Executive summary

The Department of Transport and Main Roads (TMR) have commissioned GHD to undertake concept planning to determine the corridor requirements for the future duplication of Bribie Island Bridge. The bridge is situated at the eastern extent of the state-controlled Caboolture – Bribie Island Road, and connects Bribie Island to the mainland over the Pumicestone Channel. TMR’s control of Bribie Island Road extends to the eastern abutment of the bridge, with Moreton Bay Regional Council (MBRC) controlling all roads on Bribie Island.

The bridge is approximately 835 m in length and was constructed in 1963. The bridge consists of two 3.0 m wide traffic lanes as well as a narrow footpath of approximately 900 mm. The bridge also makes provision for a range of utility services, including Telstra, Energex and Unitywater. The Bribie Island Road Bridge is the only road link connecting Bribie Island to the mainland and thus plays a vital role in the economy of Bribie Island. This link is experiencing increasing demands from urban growth, and from increasing pedestrian, cyclist and freight traffic.

Based on the Functional Specification, and prior and subsequent discussions with TMR, the purpose of the commission has been confirmed as essentially “high-level” planning only, in order to determine corridor requirements to inform potential development in proximity to Bribie Island Road Bridge. This concept planning work being undertaken therefore reflects this TMR primary objective, and this report documents the approach and findings of this work. The work has also served the purpose of being an ‘information gathering’ exercise to inform future project phases.

The scope of work undertaken for this report comprises the following;

- Assessment of bridge and approach road alignment options at 15 m and 30 m offsets to both sides of the existing bridge, which included:
  - a new two lane bridge with a 4 m cycleway
  - a new four lane bridge with a 4 m cycleway
- Preliminary bridge analysis considering constructability with regard to proximity to the existing bridge (i.e. 15 m and 30 m offsets), preliminary assessment of potential sub and super-structure options, and options for re-use of the existing bridge.
- Targeted consultation with key stakeholders MBRC, Translink, Maritime Safety Queensland (MSQ) and TMR Delivery & Operations (North Coast Region).
- Traffic modelling to confirm capacity requirements for bridge duplication or replacement, and assess potential impacts on the local network.
- Desktop review of existing environmental information and studies to determine environmental constraints.
- Desktop geotechnical analysis sufficient so that the options being evaluated do not present unacceptable geotechnical risks.
- Desktop assessment and review of existing Public Utility Plant (PUP) to determine potential constraints.
- Presentation and discussion of the following as appropriate:
  - Alignment options (including shoulders, cycle and pedestrian facilities, bus stops, etc.)
  - Intersection layouts
  - Typical bridge cross sections and elevations
– Possible resumption lines
– Assessment of potential impacts of alignment options on PUP

• Provide a recommendation to assist TMR in preserving a corridor for future bridge duplication.

Targeted consultation with key stakeholders, and liaison with PUP providers, provided no clear preferences for an alignment to either the north or south of the existing bridge. Accordingly therefore, options to both sides of the bridge were considered in terms of horizontal geometry, and potential impacts on property and existing services. Traffic analysis, bridge analysis, and identified geotechnical and environmental constraints, also contributed to the options considered.

The outcome of the options consideration is that a new bridge at a 15 m offset to the north of the existing bridge, be adopted for preserving a corridor for the future bridge duplication of Bribie Island Bridge, for the following reasons:

• Traffic forecasts suggest that the existing bridge will reach practical capacity by 2031 during the peak period (which has been observed to occur around lunchtime on Sundays). MBRC have provided a number of residential growth forecast scenarios for comparison purposes, one of which showed a potential increase in dwellings on the island of 37% by 2031, which may result in the existing bridge also approaching capacity during the weekday PM peak period by 2031. Therefore, it is considered prudent to ensure that sufficient redundancy in corridor protection is provided in the longer term.

• Bridge analysis undertaken indicates there would appear to be no insurmountable constructability issues which would preclude a 15 m offset from being adopted.

• The existing bridge could be retained for use by pedestrians and cyclists, and continue to provide for PUP services, subject to an ongoing maintenance regime to reach its 75 year design life i.e. 2038. Thus based on the traffic analysis and residual design life, it can be assumed that duplication of the bridge will become a necessity somewhere between 2031 and 2038.

• 15 m offset ensures only one undeveloped property on Bribie Island is affected, on which a current development application has lapsed. Any impacts on the adjacent Benabrow Shopping Centre are avoided.

• Further resumption requirements to Lot 6 SP199926 to the south of Bribie Island Road are avoided, and impacts on the large residential complex, between Welsby Parade and Winston Drive, on the island are avoided.

• Impacts on PUP are less for 15 m offsets than for 30 m offset options, and for all options to the north of the existing bridge.

• Favoured from a geotechnical perspective, as there are potential benefits from utilising the existing filled embankments on the north side of Bribie Island Road.

• Minimises the impacts to the local environment by locating the road corridor within previously cleared/modified areas to the greatest extent practical. Avoids impact to mapped koala bushland, mapped REs and has a lower chance of encountering items or places of Aboriginal cultural heritage value.

This report is subject to, and must be read in conjunction with, the limitations set out in section 1.4 and the assumptions and qualifications contained throughout the Report.
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1. **General**

1.1 **Introduction**

The Bribie Island Bridge is situated at the eastern extent of the Caboolture – Bribie Island Road, and connects Bribie Island to the mainland over the Pumicestone Channel. The bridge is approximately 835 m in length and was constructed in 1963. The bridge consists of two 3.0m wide traffic lanes as well as a narrow footpath of approximately 900mm. The bridge also provides provision for a range of utility services.

The Bribie Island Road Bridge is the only road link connecting Bribie Island to the mainland and thus plays a vital role in the economy of Bribie Island. This link is experiencing increasing demands from urban growth, and increasing pedestrian, cyclist and freight demands.

There were 4 vehicle crashes on the bridge during 2009 and 2010 causing significant delays on the bridge, which have continued to result in community and political pressure to upgrade the bridge. The narrow footpath on the bridge is also the subject of community concern, as is the sub-standard left-turn into Sylvan Beach Esplanade off the eastern end of the bridge. This left turn has been observed as impacting on the safety and efficiency of eastbound traffic on the bridge.

1.2 **Purpose of this report**

The Department of Transport and Main Roads (TMR) have commissioned GHD to undertake concept planning to determine the corridor requirements for the future duplication of Bribie Island Bridge.

Based on the Functional Specification, and prior and subsequent discussions with TMR, the purpose of the commission has been confirmed as essentially “high-level” planning only, in order to determine corridor requirements to inform potential development in proximity to Bribie Island Road Bridge. This concept planning work being undertaken therefore reflects this TMR primary objective, and this report documents the approach and findings of this work. It has also served the purpose of being an ‘information gathering’ exercise to inform future project phases.

1.3 **Scope of this report**

The scope of works, as outlined in the Functional Specification, and as refined in agreement with TMR in progress meetings held during the course of the commission, is as follows:

- Assessment of bridge and approach road alignment options which consider the ability to preserve a future corridor and provide direction into future business case and preliminary design phases. Alignment and offset options considered on both sides of the existing bridge include:
  - a new two lane bridge with cycleway
  - a new four lane bridge with cycleway
- Undertake preliminary bridge analysis considering constructability with regard to proximity to the existing bridge, preliminary assessment of potential sub and super-structure options, and options for re-use of the existing bridge. Provide comment on potential climate change and storm surge impacts.
- Targeted consultation with key stakeholders Moreton Bay Regional Council (MBRC), Translink, Maritime Safety Queensland (MSQ) and TMR Delivery & Operations (North Coast Region).
- Undertake traffic modelling to confirm capacity requirements for bridge duplication or replacement, and assess potential impacts on the local network, to determine future corridor requirements.
• Desktop review of existing environmental information and studies to determine environmental constraints to make recommendations for future project phases.

• Undertake desktop geotechnical analysis sufficiently so that the options being evaluated do not present unacceptable geotechnical risks, and to make recommendations for future project phases.

• Undertake desktop assessment and review of existing Public Utility Plant (PUP) to determine potential constraints and meet with PUP service providers to discuss existing and future services that may be planned for the area and/or need to be accommodated in the new corridor.

• The provision of a report summarising the above work, which also considers and presents the following as appropriate:
  – Alignment options (including shoulders, cycle and pedestrian facilities, bus stops, etc.)
  – Intersection layouts
  – Typical bridge cross sections and elevations
  – Possible resumption lines
  – Assessment of potential impacts of alignment options on PUP

• Provide a recommendation to assist TMR in preserving a corridor for future bridge duplication.

1.4 Limitations

This report has been prepared by GHD for TMR and may only be used and relied on by TMR for the purpose agreed between GHD and TMR as set out in this report.

GHD otherwise disclaims responsibility to any person other than TMR arising in connection with this report. GHD also excludes implied warranties and conditions, to the extent legally permissible. The services undertaken by GHD in connection with preparing this report were limited to those specifically detailed in the report and are subject to the scope limitations set out in the report. The opinions, conclusions and any recommendations in this report are based on conditions encountered and information reviewed at the date of preparation of the report. GHD has no responsibility or obligation to update this report to account for events or changes occurring subsequent to the date that the report was prepared. The opinions, conclusions and any recommendations in this report are based on assumptions made by GHD as described in this report. GHD disclaims liability arising from any of the assumptions being incorrect.

2. Targeted consultation

In agreement with TMR, targeted consultation was undertaken with key identified stakeholders Moreton Bay Regional Council, Maritime Safety Queensland, Translink and TMR Traffic Operations (North Coast Region), and the outcomes are discussed as follows:

2.1 Moreton Bay Regional Council

Representatives from TMR and GHD met with officers of MBRC on 20th February 2013. The following is a record of the issues raised with MBRC and their responses:

2.1.1 Do MBRC have any preferences as to the location of future bridge duplication?

• MBRC advised that a previous local Councillor may have had a preference for a new bridge to the south of the existing bridge, but were not aware of any current preferences existing within MBRC.
2.1.2 Are there any local traffic issues on the approaches to the bridge?

- MBRC advised the width of the current cyclist/pedestrian facility on the existing bridge is of concern, and that the width may be acting as a deterrent to its use (i.e. suppressed demand).
- MBRC advised they would consider the existing bridge to be an adequate cyclist and pedestrian facility, if traffic were to be removed from the bridge. GHD advised this was a potential option to be considered in a staged approach to the provision of a new bridge.
- MBRC advised cycling connectivity at either end of the bridge should be an important consideration of any option recommended. TMR noted that the bridge is part of the TMR Strategic Cycle Route Network.
- MBRC advised the development at Sandstone Point may be a trip generator for cyclists to Bribie Island.
- MBRC suggested the planning should consider disaster management planning relating to access, capacity and ageing concerns with the existing bridge.

2.1.3 Can Council provide outputs from the MBRC Strategic Traffic Model for current and future years?

- MBRC advised this Model is currently being finalised, but tabled 2031 outputs to enable GHD to undertake any traffic modelling that may be required for the planning.
- Subsequent to this meeting, TMR have been working closely with MBRC and have obtained updated outputs for use with traffic modelling. Refer to section 3 of this report for further discussion on this issue.

