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Design Development Report

Client: Transport and Main Roads

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Glossary

Term	Definition / description
AEP	Annual Exceedance Probability
AGRD	Austroads Guide to Road Design
AGTM	Austroads Guide to Traffic Management
AHD	Australian Height Datum
ARI	Average Recurrence Interval
AS	Australian Standards
ASS	acid sulfate soils
AT	active transport
B2C	Burleigh Heads to Coolangatta
B2C PTS	Burleigh Heads to Coolangatta Public Transport Study (i.e. the Project)
B2T MMCS	Burleigh Heads to Tugun Multi-Modal Corridor Study
BC	Business Case
BF2	Bombardier Flexity 2 (light rail design vehicle)
Category C	Category C Protected Planning – a classification designated in TMR's Approved Planning Policy (October 2017) that refers to planning that is approved and protected, but not included in current funding and delivery programs
CBD	Central Business District
Ch.	Chainage
CIP	cast-in-place
CLR	Contaminated Land Register
CoGC	City of Gold Coast
CPTED	Crime Prevention Through Environmental Design
DBL Option	Dedicated Bus Lane Option (Option 2)
DBYD	Dial Before You Dig
DCA	Definitions for Classifying Accidents (crash type code descriptions)
DDA	Disability Discrimination Act 1995
DES	Department of Environment and Science
DKE	Dynamic Kinematic Envelope
EBP Option	Enhanced Bus Provision Option (Option 3)
EBPC Act	Environment Protection and Biodiversity Conservation Act 1999
EDD	Extended Design Domain
EMR	Environmental Management Register
ESR	Environmental Scoping Report
E&T	Engineering and Technology
GCAMSE	Gold Coast Aimsun Model Southern Extension
GCH MMCS	Gold Coast Highway Multi-Modal Corridor Study (collectively the B2T and T2C MMCS)
GCLR	Gold Coast Light Rail
GCLR3	Gold Coast Light Rail Stage 3 (light rail extension from Broadbeach to Burleigh Heads)

Term	Definition / description
GCLR4	Gold Coast Light Rail 4 – proposed light rail extension from Burleigh Heads to Coolangatta (also referred to as the “LRT Option” or “Option 1 – Dedicated Light Rail Option)
GCSTM-MM	Gold Coast Strategic Transport Model – Multi Modal
GIS	geographic information system
Hwy	Highway
ILM	Investment Logic Map
km	kilometre(s)
km/h	kilometres per hour
LILO	left-in/left-out (intersection configuration)
LoS	Level of Service
LRUD	Landscape, Revegetation and Urban Design
LRV	light rail vehicle
LRT	light rail transit
LRT Option	Dedicated Light Rail Option (Option 1)
m	metres
MCA	multi-criteria analysis
Mwy	Motorway
M1 Motorway	M1 Pacific Motorway (also referred to as the “M1” or “M1 Motorway”)
MNES	Matters of National Environmental Significance
MUTCD	Manual of Uniform Traffic Control Devices
OHL	overhead line
O&M	Operations and Maintenance
PAF	Project Assurance Framework
PCNP	Principal Cycle Network Plan
PE	Preliminary Evaluation
PFAS	per- and poly-fluoroalkyl substances
PT	public transport
PUP	public utility plant
PWD	People with Disability
R	radius
RCP	Risk Context Profile
RPDM	Road Planning and Design Manual
RSA	Road Safety Audit
SCU	Southern Cross University – Gold Coast Campus
SSA	Safe Systems Assessment
T2C MMCS	Tugun to Coolangatta Multi-Modal Corridor Study
TfNSW	Transport for New South Wales
TMR	Department of Transport and Main Roads
TPS	traction power substation

Term	Definition / description
vpd	vehicles per day

1.0 Introduction

AECOM was commissioned by the Department of Transport and Main Roads (TMR) in March 2022 to conduct technical studies for the Preliminary Evaluation (PE) of the Gold Coast Highway (Burleigh Heads to Coolangatta) Public Transport Study (B2C PTS) (the Project). The Project investigates three public transport options that were shortlisted during the PE phase for the subject section of the highway – dedicated light rail (Option 1), dedicated bus lanes (Option 2) and enhanced bus provisions (Option 3). The project extents are shown in Figure 1. The purpose of this commission is to conduct preliminary technical investigations and prepare concept designs for these three options.

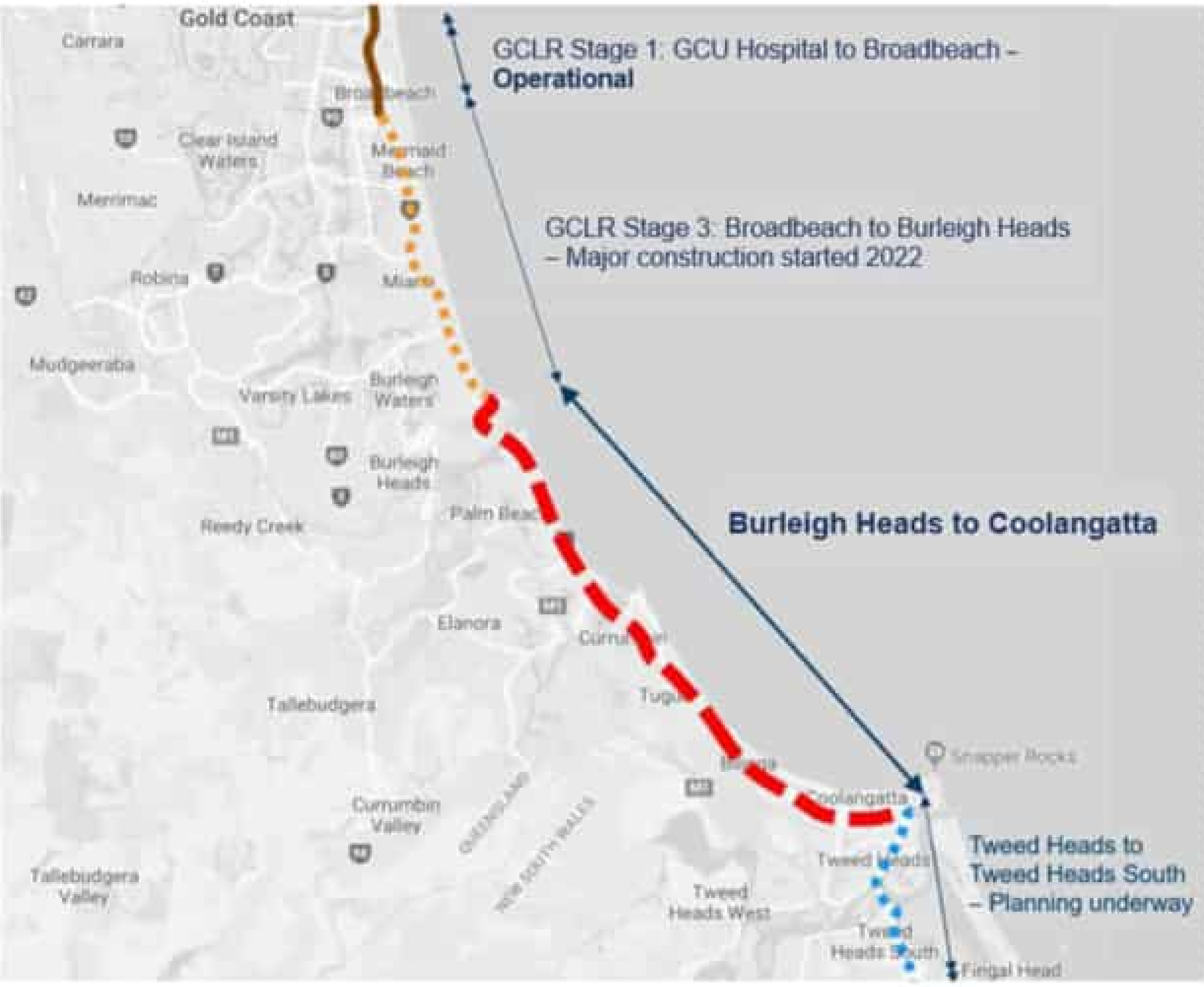

Figure 1 Project extent

1.1 Background

Historically, the Gold Coast Highway has been a major north-south traffic corridor, particularly for the Burleigh Heads to Coolangatta corridor. In recent times, upgrades to the Pacific Motorway (M1) and development along the Gold Coast Highway has changed the function of the Gold Coast Highway.

The Burleigh Heads to Coolangatta area offers an amenity-based beachside lifestyle and recreational opportunities, with a comfortable climate and an attractive urban environment. It is embedded in one of Australia's fastest growing regions, and also caters for international and domestic tourists, as well as many day trippers from the big population centres to its north.

The lifestyle and beauty of the Burleigh Heads and Coolangatta area will continue to attract population growth, day trippers and holiday makers, and this will in turn drive opportunities for increased economic activity and employment in the region[1]. Significant ongoing population and employment growth in the area is envisaged. Government policies to prevent urban sprawl, protect the coastal environment and support sustainable lifestyle are key transport challenges to overcome.

Category C planning was previously defined for the Gold Coast Highway for a future upgrade of the corridor to six lanes – primarily through the conversion of the existing parking lanes to traffic/on-road cycle lanes. At the time that the planning was completed, future GCLR extensions were not a consideration. Subsequent to this, Shaping SEQ, the Gold Coast Southern and Central Area Transport Study (GCSCATS) and the Gold Coast City Transport Strategy 2031 identified the need to extend the light rail from Broadbeach to Coolangatta via the Gold Coast Airport.

In recent years there has been growing interest for a future light rail extension to the Airport, catalysed by the 2032 Brisbane Olympics—which includes sports venues in the Gold Coast—combined with record population growth across South East Queensland has resulted in a significant increase in development activity along the corridor.

A *Strategic Assessment*[1] was recently completed by the City of Gold Coast (CoGC) for the Project in 2021. The assessment identified a strong need for a major intervention to improve public transport on the southern Gold Coast/northern Tweed. This intervention should be based on a technology that enjoys its own right-of-way to provide legibility that will attract passengers out of cars and encourage public transport utilisation by providing a quality level of service that is legible, accessible, seamless, timely and unaffected by local congestion. The new system should be fully integrated with frequent and reliable local bus services and be easily accessed by improved active transport facilities.

In parallel with the Strategic Assessment, TMR conducted a multi-modal corridor study between Burleigh Heads and Coolangatta to determine the preferred function of the Gold Coast Highway for the next 20 years and beyond. The corridor study was broken into two sections: Burleigh Heads to Tugun (B2T MMCS), and Tugun to Coolangatta (T2C MMCS) to manage the complexities along the corridor and is collectively referred to in this report as the Gold Coast Highway MMCS (GCH MMCS).

The GCH MMCS concluded that the Gold Coast Highway is the preferred route for a future southern extension of the light rail from Burleigh Heads to Coolangatta. It also concluded that an at-grade segregated double track is the most appropriate light rail configuration, consistent with previous (and proposed) light rail stages. Extension of the light rail from Broadbeach South to Burleigh Heads (referred to as Gold Coast Light Rail Stage 3 or GCLR3) is currently underway with anticipated opening in 2025.

As part of this PE, seven options were initially considered for the Gold Coast Highway such as road widening, bus service enhancements (i.e. bus priority treatments), dedicated bus lanes and light rail. An options analysis was undertaken which resulted in these seven options being reduced to the three shortlisted options (defined in Section 1.2 below). The purpose of this commission is to conduct preliminary technical investigations and prepare concept designs for these three options.

1.2 Scope of Works

AECOM's commission is to develop engineering concept designs and conduct associated technical studies and preliminary cost estimates for three public transport options along the Burleigh Heads to Coolangatta (B2C) project corridor (refer to Figure 1). These project options are defined below:

- **Option 1: Dedicated Light Rail (LRT Option)** – proposes an extension of GCLR from Burleigh Heads to the Gold Coast Airport and Coolangatta (following the Gold Coast Highway and Coolangatta Road alignment), including bus network changes to improve connectivity and accessibility to the light rail. This option involves right-of-way for the light rail with new bridges over Tallebudgera Creek and Currumbin Creek, a new stabling facility with satellite depot at Bilinga and assumes the same light rail rollingstock.
- **Option 2: Dedicated Bus Lanes (DBL Option)** – proposes new dedicated bus lanes on the Gold Coast Highway (Burleigh Heads to Coolangatta) and Coolangatta Road (to Tweed Heads), with the exception of the Tallebudgera Creek and Currumbin Creek bridges where the buses are required to merge into the general traffic lanes. This option includes improvements to the bus network in

[1] Public transport needs in the southern Gold Coast and northern Tweed region - Strategic Assessment (CoGC, 26 August 2021)

terms of frequency and connectivity. The kerbside bus lanes are proposed to operate 24/7 with bus pre-emption on approach to traffic signals.

- **Option 3: Enhanced Bus Provisions (EBP Option)** – proposes short sections of dedicated bus lanes on the Gold Coast Highway approaches at the following intersections (including traffic signal pre-emption for bus priority):
  - Tallebudgera Drive, Palm Beach
  - Nineteenth Avenue, Palm Beach
  - Palm Beach Avenue, Palm Beach
  - Thrower Drive, Palm Beach – plus a bus queue jump on the Thrower Drive (west) approach for buses turning left and right onto the Gold Coast Highway.

The purpose of the Preliminary Evaluation (PE) is to provide sufficient information to Government decision makers to enable them to make informed decisions as to whether to proceed to the Business Case phase consistent with the Queensland Government's Project Assessment Framework (PAF). Whilst this project relates to the PE stage, the PE report is being prepared by others. AECOM’s commission specifically relates to the preparation of concept drawings and associated technical studies for the three project options. The scope of this commission covers the following:

- Develop concept designs for the three public transport options (defined above) and undertake supporting engineering and technical investigations to provide appropriate assurances that the preferred designated corridor will be sufficient to cater for future intended uses for the various modes of transport demands
- Develop future bus networks for each option to define inter-connecting bus connections to communities and facilities
- Develop an active transport strategy along the corridor and include provision for active transport facilities along the corridor including the Principal Cycle Network and any Oceanway network
- Prepare cost estimates for each project option (including bill of quantities schedules) to inform the economic appraisal (being undertaken by others). The preliminary cost estimate was prepared by AECOM’s subconsultant Fission Pty Ltd.

The aim of the technical studies is to:

- Develop the three public transport options (including concept designs) between Burleigh Heads and Coolangatta that satisfy the need and functional outcomes
- Provide design certainty and confidence that the technical components of the project have been considered and/or addressed
- Provide advice and feasibility to preparing work packages and / or stages
- Ensure that the concept designs address all issues to the extent needed to allow the preferred option to be established from the developed options and to be progressed to the Business Case stage.

1.2.1 Out of Scope

The following items are out of scope:

- Detailed survey
- Strategic transport modelling (this is being undertaken by others)
- Oceanway design (except for design of connections/interfaces to existing/future Oceanway links)
- Design development/investigation for the proposed Currumbin Creek active transport bridge (by others)
- Preconstruction activities such as geotechnical investigations (drilling / coring), utility investigations, environmental investigations and detailed design calculations

- Preparation of the PE Report and supporting economic and financial assessments (by others)
- Public consultation.

1.3 Purpose of this Report

The purpose of this report is to detail the design development for the three public transport options for the B2C project corridor. This report provides a detailed description of the concept design development (including key design considerations) for the three project options. Further information regarding the design development for the options, basis of design, access strategy, active transport strategy, public transport operational assessment, property impacts and public utility impacts are provided in the appendices.

1.4 Reference Documents

- Previous planning studies:
  - Gold Coast Highway (Burleigh Heads to Tugun) Multi-Modal Corridor Study – Route Strategy Report (Jacobs, 2020) and associated reports and concept designs
  - Gold Coast Highway (Tugun to Coolangatta) Multi-Modal Corridor Study – Route Strategy Report (Jacobs, 29 June 2022) and associated reports and concept designs
- Austroads Guide to Road Design
- Light rail design standards as per the existing LRT system Project Scope Requirements
- TMR's Technical guidelines, standards, specifications, policies and reference documents which can be found on the TMR webpage under Technical Publications. The key planning documents include:
  - Road planning and design manual (RPDM)
  - Light rail design standards as per the existing LRT system Project Scope Requirements
  - Public Transport Infrastructure Manual (2020)

The technical reports (contained in the appendices) detail specific reference documents used to inform the engineering and technical investigations.

1.5 Report Structure

This report is structured in the following way:

- Section 2.0 defines the project in terms of the project objectives, corridor vision, key requirements and constraints, related projects and stakeholder engagement undertaken throughout the PE phase
- Section 3.0 provides an overview of the existing situation in terms of the corridor function, transport network, road conditions and surrounding environment
- Section 4.0 describes the design inputs and standards adopted to inform the basis of design
- Section 5.0 describes the design development of the LRT Option (Option 1)
- Section 6.0 describes the design development of the DBL Option (Option 2)
- Section 7.0 describes the design development of the EBP Option (Option 3).
- Section 8.0 describes the supporting technical investigations that were undertaken for all options
- Section 9.0 describes the risk analysis undertaken as part of the PE design development
- Section 11.0 describes the conclusion and next steps.

Sections 5.0 to 7.0 provide detailed information regarding the scope for each option and design development including identification of the preferred alignment, design standards, constructability considerations, operations, conclusion and recommendations for the subsequent Business Case (BC) phase.

2.0 Project Definition

2.1 Project Corridor

The B2C project corridor follows the alignment of the Gold Coast Highway from Burleigh Heads (current terminus of Gold Coast Light Rail Stage 3) to Bilinga, then traverses off the highway to the Gold Coast Airport, before continuing back to Coolangatta Road terminating at the Chalk Street/Warner Street intersection in Coolangatta.

For the purpose of the project, the corridor has been divided into five ‘place-based’ segments that recognise the local character and amenity as well as the highway’s transport movement function. The five project corridor segments and key features are described in Figure 2.

Currently, the posted speed of the corridor varies from 50km/h to 80km/h, with a short section of school zone in Coolangatta limited to 40km/h during school peak periods. Table 1 presents the applicable design characteristics for each of the road sections within the Burleigh Heads to Coolangatta (B2C) project corridor which will form the basis of the concept designs for each of the project options.

Further information on the corridor characteristics is provided in Section 3.3.

Figure 2 Project corridor segment map & key features

Table 1 Project corridor characteristics

Corridor Characteristic	Segment 1 – Burleigh Headland	Segment 2 – Palm Beach	Segment 3 – Currumbin Headland	Segment 4 – Tugun to Bilinga	Segment 5 – Kirra to Coolangatta
Road Name(s)	Gold Coast Highway	Gold Coast Highway	Gold Coast Highway	Gold Coast Highway	Coolangatta Road Lanham Street McLean Street Griffith Street
Responsible entity (State or CoGC) *Reference: TMR South Coast District Map (see Basis of Design Report - B2CTS-PE-430-REP-00001 in Appendix B)*	State Controlled Road: Gold Coast Highway (Broadbeach Coolangatta) (road number 11B)				CoGC roads
Current Posted Speed	50 - 60km/h	60 - 70km/h	70km/h	80km/h	50 – 60km/h*
Traffic Volume (AADT) (2020) *Reference: Traffic Census*	Over 42,000 (Site ID 10855)		Over 33,000 (Site ID 11592)	Over 38,000 (Site ID 10026)	
Road Classification *Reference: CoGC Functional Transport Hierarchy Map (see Appendix B for further information)*	Urban Arterial Road	Urban Arterial Road	Urban Arterial Road	Urban Arterial Road	Coolangatta Rd – Distributor Others - Local
B-Double Route *Reference: Multi-combination vehicles routes, Qld Govt Publications (see Appendix B for further information)*	No	No	No	25m B-Doubles and lower	Not a B-Double Route
Principal Cycle Network *Reference: TMR Principal Cycle Network Plan and CoGC Transport Strategy (see Appendix B for further information)*	Yes	Yes	Yes	Yes	Coolangatta Rd - Yes Others - No

* Part of this alignment is within a school zone with 40km/h speed limits at peak times

The project boundary at the northern extent is the proposed Burleigh Heads Light Rail Station, located to the north of Brake Street (refer to Figure 3), which will become the southern light rail terminus on completion of GCLR3. The B2C project is required to tie into the GCLR3 works.

Adapted from www.gclr3.com.au/goldlinq/gclr3/map#mapboxHotspotsAll

Figure 3 Project corridor – northern extent

At the southern end, the project corridor terminates at the Chalk Street/Warner Street intersection in Coolangatta near the New South Wales (NSW) border, as shown in Figure 4.

Figure 4 Project corridor – southern extent

2.2 Corridor Vision

The corridor vision statement was defined in the Burleigh to Tugun (B2T) and Tugun to Coolangatta (T2C) Multi-Modal Corridor Studies (MMCS) and is detailed below.

Burleigh Heads to Tugun

The Gold Coast Highway will transform to become a sustainable sub-tropical Gold Coast Boulevard between Burleigh Heads and Tugun town centres. Residents, tourists and businesses will have attractive alternatives to car travel with high quality footways and bikeways as well as reliable, frequent public transport services. Traffic will be accommodated in a way which creates safer, more liveable communities, while on-street parking will be designed to support and enliven commercial activity.

Light rail stations will knit together and form a focal point for villages and centres, stimulating new development and contributing to more vibrant communities. A range of new housing and employment options will develop within comfortable walking distance of stations as the corridor emerges as an even more desirable place to live and work. Local character will be celebrated and enhanced with appropriate and varied density. Environmental, cultural heritage and landscape values along the corridor will be protected.

Tugun to Coolangatta

The Tugun to Coolangatta corridor will connect the southern Gold Coast and its collection of distinct and unique places, with their varied character, density and scale. The corridor and communities along it will connect seamlessly through cross-corridor connections and to the wider city and region with enhanced public and active transport facilities as alternatives to private vehicle travel. Light Rail stations served by frequent, reliable G: link services, will integrate with and further activate key precincts, villages and centres (including the airport precinct).

Appropriate and diverse land uses will establish within a comfortable walking distance of the stations, contributing to more vibrant and affordable communities. High quality active transport infrastructure will complement major public transport investment to help in sustainably accommodating more people as the corridor becomes a more desirable place in which to live, work, learn and play.

2.3 Investment Logic Map

An Investment Logic Map (ILM) was developed by PricewaterhouseCoopers (PWC) during the Strategic Assessment (in consultation with TMR and CoGC) and subsequently updated during the PE phase. The ILM defines the key problems, opportunities and priority needs to be addressed by the project and describes the outcomes sought and anticipated project benefits including its alignment with TMR's *Transport Coordination Plan (TCP) 2017-2027* key areas and objectives. The ILM is detailed in Figure 5.

The key problems, priority needs and outcomes sort (identified in the ILM) were used to guide the design development process including the development of the Basis of Design strategies (discussed further in Section 4.1) and selection of the criteria adopted in the multi-criteria analysis for assessing project sub-options against the project's functional requirements (refer to Section 5.3.3).

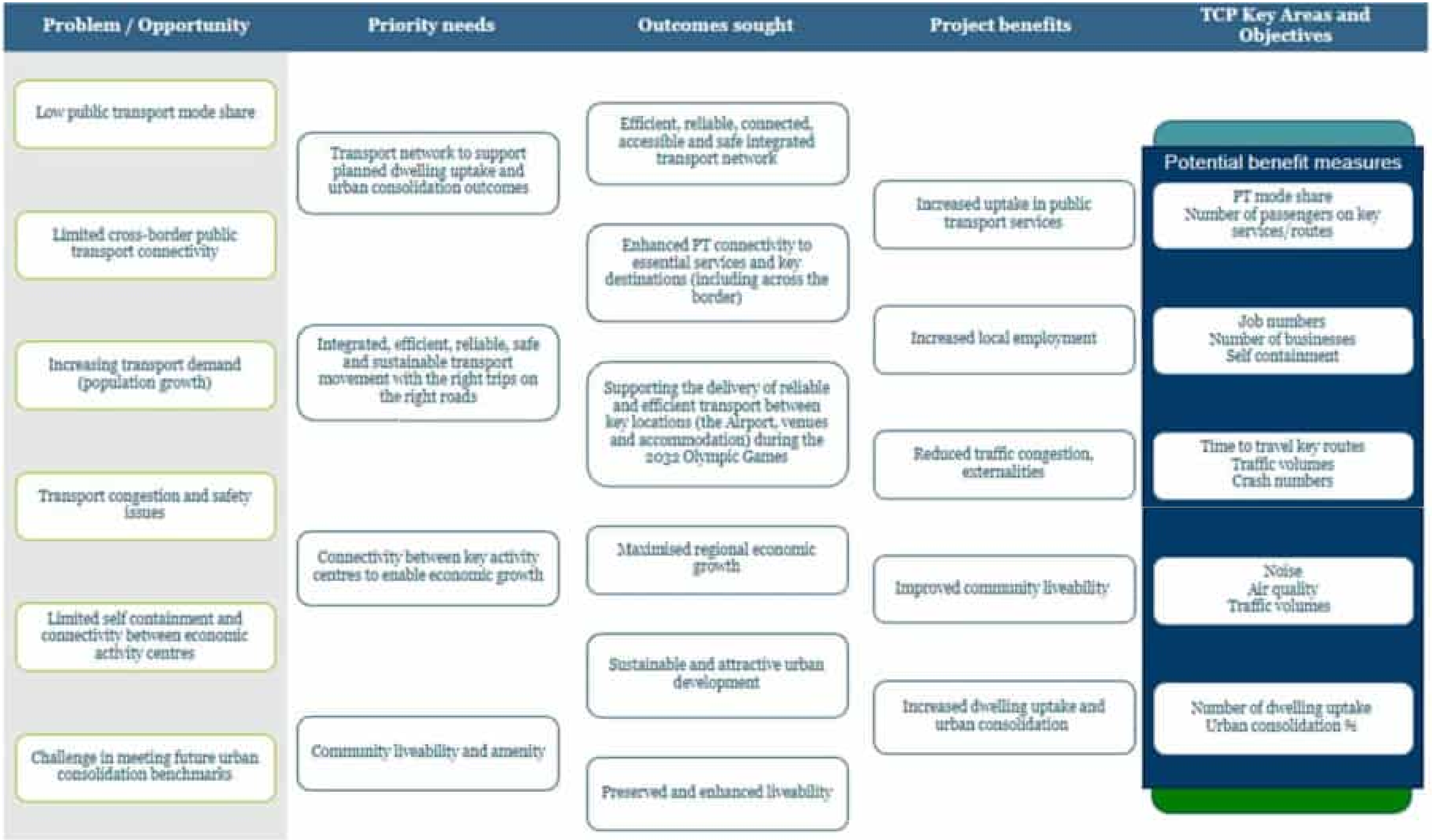

Figure 5 Investment Logic Map[2]

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[2] PWC ILM version 3.0 (Supplied by TMR, 26 April 2022)

2.4 Project Constraints / Requirements

Key project requirements and constraints are summarised in Table 2.

Table 2 Key project requirements and constraints

Element	Project constraints / requirements
General requirements	
Project alignment	The public transport alignment (for each option) must be contained on the defined project corridor (shown in Figure 2)—which was identified in the GCH MMCS—and tie into (or interface with) the Burleigh Heads Light Rail Station
General traffic lanes	Four general traffic lanes (i.e. two traffic lanes in each direction) must be maintained on the Gold Coast Highway. The GCH MMCS previously considered reducing the Gold Coast Highway to two-lanes at constrained locations. However, TMR has committed to retaining four traffic lanes on the highway (based on a ministerial commitment in response to community feedback).
Active transport	• The entire B2C corridor is defined as a Principal Cycle Route and must provide facilities for people riding bikes and include cyclist provision for Principal Cycle Routes that traverse the project corridor. • Existing width constraints within the corridor (particularly through Palm Beach) will require high quality cyclist facilities to be provided on adjacent corridors (to be informed by the Active Transport Strategy). • The project must include provision for tie-ins to existing and planned sections of the Gold Coast Oceanway south of Tallebudgera Creek and at the Currumbin Creek approaches
Community consultation feedback	Consideration of the detailed feedback received during the community consultation activities on the B2T MMCS completed by TMR in 2021 and the T2C MMCS completed by TMR in 2022.
Category C boundary	Minimise property impacts and avoid encroaching into the 'Category C' boundary (where possible). Category C Protected Planning refers to planning that is approved and protected, but not included in current funding and delivery programs, as outlined in TMR's Approved Planning Policy (October 2017). The Category C boundary was recently refined for the future light rail extension based on the GCH MMCS route strategy and concept design.
Burleigh Head National Park	• The project should minimise impacts to Burleigh Head National Park • Project Options 1 and 2 (LRT and DBL Options) must include provision of a new fauna crossing (with active transport facilities) over the Gold Coast Highway to connect the eastern and western sides of the national park
Gold Coast Airport	Minimise property impacts to Gold Coast Airport (Commonwealth) land and include a public transport station at (or in close proximity) to the airport
Pedestrian access to public transport stops/stations	The project should provide safe pedestrian crossings on the Gold Coast Highway for access to public transport stations/stops. For the LRT Option, signalised pedestrian crossings are required on both sides of LRT stations to improve pedestrian safety and accessibility.

Element	Project constraints / requirements
General requirements	
Public transport services	All project options result in changes to the existing public transport (bus) services. A Public Transport Operational Assessment was undertaken as part of the PE to conduct a preliminary assessment of the proposed bus network services (including route and timetable changes) for each project option, based on initial planning undertaken by TransLink and others (refer to Sections 5.0 to 7.0 for further information). The concept designs for all project options are required to include provision of public transport stations/stops and associated facilities (turnaround areas, interchanges and driver facilities, where required) to support the proposed bus network defined in the *Public Transport Operational Assessment - B2CTS-PE-440-REP-00001* (refer to Appendix G).
Parking	The project should aim to achieve a zero net-loss in parking (compared to the Base Case) through offsetting loss of parking along the project corridor and provision of new carparks (where required).
Project option specific requirements	
Option 1 – LRT Option	
LRT configuration and alignment	The GCH MMCS confirmed the LRT configuration shall be at-grade, dual light rail track which provides a level of priority and is consistent with the look, feel and functionality of previous (and planned) GCLR phases. The LRT alignment is required to follow the project corridor (as shown in Figure 2) and include an Airport connection. It should generally follow the preferred alignment identified in the GCH MMCS, subject to a more rigorous sub-options analysis (the subject of AECOM's commission) during the PE phase to refine the LRT alignment.
LRT stations	14 new light rail stations along the B2C corridor (excluding the Burleigh Heads Station which will be delivered as part of GCLR3). The proposed station locations (detailed in Section 5.1) were determined in the GCH MMCS based on key destinations and are generally fixed (subject to more detailed investigation as part of this PE). The stations are generally proposed at about 800m spacings through populated areas.
Future rail spur	The LRT Option will need to facilitate a future rail spur at Thrower Drive, Palm Beach for a potential western extension to Elanora (as indicated in the CoGC's 2031 Transport Strategy).
Light rail satellite depot	The LRT Option requires a new light rail satellite depot and stabling yard in Bilinga, located adjacent to the Gold Coast Highway within TMR road reserve (north of the Southern Cross University). This location was identified in the GCH MMCS and the depot requirements are discussed in further detail in Section 5.4.5.

