contract value has been adopted.

The maintenance costs have been calculated for all three options and have been included in the Medium and High confidence level cash flow calculations. The maintenance was grouped under three separate areas based on available data at this stage of the concept design development:

- Basic routine maintenance cost
- Periodic maintenance cost
- Programmed maintenance cost

Additional assumptions for the development of the cost estimates are provided in Table 7-1.

Table 7-1: Cost estimate assumptions

General assumptions	Full upgrade	Staged upgrade
Base date	May 2018	
Escalation rate (per FY)	As per PCB federal form – December 2017	
Delivery method	Design and Construct	
Construction start	September 2020	
Construction completion	June 2024	June 2031
Escalation rates (Calculated for 10 years to June 2017 based on construction program)*	FY2018 – 5.92% FY2019 – 2.30% FY2020 – 2.44% FY2021 – 2.30% FY2022 – 3.14% FY2023 – 3.10% FY2024 – 2.92% FY2025 – 2.70% FY2026 – 2.70% FY2027 – 2.70%	
Construction award date	September 2020	September 2020 to July 2028
Category estimate	Category 2 – Preliminary Estimate	
Project concept and development	% of Construction Cost	
Construction	Category 2 – Preliminary Estimate	
Finalisation	% of Construction Cost	
Contingency (deterministic)	Medium confidence – 39%, High confidence – 61%	

** There is no additional allowance for escalation after June 2027, after which the escalation is capped at the compound escalation to June 2017.*

7.2 Capital cost estimate

The capital costs for each option are presented in Table 7-2.

Table 7-2: Capital Cost Estimate Summary

Capital cost	Medium confidence	High confidence
Option 1 (Full Delivery)		
Principal's costs	*$ 106,594,979*	
Construction contractor's costs	*$ 438,230,724*	
Base estimate	$ 544,825,703	
Risk and contingency	*$ 212,482,024*	*$ 332,343,679*
Total project cost (current $)	$ 757,307,728	$ 877,169,383
Escalation	*$ 92,470,545*	*$ 106,288,590*
Total project cost (out-turn $ for delivery in 2024FY)	**$ 849,778,273**	**$ 983,457,973**
Option 2 (Staged Delivery)		
Principal's costs	*$ 107,700,374*	
Construction contractor's costs	*$ 443,372,096*	
Base estimate	$ 551,072,470	
Risk and contingency	*$ 214,918,263*	*$ 336,154,207*
Total project cost (current $)	$ 765,990,734	$ 887,226,677
Escalation	*$ 164,574,414*	*$ 187,522,917*
Total project cost (out-turn $ for delivery in 2032FY)	**$ 930,565,148**	**$ 1,074,749,595**

7.3 Maintenance / rehabilitation cost estimate

The maintenance / rehabilitation costs for each option are presented in Table 7-3.

Table 7-3: Maintenance / Rehabilitation Cost Estimate Summary

Maintenance / rehabilitation cost	Medium confidence	High confidence
Base case		
Basic Routine Maintenance	*$ 51,483,856*	
Periodic Maintenance	*$ 52,478,802*	
Programmed Maintenance	*$ 58,702,209*	
Maintenance / rehabilitation cost	$ 162,664,866	
Risk and contingency (maintenance / rehabilitation)	*$ 63,439,298*	*$ 99,225,568*
Total maintenance / rehabilitation cost (current $)	$ 226,104,164	$ 261,890,435
Escalation	*$ 54,426,996*	*$ 63,041,341*
Total maintenance / rehabilitation cost (out-turn $)	**$ 280,531,160**	**$ 324,931,776**
Option 1 (Full Delivery)		
Basic Routine Maintenance	*$ 44,592,835*	
Periodic Maintenance	*$ 45,297,296*	
Programmed Maintenance	*$ 41,992,182*	
Maintenance / rehabilitation cost	$ 131,882,314	
Risk and contingency (maintenance / rehabilitation)	*$ 51,434,102*	*$ 80,448,211*
Total maintenance / rehabilitation cost (current $)	$ 183,316,416	$ 212,330,525
Escalation	*$ 47,872,853*	*$ 55,449,852*
Total maintenance / rehabilitation cost (out-turn $)	**$ 231,189,270**	**$ 267,780,377**
Option 2 (Staged Delivery)		
Basic Routine Maintenance	*$ 52,466,839*	
Periodic Maintenance	*$ 45,431,529*	
Programmed Maintenance	*$ 36,311,628*	
Maintenance / rehabilitation cost	$ 134,209,996	
Risk	*$ 52,341,899*	*$ 81,868,098*
Total maintenance / rehabilitation cost (current $)	$ 186,551,895	$ 216,078,094
Escalation	*$ 46,937,388*	*$ 54,366,327*
Total maintenance / rehabilitation cost (out-turn $)	**$ 233,489,283**	**$ 270,444,421**

7.4 Total whole-of-life project cost

The total whole-of-life project costs for the base case and each option are presented in Table 7-4.