2.1.4 Advise of any hydraulic/drainage issues on the approaches to the bridge, and any future proposals

- MBRC advised they were currently compiling environmental and flooding constraint mapping, and would forward this onto GHD when available. This mapping would include existing issues, and planned infrastructure.

2.1.5 Advise of development plans adjacent to the Bribie Island Road corridor and adjoining local roads

- MBRC advised Bribie Island was getting close to 100% of full allowable zoned development, being predominantly National Park, although future growth may comprise intensification of existing development. MBRC advised all potential growth was captured in the Strategic Model. Refer also to section 3 for further discussion on this issue.

2.1.6 Confirm public transport requirements and plans

- MBRC advised there was an existing Park and Ride facility at the bus interchange at Bribie Island Shopping Centre. Public transport use of any future bridge is likely only to be buses.

2.1.7 Advise on any MBRC landscape and streetscape planning or related upcoming projects in the Bribie Island Road corridor and adjoining local roads

- MBRC advised the new Network and Corridor Strategy and Active Transport Strategy due out later this year would contain this information.

2.2 Maritime Safety Queensland

Representatives from TMR and GHD met with officers of MSQ on 19th February 2013. The following is a summary of the discussion with MSQ:
• MSQ advised the navigational channel through the existing bridge has remained static since the bridge was built. The bridge span accommodating the channel has navigation lights on both sides of the bridge, although currently only the lights on the south side are working. The channel through the span operates one way at a time. No dredging has been necessary to maintain this channel.

• MSQ advised that a navigation span incorporated into a new bridge should at least be equal to, or exceed, the current existing span dimensions. The preference would be for a 30m span to allow for two-way traffic. A higher bridge than the existing may encourage more use.

• MSQ advised for a possible requirement for an increased navigation span dimension when a new bridge is provided. GHD advised that a staged approach may be adopted to the provision of a new bridge which may include utilising the existing bridge for pedestrian and cyclists, thus the constraint of the existing span may still exist after the provision of a new bridge.

• MSQ advised that traffic management during construction (for vessels using the navigation span) would need to be an important consideration of any potential construction method chosen.

• MSQ advised of no preference relating to a new bridge being north or south of the existing bridge, as long as a new navigation channel span aligns with the existing. The new span should include navigation lights.

• MSQ advised current use of the bridge comprised mainly powered recreational vessels, and some small trawlers from the Spinnaker marina, up to about 12 m in length. There is an existing Marina north-west of the bridge, with other use being to the Pacific Harbour development. Access to both of these is through the existing bridge from the south.

• MSQ advised the existing height clearance from HAT (highest astronomical tide) to the underside of existing bridge is approximately 5 m. The tidal reach is approximately 2.5 m.

• MSQ advised that they would provide historical hydrographic charts.

• MSQ advised that incidents of vessels hitting the bridge were rare, but seemed mostly related to vessels breaking loose and drifting in storms.

In summary, the main consideration from the above discussion is that the navigation span incorporated into a new bridge should at least be equal to, or exceed, the current existing span dimensions.

2.3 Translink

Representatives from GHD met with officers of Translink on 6th March 2013 at their offices in Brisbane. The following is a summary of the discussion with Translink:

• Translink commented that they considered the existing bridge not to be congested, but consider the sharp left turn onto Sylvan Beach Esplanade as a reason for causing slow traffic on the bridge at times. They noted that the current bridge width, although narrow, is manageable for their drivers. Increased lane width would improve manoeuvrability for buses using the bridge.

• Translink currently has two bus routes which service the Bribie Island area, routes 643 and 640, operated through Bribie Island Coaches. These routes connect Bribie Island with the Caboolture railway station. They confirmed there are no plans for additional services to Bribie Island. Translink also advised they operate a small school bus in the area.

• Translink confirmed there is a ‘Park n Ride’ facility at Victory Road on Bribie Island, which is currently underutilised. Translink consider there is no need for a dedicated bus lane on the bridge, due to the lack of bus services and patronage in the area.
Translink considered that bridge duplication would assist with emergency or incident management. Currently ferries are used when there are incidents or accidents that require bridge closures.

With regard to a preference for the location of bridge duplication, Translink advised that duplication on the south side of the existing bridge would be preferential for operational purposes. However this is based on an assumption that a bridge on the south side would provide direct access to Sandstone Point.

2.4 TMR Delivery & Operations (North Coast Region)

Discussions with an officer from TMR Delivery & Operations (North Coast Region), has highlighted the left turn from the bridge into Sylvan Beach Esplanade as their main concern. Their comments are summarised as follows:

- The issue of the left turn into Sylvan Beach Esplanade has previously been raised with MBRC i.e. how this sub-standard intersection compromises safety and efficiency of bridge traffic flow.
- TMR observations are that the westbound traffic flow is always free flowing with traffic generally travelling at 60km/h. However eastbound traffic is often bunched, with slower speeds and often sudden stop/start flow, apparently as a result of the sub-standard geometry of the left turn into Sylvan Beach Esplanade.
- Recorded traffic incidents are all eastbound traffic, which appears to provide further evidence of this issue.

Discussions with TMR also highlighted their view that current traffic flows indicate that the directional split of vehicles is such that a 3-lane tidal flow bridge would have little merit (based on the current approximate directional split of 45% / 55% during the peak periods). Thus this possible option has not been considered as part of this commission.

2.5 Other consultation issues

A summary of other consultation issues relevant to Bribie Island Bridge, as advised by TMR, are as follows:

- Over the past 5 years, TMR has received many requests to duplicate the bridge from current and former MPs including Questions on Notice, members of the local community, Electoral Enquiries through the Minister’s office, petitions signed by the local community and Caucus Enquiries. A summary of the issues raised include:
  - Continual requests to duplicate Bribie Island Bridge based on its age, narrowness and traffic volumes.
  - Continual requests to widen the Bribie Island Bridge footpath, including representations from Bribie Island Bicycle User Group (BUG).
  - Cyclists and pedestrians unable to pass each other on the footpath (except at the passing bays).
  - Footpath too narrow for cyclists to ride across, issue with handlebars hitting the railings.
  - Traffic lanes too narrow for mobilised scooters to utilise the bridge.
- BUG are strong advocates for the existing footpath to be widened as it is considered to be too narrow and cyclists handle bars can get caught in the railings, potentially causing injuries. BUG considers a wider cycleway would improve safety for cyclists and pedestrians.
- With regard to accidents on the bridge, the following issues have been raised:
Requests to upgrade/duplicate Bribie Island Bridge initiated from four crashes that occurred on the bridge during 2009 and 2010, which caused delays of up to two to three hours at a time.

According to crash records, Bribie Island has been closed seven times in the past five years. This is as a result of vehicles crashes on the bridge, with the bridge being closed for between one and four hours whilst ambulance and police attend the incidents. The predominant contributing factor of the crashes has been identified as driver undue care and attention.

Emergency management issues are as follows:

- Helipad stations are located on the island to assist in emergency situations. In the case of an emergency on the bridge, facilities can be made available to transport people via helicopters and also boats.
- Moreton Bay Regional Council chairs a Local Disaster Management Group which comprises Emergency Management Queensland, Queensland Police Service, Queensland Fire and Rescue Service, Queensland Ambulance Service, Energex, Unitywater and TMR. These organisations sit on the Local Disaster Management Group as advisory members in order to provide support services as appropriate.

3. Traffic analysis

3.1 Introduction

3.1.1 Study background

A detailed traffic modelling exercise for the area of Bribie Island immediately adjacent to the Bribie Island Bridge i.e. Bongaree, and also an assessment of the capacity of the bridge to Bribie Island, has been undertaken in agreement with TMR.

The modelling has been undertaken for a base year of 2013 and a forecast year of 2031. It has also been undertaken as a pure traffic assignment and therefore significant changes in mode share have not been considered as a part of this study.

3.1.2 Study area

Figure 1 below outlines the study area used to define the extents of the required local area modelling. The modelled area includes the strategic and local routes through the study area and was developed in consultation with TMR officers.
3.1.5 Model scenarios and horizons

For the purposes of the traffic assessment the following models have been developed:

- 2013 Base Year models
- 2031 Forecast models

The 2031 forecast model aligns with the final model year in the Moreton Bay Region Strategic Transport Model (MBRSTM), from which future year growth rates have been extracted.

3.1.6 Modelled time periods

Each model has been developed for a weekday PM peak hour and for a Sunday tourist peak hour as follows:

- PM peak – 1545-1645
- Sunday peak – 1100-1200

These peak periods were determined from the weekly volume report for the existing bridge, provided by TMR.

3.1.7 Modelled user classes

The following user classes have been included in the modelling:

- Private vehicles (PVs)
- Commercial vehicles (CVs)
3.2 Modelling methodology and approach

3.2.1 Introduction

The modelling developed for the study utilises a two-tier approach incorporating mesoscopic and microsimulation modelling. This consists of a mesoscopic VISUM model that assesses the trip distribution and route choice in the area and which feeds into a microscopic VISSIM model.

Figure 2 Summary of two tier modelling hierarchy

3.2.2 Model network methodology

Study area mesoscopic modelling

GHD have developed mesoscopic modelling for the study area that incorporates explicit intersection delay calculation using the ICA functionality within the software together with link delay functions on key strategic routes. The purpose of this tier of the modelling hierarchy is to provide an accurate traffic distribution throughout the study area based on realistic and accurate intersection and link delay.

Local area microsimulation modelling

The traffic volumes and distributions simulated in the GHD mesoscopic VISUM models have subsequently been exported to microscopic VISSIM models also developed by GHD. The purpose of the VISSIM models is to provide a detailed and accurate assessment of the performance of each intersection within the study area. The models provide a statistical and visual demonstration of the efficiency of the local area network.

3.3 Trip matrix development

The development of base year model trip matrices for the project has been undertaken using a recent set of turning count survey data. Forecast year trip matrices have then been developed by selectively factoring origin-destination cells up based upon strategic modelling and land use forecasts. The development of base year and future year trip matrices is outlined in more detail in the following sections of the report.

3.3.1 2013 Base year matrices

To assist in the development of the base year trip matrices, turning count survey data was collected for the PM and Sunday peak hours at nine intersection locations within the study area on Thursday 14 and Sunday 17 March 2013. The data was disaggregated into 15 minute time periods and PV and CV user classes.

The following locations were surveyed, numbered as shown in Figure 3 below:

1. Bibimulya Street/Sylvan Beach Esplanade
2. Bibimulya Street/Eucalypt Street
3. Bribie Island Road/Welsby Parade/Sylvan Beach Esplanade
4. Bribie Island Road/Ferguson Avenue/Eucalypt Street
5. Bribie Island Road/ Neenuk Street
6. Bribie Island Road/Charlotte Avenue
7. Charlotte Avenue/Welsby Parade
8. Ferguson Avenue/Winston Drive
9. Benabrow Avenue/Centre car park

Figure 3  Turning count survey locations

This extensive data collection exercise allowed for the manual development of a detailed trip matrix for each user class in each of the PM and Sunday peak hours. A summary of the base year matrix totals is presented in Table 1 below.