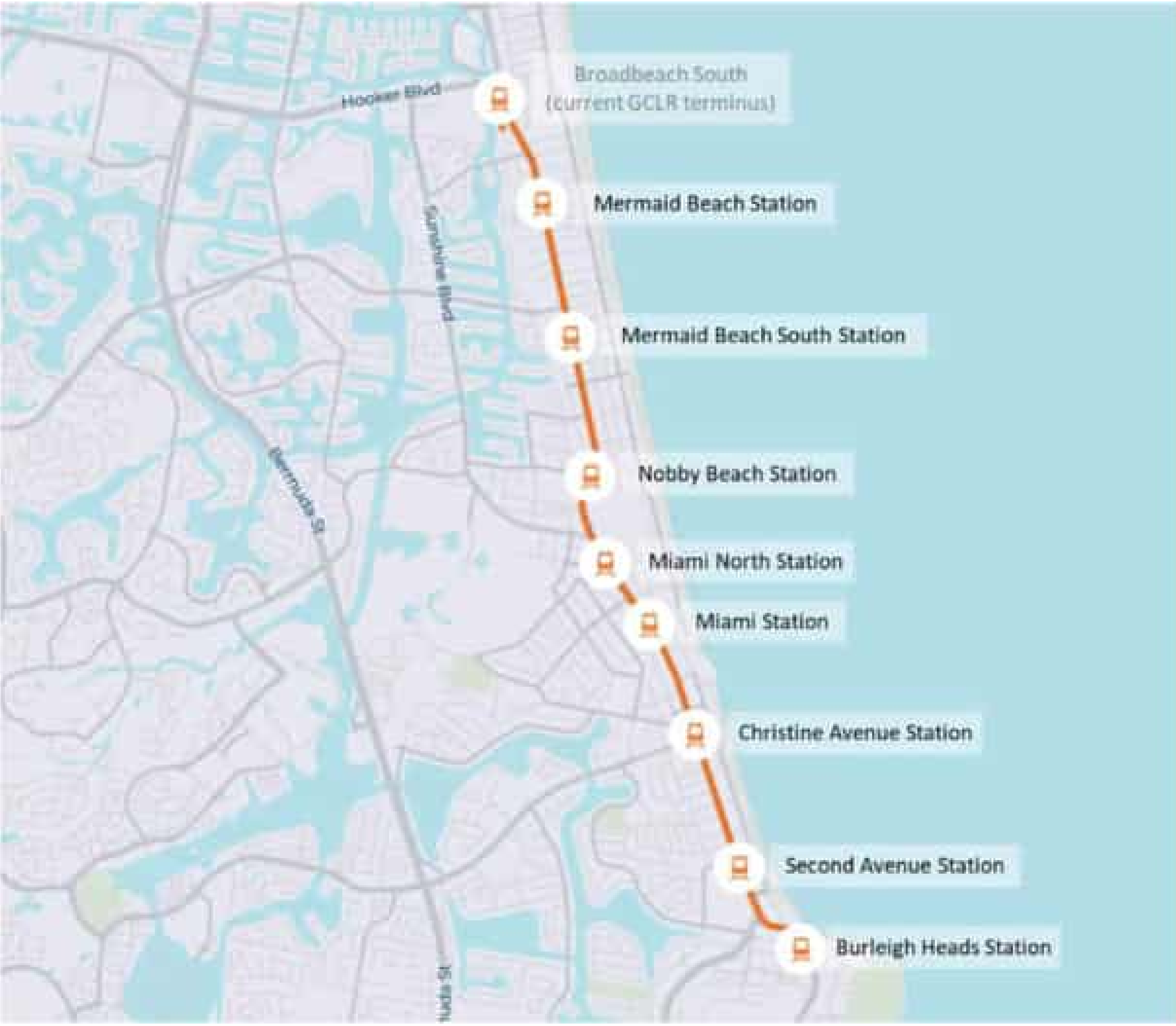
Element	Project constraints / requirements
Creek crossings	• New bridge structures are required at Tallebudgera Creek and Currumbin Creek for light rail vehicles (LRV) as the existing bridges are unsuitable for LRV loading (discussed further in Section 3.3.3) and will need to be constructed off-line adjacent to these existing structures • The new Tallebudgera Creek light rail bridge must include provision for active transport facilities • The new Currumbin Creek bridge is for LRVs only and should be situated west of the existing structures (due to lower property and environmental impacts). TMR is currently undertaking planning for a new active transport bridge at this location (with connections to the Oceanway) which will be situated to the east of the existing structures.
Option 2 – DBL Option	
Bus stop locations	This option assumes all existing bus stops are retained in their existing location on the Gold Coast Highway north of Tugun (with optimisation of bus stop locations to be investigated in subsequent phases if this option is progressed further). New bus stops are proposed along the highway through Tugun/Bilinga, generally at the same locations as the proposed LRT stations (in Option 1).
Creek crossings	• Buses are required to merge into the general traffic lanes at the Tallebudgera Creek and Currumbin Creek crossings (i.e. no dedicated bus lanes at these locations). This is based on the outcomes of the PE options shortlisting exercise (undertaken by PWC) where a DBL Option with new bridges at these two crossings was considered, however, was excluded from further consideration (in favour of the three shortlisted options defined in Section 1.2). • This project option must include provision for tie-ins to the proposed new active transport bridge at Currumbin Creek east of the existing bridge structures (described in Option 1 above).
Option 3 – EBP Option	
Bus stop locations	This option assumes all existing bus stops are retained in their existing location on the Gold Coast Highway north of Tugun (with optimisation of bus stop locations to be investigated in subsequent phases if this option is progressed further).
Creek crossings	This option assumes no new bridges at the Tallebudgera Creek and Currumbin Creek crossings (consistent with Option 2).
Property impacts	The EBP Option is intended to provide a low-cost solution for improving public transport patronage and efficiency on the project corridor. As such, property impacts have been avoided for this option.

2.5 Related Projects / Studies

The following sections include a brief overview of related projects and planning studies that have an influence on the project and were considered throughout the design development.

2.5.1 Gold Coast Light Rail Stage 3

Gold Coast Light Rail Stage 3 (GCLR3) involves a 6.7km extension of the light rail from Broadbeach South (current terminus) to Burleigh Heads (south of Goodwin Terrace). The project includes eight new stations at Mermaid Beach, Mermaid Beach South, Nobby Beach, Miami North, Miami, Christine Avenue, Second Avenue and Burleigh Heads, as shown in Figure 6. The project is currently under construction with anticipated completion in 2025.



Adapted from www.gclr3.com.au/goldlinq/gclr3/map#mapboxHotspotsAll

Figure 6 GCLR3 project extent & stations

The B2C project is required to tie-into the GCLR3 works which includes a bus turnaround facility on the Gold Coast Highway at the Brake Street intersection.

2.5.2 M1 Pacific Motorway Upgrade: Varsity Lakes to Tugun

The M1 Pacific Motorway Upgrade (Varity Lakes to Tugun) project involves 10km of motorway widening between Varsity Lakes (Exit 85) and Tugun (Exit 95). The project includes significant interchange upgrades at Burleigh Heads, Tallebudgera and Palm Beach and provision of a new two-way western service road between Tallebudgera and Palm Beach (including a new bridge over Tallebudgera Creek), provision of smart motorway technologies and active transport provisions. The project is currently under construction with anticipated opening by the end of 2023.

This upgrade will significantly reduce traffic (particularly non-local and longer distance trips) on the Gold Coast Highway and ease congestion. The project will also ease traffic on Palm Beach Avenue in Palm Beach. Currently, Nineteenth Avenue does not connect to the M1 Motorway. However, as part of this project, a new western service road (parallel to the M1) will be constructed from Palm Beach Avenue to Tallebudgera Creek Rd (via Nineteenth Avenue), which will increase traffic on Nineteenth Avenue, enhancing the importance of this intersection with the Gold Coast Highway.

2.5.3 Cobaki Lakes Development

Cobaki Lakes is a major development in New South Wales (NSW) adjacent to the Queensland border involving mixed residential, commercial and community use redevelopment. The development has been approved by the NSW Government for 5,500 dwellings comprising 17 residential precincts with a population of 10,000 to 12,000 people. However, current TMR planning assumes development of 3,500 dwellings based on previous planning.

Access to the site is currently proposed via Boyd Street and will require provision of a new intersection on the Gold Coast Highway and widening of Boyd Street to four lanes. There is currently no intersection at Boyd Street and the Gold Coast Highway.

2.5.4 Gold Coast Oceanway

The Gold Coast Oceanway is a 36km network of shared cycle and pedestrian paths along the coastline from the New South Wales border to the Gold Coast (Southport) Seaway. The CoGC has been progressively building the Oceanway in stages since the early 2000s with planning and design of future stages for the remaining sections to be completed as funding becomes available.

Within the study area, the Oceanway is mostly complete with the exception of some missing sections between Twenty Third Avenue - Laceys Lane in Palm Beach which is one of the most constrained sections and is identified in CoGC planning as a ‘possible future link’. Planning for future upgrades to the Oceanway are also underway including a new active transport bridge at Currumbin Creek; Currumbin Surf Life Saving Club to Tomewin Street; Kropp Park to Wagawn Street; and Wagawn Street to Elizabeth Street. The B2C project is required to tie-into existing sections of the Oceanway and include provision for future Oceanway connections currently in planning.

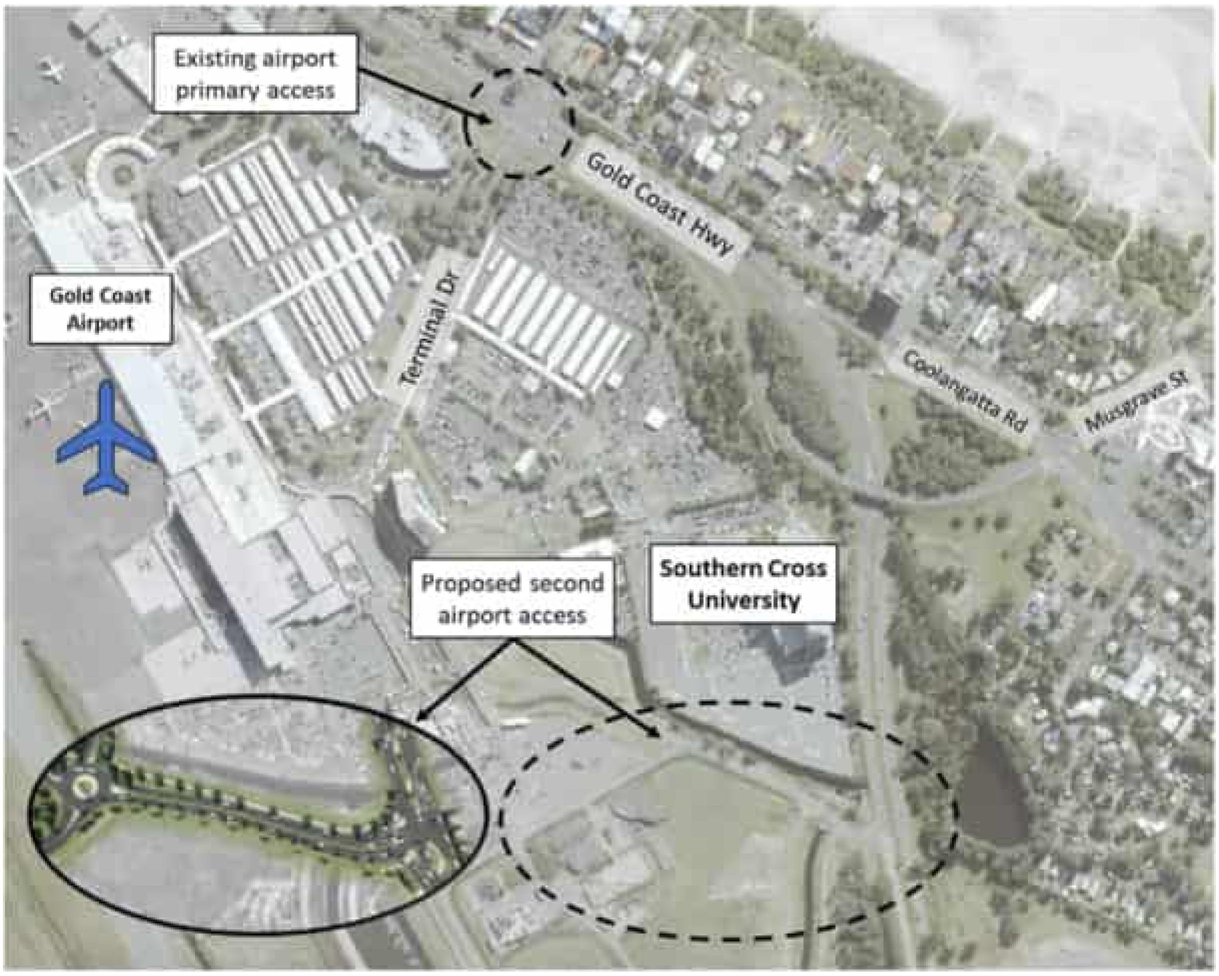
The Oceanway path currently varies between 3.5 to 5m wide and provides an attractive and uninterrupted facility for pedestrians and cyclists, particularly for recreational users.

2.5.5 Gold Coast Airport Masterplan

The Gold Coast Airport is a key destination within the ‘Southern Gateway’ Regional Economic Cluster and is situated on federal land adjacent to the Gold Coast Highway in Bilinga with the main airport entrance located at Terminal Drive. It is an international airport and is currently one of the fastest growing airports in Australia.

The *Gold Coast Airport 2017 Master Plan* outlines the airport’s strategic vision to support the continued growth of Gold Coast Airport as an economic and aviation gateway to the region. It provides a guide for the development of airport facilities, assessment of environment impacts, development of land use controls, and establishment of airport access requirements to meet the future aviation industry requirements.

The current master plan includes plans for a new southern access road from the Gold Coast Highway (new signalised intersection) near the QLD/NSW border (refer to Figure 7) which is jointly funded by both state governments. It also outlines plans for future transport connections including light and heavy rail extensions. While the plan acknowledges that timing of these projects is subject to funding availability and detailed investigations, it acknowledges that protection of these transport corridors is critical to preserve future economic growth opportunities associated with enhanced transport connectivity and accessibility. The plan notes that these transport opportunities will continue to be considered during future master planning cycles based on further project feasibility assessments and funding commitments.



Inset figure adapted from Archipelago (www.archipelago.com.au/gca-southern-entry)

Figure 7 Future airport second access

Under the Airports Act 1996, the Gold Coast Airport Pty Ltd is required to update the statutory master plan every five years, encompassing a 20-year period. Planning is currently underway for the master plan renewal. Since the GCH MMCS, TMR has been engaging with the Airport regarding the future light rail extension including a multi-modal interchange for bus and the future heavy rail extension (discussed further in the following section).

The Airport is located on Commonwealth (federal) land and is therefore outside of the QLD Government's jurisdiction. TMR therefore has no legislative or governance mechanisms available to influence the Airport Masterplan outcomes or preserve airport land (for future transport infrastructure).

The proposed light and heavy rail extensions will require changes to the airport masterplan to ensure the transport interchange is fully integrated with the airport. Details on the masterplan renewal will need to be confirmed in future phases to inform refinement of the LRT alignment (for the LRT Option). Therefore, further consultation with the Airport will be required in subsequent project phases and it is understood that the Airport will continue to consult with TMR (as a stakeholder) in relation to the Airport masterplan renewal.

2.5.6 Heavy Rail Extension

In 2005, TMR identified a possible corridor to extend the Gold Coast Heavy Rail line from Varsity Lanes (current terminus) south to Tugun. Following community consultation, a preferred rail corridor between Robina and Tugun (QLD/NSW border) was identified and preserved in 2008. The first stage between Robina and Varsity Lakes was then constructed in 2009. Further investigations were also conducted in 2009 as part of a wider Robina to Tugun Rail Impact Assessment Study that considered technical, environmental, social and economic impacts of a preferred rail alignment.

Following completion of the detailed design for the M1 Varsity Lakes to Tugun project (now under construction), which shares the same corridor for much of its length, TMR commenced further investigations to revisit and refine the planning for this future rail link. The *Gold Coast Airport Heavy Rail Options Analysis* (Jacobs, 2022) discusses the options analysis undertaken to inform the T2C MMCS, including update of the heavy rail extension concept design and confirmation/refinement of the property requirements to enable this rail extension to be implemented in the future. The design intent was to provide a consolidated Gold Coast Airport multi-modal interchange for bus and future light and heavy rail extensions.

Four heavy rail alignment options were investigated through the Airport with the heavy rail alignment passing below the existing airport runway protection slab at the southern end of the airport. An options assessment was undertaken using a multi-criteria analysis (MCA) that considered cost, land impacts, accessibility and proximity, transport performance, and social and environmental impacts. ‘Option P4’ was determined as the “emerging preferred concept” given it minimises property impacts through the Airport and SCU carpark, is centrally located within the Airport precinct near the Airport terminal and provides significant land use opportunities. This option was therefore progressed as the preferred option in the T2C MMCS. However, it was noted that further engagement with key stakeholders (specifically Queensland Rail, Translink and Gold Coast Airport Pty Ltd) is required in future phases regarding specific heavy rail and light rail design requirements and to ensure the design intent is appropriately reflected in the revised Gold Coast Airport statutory masterplan.

There is currently no committed timeframes or funding for this project.

2.6 Stakeholder Engagement

The PE is being coordinated by TMR’s South Coast Region, in partnership with CoGC. AECOM conducted engagement with the following stakeholders as part of this commission:

- TMR:
  - TransLink and GCLR advisors
  - Engineering and Technology (E&T) branch (including representatives from the following teams: Structures, Geotechnical, Environment, Hydraulics, Risk, Costs, Property, Construction, Traffic Analysis Unit, Maintenance and Assets)
  - Operational and Policies Teams: Environmental Assessment, Active Transport, Accessible Transport, Safe Systems Assessment
- CoGC: GCLR3 and GCLR4 advisors, Transport, Hydraulics and Planning teams (excluding the Service Authorities)
- Other consultants engaged by TMR and CoGC for this PE including PWC, Jacobs, Bitzios Consulting, RPS Group and Aurecon
- Transport for NSW (TfNSW) regarding future changes to the NSW public transport services.

AECOM facilitated a number of workshops throughout the project to inform the development of the concept designs and technical investigations, as summarised below:

- Project scoping workshop – held on 5 May 2022
- Basis of Design (including overview of the supporting Access, Active Transport, and People & Place strategies) – held on 3 June 2022
- LRT Opportunities workshop – held on 17 June 2022
- Active Transport Workshops – held on 29 June and 6 July 2022
- People & Place Workshop – held on 7 July 2022
- LRT Sub-Options Analysis workshop 1 – held on 14 July 2022
- LRT Sub-Options Analysis workshop 2 – held on 20 July 2022
- Cost Estimate Risk Workshop – held on 27 October 2022

- 2 x Risk Workshops – initial risk identification workshop held on 16 June 2022 and final risk workshop held on 14 December 2022.

Refer to the *Stakeholder Engagement Report - B2CTS-PE-410-REP-00001* (Appendix A) for further information on the stakeholder engagement process.

3.0 Existing Situation

3.1 Corridor Function

The Gold Coast Highway between Burleigh Heads and Coolangatta is a major arterial road and serves an important traffic function being one of the primary north-south corridors in the southern Gold Coast transport network, in addition to the M1 Pacific Motorway. The Gold Coast Highway forms the major coastal route connecting the suburbs of Burleigh Heads, Palm Beach, Currumbin, Tugun and Coolangatta for local residents and tourists to access the iconic beaches and nature reserves of the Southern Gold Coast. While the M1 Motorway serves as the primary transport corridor for freight and longer distance, inter-regional trips between Brisbane, the Gold Coast and New South Wales.

The Gold Coast Highway is a state-controlled road and multi-modal corridor carrying general traffic, high frequency public transport (bus) services, bike riders (as a TMR designated Principal Cycle Route) and pedestrians. Connections to the M1 Motorway are provided via key east-west connections (from north to south) at Reedy Creek Road/West Burleigh Road, Palm Beach Avenue, Thrower Drive (with limited connections to/from the motorway) and Tugun - Currumbin Road (Stewart Road).

At the northern end from Burleigh Heads to Tugun, the corridor functions as an urban arterial road and is characterised by numerous intersections and direct property accesses along its length adjacent to a densely populated, urban environment and a posted speed limit varying from 50-70km/h. This section includes two major creek crossings at Tallebudgera Creek and Currumbin Creek and passes through environmentally sensitive areas at Burleigh Heads and Currumbin.

The southern section of the Gold Coast Highway from Tugun to Tweed Heads serves an urban highway function and is characterised by a median divided, dual carriageway with restricted access and an 80km/h speed environment. This section serves an important function being the primary north-south alternative route for the M1 Tugun Bypass Tunnel for vehicles not permitted in the tunnel (e.g. over height vehicles, heavy vehicles carrying dangerous good) and as a detour route for the tunnel during roadworks, maintenance and temporary closures during incidents (such as crashes or vehicle breakdowns).

Coolangatta Road is a Council distributor road that connects the Gold Coast Highway at Coolangatta to the Coolangatta/Tweed Heads CBD. It has a 60km/h posted speed limit and is generally a median divided road that passes through a low density residential area and includes a number of intersections (signalised and unsignalised) and property accesses for adjoining residential properties.

South of Coolangatta Road, the project corridor traverses through Lanham Street Park towards the Coolangatta CBD, then follows the alignment of Lanham Street and Chalk Street, terminating at Warner Street. Lanham Street and Chalk Street are both classified as CoGC local roads with a default 50km/h speed limit. Chalk Street is a one-way (southbound) road that provides access to local businesses and the Chalk and Lanham Street Carpark; while Lanham Street is a two-way road that provides access to local businesses, residential properties and the carpark.

3.2 Transport Network

The Gold Coast Highway is a multi-modal transport corridor that carries general traffic, freight, public transport (bus) services and active transport. These transport modes are discussed in further detail below.

3.2.1 Road Network

The Gold Coast Highway is a TMR state-controlled urban arterial road and Coolangatta Road is Council distributor road, as noted in Table 1. In 2020, the Gold Coast Highway carried an annual average daily traffic volume (AADT) of up to 42,000 vehicles per day (vpd) through the busiest section of the project corridor at Tallebudgera Creek. The Gold Coast Highway section from Tugun Currumbin Road to the M1 Pacific Motorway interchange, Tweed Heads forms an important freight function an approved 25-metre B-double route and alternative detour route to the M1 Tugun Bypass Tunnel.

The Gold Coast Highway and M1 Pacific Motorway are the primary north-south road corridors in the southern Gold Cost area. Key side roads connecting these corridors include:

- West Burleigh Road, Burleigh Heads (TMR arterial road)
- Nineteenth Avenue, Palm Beach (CoGC distributor road)
- Palm Beach Avenue, Palm Beach (CoGC sub-arterial road)
- Thrower Drive, Palm Beach (CoGC sub-arterial road)
- Duringan Street, Currumbin (CoGC distributor road)
- Tugun Currumbin Road / Stewart Road (TMR arterial road)
- Boyd Street (CoGC sub-arterial road)
- Terminal Drive (classified as a local road, however, is the primary access to the Airport)
- Musgrave Street (CoGC distributor road).

Other key roads within the project's area of influence include:

- Golden Four Drive (CoGC distributor road) – located to the immediate east of the Gold Coast Highway, running parallel to it from Tugun to Coolangatta
- M1 Pacific Motorway (TMR motorway) – located to the west of the highway and generally runs parallel to it along the entire project extent.

3.2.2 Public Transport

The Gold Coast Highway is well served by public transport with three high frequency bus routes as summarised below:

- Route 700 travels between Broadbeach South (current GCLR terminus) and Tweed Heads up to 8 times an hour (every 7.5 minutes) with bus stops approximately every 300m.
- Route 777 operates every 15 minutes between Broadbeach South and the Gold Coast Airport. This is an express route which currently only services bus stops at Burleigh Heads, Twenty Seventh Avenue, Nineteenth Avenue, Palm Beach Avenue within the study corridor.
- Route 765 travels between The Pines Shopping Centre and Robina Town Centre via Varsity Lakes and operates every 15 minutes. This route travels along Gold Coast Highway between Christine Avenue, North Burleigh and Thrower Drive, Palm Beach.
- The Route 760 is another major trunk route that currently operates every half hour between the Gold Coast Airport and Varsity Lakes via Elanora (The Pines) and the M1 Motorway. This route operates along the Gold Coast Highway between Thrower Drive, Palm Beach the Airport and Coolangatta Road, then continues along Musgrave Street/Griffith Street through Coolangatta to Tweed Heads.

Gold Coast Light Rail Stage 3 (GCLR3) is currently under construction with anticipated completion in 2025. The project involves a 6.7km extension of the light rail from Broadbeach South (current terminus) to Burleigh Heads (south of Goodwin Terrace). On completion, the Routes 700, 777 and 765 will be truncated at the Gold Coast Highway to remove duplication with the light rail function, however, these services are expected to operate on the same headways noted above.

There are currently no public transport services operating along Coolangatta Road in Coolangatta. However, Coolangatta is well serviced by the Routes 700, 760, 768 and 601 (NSW service) which travel along Musgrave Street/Griffith Steet between Coolangatta Road and Tweed Heads and is located within 250m walking distance to Coolangatta Road.

3.2.3 Active Transport

The Gold Coast Highway and Coolangatta Road are designated as principal cycle routes in TMR's Principal Cycle Network Plan (PCNP) and is supported by local government planning. There is currently a high demand for bike riders travelling north-south along the entire B2C project corridor including longer-distance commuter, utility and education trips, and shorter distance local trips to access public transport, shops, cafes/restaurants, the beach and other key attractions.

There is also demand for east-west connections (traversing the project corridor) to access nearby land uses and other active transport corridors (such as the Oceanway) and principal cycle routes at the following locations:

- Palm Beach – Tallebudgera Drive, Nineteenth Avenue, Twenty-Third Avenue (Gold Coast Highway to the Oceanway), Palm Beach Avenue and Thrower Drive
- Currumbin – Duringan Street
- Tugun – Tugun Currumbin Road, Toolona Street (east) and Kitchener Street (west). The section of Boyd Street (west of Coolangatta Road) is also shown as a Principal Cycle route.
- Bilinga – Gibson Street (east) which connects to Golden Four Drive and the Oceanway.

Footpaths are currently provided along the Gold Coast Highway generally on both sides through Tallebudgera, Palm Beach and Tugun; and on one side (generally the eastern side) from Thrower Drive to Tomewin Street, and Tugun (between Winders Avenue and Wagawn Street). South of Toolona Street in Tugun, pedestrian facilities and on-road bicycle lanes are generally provided on Golden Four Drive and Coolangatta Road (i.e. the parallel side roads) rather than the Gold Coast Highway. There is currently limited cyclist provision on the Gold Coast Highway, with the exception of on-road bicycle lanes between Toolona Street to Terminal Drive in Tugun/Bilinga.

Note there is narrow path widths and non-compliant grades >3% at sections along the corridor, particular along the Gold Coast Highway over the Burleigh Hill (up to 6%), Currumbin Hill (up to 5%) and Tugun Hill (up to 6%), and the path through the old rail cutting is also graded up to 9%.

The two major creek crossings are key connections in the active transport network and include the following active transport provisions:

- Tallebudgera Creek: 2m wide shared path on the eastern and western sides
- Currumbin Creek: 1.8m wide shared path on the eastern side only.

Pedestrian crossing facilities are located relatively frequently (generally between 200-800 metres) on the Gold Coast Highway, generally at signalised intersections. The Palm Beach section being situated in an urban environment features pedestrian crossings at closer proximity, while the Tugun/Bilinga section and environmentally sensitivity areas through Burleigh Hill and Currumbin Hill feature pedestrian crossings at larger spacings due to the limited frontage activity and sparser distance between connecting roads/streets. Similarly, a review of signalised pedestrian crossing facilities (undertaken as part of the GCH MMCS) identified the Palm Beach crossings were the most heavily utilised, in addition to Toolona Street in Tugun (near the Tugun CBD).

The study area is also serviced by the Gold Coast Oceanway (refer to Section 2.5.4 for further information). The Oceanway path varies between 3.5 metres to 5 metres wide and generally caters for recreational users within the study area, the Oceanway is mostly complete with the exception of some missing sections between Twenty Third Avenue - Laceys Lane in Palm Beach which is one of the most constrained sections and is identified in CoGC planning as a 'possible future link'.

3.3 Existing Road Conditions

3.3.1 Corridor Width and Typical Cross Sections

The existing corridor widths and typical cross sections vary significantly throughout the corridor. Photos of the typical cross section for each segment are shown below.

Segment 1 – Burleigh Headlands

- Four-lane, median divided arterial road with parking lanes and direct property access to residential dwellings (combination of low to high density). The alignment consists of large horizontal curves and steep grades passing over Burleigh Headland

Segment 2 – Palm Beach

- Four-lane, median divided arterial road with parking lanes with numerous direct property access to medium to high density residential dwellings and commercial buildings. The alignment is generally on a straight, flat terrain.

Segment 3 – Currumbin

- Four-lane, median divided arterial road with some short sections of parking and numerous direct property accesses to low/medium residential density dwellings. The alignment is relatively straight with steeper grades passing over Currumbin Hill.