Table 7-4: Total Whole-of-Life Project Cost Summary

Cost estimate summary	Medium confidence	High confidence
Base case		
Maintenance / rehabilitation costs	$ 162,664,866	
Risk and contingency (maintenance / rehabilitation)	$63,439,298	$99,255,568
Escalation (maintenance / rehabilitation)	$ 54,426,996	$ 63,041,341
Total whole-of-life project cost (out-turn $)	**$ 280,531,160**	**$ 324,931,776**
Option 1 (Full Delivery)		
Principal's costs	$ 106,594,979	
Construction contractor's costs	$ 438,230,724	
Maintenance / rehabilitation costs	$ 131,882,314	
Risk and contingency (capital & maintenance / rehabilitation)	$ 263,916,127	$ 412,791,891
Escalation (capital & maintenance / rehabilitation)	$ 140,343,398	$ 161,738,442
Total whole-of-life project cost (out-turn $)	**$ 1,080,967,542**	**$ 1,251,238,350**
Option 2 (Staged Delivery)		
Principal's costs	$ 107,700,374	
Construction contractor's costs	$ 443,372,096	
Maintenance / rehabilitation costs	$ 134,209,996	
Risk and contingency (capital & maintenance / rehabilitation)	$ 267,260,162	$ 418,022,305
Risk and contingency (capital & maintenance / rehabilitation)	$ 211,511,802	$ 241,889,244
Total whole-of-life project cost (out-turn $)	**$ 1,164,054,430**	**$ 1,345,194,016**

The 'high confidence' and 'medium confidence' cost breakdowns for the staged upgrade by each stage are shown in Table 7-5 and Table 7-6.

Table 7-5: Cost breakdown for Option 2 (Staged Delivery) by stage – high confidence

Cost type	Capital cost						Maintenance / rehabilitation	TOTAL
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Total		
Principal's costs	$ 13,710,046	$ 43,838,716	$ 14,752,067	$ 22,551,526	$ 12,848,019	$ 107,700,374	–	$ 107,700,374
Construction contractor's costs	$ 58,230,739	$ 163,718,688	$ 67,586,203	$ 97,257,930	$ 56,578,535	$ 443,372,096	–	$ 443,372,096
Maintenance / rehabilitation	–	–	–	–	–	–	$ 134,209,996	$ 134,209,996
Risk and contingency	$ 43,883,879	$ 126,610,016	$ 50,226,345	$ 73,083,769	$ 42,350,198	$ 336,154,207	$ 81,868,098	$ 418,022,305
Escalation	$ 14,060,064	$ 63,794,900	$ 32,021,040	$ 48,791,214	$ 28,855,698	$ 187,522,917	$ 54,366,327	$ 241,889,244
Total	**$ 129,884,728**	**$ 397,962,321**	**$ 164,585,655**	**$ 241,684,440**	**$ 140,632,451**	**$ 1,074,749,595**	**$ 270,444,421**	**$ 1,345,194,016**

Table 7-6: Cost breakdown for Option 2 (Staged Delivery) by stage – medium confidence

Cost type	Capital cost						Maintenance / rehabilitation	TOTAL
	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Total		
Principal's costs	$ 13,710,046	$ 43,838,716	$ 14,752,067	$ 22,551,526	$ 12,848,019	$ 107,700,374	–	$ 107,700,374
Construction contractor's costs	$ 58,230,739	$ 163,718,688	$ 67,586,203	$ 97,257,930	$ 56,578,535	$ 443,372,096	–	$ 443,372,096
Maintenance / rehabilitation	–	–	–	–	–	–	$ 134,209,996	$ 134,209,996
Risk and contingency	$ 28,056,906	$ 80,947,387	$ 32,111,925	$ 46,725,688	$ 27,076,356	$ 214,918,263	$ 52,341,899	$ 267,260,162
Escalation	$ 12,235,479	$ 55,933,250	$ 28,172,871	$ 42,911,903	$ 25,320,912	$ 164,574,414	$ 46,937,388	$ 211,511,802
Total	$ 112,233,170	$ 344,438,041	$ 142,623,066	$ 209,447,048	$ 121,823,822	$ 930,565,148	$ 233,489,283	$ 1,164,054,430

The Cost Estimate Report is attached in Appendix P.

8. Conclusions and recommendations

This Summary Planning Report for the Centenary Motorway Upgrade Project documents the process that has been undertaken to develop a suite of short to medium term options that address the functionality and capacity issues in the Centenary Motorway corridor, taking into consideration the potential for staging delivery to align with the longer term vision. This planning study builds on previous planning studies, including the 2010 SASR and 2013 CMPS (PE Lite).

A comparative assessment was undertaken to reduce the long list, comprising of Non-infrastructure, Existing Asset and New infrastructure options, to a more manageable shortlist of options that address the Project Objectives through an OnQ Business Case (BC) and Project Assessment Framework (PAF) Preliminary Evaluation (PE). Comparative analysis and preliminary investigations were presented to the PSC, where ultimately the following recommendations were able to be made regarding the preferred project options that best addressed Project Objectives:

- STO 5: New three-lane northbound bridge over Brisbane River to be further investigated and developed to inform an OnQ BC
- MTO 2: Six lane surface upgrade, largely to be widening of the existing alignment (using extended design parameters (EDD)) to be further investigated and developed to inform an updated PAF PE report, which would incorporate any identified active transport and managed motorway options.

Importantly, the preliminary investigations of the new bridge revealed that the capital cost would likely exceed $100 million. As this capital value exceeds the threshold requirements for the OnQ BC requirements, the decision was made to by the PSC undertake further investigations and develop this project option as a separate investigation under a PAF PE.

The preliminary investigations of the six lanes surface upgrade focussed on further technical, traffic, risk and costs analysis, and understanding the potential for staging the delivery of the motorway upgrade. The outcomes of the preliminary investigations were brought to the PSC, which identified the preferred motorway upgrade options that would be taken into further detailed investigations in the remainder of the PAF PE.

Based on the preliminary investigations, the total whole-of-life project costs (in out-turn $) for both project options are:

- Option 1 (Full Delivery)
  - Medium confidence: $1,080,967,542
  - High confidence: $1,251,238,350
- Option 2 (Staged Delivery)
  - Medium confidence: $1,164,054,430
  - High confidence: $1,345,194,016

These two project options will be taken forward for further investigation in the latter stages of the PAF PE.