Table 1  2013 Base year trip matrix totals

<table>
<thead>
<tr>
<th>Day</th>
<th>Time period</th>
<th>PV trips</th>
<th>CV trips</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thurs 14 March</td>
<td>PM Peak</td>
<td>2547</td>
<td>51</td>
<td>2598</td>
</tr>
<tr>
<td>Sun 17 March</td>
<td>Sunday Peak</td>
<td>3044</td>
<td>22</td>
<td>3066</td>
</tr>
</tbody>
</table>

The base year models were calibrated using the turning count survey data to ensure that the traffic volumes at each location were representative of existing on-site conditions. Table 2 below provides a summary of the turning count calibration for each user class in each time period. Industry guidelines for calibration of microsimulation models require that at least 85% of observations have a GEH value less than five. The results show that the models are well within the required thresholds.
Table 2  Base year model calibration summary

<table>
<thead>
<tr>
<th>Time period and user class</th>
<th>Number of observations</th>
<th>Percentage of observations with GEH &lt; 5</th>
<th>Percentage of observations with GEH &lt; 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM Peak PVs</td>
<td>79</td>
<td>100.0 %</td>
<td>92.4 %</td>
</tr>
<tr>
<td>PM Peak CVs</td>
<td>79</td>
<td>100.0 %</td>
<td>100.0 %</td>
</tr>
<tr>
<td>Sunday Peak PVs</td>
<td>79</td>
<td>98.7 %</td>
<td>91.1 %</td>
</tr>
<tr>
<td>Sunday Peak CVs</td>
<td>79</td>
<td>100.0 %</td>
<td>100.0 %</td>
</tr>
</tbody>
</table>

Note that the base year trip matrices were profiled into 15 minute periods such that the ‘peakiness’ within the one hour time periods could be included within the model assessment. The profiling was developed using the turning count data to provide factors at key entry and exit locations to the model network.

3.3.2  2031 Forecast year matrices

Once the 2013 base year trip matrices had been developed for the VISUM/VISSIM models it was then possible to use these as a base point from which to forecast future year trip matrices.

A number of different datasets were used to inform the traffic forecasting process including:

- 2031 MBRSTM outputs for Bribie Island area
- 2031 MBRSTM outputs for Caboolture area
- Expected residential growth on Bribie Island to 2031

The PM peak and Sunday peak trip matrices were developed using different methodologies as they represent different types of traffic peaks (i.e. commuter and tourist peaks). Further, the MBRSTM strategic models do not provide output for Sunday time periods and could therefore not be used for that purpose.

2031 PM peak matrix development

The development of the PM peak 2031 traffic forecast analysed the predicted growth in traffic volumes from the strategic MBRSTM for three separate trip types. These were as follows:

- Trips entering the island via the Bribie Island Bridge
- Trips exiting the island via the Bribie Island Bridge
- All other intra-island trips

The relevant growth rates were calculated from the MBRSTM and it was agreed with TMR that they should be adopted under the proviso that they met or exceeded a minimum growth rate defined by the forecast growth in dwellings to 2031, assumed in the MBRSTM. Data provided by MBRC showed that the model assumes an additional 8.8 % dwellings on the island by 2031, so the following growth rates were applied to the base year PM peak matrices to generate the 2031 PM peak matrices.

Table 3  PM peak adopted growth rates (2013-2031)

<table>
<thead>
<tr>
<th></th>
<th>MBRSTM calculated trip growth rate</th>
<th>Residential growth forecast</th>
<th>Adopted trip growth rate for study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trips entering island</td>
<td>2.3 %</td>
<td>8.8 %</td>
<td>8.8 %</td>
</tr>
<tr>
<td>Trips exiting island</td>
<td>20.6 %</td>
<td>8.8 %</td>
<td>20.6 %</td>
</tr>
<tr>
<td>Intra-island trips</td>
<td>-1.2 %</td>
<td>8.8 %</td>
<td>8.8 %</td>
</tr>
</tbody>
</table>
**2031 Sunday peak matrix development**

Since the Sunday peak is driven to a more significant extent by tourist traffic than the PM commuter peak, a different approach was required. The MBRSTM could not be utilised as it does not simulate weekend traffic volumes. Further, a global 8.8% traffic increase based upon the forecast island residential growth would not account for the influx of tourist traffic generated by nearby conurbations (and further afield).

In consultation with TMR it was decided that traffic using the Bribie Island Bridge to access the island should be factored up using a growth rate in line with the AM and PM peak forecast traffic growth for the wider Caboolture area. These growth factors would give an indication of the expected growth in population and travel activity in the largest nearby conurbation. This was considered to be a reasonable estimate of growth in local tourist traffic to destinations such as Bribie Island on weekends.

An assessment of the MBRSTM models showed that generally traffic volumes in the wider Caboolture area (excluding through traffic) increased by 50%-65% in the commuter peaks to the year 2031. This growth was cross-referenced against local council forecast land-use data which suggested a growth of the order of 50% to 2031 (MBRC website showing population projections for Caboolture). It was therefore agreed with TMR to adopt a growth of 50% for trips using the Bribie Island Bridge to 2031, and 8.8% for intra-island trips for the Sunday peak model.

**Table 4  Sunday peak adopted growth rates (2013-2031)**

<table>
<thead>
<tr>
<th></th>
<th>Adopted rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trips entering island</td>
<td>50%</td>
</tr>
<tr>
<td>Trips exiting island</td>
<td>50%</td>
</tr>
<tr>
<td>Intra-island trips</td>
<td>8.8%</td>
</tr>
</tbody>
</table>

**2031 Matrix development summary**

The development of traffic forecasts for the year 2031 has used different methodologies for each of the PM and Sunday peaks. The methodology used in each case has been dependent upon the available strategic traffic modelling data and other land use data that is relevant to the time period in question. Figure 4 below shows the change in traffic volumes network-wide between 2013 and 2031 from each time period and each user class.
3.4 2031 Network layout

3.4.1 Bribie Island Bridge capacity

The demand forecasting models developed do not apply capacity constraint so a true forecast of travel demand is derived. An initial assessment was made of the forecast traffic volumes developed for the study to the year 2031. Since the bridge itself operates in a free-flow manner, the practical capacity for it has been determined using the Highway Capacity Manual (HCM 2000) estimates for the capacity of a two lane highway (1700pcus/hr/lane). The forecast 2031 traffic volumes, as well as the current peak hour volumes for the bridge structure are shown in pcus in Table 5 below for the PM and Sunday peak hours.

Table 5  Directional traffic forecasts (in pcus) for Bribie Island Bridge

<table>
<thead>
<tr>
<th></th>
<th>2013 To Island</th>
<th>2013 From Island</th>
<th>2031 To Island</th>
<th>2031 From Island</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM peak hour</td>
<td>1128</td>
<td>812</td>
<td>1227</td>
<td>980</td>
</tr>
<tr>
<td>Sunday peak hour</td>
<td>1294</td>
<td>927</td>
<td>1941</td>
<td>1390</td>
</tr>
</tbody>
</table>

Table 5 indicates that the 2031 Sunday peak hour traffic forecast of 1941 pcus exceeds the practical capacity of a two lane bridge for trips travelling in the direction of the island.

Further to the analysis undertaken above it should be noted that the growth rates for traffic using the bridge structure in the PM peak have been adopted from the MBRSTM strategic modelling. This modelling currently assumes a linear island residential growth rate of 8.8 % to 2031. However, a number of other growth forecasts have been provided by MBRC for comparison purposes. The Priority Infrastructure Plans Planning Scheme Policy (PIP PSP) provides a projected increase in dwellings of 37 % by 2031. It may therefore be prudent to assume the possibility of an upward revision of residential growth on the island at some stage in the future and therefore ensure that adequate capacity is provided i.e. a four lane bridge in the longer term.
3.4.2 Summary of network changes

The proposed upgrades associated with planning for the Bribie Island Bridge upgrade are as follows:

- New Bribie Island Bridge to north of existing bridge (existing bridge to be closed to vehicular traffic)
- Upgrade of left-in / left-out intersections of Bribie Island Road with Welsby Parade and Sylvan Beach Esplanade
- Closure of existing Bribie Island Road / Winston Drive intersection (cul-de-sac to be provided)

Figure 5 shows the proposed upgrades to the network as outlined above. Note that a four-lane bridge solution is shown in the figure.

Figure 5 Sketch layout showing proposed 2031 network upgrades

3.5 2031 Model output

3.5.1 Bridge volume summary

Table 6 below shows the current 2013 and expected 2031 traffic volumes using the Bribie Island Bridge based upon the survey data and the traffic forecasting process.

Table 6 Bribie Island Bridge traffic volumes (2013 and 2031)

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Year</th>
<th>Direction of travel</th>
<th>PVs</th>
<th>CVS</th>
<th>Total veh</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM Peak</td>
<td>2013</td>
<td>To island</td>
<td>1065</td>
<td>25</td>
<td>1090</td>
</tr>
<tr>
<td></td>
<td>2013</td>
<td>From island</td>
<td>766</td>
<td>18</td>
<td>784</td>
</tr>
<tr>
<td></td>
<td>2031</td>
<td>To island</td>
<td>1159</td>
<td>27</td>
<td>1186</td>
</tr>
<tr>
<td></td>
<td>2031</td>
<td>From island</td>
<td>924</td>
<td>22</td>
<td>946</td>
</tr>
<tr>
<td>Sunday Peak</td>
<td>2013</td>
<td>To island</td>
<td>1265</td>
<td>11</td>
<td>1276</td>
</tr>
</tbody>
</table>
### 3.5.2 Network volume summary

Table 7 below provides traffic volumes for each scenario for some key network locations.

**Table 7  Key network link traffic volumes (2013 and 2031)**

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Year</th>
<th>Direction of travel</th>
<th>PVs</th>
<th>CVs</th>
<th>Total veh</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2013</td>
<td>From island</td>
<td>907</td>
<td>8</td>
<td>915</td>
</tr>
<tr>
<td></td>
<td>2031</td>
<td>To island</td>
<td>1898</td>
<td>17</td>
<td>1915</td>
</tr>
<tr>
<td></td>
<td>2031</td>
<td>From island</td>
<td>1360</td>
<td>12</td>
<td>1372</td>
</tr>
</tbody>
</table>

#### 3.5.3 PM Peak level of service and queue length summary

Figure 6 and Figure 7 below show summarised model outputs for the 2013 and 2031 PM peak models. The level of service for each approach and intersection along the Bribie Island Road corridor is shown together with the maximum and 95th percentile queue lengths.