Segment 4 – Tugun to Bilinga

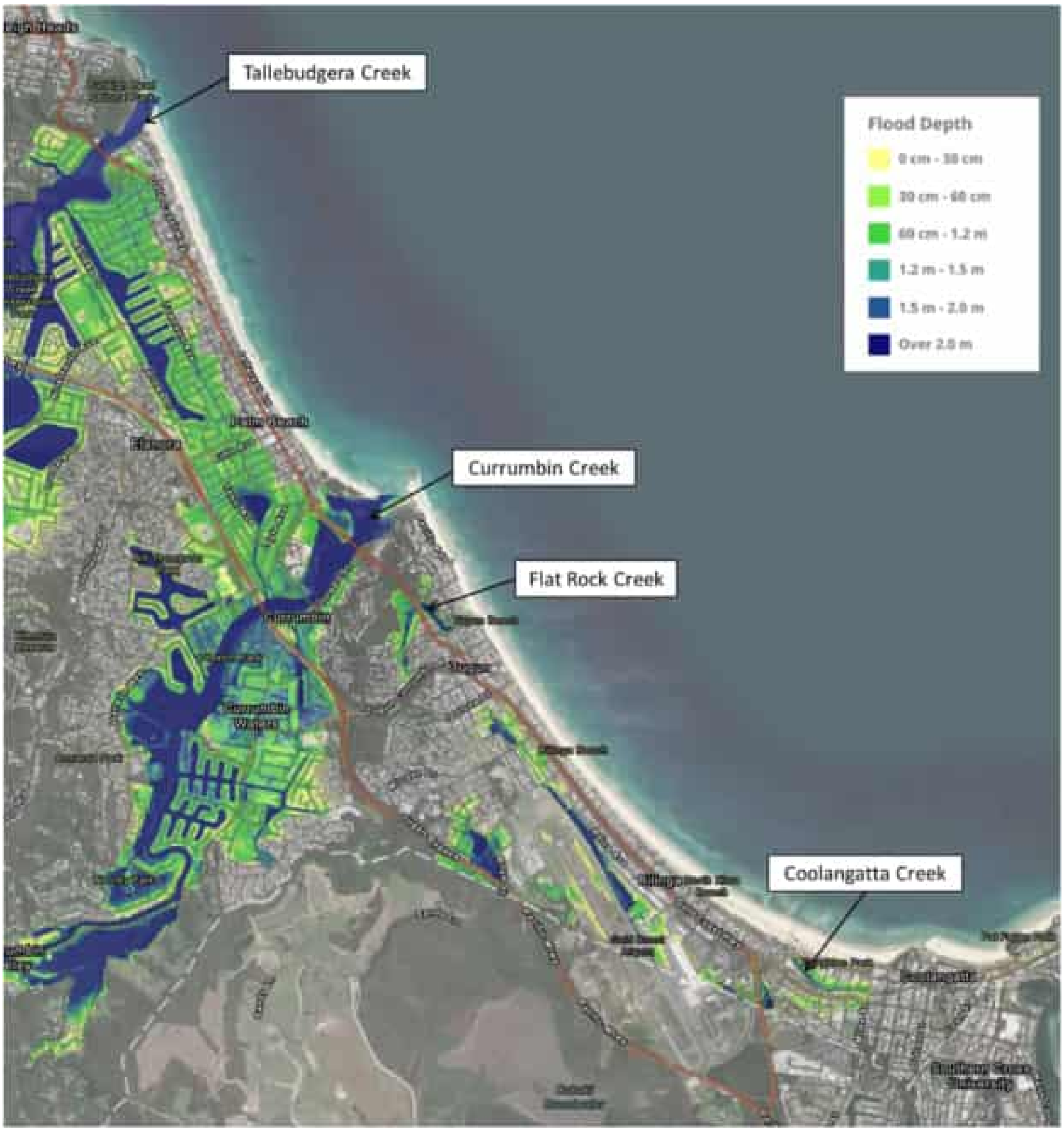
- Four-lane, median divided urban highway with bicycle lanes and limited access to signalised and unsignalised intersections. The alignment is generally on a straight, flat terrain. Property access is provided via Golden Four Drive and Coolangatta Road which run parallel to the highway (on either side) and function as the lower-order roads for local trips.

Segment 5 – Kirra to Coolangatta

- Four-lane, median divided distributor (local) road with parking lanes and numerous direct property accesses to low/medium residential density dwellings. The alignment is relatively straight and flat.

3.3.2 Key Drainage Features and Flood Immunity

Within the project corridor there are two significant floodplains: Currumbin Creek and Tallebudgera Creek. There are also two smaller creeks at Flat Rock Creek (Currumbin) and Coolangatta Creek, in addition to overland flow paths flooding in the Palm Beach and Coolangatta catchments. Figure 8 shows the 1% Annual Exceedance Probability (AEP) flood map for the study area covering these floodplains and overland flow paths.



Source: CoGC flood depth planning map (www.goldcoast.qld.gov.au)

Figure 8 Flood depths map (1% AEP year 2100 flood depths)

3.3.3 Bridge Structures

There are two existing road bridges within the project corridor: Tallebudgera Creek Bridge and Currumbin Creek Bridge.

Tallebudgera Creek Bridge is a fifteen span, simply supported structure with the southbound deck initially designed in 1968. Widening of the northbound carriageway was undertaken in 1973. Both traffic decks are extremely slender and comprise 350mm deep transversely stressed deck units. The foundations comprise a mixture of under-reamed lined caissons, short cast-in-place bored piers to rock and driven precast hollow spun piles.

Currumbin Creek Bridge is a six span, simply supported structure initially designed in 1972 for H20-S16 loading. The bridge is on a 4.1% vertical grade and consists of a north and southbound carriageway which flares over the last two spans at the southern end. The deck is formed of continuous prestressed concrete I-girders acting compositely with the deck slab and has a retrofitted girder restraint system. The pier foundations comprise a large raft of raked driven precast concrete piles within the main creek channel. The abutments are large cellular concrete structures supported on raked driven piles.

A structural analysis of the existing bridge conditions at Currumbin Creek and Tallebudgera Creek was undertaken as part of the B2T MMCS to determine suitability or otherwise for new light rail infrastructure and vehicles. This analysis concluded that:

- The existing bridge structures are over 40 years old with the Level 2 inspection reports (undertaken in 2014) rating the Currumbin Creek and Tallebudgera Creek southbound bridges as Condition State 3 (Poor).
- Both the superstructures of the Currumbin Creek and Tallebudgera Creek bridges are inadequate for light rail vehicle loading.
- The design, construction and safety constraints of strengthening/modifying the bridges would likely be unfeasible and uneconomic.

In summary, both existing bridges are structurally inadequate to accommodate the design loads specified in AS5100 2017. Therefore, the existing Tallebudgera and Currumbin Creek bridges should remain as road bridges and that new bridge structures would be required to accommodate light rail vehicles over these two creek crossings.

3.3.4 Road Pavement

The composition and condition of the existing pavement has been assessed. ARMIS data was used to determine the pavement composition. Rutting, roughness, cracking and TSD deflection values were examined and are summarised in Table 4 to Table 8 below. The current condition of the pavement has been evaluated based on the limits set out in Table 3 below.

Table 3 Criteria for the evaluation

Parameter	Limit
90^{th}% percentile of 80^{th} Percentile OWP Rutting (mm)	<7mm
90^{th} percentile of roughness counts (counts/km)	Less than 90 counts/km
Transverse Cracking (%) - average	Less than 5%
Cracking (%) – average	Less than 5%
90^{th} percentile TSD D_0 (microns)	Asphalt base <400 microns Granular base <500 microns
90^{th} percentile TSD C_u (microns)	< 200 microns

3.3.4.1 Segment 1

Table 4 Summary of Pavement Condition: Segment 1

Pavement Structure from ARMIS (Lanes 1 and 2)		
Gazettal Chainage (km)	**40.070 – 40.500**	**40.500 – 41.900**
Layer 1	60-260mm Dense Graded Asphalt	20-60mm Dense Graded Asphalt
Layer 2	150-300mm Granular Base	150-300mm Granular Base
Layer 3	Subgrade (Adopted CBR 2%)	Subgrade (Adopted CBR 7%)
Summary of Existing Pavement		
Homogenous Section	**1-1 (Ch. 40.070 – 40.500km)**	**1-2 (Ch. 40.500 – 41.900km)**

Pavement Structure from ARMIS (Lanes 1 and 2)				
Gazettal Chainage (km)	**40.070 – 40.500**		**40.500 – 41.900**	
Parameter	**Northbound**	**Southbound**	**Northbound**	**Southbound**
90^{th}% percentile of 80^{th} Percentile OWP Rutting (mm) -	6.90	7.76	13.60	8.12
90^{th} percentile of roughness counts (counts/km)	78.20	84.56	96.74	93.83
Transverse Cracking (%) - average	3.45	3.58	12.34	11.06
Cracking (%) - average	8.21	7.30	27.65	28.35
Summary of TSD Deflection Analysis				
Parameter	**Northbound**	**Southbound**	**Northbound**	**Southbound**
90^{th} Percentile D0 (Microns)	N/A	465.17	384.05	757.72
90^{th} Percentile Curvature (Microns)	N/A	167.15	154.07	246.25
Notes: Roughness counts converted from lane quarter car IRI measurements (AGPT05, 2007).				

Overall, the pavement's response to deflection testing in Section 1 is typical of what is expected of a thin asphalt on granular structure with high traffic loading.

Curvature values are mostly average (<200 microns). The exception to this is Section 1-2 in the Southbound direction which displays a curvature function value of 246 microns. It is noted that although higher curvature and deflection results are presented in the Southbound direction of Section 1-2 the Northbound direction exhibits similar levels of cracking along with higher roughness and rutting. This strengthens the case for undertaking pavement testing.

Characteristic deflections are moderate to high in all sections (384-758 microns) and did not display a correlation with rut depth as Section 1-2 displays both the lowest deflections and the highest 80^{th} percentile rutting values. No deflection data was analysed for Section 1-1 in the northbound direction.

3.3.4.2 Segment 2

Table 5 Summary of Pavement Condition: Segment

Pavement Structure from ARMIS (Lanes 1 and 2)		
Gazettal Chainage (km)	**41.900 – 45.700**	**43.350 – 44.300km (Northbound Only)**
Layer 1	20-70mm Dense Graded Asphalt	270mm Dense Graded Asphalt
Layer 2	150mm Granular Base	150mm Category 2 Cement Stabilised Granular
Layer 3	Subgrade (Adopted CBR 7%)	20mm Dense Graded Asphalt
Layer 4		150mm Granular Subbase
Layer 5		Subgrade (Adopted CBR 7%)
Summary of Existing Pavement		
Homogenous Section	**2-1 Southbound: Ch. 41.900-45.700**	**2-2 (Ch. 43.350-44.300)**

Pavement Structure from ARMIS (Lanes 1 and 2)			
Gazettal Chainage (km)	41.900 – 45.700		43.350 – 44.300km (Northbound Only)
	Northbound: Ch. 41.900-43.350 & 44.300-45.700		
Parameter	Northbound	Southbound	Northbound
90th% percentile of 80th Percentile OWP Rutting (mm) -	8.10	9.46	2.50
90th percentile of roughness counts (counts/km)	69.09	81.96	45.35
Transverse Cracking (%) - average	7.39	5.14	0.96
Cracking (%) - average	19.29	13.89	3.09
Summary of TSD Deflection Analysis			
Parameter	Northbound	Southbound	Northbound
90th Percentile D0 (Microns)	557.25	580.596	75.13
90th Percentile Curvature (Microns)	173.46	167.356	6.57
Notes: Roughness counts converted from lane quarter car IRI measurements (AGPT05, 2007).			

Overall, the pavement's response to deflection testing in Section 2-1 is typical of what is expected of a thin asphalt on granular pavement with high traffic loading. Curvature values are mostly average (<200 microns) for a thin asphalt pavement with cracking, roughness and rutting values slightly lower in the Northbound direction. Characteristic deflections are moderate in this section (557-581), although still indicating a pavement which may require intervention, with the slightly higher deflection in the Southbound direction correlating to a slightly higher rutting depth.

Section 2-2 performs as expected for a thick asphalt with a stabilised base. It displays an extremely low curvature value of 7 microns which correlates to the minimal cracking, roughness and rutting observed for this section. The Characteristic deflection for this section is also very low at 75 microns.

3.3.4.3 Segment 3

Table 6 Summary of Pavement Condition: Section 3

Pavement Structure from ARMIS (Lanes 1 and 2)		
Gazettal Chainage (km)	45.700 – 47.700	
Layer 1	20-150mm Dense Graded Asphalt	
Layer 2	150mm Granular Base	
Layer 3	Subgrade (Adopted CBR 7%) throughout & CBR 2% Ch. 46.850 – 47.150km & 47.650 – 47.750km	
Summary of Existing Pavement		
Homogenous Section	3-1 Ch. 45.700 – 47.700	
Parameter	Northbound	Southbound
90th% percentile of 80th Percentile OWP Rutting (mm) -	4.60	5.00

Pavement Structure from ARMIS (Lanes 1 and 2)		
Gazettal Chainage (km)	45.700 – 47.700	
90th percentile of roughness counts (counts/km)	76.35	56.11
Transverse Cracking (%) - average	4.33	1.98
Cracking (%) - average	10.03	5.34
Summary of TSD Deflection Analysis		
Parameter	Northbound	Southbound
90th Percentile D0 (Microns)	399.76	423.13
90th Percentile Curvature (Microns)	172.09	149.60
Notes: Roughness counts converted from lane quarter car IRI measurements (AGPT05, 2007).		

Overall, the pavement's response to deflection testing in Section 3 is typical of what is expected of a thin asphalt on granular pavement in a good condition. Curvature values are generally below 200 microns indicating a stiff pavement. Cracking and roughness is lower in the Southbound direction while rutting is lower Northbound. Characteristic deflections are moderate in this section (400-423 microns) with the slightly higher deflection in the Southbound direction correlating to a slightly higher rutting depth.

3.3.4.4 Segment 4

Table 7 Summary of Pavement Condition: Section 4

Pavement Structure from ARMIS (Lanes 1 and 2)		
Gazettal Chainage (km)	47.700 – 51.400	
Layer 1	80-275mm Asphalt (Various)	
Layer 2	150mm - 300mm Granular Base	
Layer 3	Subgrade (Adopted CBR 7%)	
Summary of Existing Pavement		
Homogenous Section	4-1 Ch. 47.700-51.400	
Parameter	Northbound	Southbound
90th% percentile of 80th Percentile OWP Rutting (mm) -	6.66	7.08
90th percentile of roughness counts (counts/km)	62.57	66.76
Transverse Cracking (%) - average	4.27	2.63
Cracking (%) - average	9.43	6.42
Summary of TSD Deflection Analysis		
Parameter	Northbound	Southbound
90th Percentile D0 (Microns)	371.246	244.092
90th Percentile Curvature (Microns)	102.718	72.306
Notes: Roughness counts converted from lane quarter car IRI measurements (AGPT05, 2007).		

Based on the available condition data, the pavement appears to be in a sound condition. This is supported by the low roughness counts, limited transverse cracking and the low rut values. The deflection data indicate sound stiff pavement.

3.3.4.5 Segment 5

Table 8 Summary of Pavement Condition: Section 5

Pavement Structure from ARMIS (Lanes 1 and 2)		
Gazettal Chainage (km)	**51.400 – 52.700**	
Layer 1	90-200mm Densely Graded Asphalt	
Layer 2	320mm - 445mm Granular Base	
Layer 3	Subgrade (Adopted CBR 7%)	
Summary of Existing Pavement		
Homogenous Section	**5-1 Ch. 51.400-52.700**	
Parameter	**Northbound**	**Southbound**
90^{th}% percentile of 80^{th} Percentile OWP Rutting (mm) -	2.29	3.48
90^{th} percentile of roughness counts (counts/km)	69.11	49.75
Transverse Cracking (%) - average	0.49	0.19
Cracking (%) - average	1.66	0.76
Summary of TSD Deflection Analysis		
Parameter	**Northbound**	**Southbound**
90^{th} Percentile D0 (Microns)	253.39	281.552
90^{th} Percentile Curvature (Microns)	70.354	84.004
Notes: Roughness counts converted from lane quarter car IRI measurements (AGPT05, 2007).		

Overall, the pavement's response to deflection testing in Section 5 is very good for an asphalt on granular pavement. Curvature values are low (<100 microns) with cracking and roughness consistent and low in both directions. Characteristic deflections are also low in this section (253-282).

3.3.4.6 Summary

Based on the available information, the pavement generally consists of a thin (approximately 100mm) of asphalt on a granular base. Some areas have thicker asphalt, like segment 5 and possible reuse of this pavement can be investigated. The condition of the carriageways are summarised below.

- Northbound Carriageway
    - Segment 1, 2 and 4 on average exhibits higher deflections and a higher percentage of cracking. Segment 1 and 2 exhibits a high percentage of crocodile and transverse cracking. A review of the 90^{th} percentile values indicate that the segments 1,2 and 4 will require remediation soon.
    - Segments 3 and 5 on average exhibit lower deflections. A review of the 90^{th} percentile data indicate possible areas of weak pavement however rutting, roughness and cracking are below intervention levels.

- Southbound Carriageway
  - Segment 1 and 2 on average exhibits deflections more than 400 microns. Segment 1 on average has more than 5% crocodile and transverse cracking, while segment 2 appears to have a lower incidence of crocodile cracking but transverse cracking in excess of 5%. The 90th percentile roughness exceeds 90counts/km in segment 1 but is below the intervention level in segment 2. Based on the analysis of the existing condition data, segments 1 and 2 require intervention.
  - Segment 3 on average has low deflections but has rutting above 7mm on average and has more than 5% crocodile cracking on average. A review of the 90th percentile values indicate a pavement that requires intervention.
  - Segment 4 on average has low deflections but has rutting above 7mm on average and a roughness count below the intervention level. A review of the 90th percentile values indicate that the roughness level is below 90 counts/km. Segment 5 appears to be in a good condition.

Based on the evaluation, the pavement is generally not suitable for reuse for the proposed options due to insufficient cover for the predicted traffic loading and due to the condition of the pavement. However, reuse of the pavement in Segment 5 and the reuse of the existing granular layers should be considered in future analysis.

3.3.5 Safety and Crash History

A crash assessment was undertaken using Queensland Government Open Data Portal based on data from the most recent five-year period from 1 July 2016 to 20 June 2021. The crashes by severity and type (based on the definitions for classifying accidents (DCA) code descriptions)) are outlined in Table 9 and Table 10, respectively.

As shown, there have been 258 crashes recorded along the project corridor over the most recent five-year period from 1 July 2016 to 20 June 2021. Of these crashes, 3 crashes resulted in a fatality and 82 resulted in hospitalisation, meaning 33% of all crashes were fatal or serious injury (FSI).

In terms of crash type, rear-end crashes were the most predominant crash type (48% of all crashes) which is typical for an urban arterial road. This was followed by intersection crashes from adjacent approaches (14%) which typically occur at unsignalised intersections or as a result of a vehicle illegally driving through a red light.

Table 9 Crashes by severity

Crash Severity	No. of Crashes	Percentage of Total Crashes
Fatal	3	1%
Hospitalisation	82	32%
Medical Treatment	114	44%
Minor Injury	59	23%
Total	**258**	**100%**

Table 10 Crashes by crash type

Crash Severity	No. of Crashes	Percentage of Total Crashes
Other	14	5%
Lane Changes	12	5%
Rear-end	123	48%
Intersection from adjacent approaches	35	14%
Vehicle leaving driveway	8	3%
Hit parked vehicle	3	1%
Off carriageway on straight hit object	11	4%
Opposing vehicles turning	21	8%
Out of control on curve	3	1%
Off carriageway on curve hit object	8	3%
Pedestrian	13	5%
U-turn	2	1%
Out of control on straight	1	0%
Head-on	4	2%
Total	**258**	**100%**

Table 11 provides more detailed information on the fatal crashes that occurred on the project corridor during the five-year period. Each of the crashes was a different crash type and all occurred at different locations along the corridor during differing time periods. As such, there are no correlations that can be observed based on the available crash data information.

Table 11 Fatal crashes

DCA Crash Description	Year	Intersecting Street	Time of Day	Crash DCA Code	Comments
Out of control on curve	2016	Thrower Drive	5:00pm	805	1 Fatality 1 Hospitalisation
Pedestrian	2018	Toolona Street	9:00pm	3	1 Fatality
Intersection from adjacent approaches	2018	Musgrave Street	8:00am	101	1 Fatality - Motorcycle

3.3.6 Public Utility Plant (PUP)

Public utility plant (PUP) assets along the project corridor were identified through Before You Dig Australia (BYDA) searches along with collating further information from utility owners' GIS information. A summary of utilities along the project corridor is provided below.

- **Electricity:**
  - Overhead electrification is predominantly located along the Gold Coast Highway, running parallel to the highway within the eastern verge between Tallebudgera Creek and Thrower Drive, Palm Beach; and through Tugun from Farrell Drive to Wagawn Street. South of Tugun, overhead electrification runs along the eastern verge of Golden Four Drive through Tugun-Bilinga.

  - Underground electrification is generally located along both verges of the Gold Coast Highway and at intersections.
- **Water** – Water utilities are generally located along the Gold Coast Highway (both verges) along most of the project corridor. Occasional perpendicular crossings are also located along the corridor, particularly through Palm Beach and Bilinga from the Gold Coast Airport to Coolangatta.
- **Gas** – Gas pipes run parallel to the Gold Coast Highway (in the eastern verge) along the majority of the corridor. There are also some perpendicular crossings to the western verge located sporadically along the corridor, including the section from Tomewin Street and Wagawn Street where the gas pipe temporarily switches to the western verge, before crossing back to the eastern verge.
- **Sewer**
  - There are some existing sewer pipes located sporadically along the Gold Coast Highway from Burleigh Heads to Tugun between the eastern and western verges. From Bilinga to the Airport, sewer pipes run along the Gold Coast Highway adjacent to the Golden Four Drive and Coolangatta Road verges, with only two perpendicular crossings, at Kiewa Avenue and Cahill Street (pressurised pipe).
- **Communications/Optical Fibre**
  - Telstra, Optus, Nextgen, TPG and NBN services are located along the project corridor, generally within the eastern and western verges of the Gold Coast Highway, with occasional perpendicular crossings and centre of road running.
  - A Telstra exchange is located on the eastern side of the Gold Coast Highway, immediately north of Wagawn Street, Tugun above the highway.
- **Sand dredge pipe**
  - Above ground pipe (combination of temporary and permanent installations) along the eastern verge of the Gold Coast Highway between Rudd Park, Burleigh Heads and Tallebudgera Creek.

3.4 Existing Environment

3.4.1 Environmental and Cultural Heritage

An Environmental Scoping Report (ESR) was prepared as part of the PE to assess potential environmental risks and opportunities associated with the Project. The ESR represents a high-level desktop environmental assessment with the intended outcome being to determine an overall environmental risk rating for the Project and identify whether further environmental assessments are warranted as part of the pre-construction process.

The ESR was based on a combination of desktop environmental database resources and the findings of targeted site investigations for noise and ecology. It draws upon existing cultural heritage assessments undertaken by TMR and Jabree Limited (owner of the Jellurgal Cultural Centre). No additional heritage investigations were undertaken. No site visit or investigations were undertaken specifically for the ESR or cultural heritage assessments as it is understood that detailed site investigations will be undertaken during subsequent project phases once a preferred option has been selected and impact areas are confirmed.

The ESR assessed the project as having a high risk rating in terms of environmental and cultural heritage risk. High risk environmental elements typically require further detailed environmental assessment and have many site specific impacts, complex legislative approvals and have numerous design and contract consideration. Key risks identified in the ESR are summarised below:

- Water quality – Erosion and sedimentation:
  - The study area traverses a number of watercourse (both marine and freshwater) and the project has the potential to impact water quality during construction and operation.

- The study area includes a number of Matters of State Environmental Significance (MSES) wetlands and groundwater dependant ecosystems (GDE) that either intersect or are proximate to the expected alignment.
- Parts of the study area fall within mapped Coastal Management Districts (CMD) and are therefore likely to be affected by coastal hazards such as sea erosion and storm tide inundation.

- Acid Sulfate Soils (ASS) – The study area contains sections which are likely to contain ASS, including: Tallebudgera Creek, Currumbin Creek, Flat Rock Creek and, Coolangatta Creek drainage outlet (near Winston Street).
- Contaminated land – The study area contains sites which are deemed high risk for Per- and Poly-fluoroalkyl Substances (PFAS), including: Bilinga Fire and Rescue Station, Tweed Heads Fire Station, Eloy Water Australia, sewerage treatment plant and the Gold Coast Airport.
- Flora:
  - The study area is likely to contain threatened flora species protected under State and Commonwealth law. High risk areas expected to contain threatened species are: Tallebudgera Creek, Burleigh Ridge Park, Burleigh Head National Park, Currumbin Creek (Tarrabora Reserve, Kandra Reserve, Currumbin Hill Conservation Park) and Flat Rock Creek (Alex Griffiths Park).
  - State and local biodiversity corridors intersect the study area at Tallebudgera Creek and Currumbin Creek
- Fauna:
  - The study area impacts mapped koala habitat and is likely to contain threatened fauna species protected under State and Commonwealth law. High risk areas expected to contain threatened species include Tallebudgera Creek, Burleigh Head National Park, Currumbin Creek and Flat Rock Creek
  - There are two Fish Habitat Areas located near the study area at Currumbin Creek and Tallebudgera Creek
- Cultural Heritage – desktop assessments identified a number of Indigenous and historic heritage values along the study area
- Noise and vibration – there are numerous sensitive receptors located within the study area.
- Native Title and land tenure – there are locations within the study area which have land tenure that may require Native Title to be extinguished.
- Offsets – the project is likely to impact Commonwealth and State threatened species through clearing of mapped habitat. This has the potential to trigger offsets under both Commonwealth and State legislation.

The *Environmental Scoping Report - B2CTS-PE-439-REP-00001* (refer to Appendix C) provides further information on the environmental and cultural heritage risks including recommended mitigation measures and further assessments/approvals required in subsequent project phases.

3.4.2 Air and Noise Scoping Assessment Report

Noise sensitive land uses are defined by the TMR *Road Transport Noise Code of Practice, Volume 1 – Road Traffic Noise* (2013) as:

- Existing residences
- Educational, community and health buildings
- Outdoor educational and passive recreational areas (including parks).

Further to the above, heritage buildings / structures, public utility plant and exiting infrastructure such as bridges and culverts are also considered vibration sensitive receivers. In addition to anthropogenic sensitive receivers, natural areas such as known breeding sites, marine areas / migratory paths are also considered to be sensitive receivers. These areas can be impacted by not only noise but also vibrations, air quality and excess light during night works. All sensitive receivers will need to be considered through construction and operational phases for public amenity (and potential health) impacts to ensure noise, air quality and light pollution does not cause long term or lasting impacts to sensitive habitat and its fauna.

Anthropogenic receivers within the study area impacted by noise include residential areas and businesses located along the corridor, open spaces at Tallebudgera Creek, Currumbin Creek and Tugun; environmental conservation areas (Burleigh Head National Park and Currumbin Hill Conservation Park), community facilities (such as the airport), recreational facilities, schools, hospitals, healthcare facilities and heritage sites.

An Acoustics Assessment was undertaken to determine where acoustic levels are being exceeded and where noise barriers or ECTs may be required. Refer to the *Acoustic Assessment - B2CTS-PE-439-REP-00003* (Appendix D) for further information.

An air quality assessment was undertaken as part of the ESR (see Appendix C) for further information.

3.4.3 Contaminated Land Assessment

There are a number of contaminated parcels primarily located adjacent to the existing Gold Coast Highway and are likely to require further contaminated land investigations. A search of the Environmental Management Register (EMR) / Contaminated Land Register (CLR) was undertaken on 10 June 2022 which identified a number of sites listed on the EMR along the project corridor at Palm Beach, Tugun, Bilinga, Kirra and Coolangatta (refer to the ESR report for a comprehensive list).

The study area also contains numerous sites which are deemed high risk for Per- and Poly-fluoroalkyl Substances (PFAS). Increased levels of PFAS have more recently been associated where fire-fighting foams or recycled water have been used, including sewage treatment plants, fire stations, landfills, airports. These sites may not necessarily be listed on the EMR but may still present a risk of contamination and spread of contaminants if disturbed. The following sites within or proximate to the study area that may be at risk of PFAS contamination include:

- Bilinga Fire and Rescue Station, Bilinga (Ch. 50,000)
- Old Tweed Heads Fire Station, Tweed Heads (~140m from southern end of study area)
- Eloy Water Australia, sewerage treatment plant in Burleigh Heads (~160m from northern end study area)
- Gold Coast Airport, Bilinga (identified in the Gold Coast Airport Master Plan 2017 as containing sites within airport land that are considered to be either known or potentially contaminated sites).

The project should aim to avoid areas of known or suspected contamination (where possible). However, given space limitations within the constrained study area are likely to prohibit this approach, sample tests/investigations should be undertaken to confirm the presence of contaminants in future project phases.

Areas of confirmed contamination that are to be impacted by construction activities should be managed in accordance with any Site Management Plans attached to their EMR listing and where material must be transported from that lot, a disposal permit must be obtained from the Department of Environment and Science (DES). Contaminated lots impacted by the project should be appropriately capped to ensure contaminants do not leach into neighbouring areas upon completion of the works. Further information including recommended future assessments/investigations are provided in the ESR report (see Appendix C).

4.0 Design Inputs and Standards

4.1 Overarching Design Principles

The design development was guided by the corridor vision (previously outlined in Section 2.2 and design criteria outlined in the Basis of Design Report. The Basis of Design is underpinned by three strategies—the Access Strategy, Active Transport Strategy, and People and Place Strategy—which combined provide a strategic appreciation of the corridor in terms of its current and future multi-modal transport function and integration with land use.

The relationship between these three strategies and the Basis of Design report is illustrated in Figure 9 and a summary of the scope for each strategy is provided below:

- **Access Strategy** – The access strategy identified key vehicle access requirements along the corridor based on the current and future transport network requirements. It also outlined how vehicular access will need to be integrated with active transport movements and facilitate connectivity to key places/land uses and proposed public transport stations along the corridor (to be informed by the below strategies).
- **Active Transport Strategy** – Defined the active transport (AT) strategy along the project corridor, integration between the Principal Cycle Network, existing and planned/proposed AT facilities (including the Oceanway network) and key land uses/precincts. This strategy also outlined the AT facilities to be incorporated in the B2C concept design including consideration of key east-west active transport links that traverse the project corridor.
- **People and Place Strategy –** Provides an appreciation of the amenity-based context of the corridor and defines a holistic people and place-based design approach that recognises local character and amenity, and integration of key places and land use with the transport network. This strategy also includes a high-level assessment of Movement and Place attributes along the corridor to inform the Access Strategy and define existing and emerging precincts along the corridor.