**Figure 6  Level of service and 95th percentile queues for 2013 PM peak**
Figure 6 and Figure 7 show that the Bribie Island Road corridor operates at an efficient level of service ‘A’ in both of the 2013 and 2031 PM peak periods. The infrastructure provided in each scenario is adequate to accommodate the forecast traffic volumes in both instances. Maximum queues of up to 52 m are noted on the key Bribie Island Road and Benabrow Avenue approaches to the Eucalypt Street roundabout with 95th percentile queues being up to 24 m in length. A full analysis of level of service (by turning movement) is provided in Table 8 as follows:

### Table 8  PM Peak 2031 level of service data

<table>
<thead>
<tr>
<th>Approach</th>
<th>Movement</th>
<th>Volume (veh)</th>
<th>Average delay (s)</th>
<th>Level of service</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Benabrow Drive</strong></td>
<td>Through Movement</td>
<td>648</td>
<td>6.5</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Right Turn 1</td>
<td>0</td>
<td>0.0</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Right Turn 2</td>
<td>85</td>
<td>7.0</td>
<td>A</td>
</tr>
<tr>
<td><strong>Ferguson Avenue</strong></td>
<td>Left Turn 1</td>
<td>0</td>
<td>0.0</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Left Turn 2</td>
<td>0</td>
<td>0.0</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Through Movement</td>
<td>55</td>
<td>12.1</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Right Turn</td>
<td>50</td>
<td>12.4</td>
<td>A</td>
</tr>
<tr>
<td><strong>Bribie Island Road</strong></td>
<td>Left Turn 1</td>
<td>8</td>
<td>4.1</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Left Turn 2</td>
<td>93</td>
<td>3.3</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Through Movement</td>
<td>714</td>
<td>3.8</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>U-turn</td>
<td>348</td>
<td>5.4</td>
<td>A</td>
</tr>
<tr>
<td><strong>Diagonal Approach</strong></td>
<td>Left Turn</td>
<td>4.6</td>
<td>1.3</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Through Movement</td>
<td>3.4</td>
<td>15.0</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Right Turn</td>
<td>3.8</td>
<td>22.2</td>
<td>B</td>
</tr>
<tr>
<td><strong>Eucalypt Street</strong></td>
<td>Left Turn</td>
<td>58</td>
<td>14.8</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Right Turn 1</td>
<td>106</td>
<td>16.5</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>Right Turn 2</td>
<td>3.2</td>
<td>23.7</td>
<td>B</td>
</tr>
<tr>
<td><strong>AVERAGE</strong></td>
<td></td>
<td>2184</td>
<td>6.3</td>
<td>A</td>
</tr>
</tbody>
</table>
### 3.5.4 Sunday peak level of service and queue length summary

Figure 8 and Figure 9 below show summarised model outputs for the 2013 and 2031 Sunday peak models. The level of service for each approach and intersection along the Bribie Island Road corridor is shown together with the maximum and 95th percentile queue lengths.

**Figure 8** Level of service and 95th percentile queues for 2013 Sunday peak

Figure 8 and Figure 9 show that the operation of the Bribie Island Road corridor will be significantly impacted by the growth in traffic to 2031 in the Sunday peak period. The performance of the large
roundabout at Eucalypt Street drops from ‘A’ to ‘C’ with a number of key approaches showing levels of service in the ‘D’ to ‘F’ range. Queue lengths are significant with queues on the key Bribie Island Road and Benabrow Drive approaches having maximum values of 435 m and 395 m. The equivalent 95th percentile queue length values are 183 m and 248 m. A full analysis of level of service (by turning movement) is provided in Table 9 as follows.

**Table 9 Sunday peak 2031 level of service data**

<table>
<thead>
<tr>
<th>Approach</th>
<th>Movement</th>
<th>Volume (veh)</th>
<th>Average delay (s)</th>
<th>Level of service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eucalypt Street/Bribie Island Road/Benabrow Drive Roundabout</td>
<td>Through Movement</td>
<td>827</td>
<td>51.7</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Right Turn 1</td>
<td>5</td>
<td>55.4</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Right Turn 2</td>
<td>106</td>
<td>52.3</td>
<td>D</td>
</tr>
<tr>
<td>Ferguson Avenue</td>
<td>Left Turn 1</td>
<td>0</td>
<td>0.0</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Left Turn 2</td>
<td>3</td>
<td>154.4</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Through Movement</td>
<td>67</td>
<td>158.9</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Right Turn</td>
<td>54</td>
<td>152.5</td>
<td>F</td>
</tr>
<tr>
<td>Bribie Island Road</td>
<td>Left Turn 1</td>
<td>11</td>
<td>10.8</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Left Turn 2</td>
<td>16</td>
<td>11.8</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Through Movement</td>
<td>1135</td>
<td>14.5</td>
<td>B</td>
</tr>
<tr>
<td></td>
<td>U-turn</td>
<td>624</td>
<td>21.2</td>
<td>B</td>
</tr>
<tr>
<td>Diagonal Approach</td>
<td>Left Turn</td>
<td>4</td>
<td>8.4</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Through Movement</td>
<td>4</td>
<td>71.6</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Right Turn</td>
<td>6</td>
<td>76.5</td>
<td>F</td>
</tr>
<tr>
<td>Eucalypt Street</td>
<td>Left Turn</td>
<td>61</td>
<td>70.6</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Right Turn 1</td>
<td>82</td>
<td>76.5</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>Right Turn 2</td>
<td>4</td>
<td>56.7</td>
<td>E</td>
</tr>
<tr>
<td>AVERAGE</td>
<td>ALL</td>
<td>3008</td>
<td>36.4</td>
<td>C</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Bribie Island Road/Sylvan Beach Esplanade/Welsby Parade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approach</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>Welsby Parade</td>
</tr>
<tr>
<td>Sylvan Beach Esplanade</td>
</tr>
<tr>
<td>AVERAGE</td>
</tr>
</tbody>
</table>

Since the Bribie Island Road approach carries large volumes of traffic it is extremely sensitive to the volume of conflicting traffic turning right from Benabrow Avenue or from Ferguson Avenue. Whilst the modelling shows a level of service ‘B’ for the Bribie Island Road approach, the lengthy associated maximum queues indicate the speed with which congestion can develop and dissipate on this approach as conflicting traffic blocks access to the roundabout.
Another key issue at the roundabout is the number of vehicles on Bribie Island Road that use the roundabout to undertake a U-turn to access Welsby Parade. In the Sunday peak hour approximately 650 vehicles will undertake this manoeuvre and this causes significant issues for traffic on the Benabrow Avenue and Ferguson Avenue approaches since it conflicts with these movements.

Elsewhere, the Sylvan Beach Esplanade approach to Bribie Island Road operates at a level of service of ‘B’ and has maximum queues of up to 236 m. The Welsby Parade approach has a level of service ‘A’ but occasionally queues in excess of 90 m will form. The issue at these two locations is essentially the lack of gaps between traffic on the Bribie Island Road preventing vehicles on the side road from accessing Bribie Island Road.

It is also worth noting that the queues and delays on Bribie Island Road approaching the large roundabout cause a slight redistribution in traffic. This leads to additional traffic turning left onto Sylvan Beach Esplanade from Bribie Island Road just after the bridge in order to avoid the queues at the downstream roundabout. This generally affects trips that would have turned left at the roundabout and amounts to approximately 150 vehicles in the hour.
3.6 Summary of modelling

A summary of the approach and results of the modelling undertaken are as follows:

- GHD have developed 2013 base year models for the study area for the PM peak (1545-1645) and Sunday peak (1100-1200) time periods.
- Traffic forecasts for the study area for the year 2031 have been developed in consultation with TMR using the MBRSTM strategic models, local and wider area land use projections and assumptions on future land use.
- The traffic forecasts showed a more significant increase in traffic for the Sunday peak period than for the PM peak period.
- Traffic models were assigned for the 2031 forecasts incorporating a revised bridge structure and associated network.
- The models showed that generally in the 2031 PM peak period the traffic network will operate adequately and at a level of service of ‘A’ to ‘B’.
- The 2031 Sunday peak models showed that the four lane bridge structure and associated intersections would work adequately but the roundabout at Eucalypt Street would be under heavily congested conditions at times, with an overall level of service of ‘C’ but with a number of approaches operating at levels of service from ‘D’ to ‘F’.
- Extensive queues will build up during the Sunday peak period in 2031, particularly along Benabrow Drive and Bribie Island Road, the former being exacerbated by the significant volume of vehicles performing a U-turn at the roundabout.

3.7 Recommendations for future modelling

The 2031 Sunday peak models showed that the roundabout at Eucalypt Street would be under heavily congested conditions at times. Whilst not a part of the initial brief, some thought has been given to resolving the Sunday peak hour issues demonstrated earlier in this report, as follows:

3.7.1 Signalisation of Eucalypt Street roundabout

The large roundabout at Eucalypt Street could be redeveloped as a large signalised intersection to accommodate the heavy traffic volumes in 2031. This would have the additional benefit of the provision of pedestrian facilities but would require a large footprint to account for the significant traffic flows on several of the approaches. Additionally the heavy U-turn movement on Bribie Island Road would require accommodating, which would further increase the size and complexity of the intersection.

3.7.2 Added right turn into Welsby Parade

A brief modelling test was undertaken to assess the benefits of providing a right turn from Bribie Island Road into Welsby Parade. This has the impact of removing many of the u-turning vehicles from the Eucalypt Street roundabout since many of these vehicles use the bridge to access the island and then ‘double back’ at the roundabout to head south along Welsby Parade. The brief modelling test showed that the successful implementation of this right turn into Welsby Parade would actually return the Eucalypt Street roundabout to a level of service ‘A’ or ‘B’. Further work would be required for this option from both a traffic modelling and an engineering perspective (i.e. additional bridge structure required) to confirm if this is feasible.

3.7.3 All movements intersection at Welsby Parade

Even more benefit could likely be accrued at the Eucalypt Street roundabout by providing an all movements intersection at the Welsby Parade intersection. This would allow the north to south movement of traffic across Bribie Island Road without the requirement to use the Eucalypt Street...
roundabout. No modelling has been undertaken for this work and it is therefore not clear whether a signalised intersection or a roundabout would be able to accommodate the expected traffic volumes. Further, the benefits accrued at Eucalypt Street roundabout might be offset by the additional delay caused by the new Welsby Parade intersection.

4. **Bridge analysis**

4.1 **Background**

The existing Bribie Island Bridge was constructed in 1963 and was designed with a 75 year design life, leaving a residual life of approximately 25 years (i.e. 2038), subject to ongoing maintenance being undertaken.

The existing bridge is 835 m long, and is a two lane single carriageway bridge with a narrow pedestrian walkway. The bridge has 38 spans which are typically 22 m in length and crosses the marine inlet and tidal waterway. The spans between piers 18, 19 and 20 provide for the main navigation channel and have navigation lights fitted mid-span to indicate the channel. The substructure at each pier compromises 5 no 550 mm hexagonal precast driven piles, with 3 no vertically and 2no raked at 1 in 4, at each pier location.

TMR Bridge Branch carried out a study into various options for improving pedestrian and cycle access on Bribie Island Bridge in June 2011. This report reviewed seven options summarised briefly as follows:

1. Three options involved incorporating or adapting the existing bridge – These were not recommended for further study due to the structural inadequacy of the existing bridge for accommodating additional loads from a widening or adapting the existing bridge, and to cater for increased lateral loads in line with the current bridge standards.

2. Four options that involved the construction of an adjacent new bridge – These were considered as viable and only varied in terms of future proofing the bridge through providing a sufficient number of lanes to accommodate future traffic growth.

Accordingly therefore this commission has considered options that require a separate new bridge. The existing bridge may be retained for use as a pedestrian/cycle facility and to continue to be used as a service corridor. Continued use of the bridge will be subject to an appropriate ongoing maintenance regime.

4.2 **Options considered**

4.2.1 **Summary**

The options reviewed include the following:

1. 22 m span deck unit bridge (2 lane bridge with 4 m cycleway)
2. 22 m span Super Tee bridge (2 lane bridge with 4 m cycleway)
3. 44 m span box girder bridge (2 lane bridge with 4 m cycleway)
4. Option’s 1 and 2 as above, but as a 4 lane bridge with 4 m cycleway

The setting of the proposed spans as a function of the existing bridge, i.e. 22 m or 44 m is based on the requirements of the Road Planning and Design Manual (RPDM), Chapter 22, Clause 22.2.6, Bridges over Waterway, which states the following:

*New Bridges are invariably designed to a standard equal to or higher than that of existing bridges, in terms of total waterway area and heights. An extremely rare occasion may arise where a span or spans shorter than existing one may be justified in non-tidal waters, but never in tidal waters.*
Therefore any new bridge should at a minimum match the existing navigational channel and spans, with consideration also given to the potential to affect the flow characteristics past the existing piers due to the presence of new piers being adjacent to the old piers. This could lead to an increased potential for scour for the existing piers. Spans of 22 m and 44 m have been chosen to line up with existing piers. Section 4.3.6 provides further comment on the interaction and the hydraulic behaviour between piers.

### 4.2.2 Option 1 – 22 m span deck unit bridge

The existing bridge spans of 22 m between piers could be replicated with the use of standard deck units on elastomeric strip bearings, with provision for replacement of bearings and expansion joints at regular intervals.

However the required design life for the bridge in a marine environment has implications for whether or not deck units could be used. Further comment is provided in section 4.5. on durability and design life considerations.

2 no 1.5 m diameter cast-in-place piles with 1.2 m diameter concrete pier columns, and a reinforced concrete headstock, would be a likely sub-structure for this option.

### 4.2.3 Option 2 – 22 m span Super Tee bridge

An open top Super Tee girder option would utilise the same pier spacing as Option 1 since it is not possible to achieve a 44 m span with this beam type.

Similar to the Ted Smout Bridge, Super Tees would be seated on laminated elastomeric bearings, tied down at the pier positions with expansion joints at regular intervals.

2 no 1.5 m diameter cast-in-place piles with 1.2 m diameter concrete pier columns, and a reinforced concrete headstock, would be a likely sub-structure for this option.

### 4.2.4 Option 3 – 44 m span box girder bridge

A constant depth precast segmental post-tensioned concrete box girder option with 44 m spans to line up with the existing piers is proposed for this option. This would require a structure depth of approximately 2.4 m.

A structure of this depth may complicate vertical alignment tie-ins at either end of the bridge, including the requirement to make provision for a cycleway under each bridge abutment.

The maximum axial load may result in only 2 number 1.5 m diameter cast in place piles being required. However, it is possible that a pile group arrangement would be required to cater for the additional bending effects resulting from longitudinal and lateral loads which would be considered in the detailed design stage. The super-structure would be cast monolithically with the sub-structure except at expansion joint locations.

### 4.2.5 Option 4 – Four lane versions of Options 1 and 2

With regard to discussion in section 3 on the future traffic capacity requirements of the bridge, 4 lane versions of the Options 1 and 2 have been considered, utilising deck units and Super Tee’s respectively.

These options will require 4 no 1.5 m diameter cast-in-place piles with 1.2 m diameter concrete pier columns, and a reinforced concrete headstock, as a likely sub-structure.
4.2.6  Alternative span lengths for Options 1, 2 and 4

A possible alternative span length could potentially be adopted subject to confirming the hydraulic and scour effect of offsetting the proposed piers in relation to the existing piers.

A longer span length of up to 33 m could be considered. This would allow the use of open top Super Tee’s (as per Option 2) with every third existing pier lining up with every second pier on the proposed bridge (as shown in the sketch below). Utilising this arrangement, the navigation channel span could be potentially increased for this option, allowing for a scenario in the future if the existing bridge were to be demolished.

4.2.7  Span options at navigation channel

Where 1.5 m diameter cast-in-place piles with 1.2 m diameter concrete pier columns are proposed with a 22 m span, a reduced navigation span will result as the piles on the existing bridge are 550 mm hexagonal precast driven. This would result in an encroachment of 475 mm either side of the sub-structure into the navigational channel, i.e. reducing the clear span by 950 mm.

To accommodate this, it is suggested that the spans over the existing navigational channel are increased by a total of 950 mm from 22 m, to 22.95 m.

4.3  Bridge location

4.3.1  Lateral positions considered

Offsets between the existing bridge and new bridge of 30 m and 15 m have been considered.

The 30 m offset is based on a preference which has been expressed by TMR Bridge Branch for the new Bribie Island Bridge. This 30 m is similar in extent to the offset adopted for the Ted Smout Bridge, which was 35 m.

A 15 m offset has been considered as this may reduce impacts on property and existing services at either end of the bridge, to the extent that a 15 m offset would provide significant benefits over a 30 m offset. This is further discussed in section 8 of this report.

4.3.2  Ted Smout Bridge position

It is understood the alignment of the Ted Smout Memorial Bridge was initially planned to be between the existing Houghton Highway (1979) and the (now demolished) Hornibrook Highway (1935). However the alignment was moved to the east of the Houghton Highway Bridge for several reasons including safety during piling operations, as well as the implications of a Hurricane Katrina-like event potentially lifting decks from the Houghton Highway and depositing them against the Ted Smout Memorial Bridge.

The Ted Smout Bridge was constructed using a temporary falsework bridge of approximately 12m wide. This was positioned to the east of the new bridge, thus moving cranage operations further away from the existing Houghton Highway Bridge. The piers were then built from this falsework bridge which provided enough room to allow for cranes and piling rigs. An overhead gantry was utilised to install the beams on the new bridge, and sufficient clear-width maintained on the already-constructed part of the new bridge for transporting materials from storage areas to point of use. Based on this construction methodology, it could be assumed that, but for the potential hurricane concerns, the offset adopted could have realistically been much less than the 35 m chosen.
4.3.3 Other bridges

There are many situations where new bridges have been constructed adjacent to existing bridges with a minimal offset, much closer than the 30 m currently being proposed. Two recent examples that GHD have designed and have been involved with are:

- Forgan Bridge Duplication and Replacement Project – The offset between the piers for Stage 1 construction of the new bridge and the original Forgan Bridge varied from a minimum of just over 2 m. A temporary piled platform was constructed in front of the new Stage 1 Bridge, installing the piles with the permanent structure following from behind. The beams were installed from the preceding spans using cranes.

- Port of Brisbane Motorway Upgrade (POBMu) – The bridges on the POBMu were constructed adjacent to the existing Port Motorway. The new Oxbow Viaduct was offset by a maximum of 1.2 m from the face of the existing bridge, this dimension being influenced by the presence of existing services strapped to the side of the bridge. In the case of the bridges on POBMu, there were no laterally raking piers.

In both cases above, any failure of the temporary works with the potential for piles dropping onto the existing infrastructure was a risk. Possible consequences could have been significant delays to traffic flows and safety risk to the travelling public, as would be the case with the existing Bribie Island Bridge, although noting there is no alternative route to and from Bribie Island apart from the existing bridge.

4.3.4 Preferred lateral position

Factors to consider in choosing an offset for a new Bribie Island Bridge are the implementation and control of safe work methods and practices to ensure construction operations can occur with no impact on the existing infrastructure, particularly the existing raking piers.

Risks in damaging the raking piers can be minimised through the adoption of an appropriate offset from the lateral toe position of the external raking piles, based on an estimated toe depth and allowing for a further safe distance to minimise impacts on existing piles due to driving steel liners.

The existing raked piles appear to be at an angle of 4 vertical to 1 horizontal. As reported in the TMR's June 2011 footpath/cycleway options investigation, the maximum offset to the toe of the raked piles is estimated to be 5.5 m beyond the headstock. It is therefore suggested that the new bridge deck should be between 10 to 20 m from the existing bridge deck to reduce the risk of impact on existing piles.

It is recommended that construction methodology adopted should include the use of a temporary falsework bridge, either similar to Ted Smout Bridge where the falsework bridge was adjacent to the new bridge, or for bridges on Port of Brisbane Motorway Upgrade and Forgan Bridge, where the temporary falsework bridges were in advance of the newly constructed bridge. In addition to the use of a falsework bridge, the adoption of safe work methods with additional fail safe mechanisms should be put in place. For example, as there is about 10 m of water depth in Pumicestone Channel, a cradle could be used to help in swinging piles from the horizontal to the vertical, while maximising the amount of pile length under the water.

Adopting an offset of 15 m from the existing bridge to the new bridge, with a further 3 m offset to a 12 m wide temporary falsework bridge, will provide the following overall dimensions:

- 15 m offset from the existing to the proposed bridge
- Maximum 24 m wide proposed bridge
- 3 m offset to a 12 m temporary wide bridge

These dimensions would result in a 42 m offset from the existing bridge to the temporary bridge, thus providing adequate separation for safe lifting and piling operations. Once the piles are in place the beams can be installed with an overhead gantry arrangement on the new bridge structure.
The actual offset adopted for the implementation phase of the bridge duplication is recommended to be the subject of further pro-active discussion between designer, contractor, piling specialists, stakeholders and TMR, during subsequent development phases.

4.3.5 Preferred vertical position

A possible soffit level of a new bridge, with consideration to climate change and wave surge, has been determined based on the following methodology:

- Results of the “Storm Tide Hazard Study” report prepared for Moreton Bay Regional Council by Cardno LawsonTreloar (2009), which provides non-cyclonic (broadscale) and cyclonic design storm tide levels at the site of the proposed structure

- A technique for probabilistically combining the two storm tide levels from the above study (Gomes and Vickery 1977)

- An estimate of the height of the maximum possible wave crest at the site of the proposed structure

- Allowances for freeboard or air gap of 0.5 m above the wave crest level.

The results of the analysis are presented in Table 8 below, for the two sites identified as MBC-059 and MBC-062 in Cardno LawsonTreloar report, and which are located in the vicinity of the proposed structure.