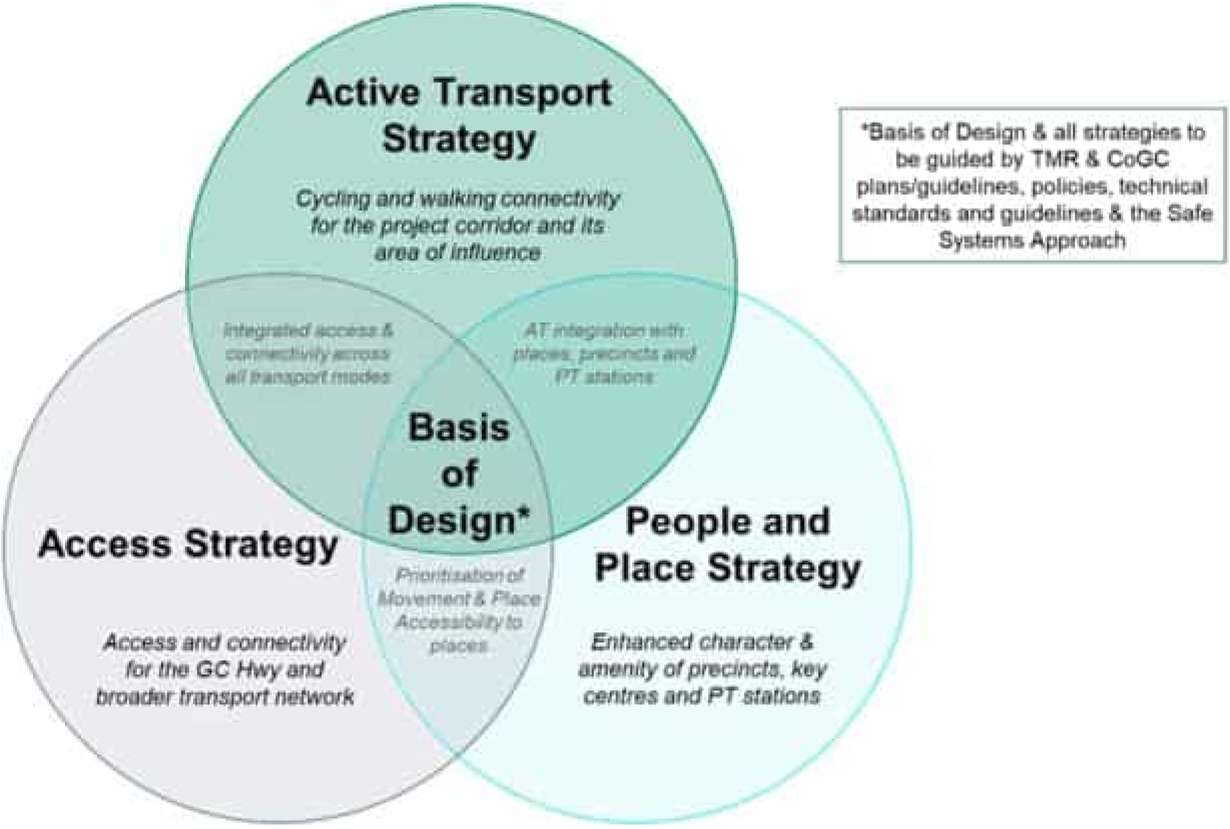


Figure 9 Relationship between the Basis of Design and supporting strategies

A summary of the key findings and outcomes from each of the strategies is provided below:

- **Access Strategy:**
  - Identified the importance of maintaining vehicle connectivity to key east-west links traversing the corridor (where possible) including George Street East, Ikkina Road, Tallebudgera Recreation Centre and Tallebudgera Tourist Park, Tallebudgera Drive, Nineteenth Avenue, Palm Beach Avenue, Thrower Drive, Duringan Street, Tomewin Street, Millers Drive, Tugun Currumbin Road, Toolona Street, Boyd Street (future intersection), Kirribin Street, Terminal Drive and Coolangatta Road.
  - Included recommendations to consolidate (or close) access to lower order roads, where possible (subject to further investigation and traffic modelling/analysis) such as Twenty Fifth Avenue, Seventeenth Avenue, Eighth Avenue, Third Avenue, Toolona Street East, Kitchener Street, Desalination Plant Road, Loongana Avenue and all unsignalised mid-block U-turn facilities.
- **Active Transport Strategy:**
  - Confirms the project requirement to explicitly provide adequate facilities for people with various abilities to walk and ride bikes on the entire B2C project corridor. The project corridor is designated as a Principal Cycle route in TMR’s Principal Cycle Network Plan (PCNP) which is supported by local government planning.
  - Identifies a current high demand for bike riders to traverse north-south along the entire B2C project corridor for commuter, utility and education trips and to access public transport. It also highlights the need to cater for east-west active transport demand that traverses the project corridor to access nearby land uses and other active transport corridors (such as the Oceanway).
  - Identifies locations where cross-corridor cycling connections are required based on the Principal Cycle Network Plan (PCNP) and Gold Coast Active Transport Network Plan 2041 (ATNP) requirements and recommends that the project should include signalised crossings at the locations to facilitate east-west active transport movements. These locations include:
    - Tallebudgera Drive, Nineteenth Avenue, Twenty-Third Avenue, Eleventh Avenue, Palm Beach Avenue and Thrower Drive in Palm Beach
    - Duringan Street in Currumbin
    - Tugun Currumbin Road, Toolona Street (east), Kitchener Street (west) and Boyd Street (west) in Tugun
    - Gibson Street (east) which connects to Golden Four Drive and the Oceanway at Bilinga.
  - Recommends provision of east-west pedestrian crossings at more regular intervals through urban areas (such as Palm Beach) to facilitate safe pedestrian and bicycle movements and connectivity across the highway, recognising the higher pedestrian activity at these precincts.
  - Recommends providing DDA compliance to all bus and LR stations/stops, particularly at LRT stations with signalised crossings at each end of the station platform to improve pedestrian safety and reduce walking distances.
- **People and Place Strategy:**
  - Identifies the current and future road function adopting ‘Movement and Place’ principles to help inform potential changes to speed limits along the Gold Coast Highway.
  - Identifies key ‘Place’ locations, station precincts and opportunities for land use integration.
  - Develops high level concept options for key precinct locations for consideration by TMR/CoGC in future project phases.

Refer to the *Basis of Design Report – B2CTS-PE-430-REP-00001* (provided in Appendix B) for further information on the basis of design including detailed design parameters and the three supporting strategies (which are appended to the Basis of Design Report).

4.2 Investigations and Design Inputs

The following section provides a high level summary of the key models and survey data used to inform the design development.

4.2.1 Traffic Models

The Gold Coast Strategic Transport Model – Multi Modal version 2.2Q (GCSTM-MM v2.2Q) and the Gold Coast Aimsun Model Southern Extension (GCAMSE) were used to inform the design development for the GCH MMCS and PE technical investigations. Refinements to these models were undertaken as part of these studies which are discussed in further detail in the *Traffic Modelling Report – B2CTS-PE-433-REP-00002* (refer to Appendix F).

The GCSTM-MM is a traditional four-step demand model which utilises EMME software and covers the Gold Coast regional area and northern Tweed. The model analyses current and future travel demands associated with demographic (population and employment) changes within an evolving transport network across public, active and private transport modes. The model adopts the Queensland Government Statistician's Office (QGSO) demographics. The strategic modelling for the PE phase is being undertaken separately by others.

AECOM's scope is to conduct the operational traffic modelling using the GCAMSE to inform the design development (including road and intersection layouts) for the three project options based on a 2041 design year horizon. The GCAMSE is a mesoscopic assignment model (utilising Aimsun software) that enables the investigation of route choice and intersection performance across the project extent. The model uses travel demand forecasts from a sub-area (cordon) of the GCSTM-MM to analyse operational aspects of the transport network, including travel patterns and traffic operations on the B2C corridor and other key parallel routes such as the M1 Pacific Motorway. A microsimulation sub-network was developed in the GCAMSE by AECOM and SIDRA intersection modelling undertaken to complement the mesoscopic modelling.

Further information on the operational traffic modelling analysis, results and key outcomes are provided in Appendix F).

4.2.2 Hydraulic Models

Several existing hydraulic models have been provided to AECOM to inform the hydraulic analysis, with the most relevant models including:

- A TMR TUFLOW hydraulic model of Tallebudgera Creek floodplain (developed by HDR&WSP, 2019). The model hydrology was based on the CoGC MIKE FLOOD Model (2016). The model terrain was derived based on 2019 LiDAR data and the surveys supplied by TMR. This model was derived as part of the M1 upgrade and includes the proposed M1 upgrade design. The setup and key features of the hydraulic model is described in the Hydraulic Analysis Design Report – M1 Pacific Motorway Upgrade – Burleigh Interchange to Palm Beach (HDR & WSP, 2019).
- A TMR hydraulic model of Currumbin Creek floodplain (developed by AECOM, 2019). The model hydrology was based on the CoGC MIKE FLOOD Model (2016). The model terrain was derived based on 2019 LiDAR data and the surveys supplied by TMR. This model was derived as part of the M1 upgrade and includes the proposed M1 upgrade design. The setup and key features of the hydraulic model is described in the Pacific Motorway – Palm Beach to Tugun Hydrologic and Hydraulic Assessment Report (AECOM & GHD, 2020).
- A CoGC Draft TUFLOW hydraulic model of the combined Tallebudgera and Currumbin Creek floodplain. It understood from communications with CoGC that at this stage CoGC have not prepared a technical report detailing the model setup, calibration, and results of this model.
- A CoGC Stormwater Drainage Study (SDS) TUFLOW hydraulic model of the Palm Beach area (Completed in September 2021 by ID Engineering Design Team).
- A CoGC Stormwater Drainage Study (SDS) hydraulic model of the Coolangatta / Tugun area (Completed in December 2019 by City Assets Stormwater Team) including Flat Rock Creek.
- A Queensland Airports Limited (QAL) TUFLOW hydraulic model of the Gold Coast Airport New Southern Access (prepared by Stantec, December 2020).

4.2.3 Survey

The following topographical survey data was supplied for the project:

- 2021 GDA202 Aerial photography (supplied by TMR on 1 April 2022)
- Detailed survey data (excluding PUP) supplied by TMR 17 May 2022 at the following approximate survey extents/locations: Burleigh Heads to Tallebudgera Creek, Tallebudgera Drive to 26th Avenue, Magnoli Apartments frontage and verge around Norfolk trees, driveway near 2nd Avenue, Flat Rock Creek, Kirra/Coolangatta disused rail cutting (Lanham Street Park).
- Aerial Lidar Scanning (ALS) 2018 MGA94 and ALS 2020 MGA2020 along with City of Cold Coast Oceanshore 2021 MGA94 ALS LiDAR (supplied 1 April 2022).

4.3 Key Design Parameters for All Options

The project team has developed key design parameters to transform the form and function of the Gold Coast Highway to align with the corridor vision statement and project objectives. Table 12 details the fundamental design parameters adopted for all three project options and Table 13 lists the assumed design speeds adopted for each option.

Table 12 Key Design Parameters for the Project corridor

Design Parameter	Segment 1 – Burleigh Headland	Segment 2 – Palm Beach	Segment 3 – Currumbin Headland	Segment 4 – Tugun to Bilinga	Segment 5 – Kirra to Coolangatta
Road Name(s)	Tweed Street Gold Coast Highway	Gold Coast Highway	Gold Coast Highway	Gold Coast Highway (26.0m B-Double Route)	Coolangatta Road Lanham Street McLean Street Griffith Street
Number of Traffic Lanes	4 through lanes (two lanes in each direction)				2 through lanes (one lane in each direction)
Road Design Vehicle	19.0m Single Articulated 12.5m Single Unit Truck/Bus			26.0m B-Double	19.0m Single Articulated 12.5m Single Unit Truck/ Bus
Road Design Check Vehicle	19.0m Single Articulated	19.0m Single Articulated	19.0m Single Articulated	26.0m B-Double	19.0m Single Articulated

4.3.1 Design Speed

TMR undertook a speed limit planning assessment for the purpose of informing future posted speed limits along the project corridor (in response to the introduction of additional signalised intersections/ accesses and increased land use intensity from residential and urban development). Table 13 lists the assumed design speeds adopted for each option.

Table 13 Speed parameters

Zone ID	Zone / Segment description	Chainages (m)	Posted speed (km/h)	Design speed (km/h)	
				LRT & DBL Options	EBP Option
1100	Segment 1: Burleigh Headlands	Ch. 40052 – Ch. 41732 (Brake St – Tallebudgera Dr Rd)	60	60	70
1200	Segment 2: Palm Beach	Ch. 41732 – Ch. 45100 (Tallebudgera Dr - Thrower Dr) Ch. 45100 – Ch. 45660 (Thrower Dr - Currumbin Creek)	60 70	60 70	70
1300	Segment 3: Currumbin	Ch. 45660 – Ch. 46400 (Currumbin Creek - Tomewin St) Ch. 46400 – Ch. 47300 (Tomewin St - Tugun Currumbin Rd) Ch. 47300 – Ch. 47700 (Tugun Currumbin Rd - south of Toolona St)	70 60 70	70 60 80	70 70 80
1400	Segment 4: Tugun to Bilinga	Ch. 47700 – Ch. 50700 (South of Toolona St - Terminal Dr) Ch. 50700 – Ch. 50900 (Terminal Dr - Coolangatta Rd)	70 50	80 50	80 60
1500	Segment 5: Coolangatta	Ch. 50900 – Ch. 53295 (Gold Coast Highway - Warner St)	50	50	60

4.3.2 Minor Road Design / Check Vehicles

The design and check vehicles that have been used in the concept design for the minor roads have been split into two categories based on the prioritisation identified in the Access Strategy. The design/check vehicles for the minor roads are shown in Table 14.

Table 14 Minor Road by Category

Road	Design Vehicle	Check Vehicle	Category
Segment 1: Park Ave, Brake St, Ikkina Rd, Tallebudgera Recreational Centre Access **Segment 2:** Tallebudgera Dr, Twenty First Ave, Nineteenth Ave, Seventh Ave, Fourth Ave, **Segment 3:** Off-Ramp to Duringan St, Thrower Dr, Tomewin St, Wagawn St, Wygerba St, **Segment 4:** Toolona St, Golden Four Dr, Surf St, Kirribin St, **Segment 5:** Coolangatta Rd, Musgrave St, Creek St, Appel St, Lord St, Miles St, McLean St, Chalk St, Griffith St	14.5m long rigid bus / 12.5m single unit truck/bus	19m prime mover and semi-trailer	Category 1 TransLink bus route Collector Distributor Primary access to commercial district
Segment 1: Burrabee St, George St E, Cotton St, **Segment 2:** Twenty Eighth Ave, Twenty Seventh Ave, Twenty Sixth Ave, Twenty Fifth Ave, Twenty Fourth Ave, Twenty Third Ave, Twenty Second Ave, Seventeenth Ave, Sixteenth Ave, Fifteenth Ave, Fourteenth Ave, Thirteenth Ave, Twelfth Ave, Eleventh Ave, Tenth Ave, Ninth Ave, Eighth Ave, Sixth Ave, Fifth Ave, Third Ave, Second Ave, First Ave, Laceys Lane, Hawaii Ave, Sarawak Ave, **Segment 3:** Farrell Dr, Millers Dr, Winders Ave, Currumbin Hill Conservation Park **Segment 4:** All local side roads from Golden Four Drive and Coolangatta Road, **Segment 5:** Charlotte St, Ocean St, Haig St, Tweed St, Gordon Ln, Lanham St,	8.8m service vehicle	12.5m single unit truck/bus	Category 2 Local Access only

4.3.3 Cross Section

The general road cross sectional widths are presented in Table 15.

Table 15 Road Design Criteria

Design Item		Desirable	Min./Abs. Min.	Project Target Standard	Reference	Comments
Traffic Lanes						
General Traffic		3.5m-3.3m (NDD)	3.1m (EDD)	3.3m 3.5m (Seg 4)	Section 4.2.5 TMR Road Planning and Design Manual (RPDM) 2nd Edition, Part 3 (2021)	EDD to be considered in constrained locations
Left Turn Slip Lane		6.5m	5.0m	5.0m	Table 4.3 AGRD Part 3 (2021)	
Right turn lane		3.5m	3.1m (EDD) 3.5m (Seg 4)	3.3m 3.5 (Seg 4)	Section 4.2.5 TMR RPDM 2nd Edition, Part 3 (2021)	
On-street parallel parking lane and cycle lane combination		4.5 m			Section 4.8.10 TMR RPDM 2nd Edition, Part 3 (2021)	
On-street parallel parking lane	60km/h	2.8m	2.5m	2.3m + 0.5m buffer	Australian Standards (AS) 2890.5 Section 3.2.2 (2020)	Parking lane includes channel width. Not recommended for 80km/h or more
	70km/h	3.8m	3.5m	2.3m + 1.5m buffer		
Crossfalls						
Road (AC Pavement)		3%	2.5%	2.5% - 3%	Table 4.2 AGRD03 (2021)	
Shoulders						
Shoulder width		1.0m (for drainage)	0.0m	0.5m	Table 6.3 AGRD04A (2021)	Not required up to 90km/h
Medians (Traffic Signals)						
Raised median width between traffic lanes	Shelter small sign	1.2m	1.2m	1.2m	Table 6.2 AGRD04A (2021)	
	Shelter signal	2.0m	2.0m	2.0m	Table 6.2 AGRD04A (2021)	Provision at all signalised intersections

Design Item		Desirable	Min./Abs. Min.	Project Target Standard	Reference	Comments
	pedestal or lighting					
	Shelter pedestrians and traffic signals	2.5m	2.5m	2.5m	Table 6.2 AGRD04A (2021)	
Raised median length	60km/h	10.0m	10.0m	10.0m	Table 6.1 AGRD04A (2021)	
	80km/h	20.0m	20.0m	20.0m	Table 6.1 AGRD04A (2021)	
Raised median (separated cycleway)		1.0m	0.6m	1.0m		Allows for back-to-back kerb
Verges						
Verge Width		6.0m	3.5m	4.3m	CoGC Standard Drawing 05-02-005	

4.3.4 Geometry

Based on Austroads Guide to Road Design, the geometric design standards are noted in Table 16.

Table 16 Geometric design standards

Design Item	Design Speed	Desirable	Min./Abs. Min.	Project Target Standard	Reference	Comments
Horizontal Alignment						
Minimum horizontal radii (cars @ 3% superelevation)	60km/h	105m		105m	Section 7.4.1 AGRD03 (2021)	(f=0.24)
	70km/h	176m		176m		(f=0.19)
	80km/h	266m		266m		(f=0.16)
Minimum horizontal radii with adverse crossfall (maximum side friction factor) (New Roads)	60km/h	220m		220m	Table 7.12 AGRD03 (2021)	(f=0.16)
	70km/h	400m		400m		(f=0.13)
	80km/h	660m		660m		(f=0.11)
As above (Existing roads)	60km/h	95m			Table 7.12 AGRD03 (2021)	(f=0.33)
	70km/h	140m				(f=0.31)
Rate of rotation	60km/h	3.5%	3.5%	3.5%	Section 7.7.7 AGRD03 (2021)	
	70km/h	3.5%	3.5%	3.5%		
	80km/h	2.5%	2.5%	2.5%		

Design Item	Design Speed	Desirable	Min./Abs. Min.	Project Target Standard	Reference	Comments
Vertical Alignment						
Maximum grade	60km/h	6%	10%	6%	Table 8.3 AGRD03 (2021)	(max. taken from mountainous terrain)
	80km/h	4%	9%	4%		
Maximum length of grades	2-3%	1800m	1800m	1800m	Table 8.4 AGRD03 (2021)	
	3-4%	900m	900m	900m		
	4-5%	600m	600m	600m		
	5-6%	450m	450m	450m		
	>6%	300m	300m	300m		
Minimum grade		1.0%	0.5%	1.0%	Table 8.5 AGRD03 (2021)	
Minimum crest curve length	60km/h	50m	40m	50m	Table 8.5 AGRD03 (2021)	
	70km/h	60m	50m	60m		
	80km/h	80m	60m	80m		
Minimum crest curve radius (K)	60km/h	11.8	-	11.8	Table 8.5 AGRD03 (2021)	h_1=1.1m, h_2=0.2m, d=0.36, R_T=2s
	70km/h	19.1	-	19.1		
	80km/h	29.3	-	29.3		
Minimum sag curve radius (K)	60km/h	6.0m	-	6.0m	Figure 8.9 AGRD03 (2021)	
	70km/h	8.0m	-	8.0m		
	80km/h	10.0m	-	10.0m		
Maximum grade change without a vertical curve	60km/h	0.8%	-	0.8%	Table 8.12 AGRD03 (2021)	
	70km/h	0.7%	-	0.7%		
	80km/h	0.6%	-	0.6%		
Intersections						
Length of acceleration lanes for cars	60km/h	85m	-	85m	Table 4A-2 TMR RPDM04A 2nd Edition (2021)	Speed of entry curve = 30km/h (Not inc. grade correction)
	70km/h	125m	-	125m		
	80km/h	195m	-	195m		
Acceleration lane merge taper	60km/h	60m	-	60m	Table 4A-2 TMR RPDM04A 2nd Edition (2021)	3.5m lane width with lateral movement of 1.0m/s
	70km/h	70m	-	70m		
	80km/h	80m	-	80m		
	60km/h	36m	-	36m		3.5m lane width with lateral
	70km/h	42m	-	42m		

Design Item	Design Speed	Desirable	Min./Abs. Min.	Project Target Standard	Reference	Comments
Auxiliary through lane merge taper	80km/h	48m	-	48m	Figure 5.6 AGRD04A (2021)	movement of 0.6m/s
Deceleration distance for cars	60km/h	55m	-	55m	Table 5.2 AGRD04A (2021)	Speed at exit curve = 0km/h Stop condition = 2.5m/s.
	70km/h	75m	-	75m		
	80km/h	100m	-	100m		
Deceleration distance for cars	60km/h	40m	-	40m		Speed at exit curve = 30km/h Stop condition = 2.5m/s.
	70km/h	60m	-	60m		
	80km/h	85m	-	85m		
Auxiliary lane diverge taper	60km/h	20m	-	20m	Table 5.1 AGRD04A (2021)	3.5m lane width
	70km/h	23m	-	23m		
	80km/h	25m	-	25m		
Auxiliary departure lane length (clearance capacity)	60km/h	70m		70m	Section 5.5 AGRD04A (2017)	
	70km/h	80m		80m		
	80km/h	90m		90m		
Minimum area of traffic islands		40m^2	-	40m^2	Section 6.1.3 AGRD04A (2021)	Urban environment. May be reduced to 25m^2 if unsignalized (Figure A 40, AGRD04)
Minimum width of traffic islands		2.0m	1.4m (EDD)	2.0m		To accommodate traffic signal poles
		1.2m	1.0m (EDD)	1.2m		To accommodate a small sign
Minimum width of pedestrian crosswalk		3.0m	2.0m	3.0m	Figure 6.4 AGRD04A (2021)	Crossings set 3m from stop lines
Minimum clearance between opposing right turn	Single	1.0m			Section A.16.2 AGRD4 (2017)	
	Double	2.0m				

4.3.5 Public Transport Facilities

Public transport facilities such as light rail stations and bus stops have generally been designed in accordance with TMR's Public Transport Infrastructure Manual (2020).

4.3.6 General Flood Immunity

The 1% AEP flood level is a critical design level for any new infrastructure within the corridor including new roads or LRT as per AS5100.1. However, any new active transport only facility could be designed to achieve a 2% AEP level of immunity.

The TMR Road Drainage Manual Table 2.5.8 states state controlled roads (such as the Gold Coast Highway) shall have an immunity of 2% AEP.

The objective of the proposed road or rail design is to match existing levels of flood immunity and where possible provide 1% AEP flood immunity under future climate conditions at major bridge and culvert crossings due to flooding from creeks, or major drainage channels.

- Transport Corridor Flood Immunity at bridge crossings:
  - Minimum Flood Immunity for Soffit Level: 1% AEP for Light Rail Bridge as per AS5100.2-2017 Clause 11.1
  - Minimum Flood Immunity for Soffit Level: 2% AEP for Shared Path Bridge as per AS5100.2-2017 Clause 11.1
  - Bridge structures are to be designed to withstand the 0.05% AEP design flood event.
  - Scour protection provided for the 1% AEP in accordance with the TMR Bridge Scour Manual (2019) where required.
- Transport Corridor Flood Immunity at major culvert crossings
- 1% AEP flood level remains below the existing road level.
- Appropriate scour protection to be provided for 1% AEP outlet velocity greater than 2.5m/s in accordance with Road Drainage Manual (2019).
- Blockage factors to be addressed using Book 6, Chapter 6. Blockage of Hydraulic Structures (Australian Rainfall and Runoff 2019).

4.3.7 Drainage

Design flow widths have been developed in accordance with TMR's Road Drainage Manual. Allowable flow widths requirements are shown in Figure 10.

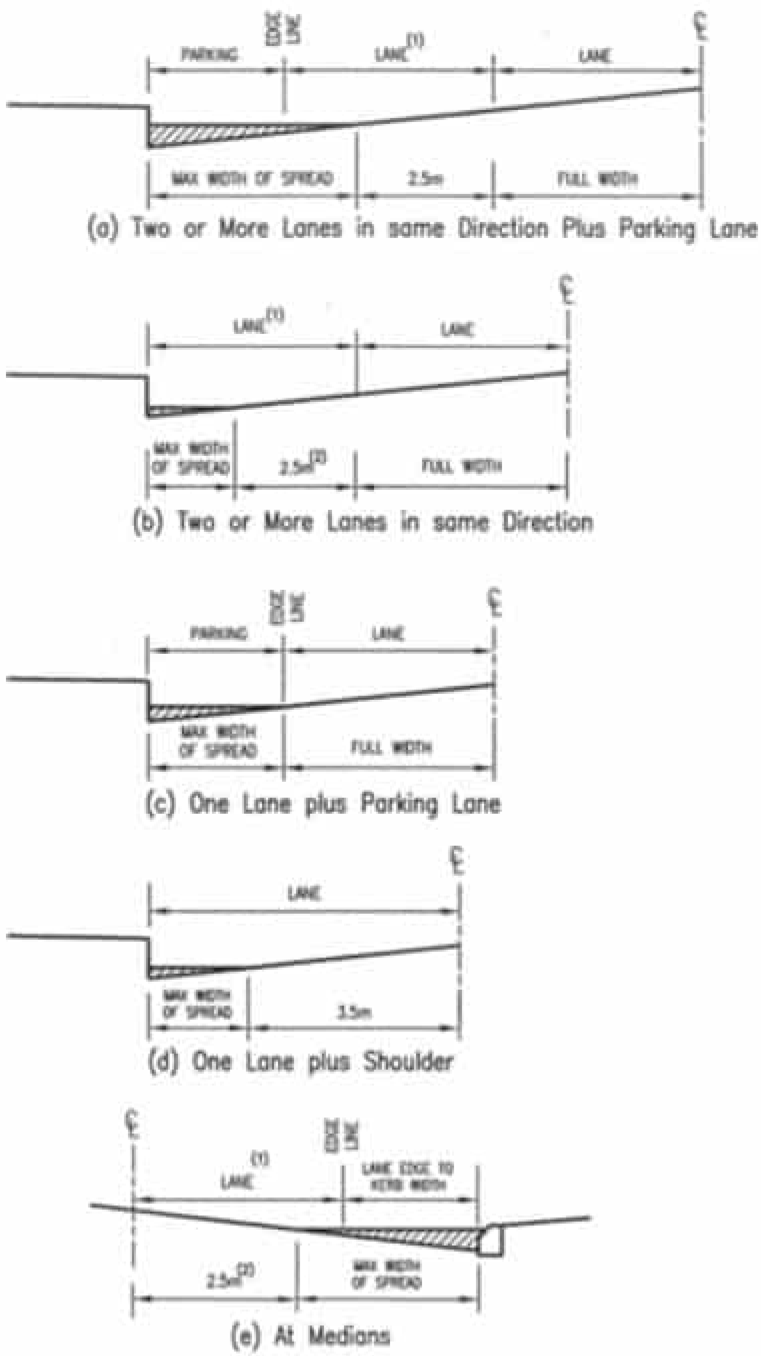


Figure 10 Allowable flow widths – 10% AEP flood (TMR Road Drainage Manual)

4.3.8 Pavement Design

The following pavement design guides were used to inform the pavement design:

- Austroads Guide to Pavement Technology Part 2, Pavement Structural Design. 2017 (AGPT02-17)
- Department of Transport and Main Roads (TMR), Pavement Design Supplement, July 2021 (TMR PDS-21)
- Department of Transport and Main Roads (TMR), Pavement Rehabilitation Manual, February 2020 (PRM-20)

- Austroads Guide to Pavement Technology Part 4K, Selection and Design of Sprayed Seals, 2018 (AGPT04K-18), and
- TMR Technical Note 175, Selection and Design of Sprayed Bituminous Treatments, October 2017 (TN175).

4.3.9 Bridge Design

The project specifications for the bridge designs are based on the Department of Transport and Main Roads – Technical Standards. The applicable TMR Standards and Specifications are listed in Table 17.

Table 17 TMR Standards and Specifications

Standards & Specifications	
A	TMR Design Criteria for Bridges and Other Structures, Feb 2021
B	TMR Geotechnical Design Standard – Minimum Requirements, March 2020
C	TMR Drafting and Design Presentation Standards Manual (DDPSM) Volume 3: Structural Drafting Standards, November 2015 (TMR Drafting Manual)
D	TMR Bridge Scour Manual, January 2019
E	TMR Material Testing Manual
F	TMR Structures Inspection Manual – by TMR Bridge Asset Management Department, September 2016 (TMR SIM)
G	TMR Standard Drawings
H	Bridge Heavy Load Assessment Criteria, (BHLAC) Version 4.00, Apr. 2018 #

- The BHLAC document is in draft form and is to be used for information until the final version is issued.

The full bridge design criteria are noted in the *Basis of Design Report - B2CTS-PE-430-REP-00001* (see Appendix B).

4.3.10 Traffic Signal Design

It is noted that spatial allowance has been made with indicative layouts of proposed signal post locations using Figure 4 below for the options. However, no electrical or signal operations designs have been completed at this stage. The future traffic signal design should conform to the following:

- Queensland Manual of Uniform Traffic Control Devices (MUTCD), Part 14: Traffic Signals, May 2017·
- TMR's Supplement to the AGRD Part 4A: Unsignalised and Signalised Intersections
- Austroads Guide to Traffic Management (AGTM) Part 10: Traffic Control and Communication Devices, 2016 (AGTM Part 10)
- AS1742.14, MUTCD, Part 14: Traffic Signals, 2014 (AS1742.14)
- TMR Standard Drawing 1439, December 2014 (SD1439).
- TMR Technical Specification 93 (MRTS93)

Additionally, the AGTM Part 10, Figure 10.28 shows the minimum signal layouts for undivided, divided and T-junction intersections as well as pedestrian-actuated traffic signal and is reproduced in Figure 11.

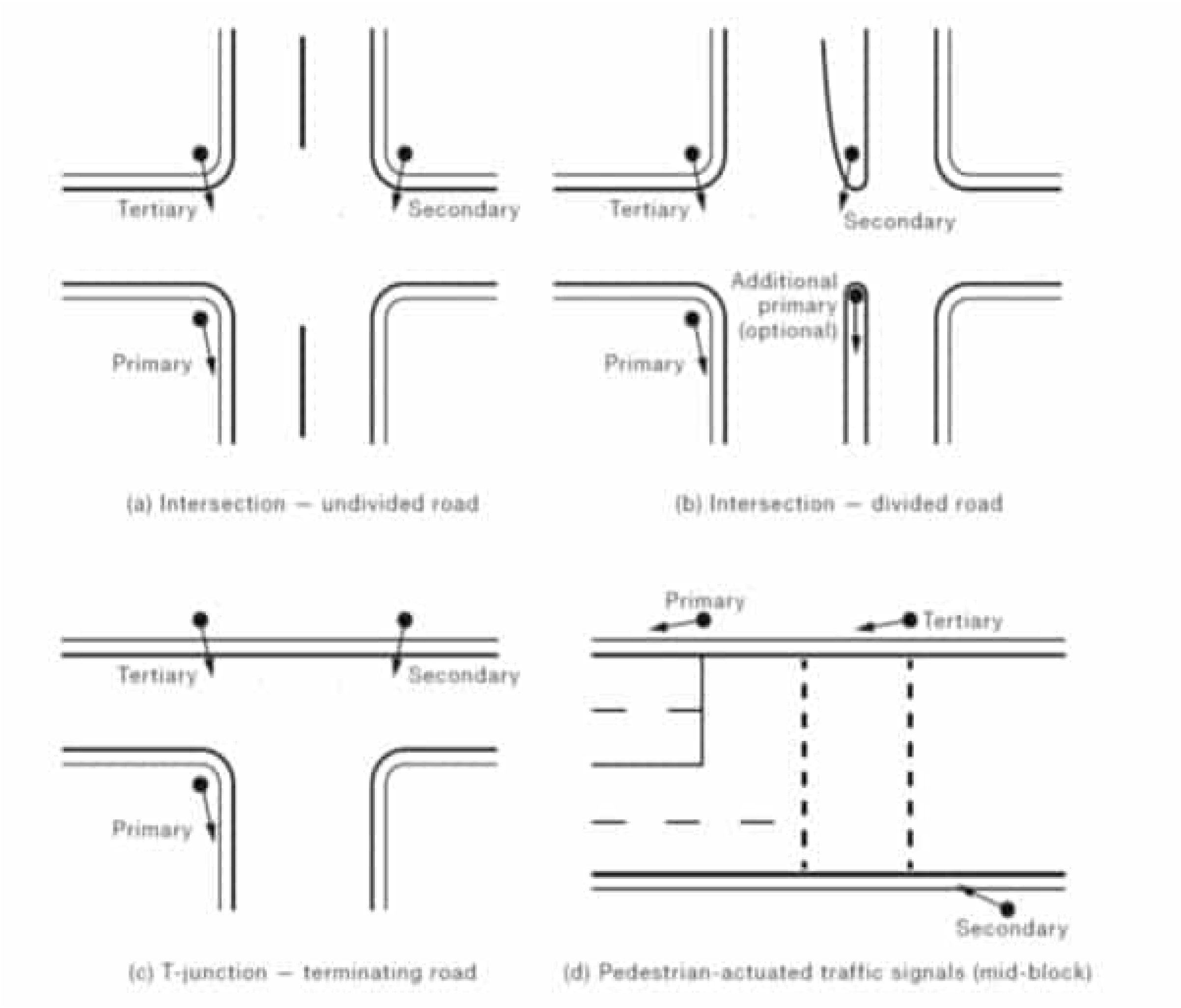


Figure 11 Minimum traffic signal layout

5.0 Option 1: Light Rail Transit

The Dedicated Light Rail (LRT) Option proposes an extension of GCLR from Burleigh Heads to the Gold Coast Airport and Coolangatta (i.e. GCLR Stage 4 or GCLR4). The LRT alignment generally follows the Gold Coast Highway and Coolangatta Road and includes bus network changes to improve connectivity and accessibility to the light rail. This option involves right-of-way for the light rail with new bridges over Tallebudgera Creek and Currumbin Creek, a new stabling facility and satellite depot at Bilinga and assumes the same light rail rollingstock as currently operating on GCLR.

Key components of the LRT Option are summarised in Table 18 below.

Table 18 Key LRT components

Component	Description
System	Expansion of existing GCLR LRT system, including dual standard gauge track and overhead wire power supply. Extension connects near Burleigh Heads station and continues south through Tallebudgera, Palm Beach, Currumbin, Tugun, Gold Coast Airport and will have a terminus at Coolangatta.
Route length	13.4km
Stations	14 LRT stations as follows: • 6 side platform stations • 7 island platform stations • 1 island terminus station (Warner Street, Coolangatta)
Cross section	• Two-way dedicated LRT corridor separated from general traffic, combination of centre running and side (verge) running. • Width varies from 8m to 9m.
Light rail vehicle (LRV) details	• Bombardier Flexity 2 Tram, as per existing GCLR system • 43.45m long, bi-directional vehicle with 7 modules • Static width – 2.65m • Max. operating speed – 70km/h (not to exceed road posted speed limit) • Max. design speed - 80km/h (dependent on the adjacent road speed and position in the transport corridor)
Depot location	• Main existing LRT depot located in Southport with all existing light rail vehicles (LRVs) to be maintained at this depot. • New satellite depot proposed at Bilinga (adjacent to the Gold Coast Airport) with a stabling yard for 8 LRVs
Key traffic interactions	72 at-grade intersections, including major intersections on the Gold Coast Highway at Tallebudgera Drive, Nineteenth Avenue, Palm Beach Avenue, Thrower Drive, Tomewin Street, Tugun Currumbin Road, Toolona Street, Kitchener Street, Boyd Street, Terminal Drive and Coolangatta Road; and at the Coolangatta Road/Musgrave Street intersection
Indicative Property impacts	78 full property impacts, 157 partial property impacts
Bridges and structures	Two new light rail bridge structures, one fauna overpass and two active transport/pedestrian bridge structures (note the Currumbin Creek active transport bridge is currently being designed by others)
Active transport	Active transport provisions for the length of the corridor
Power System	750V DC Traction Power supply and Overhead Line system

Component	Description
Bus network	Bus interchanges at Thrower Drive (Palm Beach), Toolona Street (Tugun), Boyd Street (Tugun), Gold Coast Airport and Warner Street (Coolangatta) Refer to Section 5.5.6 and the *Public Transport Operational Assessment - B2CTS-PE-440-REP-00001* (Appendix G) for further details on the supporting bus network
Running time	2041 forecast light rail journey time of 27-31 minutes from Burleigh Heads to Coolangatta (based on the 2041 GCAMSE microsimulation model)
Service hours	Weekday services: • 10 minute headways during early morning (5am-7am) • 7.5 minute headway during peaks (7am-7pm) • 15 minutes during evenings (7pm-12am) • No operations from 12am-5am (service replaced by 700 night bus) Weekend services: • 10 minute headway during early mornings and peaks (5am-7pm) • 15 minute headway during evenings (7pm-12am) • 30 minute headways during early mornings (12am-5am)

5.1 Previous Corridor Planning

The primary purpose of the GCH MMCS was to consider the strategy, needs and functions of all modes of transport within the study corridor over the planning horizon to 2041. The ultimate purpose of the study was to identify the land requirements to enable implementation of a preferred range of transport infrastructure solutions including for light rail, buses, pedestrians, bike riders, private transport (including freight) and manage encroachment by development.

The study concluded that the Gold Coast Highway is the preferred route for a future southern extension of the light rail from Burleigh Heads to Coolangatta. It also concluded that an at-grade, segregated dual track is the most appropriate light rail configuration, consistent with previous (and proposed) Gold Coast light rail stages.

As part of the MMCS, a preliminary options analysis was undertaken to identify the preferred track alignment and station locations for the light rail, which is summarised below:

- LRT alignment is generally central-running along the Gold Coast Highway and Coolangatta Road (due to the high density of intersections and residential driveways) with the exception of the following locations:
  - Side running (east of the Gold Coast Highway) across Tallebudgera Creek for a new light rail bridge with active transport provisions
  - Side running (west of the Gold Coast Highway) across Currumbin Creek (for a new light rail bridge) and Currumbin Hill
  - Side running (east of the Gold Coast Highway) through Tugun and Bilinga from Tugun Currumbin Road to Terminal Drive
  - LRT then traverses the Gold Coast Highway at Terminal Drive with a connection to the Gold Coast Airport and new light rail satellite depot (adjacent to airport land), then crosses the Gold Coast Highway near the Southern Cross University (SCU) Gold Coast Campus to Coolangatta Road at the Musgrave Street intersection
  - Side running (east of Coolangatta Road) between Lord Street and Miles Street, then becomes fully segregated passing through Lanham Street Park then on-road following Chalk Street to the Warner Street intersection, Coolangatta (proposed terminus).
- 14 LRT stations located near key trip attractors, generators and east-west connections. The stations are generally located at about 800m spacings through the populated areas to provide an

effective balance between public transport (PT) efficiency and accessibility at the following locations:

- Burleigh Head National Park (north of Tallebudgera Creek)
- Five stations in Palm Beach located at Twenty Eighth Avenue, Nineteenth Avenue, Twelfth Avenue, Palm Beach Avenue and Thrower Drive
- Tomewin Street, Currumbin
- Two stations in Tugun located at Toolona Street and Boyd Street
- George Street, Bilinga
- Gold Coast Airport
- Three Coolangatta stations located at Musgrave Street, Miles Street and Warner Street (terminus).

The proposed spacing between LRT stations is consistent with GCLR stages 1 to 3 (for urban segments) and is consistent with typical international practice. It is noted that the station names attributed to each station are based on the nearest crossroads (or major attraction) and are intended to be working titles only, subject to confirmation in subsequent phases.

Figure 12 provides a schematic of the preferred LRT alignment and station locations from the GCH MMCS.

The GCH MMCS route strategies were used to support the designation of land requirements associated with future transport upgrades of the corridor as ‘Category C Protected Planning’, in accordance with the TMR’s *Approved Planning Policy* (October 2017). This category refers to planning that is approved and protected but not included in current funding and delivery programs. The Category C designation ensures that the project corridor is protected from developments that could otherwise hinder the feasibility of the project and provides TMR with the opportunity to work collaboratively with developers to achieve mutually beneficial outcomes for the transport corridor.

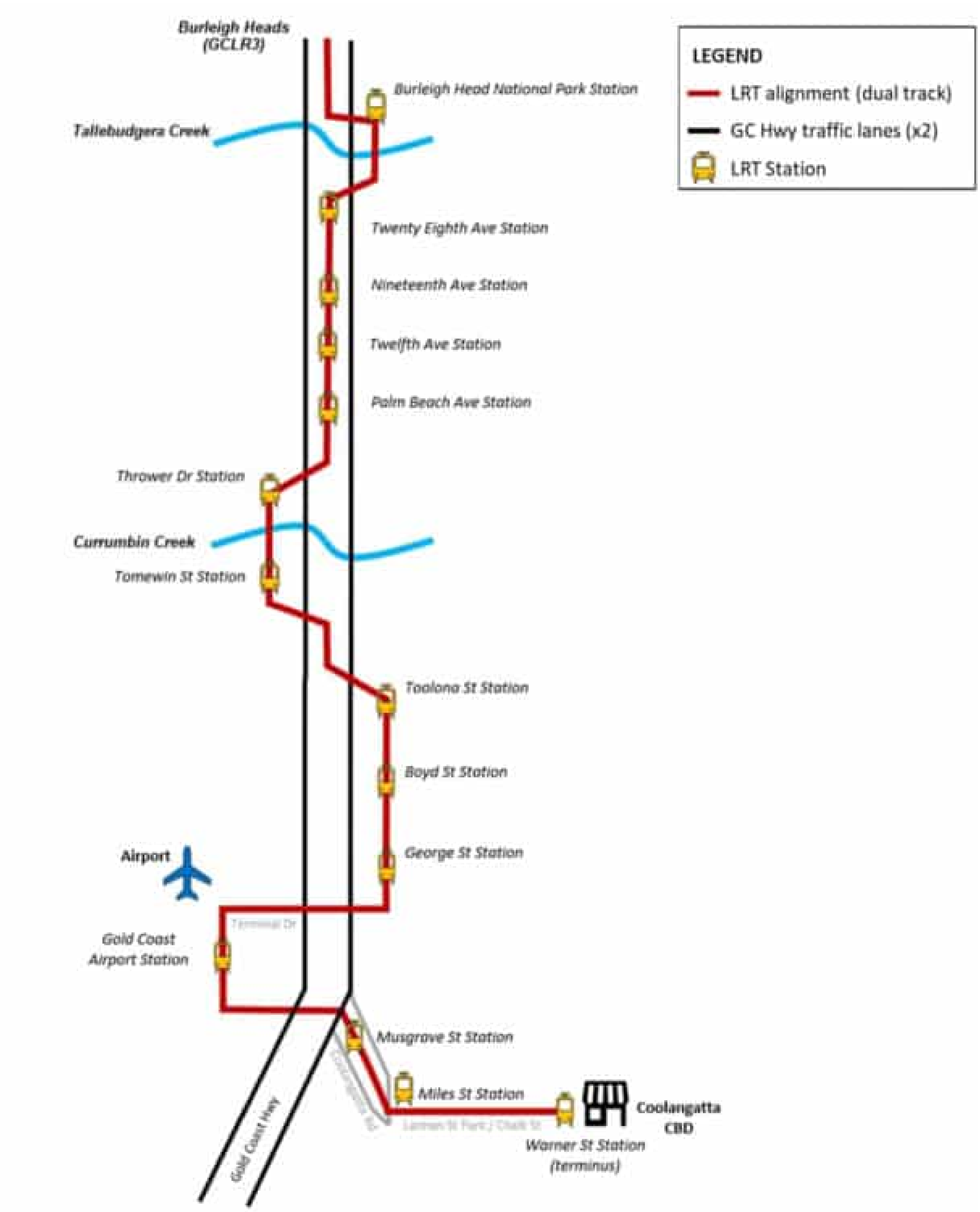


Figure 12 Schematic of the preferred GCH MMCS LRT alignment and station locations

5.2 Design Parameters

The following sections outline key design parameters specific to the LRT Option.

5.2.1 Light Rail Vehicles

The LRV design vehicle is the Bombardier Flexity 2 (BF2), which is the same vehicle that is currently used for GCLR Stages 1-2 and is currently being procured for Stage 3 operations. The BF2 comprises seven modules with a driving cab at each end and is 43.45m long and 2.65m wide. The maximum axle load is 12.5t.

5.2.2 Clearances

The design Dynamic Kinematic Envelope (DKE) has been established using the Bombardier Flexity 2 tram requirements. The DKE is based on a nominal 2.65m wide LRV. The development of the DKE considers the outline of the LRV, allowance for end and centre throw around curves, and dynamic movement of the LRV. The DKE is defined for a range of track alignment radiuses.

Table 19 Dynamic Kinematic Envelope

Alignment (m)	Value from centreline		Total DKE
Radius	Outside Curve	Inside Curve (excludes cant effect)	Width
25 ≤ R ≤ 80	1.80m	1.70m	3.50m
80 < R ≤ 200	1.65m	1.60m	3.25m
200 < R ≤ 1000	1.60m	1.55m	3.15m
1000 < R ≤ tangent	1.50m	1.50m	3.00m

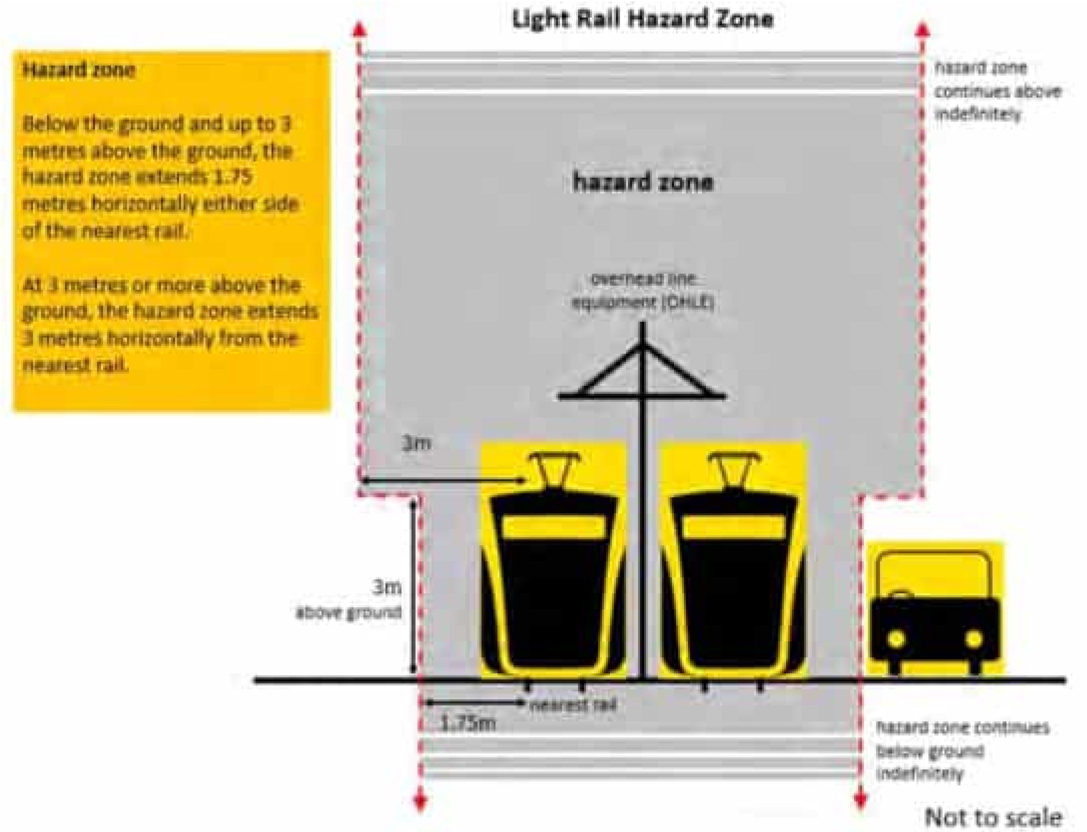
The light rail typical corridor width at any point along the alignment is established with regard to the following clearance requirements detailed in Table 20.

Table 20 LRV Corridor Clearance

Design Element	Desirable	Min	Project Target Standard	Reference	Comments
Track centre spacing with traction pole in median	3.85m	3.70m	3.85m	GCLR3 Updated for compliance with DKE requirements	For tangent track, excluding cant effects
Track centre spacing without traction pole in median	3.15m	3.15m	3.15m	As per previous GCLR stages	For tangent track, excluding cant effects
LRV DKE to edge of traction pole	275mm	200mm	275mm	As per previous GCLR stages	
Lighting masts, traffic signal masts and other isolated masts and other isolated structures not exceeding 500mm diameter or length	550mm	550mm	550mm	As per previous GCLR stages	Horizontal offset measured from the outside of the DKE
Tunnel walls, retaining walls, fences, cuttings, top of batters and continuous structures or obstructions	1.0m	1.0m	1.0m	As per previous GCLR stages	Horizontal offset measured from the outside of the DKE
For design of roads, shared paths, lanes and footpaths the	550mm	550mm	550mm	As per previous GCLR stages	Horizontal offset measured from the outside of the DKE

Design Element	Desirable	Min	Project Target Standard	Reference	Comments
nearest edge of road traffic lane					where operating speed > 40km/h
	300mm	300mm	300mm	As per previous GCLR stages	Horizontal offset measured from the outside of the DKE 300mm where operating speed ≤40km/h
Vertical clearance to rail structures (including OHL)	6.0m	5.5m	6.0m	As per previous GCLR stages	Vertical clearance measured from track slab
Existing structures and creek crossings			Existing Clearance	As per previous GCLR stages	
Structure vertical clearance over TMR Infrastructure	6.0m	5.5m	6.0m	As per previous GCLR stages	
Shared use paths and footpaths			2.5m	As per previous GCLR stages	
Light Rail Hazard Zone			3.0m from nearest rail	Guide to Development in a Transport Environment – Light Rail 2018	Including the mature canopy of trees and vegetation
LRV Typical Corridor Width	9.3m (includes low planting on edge of track form)	7.9m	8.0m		For tangent track, excluding cant effects, based on 550mm clearance to road edge

Figure 13 demonstrates the LRV Hazard Zone to be considered in regard to the interface to existing and new building developments, including the clear area for tress and vegetation.



Source: Guide to Development in a Transport Environment – Light Rail (2018)

Figure 13 Light rail hazard zone

5.2.3 Track Configuration

The LRT track configuration is an at-grade, segregated dual track. The GCH MMCS determined this to be the most appropriate light rail configuration, consistent with previous (and proposed) Gold Coast light rail stages.

The LRT alignment is generally centre running along most of the project corridor, with the exception of the selected locations such as the Tallebudgera and Currumbin Creek crossings (where side running is required to retain the existing road bridges); the Gold Coast Airport (where the alignment veers off the highway into Airport land), and at specific locations where the options assessment identified side running to be the preferred option (discussed further in Section 5.3).

Figure 14 and Figure 15 show typical cross-sections of the LRT and road corridor based on a central running alignment. The rail cross-sections are:

- 8.0m (minimum) light rail corridor
- 4.0m (typical) rail track centres.

The light rail corridor width of 8.0m generally satisfies the minimum requirement for a narrow dual track on a straight (tangent) section of rail alignment.

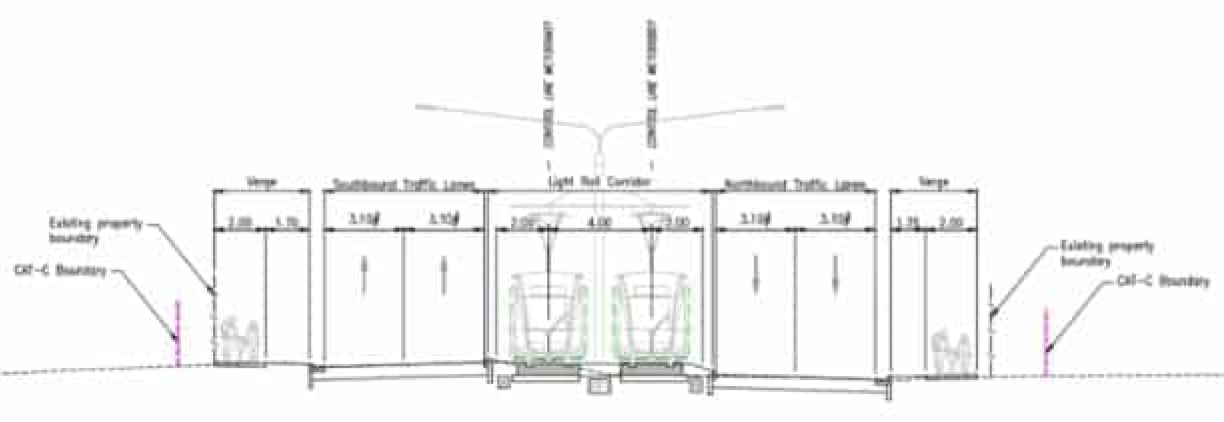


Figure 14 Typical LRT cross-section with centre running

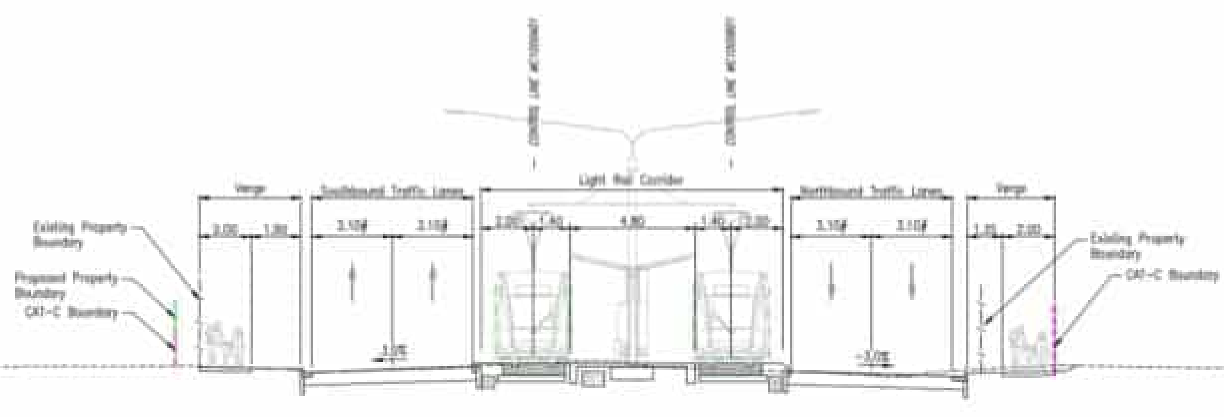


Figure 15 Typical LRT cross-section at stations

5.2.4 Road Corridor Configuration

The Gold Coast Highway is a four-lane road (i.e. two traffic lanes in each direction) for the entire length of the project corridor. On-street parking is currently permitted on sections of the project corridor, as previous discussed in Section 3.3. Coolangatta Road is predominantly a two-lane road, with short sections of auxiliary lanes provided near intersections.

The typical road cross-section is summarised below:

- Median Lane – 3.3m
- Kerbside Lane – 3.3m
- No on-street parking allowance
- No cycle lane allowance
- Verge width – 4.3m typical.

Table 21 details the key road design parameters adopted for the project. Refer to the *Basis of Design Report - B2CTS-PE-430-REP-00001* (see Appendix B) for more detailed information on the design parameters and assumptions.

Table 21 Key Road Design Parameters

	Applicable Design Standard	Comments
General Traffic Lanes	3.5m	Reduced to 3.3m for constrained areas and 3.1m (EDD) through Palm Beach
Footpath	2.0m nominal	High pedestrian volumes 2.5m preferred width
Shared Path	3.0m	2.5m min
Active Transport Path	3.0m	2.0m where one-way
On-Road Cycle Lane	1.5m	Through vehicle traffic speed = 60km/h

5.3 Design Development

5.3.1 Methodology

The preferred LRT alignment from the GCH MMCS was taken forward during the PE phase for further assessment including options analysis and design development/refinement. Figure 16 shows a flowchart of the design development process undertaken during the PE phase to refine the LRT Option.

An initial options analysis was undertaken as part of the GCH MMCS to determine the preferred corridor alignment. However, it was understood that a more detailed options analysis would be undertaken during the PE phase against the current project objectives to further refine the concept design.

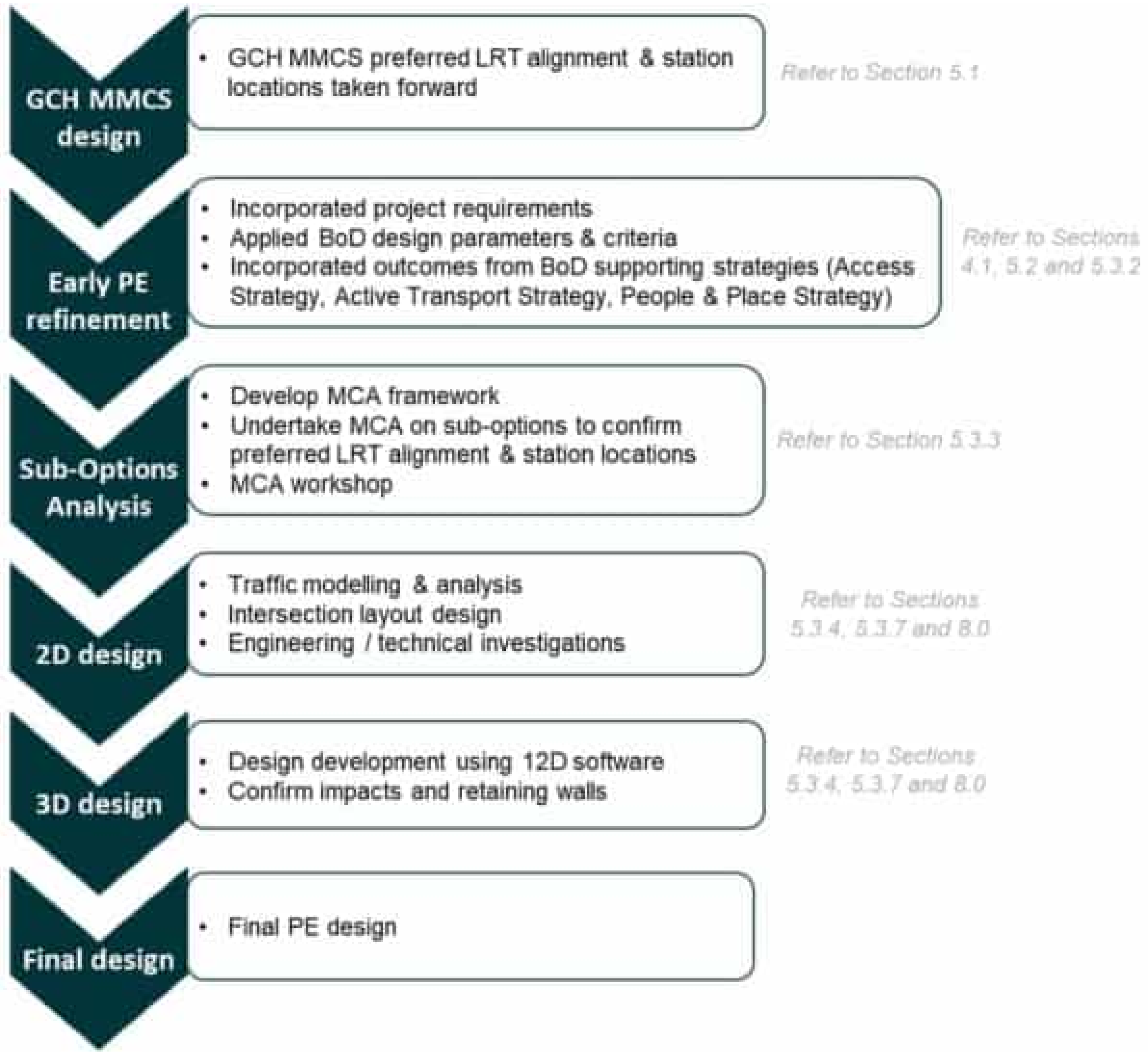


Figure 16 LRT Option – PE design development process

The following sections provide further information on the design development process.