<table>
<thead>
<tr>
<th>Site identifier</th>
<th>Combined design water level without wave setup (m)</th>
<th>Significant wave height (m)</th>
<th>Wave period (s)</th>
<th>Assumed average depth to chart datum (m)</th>
<th>Estimated averaged depth to MSL (m)</th>
<th>Maximum wave crest (m)</th>
<th>Height above MSL at specified location (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MBC-059</td>
<td>2.94</td>
<td>1.49</td>
<td>3.03</td>
<td>9.8</td>
<td>10.90</td>
<td>1.26</td>
<td>4.70</td>
</tr>
<tr>
<td>MBC-062</td>
<td>2.92</td>
<td>1.09</td>
<td>2.79</td>
<td>2.8</td>
<td>3.90</td>
<td>0.90</td>
<td>4.32</td>
</tr>
</tbody>
</table>

The adopted design sea-state corresponds to the 2000y ARI and includes the effects of sea level rise. Projected sea level rise is estimated at 0.8m by 2090 due to climate change (relative to 1990, Queensland Coastal Plan 2012). Figure 12 below illustrates the key parameters involved in the analysis (site MBC-059).
Semidiurnal tidal planes at Bongaree (2013), the location closest to the proposed structure where tidal levels are published, have been obtained from Maritime Safety Queensland and are provided in Table 11 as follows:

Table 11  Semidiurnal tidal planes

<table>
<thead>
<tr>
<th>Tidal Plane</th>
<th>Level (m LAT)</th>
<th>Level (m AHD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest Astronomical Tide</td>
<td>2.35</td>
<td>1.25</td>
</tr>
<tr>
<td>Mean High Water Spring</td>
<td>1.87</td>
<td>0.77</td>
</tr>
<tr>
<td>Mean High Water Neap</td>
<td>1.53</td>
<td>0.43</td>
</tr>
<tr>
<td>Mean Sea Level</td>
<td>1.06</td>
<td>-0.04</td>
</tr>
<tr>
<td>Mean Low Neap Water</td>
<td>0.65</td>
<td>-0.45</td>
</tr>
<tr>
<td>Mean Low Water Spring</td>
<td>0.32</td>
<td>-0.78</td>
</tr>
<tr>
<td>Lowest Astronomical Tide</td>
<td>0</td>
<td>-1.10</td>
</tr>
</tbody>
</table>

The assumed soffit of 4.70 m indicated in Figure 12 above equates to 3.45 m HAT. It is understood that the existing bridge is at 4.80 m HAT. Thus it can be concluded that if the new bridge soffit level is no lower than the existing bridge soffit level (to maintain existing vertical navigational clearance), the new bridge will be sufficiently protected from any potential climate change and wave surge impacts.
4.3.6 Interaction and the hydraulic behaviour between piers

There are implications for constructing the proposed bridge adjacent to the existing bridge, in terms of interaction and the hydraulic behaviour between the piers, although there appears to be no readily available data that could be applied directly to determine design currents. Hydrodynamic and sediment transport models cover the area of interest and as such could be used to provide a solid platform for analysis. These have been operated for projects involving hydrodynamic analysis and cover the Pumicestone passage at high resolution thus could be used to predict tidal currents combined with day-to-day wave climate.

As currents associated with tropical cyclone conditions are the primary concern, models could be used to simulate a tropical cyclone scenario reconstructed from the Cardno LT study and determine appropriate design currents as well as investigating the interaction between adjacent piers (new and existing bridge).

Additionally, it is suggested that physical modelling be carried out in subsequent project phases to determine the scour effects on the existing bridge piers as a result of the change in hydraulic effects, due to the proximity and pier positions of the new bridge.

4.4 Durability

4.4.1 Design life

In accordance with AS5100 and TMR document, Design Criteria for Bridges and Other Structures, the design life for bridges is normally 100 years, with components that are capable of being replaced, having a reduced life span. Some structures of significance have been designed in recent years with a 300 year design life, e.g. the new Gateway Bridge in Brisbane. However as this post-tensioned box girder structure is 75 m in the air, the consequential higher routine and long term maintenance costs would support a longer design life being adopted.

It is understood that the design life for the Ted Smout Bridge was 100 years. Therefore it would be assumed a design life of 100 years for a new Bribie Island Bridge would be appropriate. If a design life of greater than 100 years is required, the design and specifications for the project will likely involve non-standard solutions, and would include departures from TMR’s concrete specification MRTS70.

4.4.2 Improving design life

The following comments relate to issues associated with meeting, or improving upon, the required design life, for consideration in subsequent project phases:

Cover to reinforcement

Increasing cover prolongs the time for deleterious agents, such as chlorides, to reach the steel reinforcement and initiate corrosion. There is however a number of drawbacks associated with increased cover. Increasing cover for pre-cast prestressed elements presents several difficulties. These elements typically employ standard spacing of strand and reinforcing which is linked to manufacturers work methods and standard forms used in the pre-casting beds. Altering these is difficult and is dependent on the pre-casters manufacturing new stop ends and forms, which will impact on the overall cost.

Furthermore, with the pre-cast elements, a small increase in cover can have a significant effect on the design resulting in potential need for increasing the overall section size or in the case of 550 octagonal piles, increasing the number of piles in a group.

Curing

To achieve the required material performance characteristics, the concrete must be well cured. This is particularly important for mixes containing supplementary cementitious materials where poor early
age curing can result in the concrete having worse performance than a traditional "standard" concrete mix.

**Compaction**

The concrete must be well compacted, free from voids, segregation and cracking. The use of self compacting concrete may be appropriate for some elements.

**Non ferrous reinforcement**

Galvanised steel, stainless steel reinforcement or other corrosion resistant reinforcement to replace standard black bar can be used to improve corrosion resistance. Similarly, non ferrous reinforcement of polymeric fibres can be used to control cracking in the cover zone where large covers (>80 mm) are required.

**Concrete mix design**

Binary blends comprising FA and GP are unlikely to achieve a 300 year service life at code compliant cover depths. As a minimum triple blends employing GP/FA and silica fume, GP/FA and GGBS or GGBS/GP and silica fume would be required. In addition, low water binder ratios of 0.35 will improve resistance to the penetration of chlorides.

**Admixtures**

High range water reducing admixtures would be required to increase design life, with consideration also given to the performance benefits provided by corrosion inhibitors and waterproofing admixtures.

**Crack width**

Limiting the occurrence of cracks and crack widths is critical to good durability performance. For a marine environment crack widths should be limited to <0.15 mm.

**Piles**

Cast-in-place piles would be cast within steel liners, and given this would be in water, the concrete may have to be placed underwater by tremmie.

The concrete mix would need to have the physical properties suitable for underwater placement. These would include high cohesion and high workability to enable compaction under self-weight without excessive bleed. A concrete mix with these parameters would require constituents, performance criteria and quality control not covered under current MRTS70 requirements. Tighter control over fine aggregate grading, the inclusion of silica fume or air entrainment would assist with cohesion and reduce bleed and a workability in excess of 200 mm slump.

Cast in place piles would require an increased cover above standard code provisions. To prevent cracking, non-ferrous crack control reinforcement would be required. Alternatively impressed current cathodic prevention installed during construction could be considered.

For precast piles where increased cover would not be practical the reinforcement would likely be stainless steel.

**Impacts of ASR on pile options**

TMR have expressed concern that alkali silica reaction (ASR) poses a greater risk in precast concrete elements than for cast in place concrete, as follows:

"It is considered that cast in place piles would be preferred for the new Bribie Bridge (despite previous drawings supplied, circa 2011. This is to minimise sub-structure costs and to avoid ASR future issues (present in the existing bridge piles)"
Reactive aggregates in the presence of water and alkalis can cause alkali aggregate reaction which is evidenced by cracking in concrete and formation of a characteristic white gel. The potential for ASR to occur is dependent on the reactivity of the aggregate, presence of moisture and alkalis, and hence can occur in precast and cast in situ concrete.

It has been suggested that the occurrence of delayed ettringite formation (DEF) in concrete can increase the risk of ASR occurring. DEF can occur when the early age temperature of concrete during hydration exceed 75°C. The higher the temperature the higher the risk of DEF occurring. DEF is evidenced by cracking in the concrete and the presence of ettringite in those cracks. DEF can occur in both precast and cast in situ concrete. The use of steam curing to accelerate early age strength gain in precast operations can, if not adequately controlled, be at risk of high early age temperatures. However this can be avoided through the implementation of appropriate workmanship and quality control processes.

Similarly large in situ concrete pours (i.e. pours with a dimension greater than 1m) are at risk of high early care core temperatures that could cause DEF, hence the increased focus from TMR Design Criteria on thermal modelling of large concrete sections, in the case of DEF it is necessary that the core temperatures are controlled to a level below the limit of 75°C.

**Super-structure**

The height of the super-structure above the splash zone will have a significant impact on durability performance owing to the severity of exposure to chlorides.

Typical cover to reinforcement on a deck unit girder would be 35 mm. This is not sufficient to achieve a 300 year life, even if a triple blend concrete containing GP/FA /GGBS was used. The lower corrosion allowances for prestressed strand compared to unstressed bar reinforcement would mean that cover depths required would not be practical.

Options that would need to be explored include corrosion inhibitors, integral waterproofing admixtures, cathodic protection and stainless steel reinforcement.

Alternative construction methods that would allow large covers or the use of post tensioning could present the most cost effective whole of life solution.

**Approach to durability design**

The durability design should follow the approach described in TMR guideline for the Durability Design of Road Structures. The approach is based on classifying the exposure environments the bridge components are exposed to e.g. tidal, submerged, buried, and atmospheric, and determining the deterioration mechanisms and modelling these mechanisms to determine in service performance and expected design life.

Potential deterioration mechanisms that would need to be considered are:

- Chloride induced reinforcement corrosion
- Carbonation induced reinforcement corrosion
- Alkali silica reaction (ASR)
- Acidic ground water from ASS

Other factors that would influence durability performance and would need evaluation:

- Early thermal cracking
- Delayed ettringite formation
- Allowable crack width


**Finishings**

It is proposed that due to the marine environment, exposed metal components are manufactured from either Duplex or 316 grade stainless steel or marine grade aluminium alloy. This will include any cycle rails, bearing plates, bridge rails and any other exposed metal components. For Option 3, the box girder bridge will require full articulation using guided, and sliding guided bearings, which will also be stainless steel.

### 4.5 Existing bridge condition and remediation options

A possible future option for the existing bridge is for it to be retained for use by pedestrians and cyclists following the construction of a new bridge, and to continue to provide for the PUP services which utilise the bridge. A review of available information relating to the existing bridge has been undertaken, in order to provide comment on this as a possible option.

A report on Bribie Island Bridge by TMR (author Alan Carse) was prepared in 1994 which concluded that "An asset management strategy has been proposed identifying immediate, short and long term actions for the efficient management of this structure to meet its expected design life of 75 years."

It should be noted that these strategies were proposed to ensure the bridge would achieve its original 75 year design life. Three specific actions that were identified in the report are:

- **Immediate term** – Carry out repairs to damaged pile 13
- **Short term** – Carry out further underwater inspection of the remaining piles over a 3 year period
- **Long term** – Monitor change in the chloride ion levels in the headstocks and decks through taking further samples

Level 2 inspections have been carried out in 1999, 2007 and most recently in December 2011. The 1999 overall condition rating for the bridge was 3. A condition rating of 2 was given in 2007, with a Level 3 inspection recommended to be carried out. A Level 3 Inspection would typically encompass a detailed bridge inspection by an experienced bridge engineer, investigation of the cause of deterioration observed, and may or may not include a structural assessment of the bridge in order to determine the load carrying capacity.

The 2011 Level 2 inspection report records an overall condition rating of 3, with the vast majority of components receiving an individual rating of 3 or 4. From this report the minimum remedial work that is required is replacement of all bearings, expansion joints and repairs to all cracking and spalling on the beams and cross girders.

It is recommended that a Level 3 inspection is carried out to include an extensive underwater inspection and an assessment of the change in chlorides in the headstocks and deck. This information will be required to assess the residual life and the appropriateness of patch repairs as a remediation strategy and the consequence risk of incipient anode effects inducing corrosion in areas adjacent to repairs.

#### 4.5.1 Existing bridge rehabilitation

In order to establish a realistic cost to rehabilitate the bridge to an acceptable standard, a Level 3 inspection, including underwater survey of the piles should be undertaken. Inspection of the bridge super-structure and headstock would also need to be undertaken, with tests carried out to determine the extent of chloride contamination. To carry out this inspection, an underbridge inspection unit would need to be utilised, which may require traffic management and temporary lane closures in order to ensure a safe inspection can be conducted (this could be undertaken at night to minimise traffic disruption).

Without further inspection as indicated above, the full extent of rehabilitation work and likely cost is difficult to determine. However it is understood preliminary discussions have taken place between
TMR’s Bridge Branch and a specialist bridge repair contractor company, which has proposed to encase the existing piles using a system of custom made formwork and specialised high performance concrete designed to combat the expansive nature of ASR.

Without knowing the extent of chloride contamination of the deck, headstocks and girders, an appropriate repair cannot be determined for those elements. Undertaking traditional concrete patch repairs will have a limited life due to the potential for incipient anode effects. By including galvanic anodes in the repairs the risk of incipient anode corrosion can be reduced, however corrosion can still occur in unrepaired areas. Impressed current cathodic protection is an accepted method for the long term repair of chloride contaminated concrete, but would be significantly more costly than part repairs.

5. **Geotechnical assessment**

The following is a summary of the main issues identified from the desk top study and recommendations to be considered for future project phases.

5.1 **Comments on alignment options**

The geotechnical issues relevant to the alignments considered include:

5.1.1 **Eastbound approach alignment, to the north of Bribie Island Road**

Existing fill appears over most of the proposed alignment for the eastbound approach. Subject to this fill being compliant as road embankment material, there is the potential to utilise it to form part of the proposed road embankment. As this fill appears to have been in place for a number of years, it is likely that a significant amount, if not all, of the settlement from the underlying alluvial soils has already occurred.

The existing fill may also provide an adequate working platform for pavement construction, reduce or eliminate the need to excavate and treat potential ASS soils and will likely reduce the amount of imported material required to construct a pavement embankment for this alignment.

5.1.2 **Eastbound approach alignment, to the south of Bribie Island Road**

This area appears to be primarily an undisturbed low lying area with the potential for groundwater to be close to the existing surface. The existing ground conditions will likely require removal of vegetation, construction of a working platform, possible removal and/or treatment of unsuitable material and treatment of ASS soils.

This area presents a higher potential for construction and post-construction settlement, compared to the northern alignment, given that area appears to have never been preloaded and consists of an unknown depth of alluvial soils.

5.1.3 **Alignment on Bribie Island**

The choice of preferred alignment on Bribie Island is unlikely to be influenced by the existing ground conditions. The anticipated ground conditions for the proposed bridge approach on Bribie Island is likely to consist of alluvial material, primarily sandy material. Settlements are likely to be minimal and predominately completed during construction.

There is potential for ASS soils to be present within the alluvial material on Bribie Island.

5.2 **Pile options**

From a geotechnical perspective, driven prestressed precast concrete piles and bored cast-in-place piles are both considered to be feasible options. The choice of pile can be finalised when bridge span lengths and hence pier loads are confirmed in the preliminary and detailed design stages. The
choice of pile will also be subject to constructability and design life considerations, noting also the TMR Bridge Branch preference for bored piles in marine environments.

5.3 Recommendations

With regard to the proximity of a new bridge to the existing bridge, it is suggested that the new bridge deck should be about 10 to 20 m from the existing bridge deck, to reduce the risk of any potential impacts from installing new piles on existing piles (e.g. vibration due to piling operations).

Based on the geotechnical desk top study findings, the preferred alignment could be considered to be on the northern side of Bribie Island Road. This recommendation is based on the potential benefits from utilising the existing filled embankments as discussed above. Notwithstanding this, based on the limited existing geotechnical information within Pumicestone Passage and on Bribie Island, there would however appear to be no significant advantage as to which side of the existing bridge the new bridge is placed.

6. Environmental management

6.1 Environmental scoping

GHD has undertaken a desktop assessment to detail the environmental constraints and opportunities associated with the duplication of the bridge to Bribie Island. This work has involved the following:

- A desktop assessment of environmental and cultural heritage databases relevant to the area which may be affected by a road upgrade, to determine the nature of the environment to be impacted and to identify any areas of concern that may influence or have bearing on the project.
- A legislative review of the likely statutory approvals to be required for the works and current and proposed land use and planning documents that may conflict with the proposed works.
- An assessment of the likelihood that works will impact on conservation significant species or items/places of cultural or historical significance.
- Prepare a Cultural Heritage and Environmental Risk Checklist for the Project.
- Identification of information gaps and provision of recommendations including mitigation options and identification of scope for future additional studies.

6.2 Constraints and recommendations

The work undertaken has identified the following possible environmental constraints relevant to the assessment area:

- Statutory approvals for works involving:
  - operational work completely or partly within a coastal management district that involves interfering with quarry material on State coastal land above high water mark
  - tidal works
  - disturbance to marine plants
  - marine park
  - potential impacts to matters of National Environmental Significance
- The presence of and costs associated with offsetting:
  - remnant vegetation
  - koala habitat trees
- marine plants
- essential habitat
- habitat for conservation significant species

- Land resumptions

The key environmental opportunities present within the area include the presence of modified environments on Bribie Island and the previously cleared area(s) on the mainland. A preferred alignment has been selected north of the existing bridge which minimises the impacts to the local environment by locating the road corridor within previously cleared/modified areas to the greatest extent practical. The preferred alignment avoids impact to mapped koala bushland, mapped REs and has a lower chance of encountering items or places of Aboriginal cultural heritage value. A number of State and Commonwealth statutory approvals are still anticipated to be required for the works to progress and relevant duties of care will apply during the works.

7. **Public Utility Plant**

Dial Before You Dig (DBYD) information has been requested and received, indicating that the following services are present throughout the project area:

- Telstra
- Optus
- Energex
- Unitywater
- Moreton Bay Regional Council
- TMR services on the bridge comprise lighting, and communications cabling servicing a CCTV camera

TMR consider that any new bridge should not contain any new services apart from that for bridge lighting and CCTV (including cabling), and a fire hydrant for incident management purposes. However it is likely that the re-alignment of approach roads to a new bridge would impact on existing services, the extent dependant on the alignment chosen.

Following receipt of the DBYD information, consultation was undertaken with the PUP providers, and is summarised as follows:

7.1 **Telstra**

Representatives from GHD met a Telstra officer on site on 13 February 2013. Telstra services on the existing bridge include two steel conduits attached to the south side parapet of the bridge. Both contain optic fibre, one of which is utilised by Optus. Telstra advised there is a submarine cable on the bed of Pumicestone Passage, on the north side of the bridge. This cable has been capped and made redundant. Figure 13 below shows the existing services running onto the western end of the bridge.
Telstra have extensive services, including optic fibre road crossings, on the approach roads at either end of the bridge. All bridge duplication options will impact on Telstra services, although options to the south side of the existing bridge are likely to have a greater impact on the optic fibre network, than options to the north.

Should the existing bridge be demolished as part of a staged approach to providing bridge duplication, Telstra indicated that they would request two conduits in a new bridge, to accommodate the Telstra and Optus optic fibre cables, as is the current situation.

Telstra indicated they have no preference as to the location for a new bridge.

7.2 Optus

Optus cables exist in the road corridor, however they are located in Telstra conduits, and will thus be similarly impacted, as described in section 7.1 above.

7.3 Unitywater

 Representatives from GHD met a Unitywater officer at their Morayfield offices on 13 February 2013. Unitywater indicated that there are four 150mm diameter uPVC sewer rising mains attached to the underside of the bridge and one 500mm diameter steel trunk main attached to the south side of the bridge. Refer Figures 14 and 15 below showing these services respectively.
The trunk main distributes water from the island to the mainland, feeding the Ningi area. The rising main conveys sewage from the mainland to a treatment plant on the island.

According to DBYD plans, Unitywater has underground assets running the extent of the planning area from Bestmann Road East in the west to Benabrow Avenue in the east, comprising the sewer mains and water mains network. Of note, a pump station as part of the sewer pressure network, is located on the northern side of Bribie Island Road at Sandstone Point. Alignment options to the north of the existing bridge may impact the pump station.

Should the existing bridge be demolished as part of a staged approach to providing bridge duplication, Unitywater tabled a preferred location for their water and sewer services, comprising a 500 mm diameter mild steel cement lined water main and a 375 mm diameter mild steel cement lined sewer main, as illustrated in Figure 16 below.
GHD were by commissioned by Cabwater (now Unitywater) in 2005 to undertake a risk assessment of the sewer rising mains attached to the underside of the bridge. Cabwater were concerned that these were at risk of failure, principally because some of the supporting beams had moved, and also concerns with the integrity of the fixing arrangements. GHD were engaged to inspect and assess the risks, and make recommendations for mitigation of the risks identified, which encompassed an ongoing inspection and maintenance regime. Unitywater reiterated these concerns, noting that maintenance of the mains requires the use of a barge.

Unitywater indicated a preference for bridge duplication to the south of the existing bridge, on the assumption that this would not affect the existing pump station on the north side of Bribie Island Road.

### 7.4 Energex

Representatives from GHD met an Energex officer on site on 27 February 2013. Energex has numerous underground and overhead cables on Bribie Island Road between Bestmann Road East and the bridge, and an underground network on the island. There are two 3-core cables in a cable tray attached to the underside of the bridge, one of which is live 33kV whilst the other is redundant until needed. There is also an 11kV submarine cable approximately 100m south of the Bribie Island Bridge spanning Pumiceston Passage.

Alignment options to the south of the existing bridge could potentially significantly impact the overhead network on the mainland.

Figure 17 below shows the cable tray attached to the underside of the existing bridge.
Should the existing bridge be demolished as part of a staged approach to providing bridge duplication, Energex indicated their requirements would include six 125 mm conduits. If the submarine cable was affected by bridge duplication, seven 125 mm conduits would be required. Energex also noted that if a desalination plant were to be constructed on Bribie Island, provision for a 110kV cable may be necessary.

Energex indicated they have no preference as to the location for a new bridge.