5.3.2 Early Design Refinements

The LRT alignment and station locations identified during the GCH MMCS were taken forward for further refinement. The design was updated to incorporate key project requirements (previously defined in Section 2.4) and key feedback from the GCH MMCS community consultation. Key feedback of particular note are detailed below:

- Community concerns regarding the proposed narrowing of the Gold Coast Highway to two-lanes (i.e. one lane in each direction) through sections of Palm Beach, Currumbin Hill and Tugun (between Duringan Street and Wagawn Street) to minimise property impacts and environmental impacts in Currumbin.
- Restricted right/U-turn access on the Gold Coast Highway through Palm Beach and potential for increased “rat-running” of non-local traffic through the local Council road network.
- Removal of the Gold Coast Highway northbound left turn into Thrower Drive, Currumbin. The GCH MMCS proposed to remove this access given improved access is provided at the Gold Coast Highway / Duringan Street connection with a new signalised intersection.

- Consider alternative locations for the Toolona Street LRT Station closer to the Tugun town centre to improve pedestrian accessibility/connectivity to the town centre and interchange opportunities with the Golden Four Drive bus stops (located north of Toolona Street East).
- Loss of on-street parking throughout the project extent was raised as a concern. Development of a parking strategy or requirements for each option is not in scope as this is to be undertaken as a separate study (by others) on the preferred project option from the PE phase.
- Remove the proposed new intersection at Tugun Currumbin Road / Durran Street intersection to minimise ‘rat running’ through local roads in Tugun.
- Proposed closure of the Gold Coast Highway/Kitchener Road intersection in Tugun. The GCH MMCS proposed to remove highway access to/from Kitchener Street in favour of Boyd Street which will become the primary connection to the proposed Cobaki Lakes development (discussed previously in Section 2.5.3), and form one of the primary accesses to the Tugun residential catchment west of the highway (in addition to Toolona Street).

The *Basis of Design Report - B2CTS-PE-430-REP-00001* (see Appendix B) defined key design parameters, overarching design principles and design standards/guidelines/criteria to be adopted (for confirmation with TMR and CoGC). Key design parameters applicable for all project options are summarised in Section 4.3 and design components specific to the LRT Option are listed in Section 5.2 with more detailed information provided in the Basis of Design report.

Three supporting strategies (Access Strategy, Active Transport Strategy, and People & Place Strategy) were developed to underpin the Basis of Design. These strategies were used to guide the design development process with respect to vehicle access requirements, provision of active transport facilities for the project corridor (and active transport strategy for the broader study area), and consideration of people and place requirements and interfaces with key land uses and stations (refer to Section 4.1 for further discussion).

A summary of the key design refinements undertaken based on the strategy outcomes and community consultation feedback is provided below:

- Gold Coast Highway retained as four traffic lanes along the entire project corridor based on community consultation feedback and a ministerial commitment (refer to Section 2.4). This resulted in removal of parking, reduced lane widths and footpath verges through Palm Beach to minimise property impacts.
- Provision of the following parking facilities at the Jellurgal Cultural Centre – parking for up to 2 coaches near centre, retention of two People with Disability (PWD) parking bays and a loading zone for deliveries.
- Reinstatement of right/U-turn access on the Gold Coast Highway at Palm Beach at the following intersections: Northbound right/U-turn bays included at Tallebudgera Drive, Twenty-Third Avenue, Eleventh Avenue and Fourth Avenue; and a southbound right/U-turn bay at Palm Beach Avenue (refer to Table 22 which shows the proposed right turn strategy for Palm Beach).
- The Palm Beach Avenue LRT Station was relocated approximately 130m south of Palm Beach Avenue to provide a southbound right turn bay on the Gold Coast Highway, given this road provides an important connection to the M1 Motorway (based on the Access Strategy outcomes, as noted above). The revised station location also provides an opportunity to enhance the “place” function of the Palm Beach precinct by making Fifth Avenue a pedestrian friendly street.
- The existing mid-block signalised pedestrian crossing near Hawaii Avenue was reinstated and the signalised intersection at First Avenue was removed. First Avenue was not identified as a critical location for vehicle access in the Access Strategy and it was considered more critical to retain right turn access at Palm Beach Avenue and Thrower Drive (which are both higher order roads of important significance to the road network). However, the Active Transport Strategy noted retention of the pedestrian crossing is desirable to retain pedestrian accessibility and connectivity across the highway, particularly given the adjacent pedestrian crossings (at Fourth Avenue and Thrower Drive) are approximately 650m apart, which is beyond the desirable 400m walking distance identified in the Active Transport Strategy.

- Reinstating left turn access from the Gold Coast Highway northbound into Thrower Drive, Currumbin.
- Toolona Street LRT Station relocated approximately 100m north to improve pedestrian connectivity and accessibility to the Tugun Central Business District (CBD) and bus stops on Golden Four Drive.
- Tugun Currumbin Road / Durran Street intersection removed based on the consultation feedback and the Access Strategy (which did not identify this intersection as essential for vehicle accessibility).
- Retaining vehicle access at the Gold Coast Highway / Kitchener Street intersection based on concerns raised during the B2T community consultation and feedback from CoGC. Initially, options were explored to convert the Gold Coast Highway / Kitchener Street intersection to a left-in/left-out (LILO) arrangement with a signalised pedestrian crossing on the highway (as Kitchener Street is a principal cycle route and to replace the existing mid-block pedestrian crossing located 160m to the south near Sand Street). However, this intersection arrangement was later refined based on the traffic modelling (refer to Section 5.3.4.2 for further discussion).

Table 22 Palm Beach right turn access arrangements

Intersection	Current access		GCH MMCS concept (preferred minimum option)		PE concept design	
	Southbound	Northbound	Southbound	Northbound	Southbound	Northbound
Tallebudgera Drive	Right turn	Right turn	Right turn	-	Right turn	Right/U-turn
25th Ave	Right/U-turn	Right/U-turn	-	-	-	-
23rd Ave	Right/U-turn	Right/U-turn	-	-	-	Right/U-turn
19th Ave	Right/U-turn	Right/U-turn	Right/U-turn	-	Right/U-turn	-
17th Ave	U-turn	Right/U-turn	-	-	-	-
15th Ave	Right/U-turn	Right/U-turn	-	-	-	-
11th Ave	Right/U-turn	Right/U-turn	-	-	-	Right/U-turn
8th Ave	Right/U-turn	-	-	-	-	-
7th Ave	Right turn	Right turn	Right/U-turn	-	-	-
Palm Beach Ave	Right turn	Right turn	-	-	Right/U-turn	-
4th Ave	Right turn	Right turn	-	-	-	Right/U-turn
3rd Ave	-	Right turn	-	-	-	-
1st Ave	-	-	Right turn	-	-	-
Thrower Drive	Right/U-turn	Right turn	Right/U-turn	Right turn	Right/U-turn	Right turn

5.3.3 LRT Sub-Options Analysis

A sub-options analysis was undertaken of the LRT alignment (and station locations) to assess alternative alignment options at seven key locations along the project corridor using a multi-criteria analysis (MCA).

An MCA framework was developed for the LRT sub-options analysis to objectively assess each sub-option against the project's functional requirements and allows the relative importance of a broad range of impacts and benefits to be considered. The MCA framework consists of 10 criteria that aligned with the project objectives and outcomes sought (derived from the ILM, previously shown in Figure 5). The

Redaction of detailed methodology that is commercially sensitive to the report author.

Redaction of detailed methodology that is commercially sensitive to the report author.

The following section provides an overview of the key outcomes from the LRT Sub-Options assessment undertaken at the seven key locations along the project corridor, including preferred alignment and key changes from the GCH MMCS. The *LRT Sub-Options Report* provides detailed information on all sub-options assessed and the MCA results for all locations. The *LRT Option Concept Designs - B2CTS-PE-431-DWG-00001* are provided in Appendix I.

5.3.3.1 Segment 1: Burleigh Heads

The project ties into the future GCLR terminus at Burleigh Heads Station (north of Brake Street) and extends the light rail to the south maintaining the central-running alignment on the Gold Coast Highway. The GCH MMCS proposed a central running LRT alignment through Burleigh Heads including the Burleigh Hill vegetation area. The alignment then crossed to east side-running at Ikkina Road and over Tallebudgera Creek, then crossed back to central running south of the creek and through the Tallebudgera Drive intersection, as shown in Figure 17.

Five options were considered for the LRT alignment from George Street through Burleigh Headland across Tallebudgera Creek to Tallebudgera Drive, including combinations of central running, side running (to the eastern and western sides of the highway), and a western alignment with a cut and cover structure at Burleigh Headland to minimise environmental impacts.

The eastern LRT alignment with an eastern creek crossing was selected as the preferred option at the MCA workshop. This option is central running at the start of the project corridor (to tie into the GCLR3 works) then crosses to east side-running at the George Street East intersection and continues side-running through Burleigh Hill, across Tallebudgera Creek then switches to central running at the Tallebudgera Drive intersection. This option was the highest scoring option in the MCA and all sensitivity cases, followed closely by the GCH MMCS alignment. The key reasons were:

- Improved traffic efficiency (compared to the GCH MMCS alignment) with the longer section of side-running resulting in less disruptions (and delays) to general traffic at signalised intersections
- Positive constructability outcomes due the separation of the road and LRT corridors and offline bridge construction
- Positive amenity and place opportunities with the new LRT bridge/active transport bridge and Burleigh Head National Park LRT Station situated on the beach side which enhances the visual amenity of this infrastructure.

All five options scored low in terms of environmental impact as they all require widening into National Park. Two alternative options proposed a new light rail bridge west of the highway were also noted to potentially impact the fish traps in Tallebudgera Creek.

Figure 17 shows the preferred LRT alignment compared to the GCH MMCS, for reference.

This image has been removed as it contains property impacts that are not approved.

Figure 17 Burleigh Headland LRT alignment: GCH MMCS design (top) vs. PE LRT design (bottom)

5.3.3.2 Segment 2: Palm Beach

The Palm Beach segment stretches from Tallebudgera Drive to Currumbin Creek. The concept design for this section was refined early in the PE phase to retain four traffic lanes on the Gold Coast Highway through Palm Beach and provide additional turn bays for right/U-turn movements at key intersections (outlined previously in Section 5.3.2).

The LRT alignment through Palm Beach was retained as centre running from Tallebudgera Drive to north of Thrower Drive (consistent with the GCH MMCS); however, the corridor has been narrowed to the minimum width, removing any opportunity for low planting beside the track slabs. No further options analysis was undertaken for this segment, with the exception of the Thrower Drive LRT Station where alternative alignment options were investigated and are discussed below.

The GCH MMCS proposed a LRT crossing of the Gold Coast Highway northbound carriageway to the north of Sarawak Avenue, as shown in Figure 18. The LRT alignment then remains western side running through the Thrower Drive LRT Station and across Currumbin Creek.

Four alternative options were considered for the Thrower Drive intersection based on alternative central running LRT alignments. The GCH MMCS alignment (i.e. west side running with western station option) scored the highest in the MCA (pairwise), as well as all sensitivity cases. The key reasons were:

- Scored highest in terms of transport efficiency outcomes such as improved public transport connectivity and accessibility as the LRT station and bus interchange are proposed to be situated adjacent to each other (west of the highway). This also positions the transport interchange closer to the Palm Beach Currumbin State School and the larger residential catchment west of the highway.
- Scored highest for traffic efficiency as this option has the least impact to traffic movements at the Thrower Dr intersection and the shortest LRT crossing through the intersection (compared to other options).

- Moderate cost and constructability outcomes (compared to other options) requiring a modest degree of construction complexity and traffic management. Other options required major realignment of the Gold Coast Highway or Thrower Drive and therefore scored lower for this criterion.
- Minimal change to the existing place function as the option maintains the status quo access to the park land and parking on the eastern side of the intersection.

Figure 18 shows the revised PE alignment for this location, compared to the GCH MMCS for reference. As shown, the PE design remains relatively unchanged at this location, with the exception of some minor refinements to turn lane lengths and lane allocations (based on the traffic modelling findings).

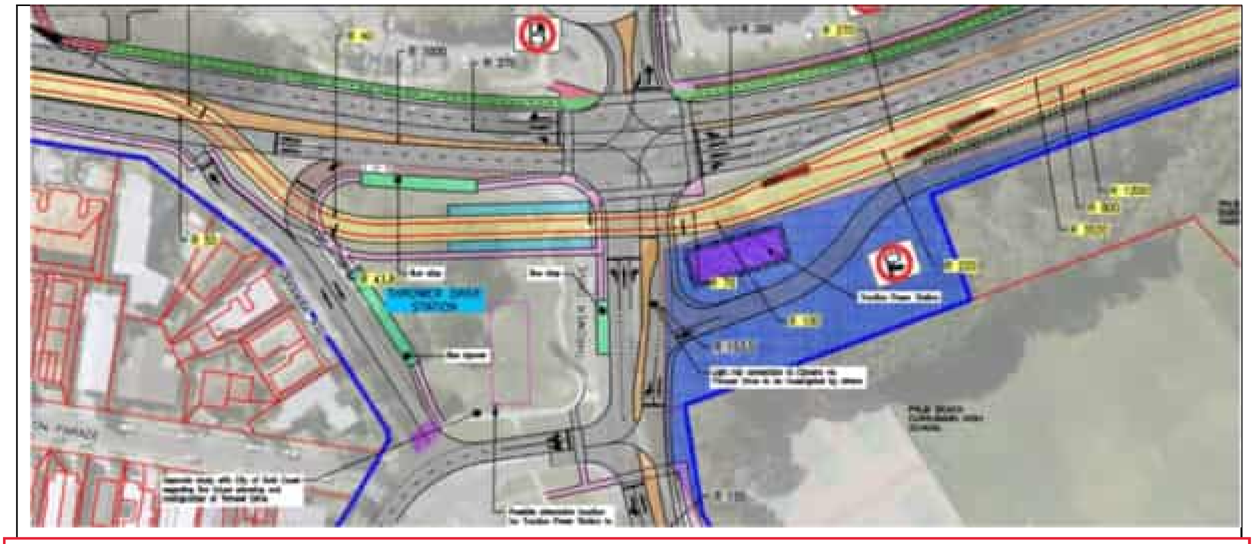


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Figure 18 Thrower Drive intersection: GCH MMCS design (top) vs. PE LRT design (bottom)

5.3.3.3 Segment 3: Currumbin Headland

The Currumbin Headland section stretches from Currumbin Creek to Tugun Currumbin Road. The concept design for this section was refined early in the PE phase to retain four traffic lanes on the Gold Coast Highway through Currumbin Hill and Tugun north (from the Duringan Street connection to Wagawn Street) and reinstatement of the Gold Coast northbound left turn into Thrower Drive, Currumbin.

An options analysis was undertaken at two locations (sub-segments) for the Currumbin Headlands segment:

- Currumbin Hill: from the Duringan Street connection to Tomewin Street Station. The options analysis considered two sub-options: a western side running LRT alignment and western Tomewin St LRT Station (consistent with the GCH MMCS) and centre running LRT alignment with central LRT Station.
- Tugun Central: from Wagawn Street to Toolona Street. Three sub-options were considered at this location – all options proposed central running south of Tomewin Street with differing LRT crossings to east side running occurring at Tugun Currumbin Road or Wagawn Street (with two different Tugun CBD station locations).

For the Currumbin Hill sub-segment, the west side LRT alignment and station location scored highest in the MCA and in all sensitivity tests, primarily due to the lower cost and constructability risks as the majority of the LRT corridor can be constructed offline with minimal impact to the Gold Coast Highway. In contrast, the central LRT alignment would require a higher degree of traffic control and constructability challenges (compared to the western alignment option). This option also scored higher in terms of Amenity and Place, as it provides the opportunity for an improved visual amenity and character for the station by situating it adjacent to the Currumbin Hill Conservation Park.

For the Tugun Central sub-segment, the two options with the LRT crossing at Wagawn Street (with east side-running from Wagawn Street to Toolona Street) scored highest in the MCA. These options were considered to provide improved outcomes in terms of PT efficiency and traffic efficiency with the LRT alignment located offline through the busy Tugun Currumbin Road intersection, resulting in less delays for LRVs and general traffic.

Subsequent to the MCA, further assessment was undertaken for the east side-running alignment between Wagawn Street and Toolona Street which identified the following issues:

- Potential safety issues at the Wagawn Street intersection with southbound traffic inadvertently traversing into LRVs as the LRT crossing is proposed on a horizontal curve through this intersection.
- The east side-running alignment with an island station platform requires a wider footprint and would therefore result in increased property impacts beyond the Category C boundary (compared to a central running alignment option).

Based on the above, the preferred LRT alignment from the GCH MMCS was retained with the LRT remaining central running through the Wagawn Street intersection, then crossing to east side running at the Tugun Currumbin Road intersection.

Figure 19 and Figure 20 shows the PE design with the LRT and road alignment for the Currumbin Hill and Tugun Central sub-segment, respectively.

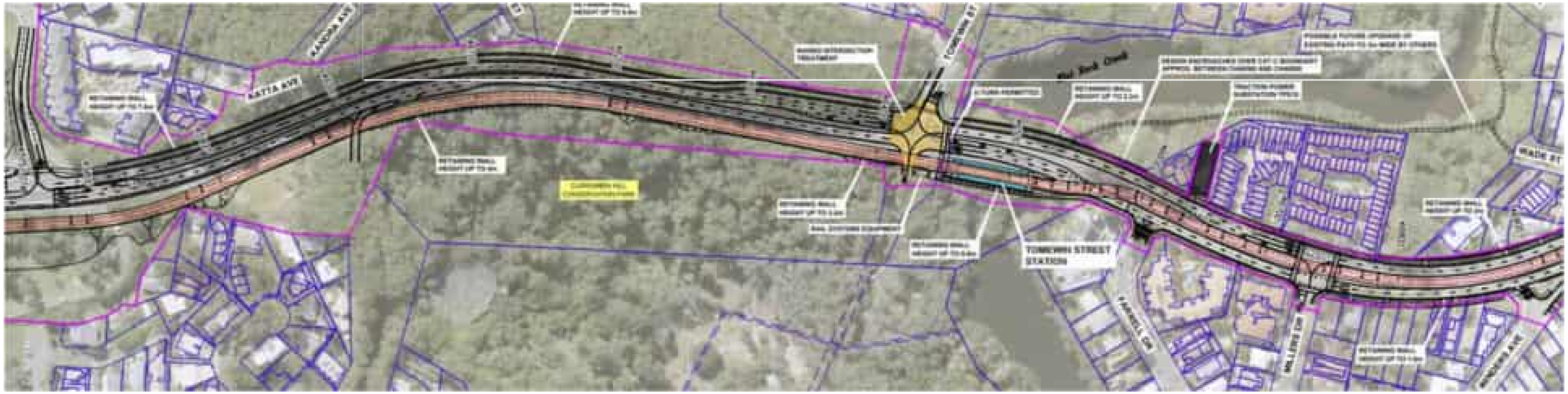

Figure 19 Currumbin Hill sub-segment – PE LRT design

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Figure 20 Tugun Central sub-segment – PE LRT design

5.3.3.4 Segment 4: Tugun to Bilinga

The Tugun to Bilinga segment commences from the Gold Coast Highway at Toolona Street, Tugun to Terminal Drive near the Gold Coast Airport. The LRT alignment follows the Gold Coast Highway from Tugun to Terminal Drive, then veers west of the highway along Terminal Drive with connections through the Gold Coast Airport, then continues south over the Gold Coast Highway towards the Musgrave Street/Coolangatta Road intersection.

The GCH MMCS proposed a side-running LRT alignment from Toolona Street to Terminal Drive, located immediately east of the Gold Coast Highway (i.e. between the highway and Golden Four Drive). Key intersections through this segment include Toolona Street, Kitchener Street, Boyd Street, Kirribin Street, Terminal Drive and Coolangatta Road. The Kitchener Street intersection was also proposed to be closed, however, based on community feedback, options were investigated to reinstate access at this intersection (refer to Section 5.3.4.2 for further discussion).

Two alternative LRT alignment options were investigated for the Tugun to Bilinga section during the PE – a central alignment (i.e. LRT corridor positioned in the Gold Coast Highway median) and a western LRT alignment option (between the Gold Coast Highway northbound carriageway and Coolangatta Road). The eastern side running LRT alignment (preferred MMCS alignment) scored highest in the MCA for the following reasons:

- Performs highest in terms of PT efficiency and traffic efficiency given the LRT is located offline and therefore avoids delays and removes traffic disruptions to the busy Gold Coast Highway corridor and intersections. It also scored highest in terms of PT connectivity/accessibility given it is closer to the higher density residential catchment along the coastline (east of the highway).
- Performs highest in terms of safety with reduced LRT conflicts with general traffic given the LRT corridor is located mostly offline.
- Performed moderate to other options in terms of environmental impact, amenity & place function and property impacts, based on minimal impact to existing vegetation and the alignment provides some opportunity to improved landscaping and street trees.

While this option scored lowest in terms of strategic cost and constructability (compared to the other options) due to the requirement to realign a large portion of the Gold Coast Highway; this was offset by the improved PT and traffic efficiency outcomes. Based on this, the eastern side running alignment was retained for this section (consistent with the GCH MMCS findings), as shown in Figure 21 to Figure 23.

For the LRT alignment through the Airport, a number of alignment options were investigated during the T2C MMCS. The MMCS preferred LRT alignment follows Terminal Drive and Tom Norris Road through the Airport, then continues south-east across the Gold Coast Highway as shown in Figure 23.

No further options analysis was undertaken during the PE for the Airport sub-segment given uncertainties in relation to the Airport Masterplan revisions (previously discussed in Section 2.5.5). TMR have been in consultation with the Airport regarding the proposed LRT alignment through the Airport (based on the GCH MMCS), however, further consultation with the Airport will be required in subsequent project phases to confirm the proposed LRT alignment including interchanges with bus and future heavy rail. The PE design therefore retains the preferred GCH MMCS LRT alignment (including bus/rail interchange) and location of the proposed Bilinga LRT satellite depot. Further information on the satellite depot is provided in Section 5.4.5.

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Figure 21 Tugun to Bilinga segment (Tugun sub-segment) – PE LRT design

Figure 22 Tugun to Bilinga segment (Bilinga sub-segment) – PE LRT design

Figure 23 Tugun to Bilinga segment (Bilinga to Airport sub-segment) – PE LRT design

5.3.3.5 Segment 5: Kirra to Coolangatta

This segment connects the Gold Coast Airport at Bilinga to the Coolangatta CBD and generally follows the Coolangatta Road alignment from the Airport to Miles Street, then traverses offline through Lanham Street Park then continues on-road along Chalk Street to the Warner Street intersection (southern project extent).

The GCH MMCS LRT alignment traverses from the Airport (near the SCU campus) across the Gold Coast Highway and is centre running through the Coolangatta Road / Musgrave Street intersection then follows the Coolangatta Road alignment with a centre running alignment. The design includes a proposed western extension of Musgrave Street from Coolangatta Road to the Gold Coast Highway and proposes removal of the existing northbound flyover to the Gold Coast Highway northbound, as shown in Figure 24. This is proposed to address safety issues associated with northbound traffic (from the NSW border) destined to Terminal Drive weaving across two traffic lanes (from the flyover).

The LRT alignment then follows Coolangatta Road from Musgrave Street to the Lord Street / Appel Street intersection, then veers off Coolangatta Road across Miles Street through the Lanham Street Park to the Chalk Street / Warner Street intersection, terminating in the Coolangatta CBD.

An options analysis was undertaken for the following two locations:

- Musgrave Street – includes the proposed new intersection with the Gold Coast Highway and the existing Musgrave Street / Coolangatta Road intersection
- Miles Street Station – section from the Coolangatta Road / Lord Street / Appel Street intersection to Lanham Street Park.

No options were assessed for the LRT alignment to the south of Miles Street, given a comprehensive analysis was undertaken during the GCH MMCS.

For the Musgrave Street section, two alternative alignment options were investigated – one proposing separation of the road and LRT between the Gold Coast Highway and Musgrave Street with a northern extension of Coolangatta Road and side-running LRT alignment to the south (includes removal of the existing flyover), as shown in Figure 24. The other proposing retention of the existing Musgrave Street northbound flyover to the Gold Coast Highway also with a side-running LRT alignment to the south.

The option with the Coolangatta Road north extension scored the highest in the MCA given it proposes:

- Improved safety outcomes by separating the road and LRT corridors between the highway and Musgrave Street, and also includes removal of the flyover which resolves the weave issue noted above.
- Performs comparable to other options in terms of the transport effectiveness criteria, engineering/technical compliance, property and environmental impacts and amenity and place function.

While the option that proposed retention of the existing flyover scored highest in terms of cost, this was outweighed by the reduced safety and engineering/technical compliance concerns associated with not addressing the weaving issues. The preferred LRT alignment taken forward during the PE is shown in Figure 24.

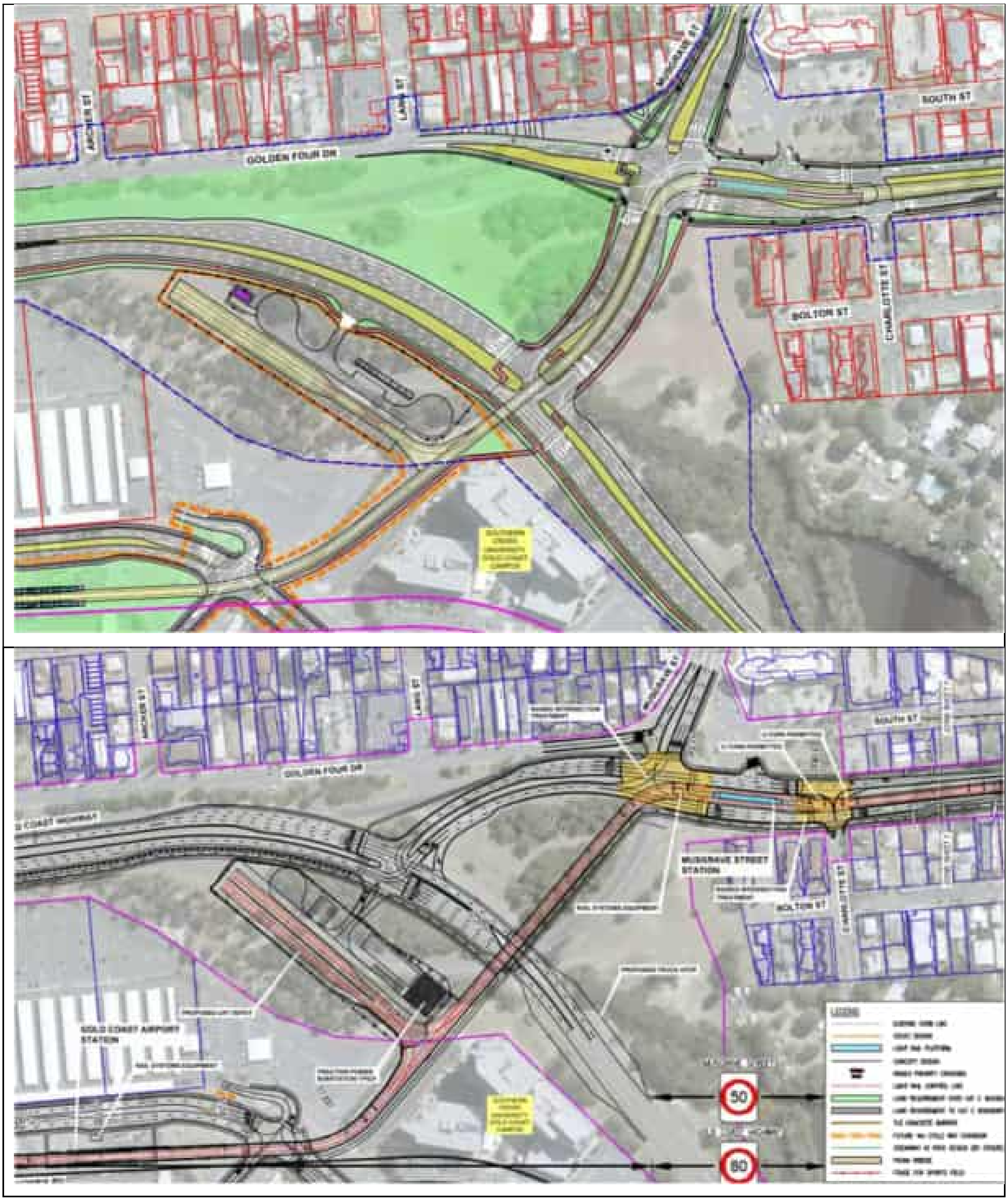


Figure 24 Gold Coast Highway / Coolangatta Road intersection: GCH MMCS design (top) vs. PE LRT design (bottom)

For the Miles Street LRT Station, two alternative alignment options were investigated – both propose alternative side-running alignments north of Coolangatta Road (between Lord Street and Miles Street) to address the long LRT crossings over the general traffic lanes proposed in the GCH MMCS design, and enhance the amenity and place appeal of the proposed LRT station.

- The Enhanced Station Precinct option scored the highest in the MCA given it proposes:

- Improved traffic efficiency with the shorter LRT crossing through the Lord Street / Appel Street intersection and across Miles Street, resulting in reduced traffic impacts and delays to general traffic at these locations; and improved safety outcomes.
- Reduced engineering and technical compliance challenges as a result of the straighter LRT alignment through the Miles Street Station.
- Improved outcomes in terms of amenity and place through improved land use opportunities for the station precinct, improved visibility of pedestrian desire lines to beach and opportunity to enhance the visual amenity of the station.

However, this option scored lowest in terms of property impacts as it results in impacts to several residential apartments north of Coolangatta Road that fall outside of the Category C boundary.

Following the MCA workshop, further investigations were undertaken for the preferred MCA alignment. It was noted that whilst this option improved safety for LRVs and general traffic and provided a more desirable LRT alignment through the Miles Street Station, there was insufficient engineering/technical compliance issues to justify the need to require several multi-dwelling properties that currently fall outside of the approved Category C boundary. As a result, the preferred alignment from the GCH MMCS was adopted which does not require impacts to these properties.