### 7.5 Moreton Bay Regional Council

The DBYD information received from MBRC indicate that no assets are present on the bridge, although existing stormwater assets (associated with local roads) may be affected by some of the alignment options considered, to a lesser or greater extent.

### 7.6 Summary of possible PUP impacts

The following table illustrates the potential impacts on existing services of the various alignment options considered (refer to section 8). The impacts have been considered in terms of minor, moderate and major potential impacts, for the purposes of comparison.

#### Table 12 Potential PUP impacts

<table>
<thead>
<tr>
<th>Option</th>
<th>Energex</th>
<th>Unitywater</th>
<th>Telstra/Optus</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mainland</td>
<td>Island</td>
<td>Mainland</td>
</tr>
<tr>
<td>Option 1, 30 m north</td>
<td>Moderate</td>
<td>Minor</td>
<td>Major (pump station)</td>
</tr>
<tr>
<td>Option 2, 30 m south</td>
<td>Major (overheads)</td>
<td>Minor</td>
<td>Minor</td>
</tr>
<tr>
<td>Option 3, 15 m north</td>
<td>Minor</td>
<td>Minor</td>
<td>Moderate</td>
</tr>
<tr>
<td>Option 4, 15 m south</td>
<td>Major (overheads)</td>
<td>Minor</td>
<td>Minor</td>
</tr>
<tr>
<td>Option 5, 15 m north (4 lanes)</td>
<td>Moderate</td>
<td>Minor</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

The above table indicates that options to the north have potential for lesser impacts to existing PUP services, than options to the south.
8. Alignment options

8.1 Introduction

This section provides a summary of the layout and alignment options considered for future bridge duplication. Targeted consultation with key stakeholders, and liaison with PUP providers, provided no clear preferences for an alignment to either the north or south of the existing bridge.

Accordingly therefore, options to both sides of the bridge were considered in terms of horizontal geometry, and potential impacts on property and existing services. Traffic analysis, bridge analysis, and geotechnical and environmental constraints, also contributed to the options consideration.

8.2 Options considered

Two 2 lane bridge options were considered at 30 m offsets to the north and south of the existing bridge. The 30 m offset was based on TMR Bridge Branch advice that this would be their preferred offset.

Two 2 lane bridge options at 15 m offsets north and south of the existing bridge were also considered. A 15 m offset was considered, as this may reduce impacts on property and existing services, to the extent that a 15 m offset would provide significant benefits over a 30 m offset.

A further bridge option at a 15 m offset to the north of the existing bridge was also considered, this option however being for a 4 lane bridge (refer discussions in traffic analysis section 3). In consideration of corridor management, being the primary driver for this commission, an ultimate 4 lane bridge would provide the most redundancy for corridor protection purposes.

All options include a 4 m wide shared cycle and pedestrian facility (in agreement with TMR), for the purposes of providing for sufficient corridor width, and to allow for incident management and maintenance.

Common to all options is the closure of Winston Drive intersection with Bribie Island Road. The closure of this intersection would allow the existing bus stop to be re-located to a safer location than its current location between Winston Drive and Welsby Parade. A Road Safety Audit undertaken as part of GHD’s previous Bribie Island Bridge Road Link Planning identified the current location as a risk due to buses having to weave across the Welsby Parade designated left turn lane to access Bribie Island Bridge. Figure 18 below shows the location of the existing bus stop.

Figure 18 Existing bus stop, between Winston Drive and Welsby Parade

It should be noted that the geometry of the options is based on a two-dimensional assessment only, as no survey was available on the island for utilisation with the alignment assessment.
The main geometric components and major potential impacts of the options considered are as follows:

8.3 Option 1 – 30 m offset to the north (2 lane bridge)

8.3.1 Mainland
- Incorporates a compound R380 m to R260 m curve, complying with minimum 2/3 rule
- Joins into existing Bribie Island Road alignment, prior to Bestmann Road East intersection
- Proposed curves allow for full super transition before the bridge

8.3.2 Island
- AUL left-turn treatment provided from bridge into Sylvan Beach Esplanade
- Allows for full bicycle lane treatment through Sylvan Beach Esplanade/Welsby Parade intersection, from bridge to Benabrow Avenue.
- Allow breaks in median for cyclists to cross between Sylvan Beach Esplanade and Welsby Parade
- Sylvan Beach Esplanade left-turn into added lane with R20 curve at design speed 30 km/h

8.3.3 Major impacts of Option 1
- Resumption through pump station required. Pump station will require relocation
- Existing toilet block may require relocation
- Resumption required to Benabrow Shopping Centre, requiring modification of building or full resumption
- Trunk main on mainland will require some relocation

8.4 Option 2 – 30 m offset to the south (2 lane bridge)

8.4.1 Mainland
- Incorporates a compound R460 m to R380 m curve, complying with minimum 2/3 rule
- Joins into existing Bribie Island Road alignment, prior to Bestmann Road East intersection
- Pump station and toilet block unaffected
- Proposed curves allow for full super transition before the bridge

8.4.2 Island
- AUL left-turn treatment provided from bridge into Sylvan Beach Esplanade
- Allows for full bicycle lane treatment through Sylvan Beach Esplanade/Welsby Parade intersection, from bridge to Benabrow Avenue.
- Allow breaks in median for cyclists to cross between Sylvan Beach Esplanade and Welsby Parade
- Sylvan Beach Esplanade left-turn into added lane with R20 curve at design speed 30 km/h

8.4.3 Major impacts
- Full resumption of large residential complex and adjacent individual residential lot, between Welsby Parade and Winston Drive
- Further resumption required to Lot 6 SP199926 to the south of Bribie Island Road, with resumptions already negotiated requiring amendment
- Potential major impacts to fibre optic network and overhead electricity, with trunk main on island also requiring some relocation

**8.5 Option 3 – 15 m offset to the north (2 lane bridge)**

**8.5.1 Mainland**
- Incorporates a compound R380 m to R260 m curve, complying with minimum 2/3 rule
- Joins into existing Bribie Island Road alignment, prior to Bestmann Road East intersection
- Resumption through pump station can be avoided, although some protection works may be required e.g. retaining walls
- Proposed curves allow for full super transition before the bridge

**8.5.2 Island**
- AUL left-turn treatment provided from bridge into Sylvan Beach Esplanade
- Allows for full bicycle lane treatment through Sylvan Beach Esplanade/ Welsby Parade intersection, from bridge to Benabrow Avenue.
- Allow breaks in median for cyclists to cross between Sylvan Beach Esplanade and Welsby Parade
- Sylvan Beach Esplanade left-turn into added lane with R20 curve at design speed 30 km/h

**8.5.3 Major impacts**
- No resumption required to Benabrow Shopping Centre, with resumption required to vacant lot on corner, where DA has lapsed
- Existing toilet block to be removed or relocated
- Trunk main on mainland will require some relocation

**8.6 Option 4 – 15 m offset to the south (2 lane bridge)**

**Mainland**
- Incorporates a compound R460 m to R380 m curve, complying with minimum 2/3 rule
- Joins into existing Bribie Island Road alignment, prior to Bestmann Road East intersection
- Proposed curves allow for full super transition before the bridge
- Pump station and toilet block unaffected

**Island**
- AUL left-turn treatment provided from bridge into Sylvan Beach Esplanade
- Allows for full bicycle lane treatment through Sylvan Beach Esplanade/ Welsby Parade intersection, from bridge to Benabrow Avenue.
- Allow breaks in median for cyclists to cross between Sylvan Beach Esplanade and Welsby Parade
- Sylvan Beach Esplanade left-turn into added lane with R20 curve at design speed 30 km/h
8.6.1 Major impacts

- Full resumption of large residential complex and partial resumption to adjacent individual residential lot, between Welsby Parade and Winston Drive
- Further resumption required to Lot 6 SP199926 to the south of Bribie Island Road, with resumptions already negotiated requiring amendment
- Potential major impacts to fibre optic network and overhead electricity, with trunk main on island also requiring some relocation

8.7 Option 5 – 15 m offset to the north (4 lane bridge)

Mainland

- Incorporates a compound R380 m to R260 m curve, complying with minimum 2/3 rule
- Joins into existing Bribie Island Road alignment, prior to Bestmann Road East intersection
- Resumption through pump station may be avoided, but will need confirming in subsequent design phase
- Proposed curves allow for full super transition before the bridge
- 0.9 m wide kerbed median provided on bridge for traffic separation of dual opposing lanes

Island

- AUL left-turn treatment provided from bridge into Sylvan Beach Esplanade
- Allows for full bicycle lane treatment through Sylvan Beach Esplanade/ Welsby Parade intersection, from bridge to Benabrow Avenue.
- Sylvan Beach Esplanade left-turn to the main road will be a give way

8.7.1 Major impacts

- No resumption required to Benabrow Shopping Centre, with resumption required to vacant lot on corner, where DA has lapsed
- Existing toilet block to be removed or relocated
- Trunk main on mainland will require some relocation

9. Recommendation

It is recommended that a new bridge at a 15 m offset to the north of the existing bridge, be adopted for preserving a corridor for the future bridge duplication of Bribie Island Bridge, for the following reasons:

- In consideration of corridor management, being the primary driver for this commission, an ultimate 4 lane bridge would provide the most redundancy for corridor protection purposes.
- Traffic forecasts suggest that the existing bridge will reach practical capacity by 2031 during the peak period (which has been observed to occur around lunchtime on Sundays). MBRC have provided a number of residential growth forecasts for comparison purposes, one of which showed an increase in dwellings on the island of 37% by 2031, which may result in the existing bridge also approaching capacity during the weekday PM peak period by 2031. Therefore, it is considered prudent to ensure that sufficient redundancy in corridor protection is provided by assuming a future possible requirement for a four lane bridge.
- Bridge analysis undertaken indicates there would appear to be no insurmountable constructability issues which would preclude a 15 m offset from being adopted.
• The existing bridge could be retained for use by pedestrians and cyclists, and to continue to provide for PUP services, subject to an ongoing maintenance regime for the bridge to reach its 75 year design life i.e. 2038. Thus based on the traffic analysis and residual design life, it can be assumed that duplication of the bridge will become a necessity somewhere between 2031 and 2038.

• 15 m offset ensures only one undeveloped property on Bribie Island is affected, on which a current development application has lapsed. Any impacts on the adjacent Benabrow Shopping Centre are avoided.

• Further resumption requirements to Lot 6 SP199926 to the south of Bribie Island Road are avoided.

• Impacts on the large residential complex, between Welsby Parade and Winston Drive, on the island are avoided.

• Impacts on PUP are less for 15 m offsets than for 30 m offset options, and for all options to the north of the existing bridge. Specifically the 15 m offset to the north, albeit with a 4 lane bridge, appears to avoid impacts on the sewer pressure main pump station.

• Favoured from a geotechnical perspective, as there are potential benefits from utilising the existing filled embankments on the north side of Bribie Island Road.

• Minimises the impacts to the local environment by locating the road corridor within previously cleared/modified areas to the greatest extent practical. Avoids impact to mapped koala bushland, mapped REs and has a lower chance of encountering items or places of Aboriginal cultural heritage value.
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