Figure 25 Miles Street LRT Station – preferred PE alignment

5.3.4 LRT/Road Alignment Refinement

The following sections outline further refinements undertaken throughout the PE phase to refine the concept design for the LRT, road corridor and intersection along the project corridor. The PE concept designs for the LRT Option are provided in Appendix I.

5.3.4.1 Methodology

Traffic modelling and analysis was undertaken on the revised LRT concept design using the GCAMSE to assess the operational performance of the project corridor (and surrounding study area) for the LRT Option and refine the concept design (including intersection layouts), identify any key traffic operational risks and ensure the transport network continues to operate efficiently to a 2041 design horizon.

Additional traffic modelling/analysis was undertaken to support the GCAMSE network modelling including SIDRA intersection analysis and turn warrants assessment to inform the intersection configurations (such as number of lanes/turn bays, storage lengths, lane allocation, geometry, signal phasing and timings etc.) Refer to the *Traffic Modelling Report - B2CTS-PE-433-REP-00002* (Appendix F) for detailed information regarding the traffic modelling and analysis findings.

Intersection design layouts were developed based on the traffic modelling/analysis outcomes and outcomes from the Access Strategy and Active Transport Strategy with respect to pedestrian and cyclist provisions. These intersections were checked using V-paths and spatial provisions were made for traffic signals and pram ramps in the confined locations.

A preliminary 12d model was developed to further assess the design to identify areas of cut/fill and retaining walls. Geometric compliance checks were undertaken on the major horizontal and vertical road and rail alignments (refer to Section 5.3.7 for further information).

Engineering and technical investigations were carried out throughout the PE to identify key project risks and considerations, and to inform the concept design and cost estimate. Further information on these investigations is provided in Section 8.0 and more detailed information can be found in the report appendices.

5.3.4.2 Key Design Refinements

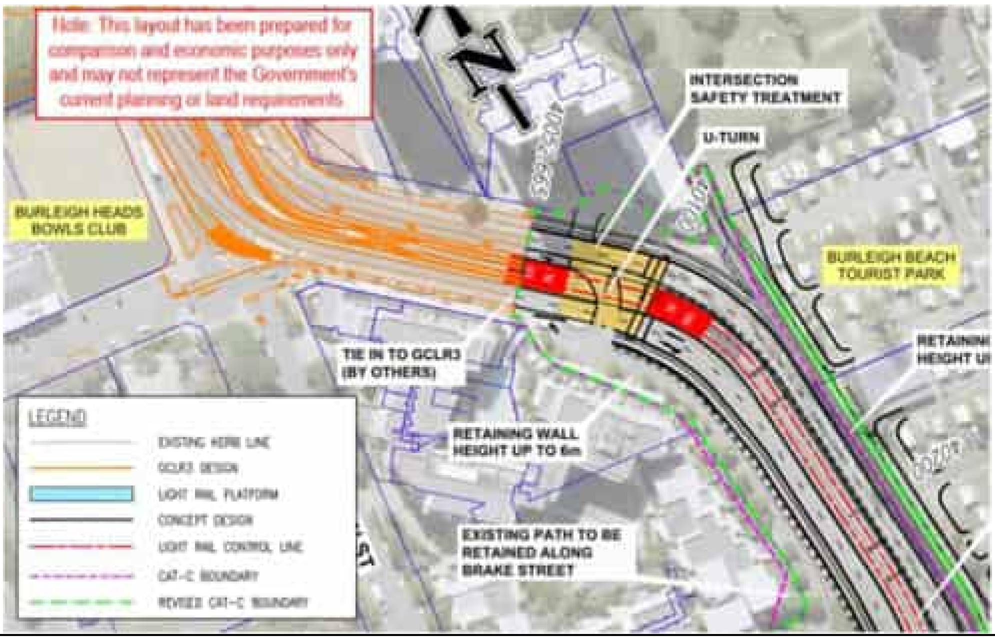
The following sections discuss key refinements undertaken throughout the PE phase for the LRT design, road and intersection designs along the project corridor. The refinement areas are discussed by project segment (from north to south) for ease of reference.

5.3.4.2.1 Segment 1: Burleigh Heads

SEGMENT 1 – BURLEIGH HEADS

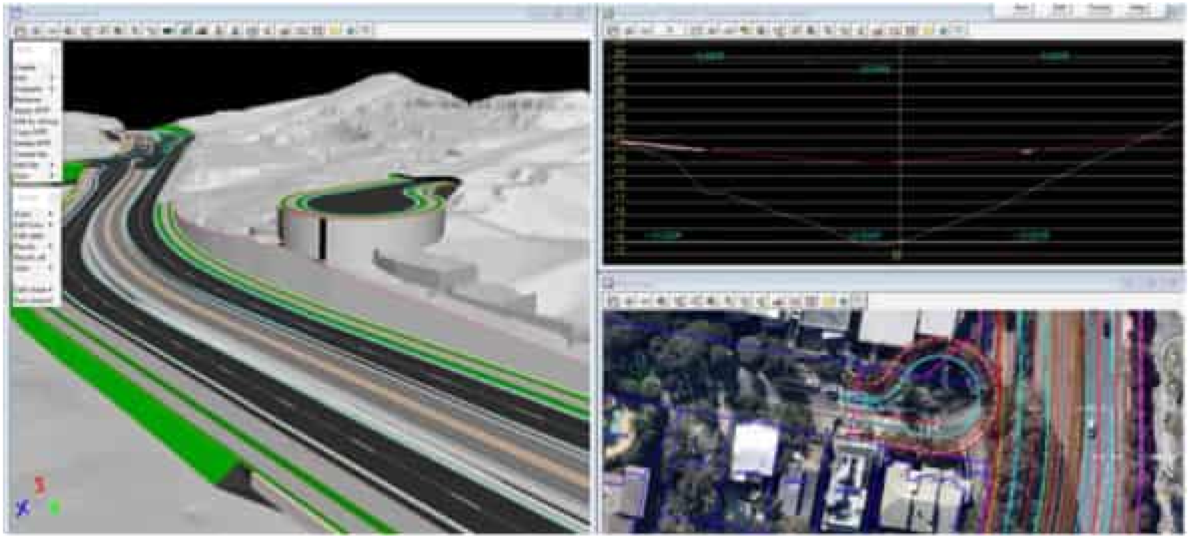
GCLR3 Interface (Ch 40052)

The tie-in for GCLR3 was included in the design based on the Detailed Design (as of December 2022), as shown in the figure below. The end of line treatment (sand trap) will need to be removed, and there may be an opportunity to upgrade the non-standard scissor crossover as part of the GCLR4 project. The proposed bus turnaround area (to the south of the Burleigh Heads Station) is required to be retained, as shown.

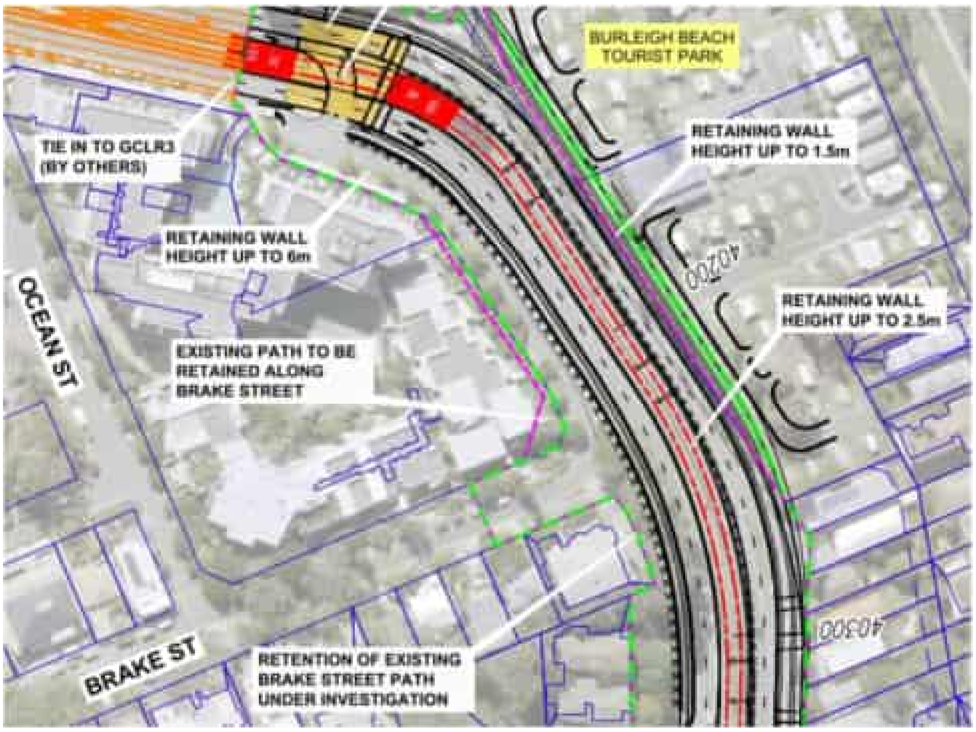


Brake Street (Ch 40052 – Ch 40300)

Several options for Brake Street were investigated including the potential closure of the through connection to the Gold Coast Highway, and provision of a cul-de-sac near Chainage 40240. It was determined that a cul-de-sac in this location was not feasible due to the steep vertical grading (over 20%) and insufficient width of the Brake Street corridor. A compliant cul-de-sac with 5% maximum grading shown below would have significant impacts on the adjacent properties with addition property procurement requirements.



As a result, the through function of Brake Street will need to be maintained which requires additional property impacts outside of the Category C boundary to the Burleigh Beach Tourist Park on the eastern side of the Gold Coast Highway. This option also allows a pedestrian path to be included on the western verge, providing improved connectivity for residents on this side of the corridor.



George Street East intersection and Cotton Street (Ch 40400 – Ch 40500)

The PE design proposes an LRT crossing from centre to side-running at the George Street East intersection in Burleigh Heads. It was noted during the PE that the Gold Coast Highway southbound through traffic lanes align with the LRT corridor on the departure side of the intersection. This could result in an errant vehicle driving onto the LRT track, resulting in a head-on collision with an LRV.

To resolve this issue, the LRT alignment would need to be realigned to remove the hidden curve through the intersection. This requires further impacts to the properties on the corner of George Street East intersection are required (which is outside of the Category C boundary).

The side-running LRT alignment also requires removal of Gold Coast Highway/Cotton Street. The PE design proposes to cul-de-sac Cotton Street, as shown in the below figure.

This image has been removed as it contains property impacts that are not approved.

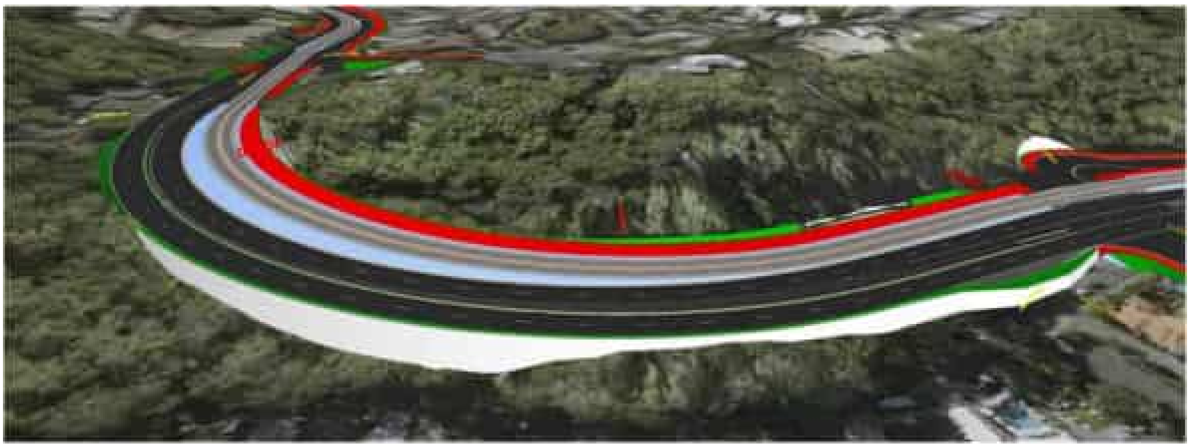
Further investigation is required to improve the road and LRT alignments through the intersection and determine whether on-street parking can be retained along George Street East.

Burleigh Head National Park Hill (Ch 40500 – Ch 40800)

Community concerns were raised during the GCH MMCS consultation regarding the loss of vegetation on the western side of the Gold Coast Highway near Djerral Avenue. Various options were explored through this section of highway to retain the trees, with an aim to have least impact to the Burleigh Head National Park on the eastern side of the highway.

It was found that the trees are likely to be impacted due to the project corridor width requirements based on the tight curve radius triggering the requirement for curve widening for vehicle tracking and sight distance, in addition to clearing required for construction of the proposed retaining wall adjacent to the northbound carriageway. Furthermore, the fauna bridge requires a central pier with LRT derailment provisions, which further increased the width requirement between the traffic lanes and the LRT corridor.

Retaining structures will be required along the western verge of the highway through this section up to 5m in height adjacent to Djerral Avenue, and a reduction from the MMCC strategy design outcomes. An options assessment was undertaken to minimise the height of the retaining structure, and the retention of mature trees along the existing western verge. The LRT and road geometry through is section are tight radius and minimum for the desired speeds on the Gold Coast Highway. Further assessment is recommended in the next design phase to further refine and reduce impact to the community, Burleigh Hill National Park, and Aboriginal Cultural Heritage.



Detailed geotechnical investigations are required to assess the safety of the existing slopes and vegetation to determine the optimal road and LRT alignments while balancing the loss of vegetation either side of the Gold Coast Highway.

Due to the existing longitudinal grade of the road over the hill (up to 5.9%), the project has nominated rest provisions every 60-100m apart to improve accessibility as part of the overall active transport strategy.

There is a potential property impact on western side of the Gold Coast Highway outside of the Category C boundary (at Chainage 40500), due to potential driveway grading that will need to be further investigated in the next phase of the project.

Burleigh Hill Fauna Bridge (Ch 40580)

A number of fauna bridge crossing alignments were investigated. The below option was chosen based on the opportunities to retain the natural park ridge line fauna connection and minimise requirement for additional retaining wall infrastructure, which would impact vegetation on the western park reserve, while improving vegetation and habitat at the crossing location.

This image has been removed as it contains property impacts that are not approved.

Earthworks for connection to the bridge crossing will impact properties outside the Category C boundary. For further details refer to Section 8.4.1.

This recommendation is subject to the completion of a Fauna Connectivity Study (to be undertaken during the BC phase) to reinforce the importance of establishing a permanent fauna crossing across the Gold Coast Highway.

Ikkina Road Intersection / Jellurgal Aboriginal Cultural Centre / LRT Station / Carpark (Ch 40800 – Ch 41080)

The design in this location was largely based on the outcomes from the GCH MMCS, including community consultation feedback. The overall intent was to generally retain the current vehicle access, parking arrangements and function of the Jellurgal Cultural Centre, which included parking provision for two coaches directly in front of the centre, a proposed off-street car park (including PWD bays), loading zone and provision for a bus turn-around area.

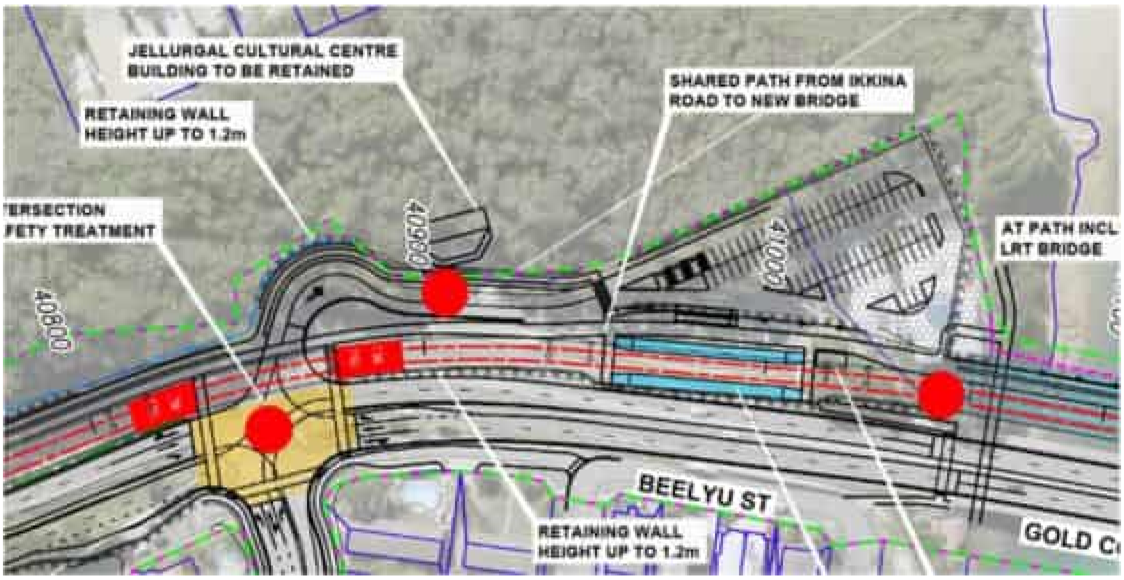
The Ikkina Road intersection layout was revised to include the recommendations from the Access Strategy and traffic modelling including retaining access (from all directions) to/from the Jellurgal Cultural Centre (see Inset A below). Based on this, the concept design was revised to retain the existing access at the Ikkina Road intersection (including retaining the northbound right turn bay). The intersection design also permits U-turn movements from the Gold Coast Highway southbound for vehicle access to the properties located west of the highway (opposite Cotton Street). A signalised mid-block pedestrian crossing was included on the Gold Coast Highway to the south of the LRT Station, as per the project requirements (refer to Section 2.4).

Another key consideration in this area was the vertical level requirements of the proposed Tallebudgera Creek Bridge being approximately 1m higher than the existing bridge due to the requirement of the underside of the girders (see Inset C below). This results in a vertical grade on the LRT alignment prior to the station (at Ch. 41000) to meet the bridge tie-in level. The level constraints at the Ikkina Road intersection, Jellurgal Cultural Centre and the Tallebudgera Creek Bridge abutment result in a constrained design outcome at this location with sub-optimal access provision (stairs and ramps) at the proposed LRT Station. The remaining structural life of the existing Gold Coast Highway bridge over Tallebudgera Creek is unknown and will need to be investigated and considered in the BC Stage. Should the existing road bridge need to be replaced, the sub-option for the LRT to remain as centre running will need to be reviewed.

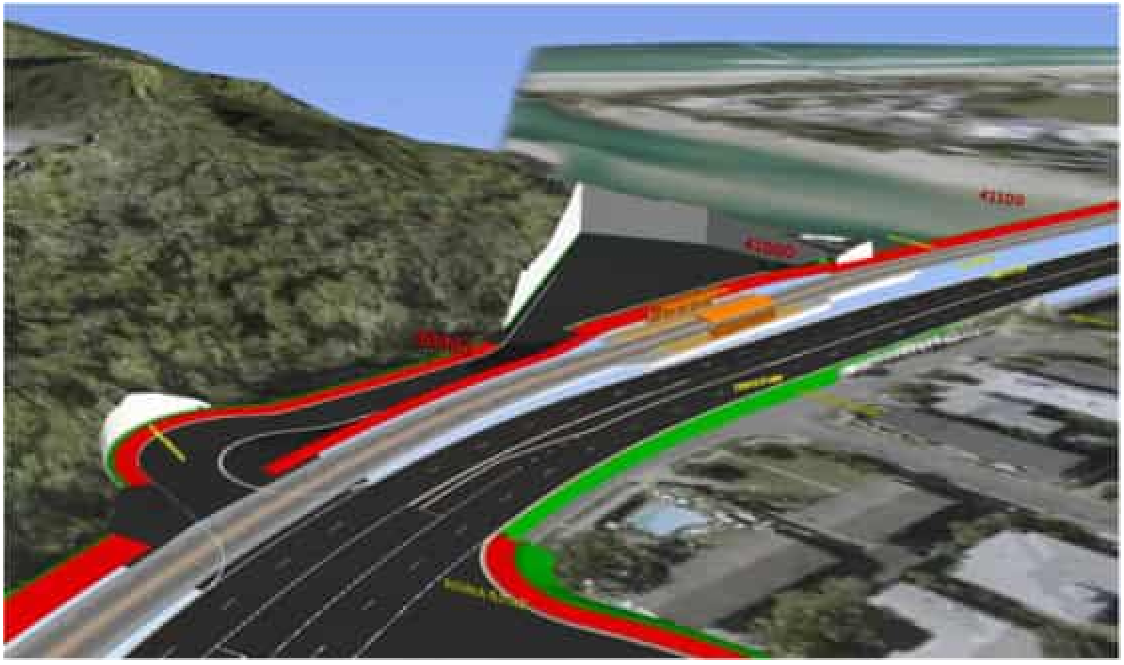
Further, the proposed car park (required for parking offsets) will require significant retaining walls greater than 10m in height (see Inset B below). This results in a complex and high cost design outcome near the sensitive environmental and culturally sensitive areas of Tallebudgera Creek and the Burleigh Head National Park. This solution may pose a risk to TMR/CoGC in terms of community acceptance, given it can be perceived as a poor amenity outcome around Tallebudgera Creek and Burleigh Hill—both of which are tourist attractions of community, environmental and cultural heritage significance.

A shared path (rather than the separated cycleway) has been included from the Ikkina Road intersection to the Tallebudgera creek bridge. This has been provided due to the spatial constraints between the LRT corridor and the car park access, but also in consideration of the proximity of the station to minimise potential conflict points between passengers and cyclists. This design outcome is still considered to generally comply with the PCNP.

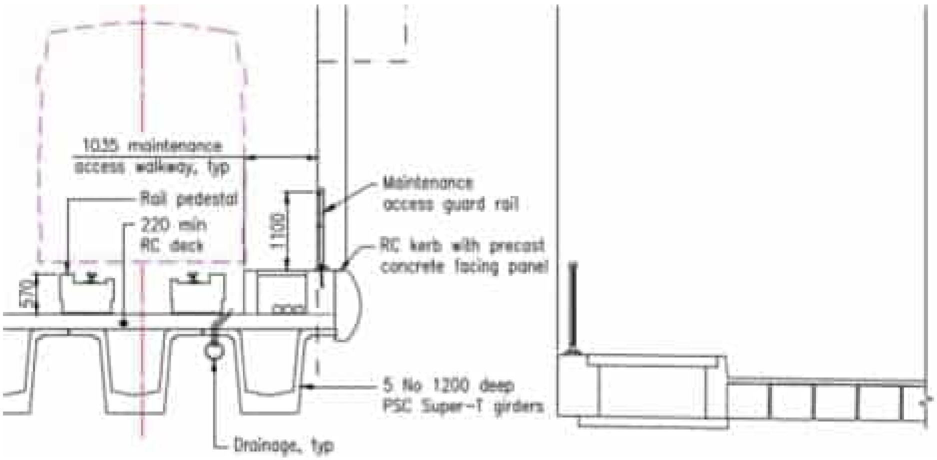
It is recommended that TMR and CoGC undertake further community consultation (including the Jellurgal Cultural Centre and traditional owners) to inform further design options and investigations with the LRT, road, carpark and pedestrian interfaces around the station in the next phase of the project.



Inset A – Ikkina Road intersection & Burleigh Head National Park LRT Station – concept design



Inset B – Burleigh Head National Park LRT Station – 3D model



Inset C – Tallebudgera Creek LRT bridge cross-section

Tallebudgera Recreation Camp / Tallebudgera Creek Tourist Park intersection (Ch 41200 – Ch 41500)

The GCH MMCS design proposed to relocate the existing vehicle access to the recreation camp to the north, adjacent the Tallebudgera Creek southern bridge abutment. Upon further investigation, this was determined to not be feasible due to the grading of the LRT approximately 1m higher than the Gold Coast Highway.

An alternative side-running option was investigated from Tallebudgera Creek to Tallebudgera Drive with a LRT crossing (from side to centre running) at Tallebudgera Drive. However, this option was not feasible due to the superelevation around the horizontal curve and split carriageway levels of the Gold Coast Highway (south of Tallebudgera Drive).

Therefore, the preferred option was identified to retain the existing access arrangements (with a consolidated four-way intersection) at the Tallebudgera Creek Recreation Camp / Tallebudgera Creek Tourist Park access and include the side to centre LRT crossing at this intersection. This also allows the existing access arrangements (i.e. all turn movements) to be retained at this intersection, which was a recommended outcome from the GCH MMCS community consultation feedback. Further refinements are required in the BC phase for the active transport connection to the Oceanway and the boat ramp, considering CoGC redevelopment opportunities of the parklands.

5.3.4.2.2 Segment 2: Palm Beach

SEGMENT 2 – PALM BEACH

Tallebudgera Drive Intersection (Ch 41500 – Ch 41800)

The intersection design was refined to incorporate a right turn bay on the Gold Coast Highway northbound for right/U-turn access (based on the Access Strategy and community feedback). The PE traffic modelling also identified high right turn demand on the Gold Coast Highway southbound (into Tallebudgera Drive) in the afternoon peak, resulting in a requirement for dual right turn bays. Additionally, the Tallebudgera Drive intersection is a key connection for Active Transport and the terminus point for the cycleway from Burleigh Heads, so a protected intersection with separated cycle/pedestrian crossing points has been included in the design.

The combination of these two elements has resulted in additional land requirements outside of the Category C boundary to the sports field at the Tallebudgera Recreational Camp and the property on the north-western corner of the intersection.

Twenty Fifth Avenue Station (Ch 41800 – Ch 42200)

The proposed LRT station at Twenty Eighth Avenue was relocated approximately 230m south, adjacent to Twenty Fifth Avenue due to geometric constraints on the Gold Coast Highway imposed by the Category C boundary between Ch. 41800 - 42150. The split carriageway levels on the Gold

Coast Highway requires provision of a retaining wall through the median between Ch. 41710-41950 and requires provision for a road shoulder for breakdown clearance to the retaining wall. There is insufficient road width (between the Category C boundary) to accommodate required cross-section for the LRT station, four traffic lanes, footpaths (including DDA compliant pedestrian access to the LRT Station with stairs), retaining wall (and required offsets).

Based on this, a decision was made to relocate the LRT station to the north of Twenty Fifth Avenue, where the grade difference between the highway carriageways flattens and there is sufficient corridor width available for the station. The relocated Twenty Fifth Avenue Station is approximately 1,100m south of the Burleigh Head National Park LRT Station and 757m to the north of the Nineteenth Avenue LRT Station, which considered to be an acceptable spacing between these LRT stations based on 800m spacings (roughly) through the populated areas (subject to site constraints).

Given the requirement for dual southbound right turn lanes at the Gold Coast Highway / Tallebudgera Drive intersection (which encroaches into the Category C), there is no opportunity to relocate the station to the north of Tallebudgera Drive without further property impacts.

Twenty Third Avenue intersection (Ch 42400)

The Gold Coast Highway / Twenty Third Avenue intersection has been revised in the PE to include a northbound right turn bay (for right/U-turn access) based on the Access Strategy recommendations and to address community concerns regarding limited right turn access through Palm Beach (discussed previously in Section 5.3.2).

Nineteenth Avenue intersection (Ch 42800)

The Gold Coast Highway / Nineteenth Avenue intersection layout was revised in the PE phase with the Nineteenth Avenue (west) approach changes to a single shared left turn lane (instead of dual left turn), and a shared through/right turn lane. Provision of dual left turn lanes would require full pedestrian protection for the Gold Coast Highway (north) crossing and would result in extensive delays on this approach (based on the traffic modelling), while a single left turn lane reduced delays on all approaches.

The project identified the need for active transport connection between the Oceanway and Nineteenth Avenue (part of the PCNP) and recommends provision along Nineteenth Avenue and across the Gold Coast Highway to be investigated in the next project stage.

Eleventh Ave intersection (Ch 43650)

A northbound right turn bay has been included at the Gold Coast Highway / Eleventh Avenue intersection based on the Access Strategy recommendations and to address community concerns regarding limited right/U-turn access through Palm Beach (discussed previously in Section 5.3.2). The proposed northbound right turn bay will also accommodate U-turn movements for improved access to properties located east of the highway.

Palm Beach Ave intersection and LRT Station (Ch 44100 – Ch 44300) The Access Strategy recommended that a southbound right turn bay be provided at the Gold Coast Highway / Palm Beach Avenue intersection given Palm Beach provides an important transport function as a key connection to the M1 Motorway and Elanora, and to address community feedback regarding limited right/U-turn access through Palm Beach (discussed previously in Section 5.3.2). The proposed southbound right turn bay will also accommodate U-turn movements for improved access to properties and the local road network west of the highway. Retention of the southbound right turn bay required the Palm Beach Avenue LRT Station to be relocated to the south side of Palm Beach Avenue (instead of the north side, as proposed in the GCH MMCS) to minimise property impacts. The revised station location also provides improved pedestrian accessibility station to the Palm Beach precinct between Palm Beach Avenue and Fourth Avenue. The AT Strategy identified the need for active transport connection between the Oceanway and Palm Beach Avenue (part of the PCNP) and recommends provision along Palm Beach Avenue and across the Gold Coast Highway to be investigated in the next project stage.
Fourth Ave intersection (Ch 44400) A northbound right turn bay was provided at the Gold Coast Highway / Fourth Avenue intersection to address community concerns regarding the restricted right turn access to Palm Beach and recommendations from the Access Strategy (as discussed previously in Section 5.3.2). The proposed northbound right turn bay will also U-turn movements for access to Jefferson Lane and properties located east of the highway.
First Ave intersection and Hawaii Ave pedestrian crossing (Ch 44650 – Ch 44900) The First Avenue intersection is proposed to remain unsignalised, as recommended in the Access Strategy, and the mid-block signalised pedestrian crossing at Ch 448200 (near Hawaii Avenue) is proposed to be retained as a staggered pedestrian crossing (refer to Section 5.3.2 for further information). The emergency vehicle cross-over (also known as a “hot exit”) on the Gold Coast Highway at Ch 44800 is retained in the design to provide right turn access in/out of in the Queensland Police Service (QPS) Palm Beach Station. Further consultation with QPS should be undertaken in the next phase regarding specific access requirements for this crossover.
Thrower Drive intersection (Ch 44900 – Ch 42500) The intersection layout and LRT station at the Thrower Drive intersection is generally consistent with the GCH MMCS design. However, minor refinements to the southbound right turn bay and northbound left turn bay were undertaken based on the PE traffic modelling findings to accommodate increased turn storage capacity, and the lane allocation on the Thrower Drive (west) approach was revised to cater for the high right turn demand. Minor refinements to the bus interchange facilities were also undertaken to consolidate all the bus stops to Sarawak Avenue with capacity for three buses operating in a nose-to-tail arrangement. The GCH MMCS proposed bus stops/layover areas on Sarawak Avenue, Thrower Drive (north of Luzon Parade) and the Gold Coast Highway which is not considered ideal in terms of passenger connectivity, accessibility and amenity as it can requires bus passengers to navigate between three different bus stop locations (including crossing the LRT). The proposed bus stops/bays on Thrower Drive and the Gold Coast Highway may also create safety issues and impact traffic efficiency at this busy intersection. Therefore, it is preferred to consolidate all bus stops to Sarawak Avenue to remove these issues. Further design and engagement with Translink will be required to confirm the requirements for the bus interchange facilities and to improve bus access and circulation (reduce the number of signalised crossings) in the next phase of the project. Translink have also advised the driver facilities (with layover area) will be required in the vicinity of this area given that two bus routes (the 771 and 773) are proposed to be truncated at this stop. The *Public Transport Operational*

Assessment - B2CTS-PE-440-REP-00001 (refer to Appendix G) provides further information regarding the public transport operational requirements at this LRT station/bus interchange.

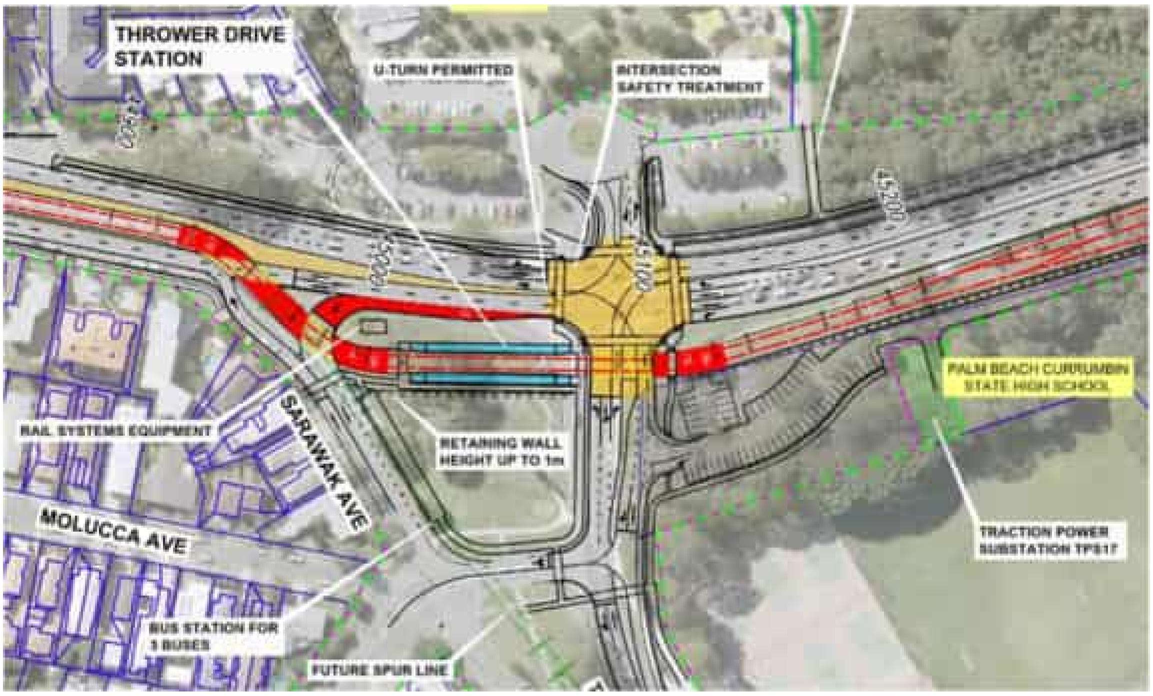
The location of the traction power station (TPS) has been revised in the PE to be relocated to the south-west of the Thrower Drive intersection. The GCH MMCS proposed for the TPS to be located in the centre of the Thrower Drive/Sarawak Avenue/Luzon Parade island near the LRT station which would impact the existing hydraulic conditions and drainage retention of this island.

The PE design can accommodate a future LRT spur for a potential western extension to Elanora (refer to Section 5.5.3 for further information).

The project identified the need for active transport connection between the Oceanway and Thrower Drive (part of the PCNP) and recommends provision along Thrower Drive and across the Gold Coast Highway to be investigated in the next project stage. Thrower Drive has access to a number of key public facilities such as the school, parklands, recreational centres, shopping centre.

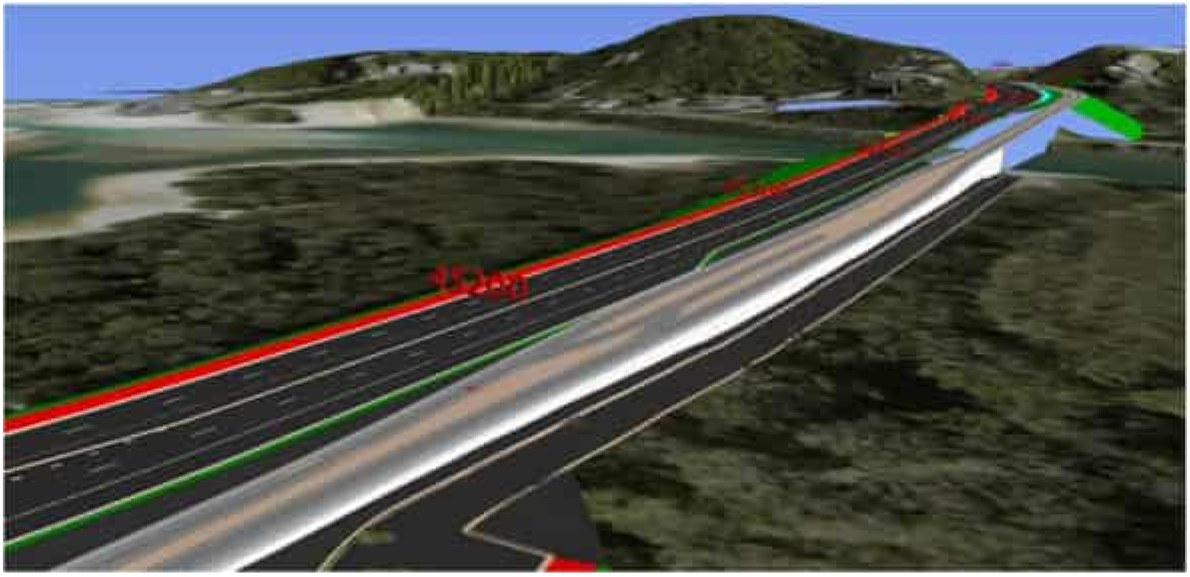
Off-street parking at Thrower Drive has been amended with the aim to retain the same number of parking bays at the Lions Park. There is an opportunity to investigate additional parking along Thrower Drive/Sarawak Avenue in the next project phase, should there be a requirement.

As a key public transport and activity centre, the Thrower Drive LRT and bus interchange, road arrangements and pedestrian connections should be reviewed in the next project phase.

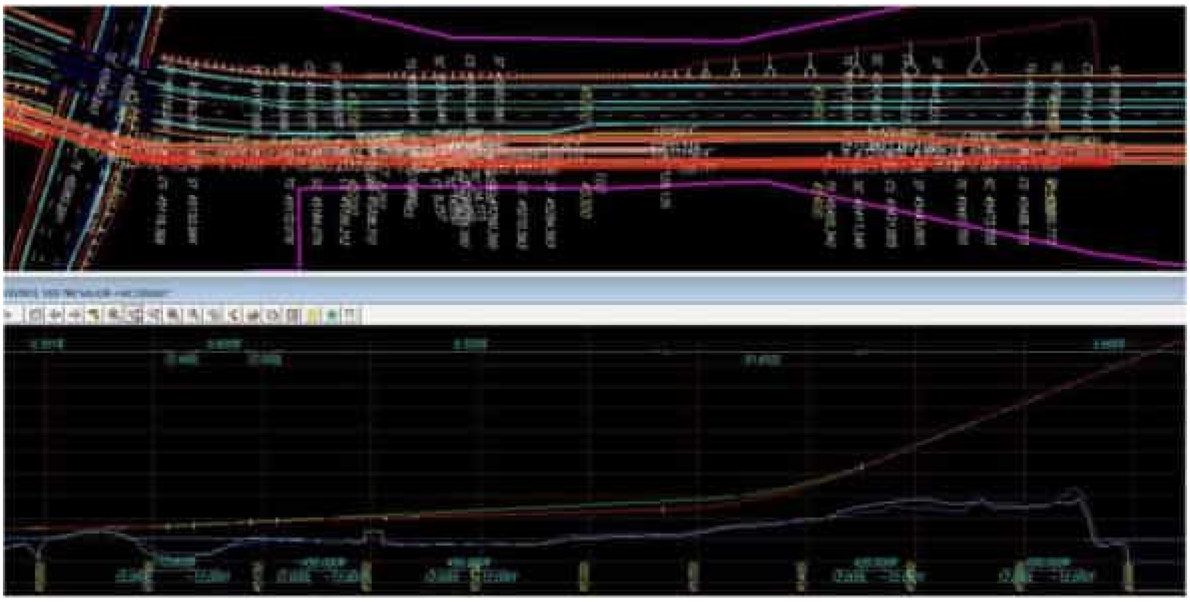


Thrower Drive layover and turnback facility

The Thrower Drive layover and turnback facility for short term storage is shown in the figure below. The position of the turnback facility has been optimised considering the rising vertical grade over Currumbin Creek and the intersection requirements for Thrower Drive.



The turnback has been positioned on a non-complying 0.3% rising vertical grade (matching existing accepted storage grades in the Southport Depot), and allows for storage of one LRV clear of the turnout. Extension of the LRV storage length is possible, however would result in an increased vertical grade to store LRVs which is undesirable. The layout with eastern facing turnouts was adopted from the MMCS Phase design, with the turnout locations moving south due to the required left turn lane extents on the Gold Coast Highway into Thrower Drive.



The location and proposed operation of the LRT temporary storage and turnback with a potential southern track crossover should be reviewed with the LRV Operations and Maintenance (O&M) Contractor, to ensure intent is achieved.

5.3.4.2.3 Segment 3: Currumbin

SEGMENT 3 – CURRUMBIN

Thrower Drive – northbound left turn from the Gold Coast Highway (Ch 46000)

The left turn from the Gold Coast Highway northbound into Thrower Drive, Currumbin was reinstated as a signalised auxiliary left turn based on the GCH MMCS community consultation feedback (refer to Section 5.3.2 for further information).

Currumbin Creek AT bridge (Ch 45400 – Ch 45700)

The proposed AT bridge (and connecting paths) across Currumbin Creek is currently being designed by others with tie-ins to the B2C project. As such, the connecting AT path on the southern approach will need to be reviewed further once the design for the new AT bridge is finalised during future design phases.

Currumbin Hill (Ch 45750 - Ch 46500)

The concept was revised to retain two through lanes on the Gold Coast Highway in each direction. This is an increase from the one lane in each direction nominated in the GCH MMCS. This impacted the overall corridor width which required widening into the existing cut faces and over embankments where retaining walls (up to 8m high) have been included.

Due to the existing longitudinal grade of the road over the hill (up to 5.3%), the project has nominated rest provisions every 60-100m apart to improve accessibility as part of the overall Active Transport Strategy.

Tomewin Street intersection and LRT Station (Ch 46500)

The Tomewin Street intersection was revised to retain two through lanes on the Gold Coast Highway (i.e. four-lanes in total) and a southbound auxiliary left turn lane was incorporated based on the turn warrants assessment. The northbound and southbound turn bays on the Gold Coast Highway were also extended based on the traffic modelling findings (refer to the *Traffic Modelling Report - B2CTS-PE-433-REP-00002* in Appendix F).

Four Lanes between Duringan Street and Wagawn Street (Ch 45760 – Ch 47100)

As noted in Section 5.3.2, the LRT concept design was refined in the PE phase to retain all existing general traffic lanes on the Gold Coast Highway, as per the project requirements. This resulted in an increased cross-section through Currumbin and Tugun (from Duringan Street and Wagawn Street), which was proposed as two lanes in the GCH MMCS.

This image has been removed as it contains property impacts that are not approved.

Several options were investigated to minimise additional property impacts. However, it was determined that it was not feasible to maintain the property accesses on both sides of the Gold Coast Highway between Ch 40800 to 47100 due to the limited grade separation between the carriageways as a result of the LRT corridor. Further, the side road access to Winders Avenue (Ch 46500) was found to be excessively steep (approximate 30%) and was not feasible to remain.

The short one-way section of Winders Avenue (north of Wagawn Street) was upgraded to a two-way road to retain access to the Gold Coast Highway. The Gold Coast Highway's western pedestrian path that connected to Winders Avenue's link road is relocated along and to the same level as the Gold Coast Highway to improve accessibility to Tugun CBD.

This resulted in a significant amount of additional property impacts outside of the Category C boundary on the western side of the road between 46900 and 47100.

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Millers Drive intersection (Ch 46750)

The Gold Coast Highway / Miller Drive intersection has been refined in the PE to include pedestrian crossings on all approaches (as per TMR's Road Safety Policy) and the southbound right turn bay extended (based on the traffic modelling findings). The turn warrants assessment identified a requirement for a dedicated left-turn lane on the Gold Coast Highway (south) approach (i.e. auxiliary left-turn or channelised left-turn), however, this was not included in the PE design as it would require further impacts to the Category C boundary.

An option was investigated to relocate the right turn movements to Farrell Drive, however, this was not progressed as the Access Strategy noted that Millers Drive currently functions as the primary access point to/from the Gold Coast Highway and provides the most direct access to the local road network west of the highway (compared to Farrell Drive, Winders Avenue and Wagawn Street). Relocating this access to Farrell Drive would also result in poor outcomes as it increases traffic through a local road (Farrell Drive) and reduces the distance to the adjacent Tomewin Street traffic signals which can create safety issues due to the "see through" effect of consecutive traffic signals (where the downstream green signal is visible to approaching motorists on the Gold Coast Highway, resulting in drivers inadvertently driving through a downstream red light).

Wagawn Street intersections (Ch 47150)

The Gold Coast Highway / Wagawn Street intersection is proposed to be reconfigured to a four-way intersection with all turn movements permitted, given that the LRT Option proposes removal of highway access to/from Toolona Street East (which is currently the primary access to the Tugun town centre). The layout of the Gold Coast Highway / Wagawn Street intersection is generally consistent with the GCH MMCS design. Minor design refinements were undertaken to include a staggered crossing on the southern approach (to improve the intersection's performance) and adjustments to the turn bay lengths based on the traffic modelling findings.

The Wagawn Street / Golden Four Drive intersection is proposed to be signalised to manage vehicle queues on the Wagawn Street west approach and reduce the risk of queue spillback onto the highway. Signalisation will also improve safety for pedestrians and cyclists and address safety risks associated with poor intersection sight distance (as a result of the vertical crest on Teemangum Street north of the intersection, which restricts sight distance).

The project identified the need for active transport connection between Golden Four Drive and Wagawn Street (part of the PCNP that connects to Stewart Road off-road path) and recommends provision to cross the Gold Coast Highway to be investigated in the next project stage.

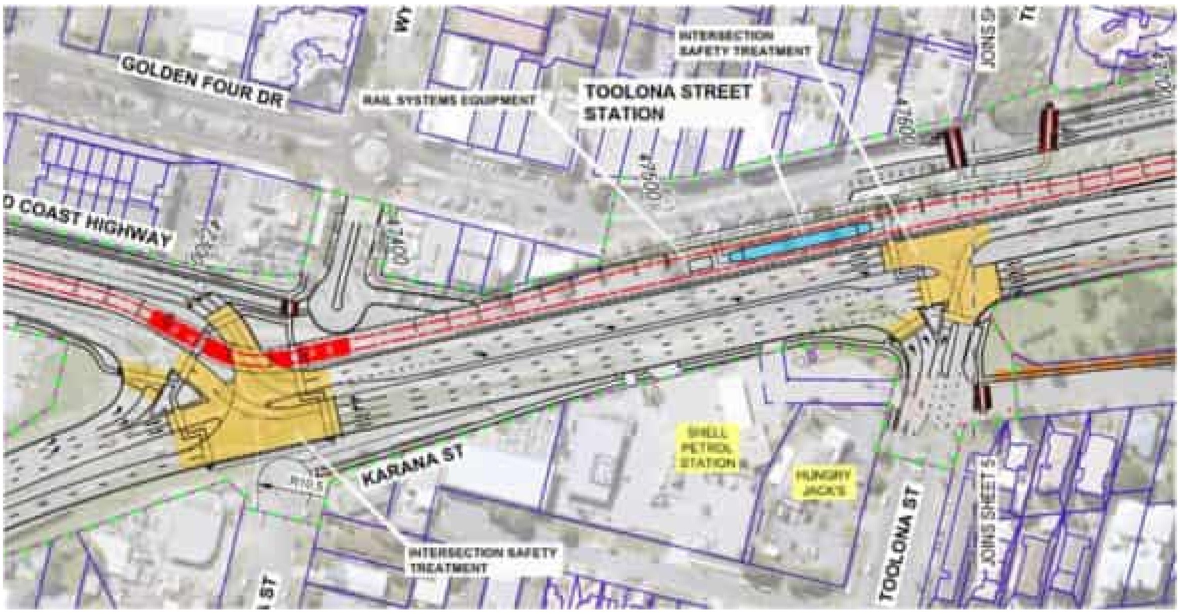
Tugun Currumbin Road intersection (Ch 47300)

The Gold Coast Highway / Tugun Currumbin Road intersection is generally consistent with the GCH MMCS design with the following refinements:

- Staggered pedestrian crossings are proposed on all four legs of the intersection based on the traffic modelling findings (to reduce congestion and traffic delays through this busy intersection) and in line with TMR's *Road Safety Policy* (2022). The GCH MMCS design did not include a pedestrian crossing on the north-west approach which was noted as a deficiency in the Active Transport Strategy.
- Additional parking has been provided on Wyberba Street (where possible) to address the loss of parking associated with introduction of the LRT
- The proposed new intersection at Tugun Currumbin Road / Durran Street has been removed based on feedback received during community consultation (refer to Section 5.3.2 for further information).

Consideration was given to reconfiguring the existing left-turn slip lane at the Tugun Currumbin Road (west) approach to dual auxiliary left-turn lanes (in line with TMR's *Road Safety Policy* (2022) which states left-turn slip lanes should be avoided at intersections). However, auxiliary lanes are not practical on this approach due to the acute angle for a left-turning vehicle to negotiate and stay in its respective lane. This would also require a longer pedestrian crossing across the Gold Coast Highway (north) approach, resulting in increased traffic delays and reduced safety for pedestrians.

Therefore, the dual slip lanes have been retained (with a high-entry angle) and a raised signalised pedestrian crossing included, as per the guidelines in the *Road Safety Policy* and supporting factsheets.



Inset D – Tugun Currumbin Road intersection, Toolona Street intersection and LRT Station

5.3.4.2.4 Segment 4: Tugun to Bilinga

SEGMENT 4 – TUGUN TO BILINGA

Toolona Street intersection (Ch 47600)

The Gold Coast Highway / Toolona Street intersection layout is generally consistent with the GCH MMCS design which proposed closure of Golden Four Drive and Toolona Street East to the Gold

Coast Highway to improve safety (due to conflicts with the LRT and the complex intersection layout with multiple approaches). The PE design includes the following refinements (as shown in Inset D):

- Two southbound traffic lanes have been included on the Gold Coast Highway to improve traffic efficiency (as per the traffic modelling recommendations). The GCH MMCS proposed three southbound through lanes, however, this cannot be accommodated due to site constraints from the relocated Toolona Street LRT Station, Category C boundary and dual right turn lanes on the Gold Coast Highway northbound approach to the Tugun Currumbin Road intersection.
- Toolona Street west approach revised to include two left turn slip lanes and a single right turn lane based on the traffic demands
- Northbound approach revised to include three dedicated through lanes and an auxiliary left turn lane (based on the turn warrants assessment)
- The Gold Coast Highway pedestrian crossing on the north approach reconfigured to a staggered crossing to reduce intersection delays for the light rail and general traffic.

Consideration was given to replacing the left turn slip lanes on the Toolona Street (west) approach with auxiliary left turn lanes. However, the Toolona Street (west) approach is orientated at an acute angle with the Gold Coast Highway and requires the pedestrian crossing on the Gold Coast Highway (north) approach to be repositioned further north, again resulting in increased walking distances and delays for pedestrians and traffic (similar to the Tugun Currumbin Road intersection). The PE design therefore proposes to dual left-turn slip lanes with a raised signalised pedestrian crossings to reduce vehicle speeds and improve safety for pedestrians.

A pedestrian crossing has not been included on the Gold Coast Highway (south) approach as this would increase delays at this intersection for the light rail and general traffic. The project identified the need for a cycle-only crossing of the Gold Coast Highway connecting Golden Four Drive / Oceanway and Coolangatta Road near the Tugun CBD (as Coolangatta Road is part of the PCNP). Further investigation is required in the next project stage to determine the feasibility of a Gold Coast Highway pedestrian/cycle crossing at Toolona Street on the southern approach of the intersection. As Tugun is a key focal point for people, any changes should align with CoGC's Tugun CBD future road, parking, pedestrian strategies and place planning.

Toolona Street LRT Station (Ch 47500)

The Toolona Street LRT Station was relocated approximately 100m north (from the GCH MMCS design) to improve pedestrian connectivity and accessibility to the Tugun town centre and interchange opportunities with the bus stops on Golden Four Drive (as discussed previously in Section 5.3.2). In addition, a pedestrian access to both sides of the LRT station island platform has been incorporated in the PE design (with connections to the raised pedestrian crossings on Golden Four Drive), and a footpath connection to the north of the station from the existing Wyberba Street footpath. As a result of these design refinements, additional land is required from the service station at Ch 47450.

Alternative locations for the LRT Station were investigated during the LRT sub-options analysis, including relocation of the LRT station to the centre of the GC Hwy road corridor. Although this option reduced impacts on commercial properties fronting Golden Four Drive and the GC Hwy, the design was not preferred due to the increased pedestrian safety hazards and disconnection from the proposed Toolona Street pedestrianisation (refer to Section 5.3.3.3 and the *LRT Sub-Options Report* for further information).

Golden Four Drive / Dune Street intersection (Ch 47900)

The primary signalised access at the Gold Coast Highway / Golden Four Drive has been relocated to Dune Street (from Shell Street as per the MMCS design). This design change was undertaken based on the outcomes of an options analysis and reinstatement of vehicle access at the Gold Coast Highway / Kitchener Street intersection (discussed further in the next section). The options analysis concluded that the Golden Four Drive / Dune Street was the preferred location for access to/from the highway (instead of near Shell Street) based on improved traffic efficiency and safety (due to conflicts with turning vehicles at the Kitchener Street intersection) and improved accessibility to/from the Tugun CBD for local businesses and the community. Refer to the Dune Street Assessment Technical Note - B2CTS-PE-431-MEM-00003 (see Appendix **E**) for further detail.

Kitchener Street intersection (Ch 48200)

The Gold Coast Highway / Kitchener Street intersection was refined in the PE phase to reinstate vehicle access to the highway with a LILO arrangement and mid-block signalised pedestrian crossing on the Gold Coast Highway (refer to Section 5.3.2). Various refinements were undertaken to the Gold Coast Highway / Kitchener Street intersection based on the traffic modelling as follows:

- A southbound right turn provided to address congestion through Tugun CBD and relieve heavy right turn demand into Toolona Street (west)
- Signalised left turn out of Kitchener Street required to provide sufficient gaps in northbound traffic for vehicles to safely enter the highway (due to volumes of northbound traffic including vehicles entering the highway from the upstream Boyd Street intersection).

The intersection was therefore revised to a signalised T-intersection with a southbound right-turn and pedestrian crossings on the west and south approaches. Right-turn movements out of Kitchener Street were not included as these movements are provided at the Toolona Street and Boyd Street intersections. There is no pedestrian crossing proposed on the north approach to reduce delays to the LRT and general traffic. Further information on the traffic modelling findings is provided in the *Traffic Modelling Report - B2CTS-PE-433-REP-00002* (see Appendix F).

The Kitchener Road / Coolangatta Road was configured as a four-way, priority controlled intersection with the Coolangatta Road north and south approaches required to give-way, to optimise traffic flows on Kitchener Street and prioritise turn movements to/from the highway. Raised pedestrian (wombat) crossings are provided on these intersection approaches for active transport.

Boyd Street intersection and Desalination Plant Road Intersections (Ch 48400 – 48800)

The GCH MMCS design includes two new intersections on the Gold Coast Highway at Boyd Street and Desalination Plant Road. It also proposes a left-only direct connection from Coolangatta Road (south) to Boyd Street with Coolangatta Road (north) disconnected from Boyd Street (i.e. as a cul-de-sac with all turn movements removed).

Several safety issues with the GCH MMCS design were raised as a result of the proximity of the two intersections and complexity of the connections with the service road. As a result it was determined that a direct connection from Coolangatta Road to Boyd Street was not feasible, which results in additional property impacts outside the Category C boundary at the corner of Boyd Street.

The Gold Coast Highway / Desalination Plant Road was removed based on the Access Strategy recommendations and the traffic modelling findings (which indicated that permitting southbound right turns from the highway into Desalination Plant Road resulted in traffic disruptions at the Boyd Street intersection). Therefore, a new connection from Coolangatta Road to Boyd Street at Tugun Street has been included in the design, which could also provide access to a potential park 'n' ride site (to be investigated further in the BC phase). This access also allows bus connectivity between Boyd Street and Coolangatta Road to be retained for the Route 768.

This image has been removed as it contains property impacts that are not approved.

Golden Four Drive / Surf Street intersection (Ch 49200)

The Golden Four Drive / Surf Street intersection layout is generally consistent with the MMCS design. Minor refinements have been included in the design such as a raised pedestrian crossing on Coolangatta Road.

Future Coolangatta Road Cycleway (Ch 47600 – Ch 50400)

It is understood that CoGC have completed some preliminary investigations for a 3m wide separated cycleway on the eastern side of Coolangatta Road. The drawings show the location of this cycleway indicatively, and the design has included spatial allowance for this cycleway where possible.

This section of the cycleway has not been included in the LRT project and is assumed to be delivered under a separate project.

The project identified the need for active transport connectivity between the Oceanway / Golden Four Drive and Boyd Street (part of the PCNP) and recommends provision along Boyd Street and across the Gold Coast Highway to be investigated in the next project stage.

Terminal Drive (north) intersection and commercial property accesses (Ch 50500 – Ch 50800)

The intersection arrangement at the Terminal Drive intersection has been revised to include a ‘bus only’ connection to/from Golden Four Drive (eastern approach). This connection is required only for the Route 760 (Robina to Airport) which currently travels along Golden Four Drive and traverses the highway to access the airport via Terminal Drive. A number of route alignment options were investigated for this bus route and will require further assessment/confirmation during the BC phase (including the need for this ‘bus only’ connection). A stand-up bus lane has also been included on the Terminal Drive (west) approach to minimise delays for buses during peaks.

Access to the commercial access properties on the eastern side of the Gold Coast Highway have been revised to include a service road arrangement similar to the existing situation.

LRT alignment through Gold Coast Airport

Refinement of the LRT alignment through the Gold Coast Airport was not undertaken during the PE phase given that TMR were undertaking consultation with the Airport (early during the PE phase) and uncertainties around the Airport masterplan renewal. However, it is noted that an options analysis of LRT and heavy rail alignment options was previously undertaken as part of the T2C MMCS to inform the masterplan renewal and layout for the proposed Airport multi-modal interchange (refer to Section 2.5.5 and 2.5.6 for further detail).

It is recommended that further assessment of the LRT alignment, heavy rail and multi-modal interchange be undertaken in future phases, including further stakeholder engagement with, Translink, QLD Rail and Gold Coast Airport Pty Ltd to refine the concept design in response to the masterplan renewal and ensure an appropriate design solution is delivered that provides optimal outcomes in terms of transport performance, accessibility and proximity to the Airport, and social and environmental impacts, consistent with the previous planning and design intent.

Bilinga LRT Satellite Depot (Ch 51400)

The GCH MMCS identified the requirement for a new light rail satellite depot and stabling yard in Bilinga. A number of sites were investigated, with the preferred location identified within vacant TMR road reserve between the Gold Coast Highway and the airport (near the SCU campus). The MMCS design includes a new stabling yard with capacity for eight LRVs and proposed vehicle access to the depot via the Gold Coast Highway near the Musgrave Street extension intersection to minimise impacts on airport properties and operations.

Section 5.4.5 provides further information on the location, function, requirements, layout and design of the proposed Bilinga satellite depot and stabling yard. Refinements to the Gold Coast Highway / Coolangatta Road / satellite depot access intersection are discussed in the following section.

Inset E – LRT satellite depot, Gold Coast Highway / Coolangatta Road intersection, Coolangatta Road / Musgrave Street intersection and heavy vehicle inspection site

5.3.4.2.5 Segment 5: Coolangatta

SEGMENT 5 – COOLANGATTA

Gold Coast Highway / Musgrave Street intersection and Musgrave Street / Coolangatta Road intersection (Ch 51500 to Ch 51700)

The LRT sub-options analysis for Segment 5 (Musgrave Street) resulted in changes to the LRT alignment and proposes a new four-way intersection at the Gold Coast Highway / Coolangatta Road (with Coolangatta Road extended north to the highway) and consolidated access to/from the satellite depot via the western approach (refer to Section 5.3.3.5 for further information). The key design features and changes to this intersection are shown in Inset E (above) and summarised below.

Gold Coast Highway / Coolangatta Road intersection

- Consolidated four-way intersection on the Gold Coast Highway with access to Coolangatta Road (east approach) and Bilinga LRT satellite depot (west approach)
- Provision of northbound left turn and southbound right turn lanes on the Gold Coast Highway (based on the traffic modelling, turn warrants assessment and safety considerations given the depot access is located along a horizontal curve in a higher speed environment)
- Provision of a northbound left turn slip lane Coolangatta Road to improve capacity for this high turn movement (based on the traffic modelling recommendations)
- Side-running LRT alignment to the south of the intersection from the Airport over the highway to the Coolangatta Road / Musgrave Street intersection
- Opposing dual left/dual right turns to cater for heavy traffic accessing Coolangatta Road from the Gold Coast Highway
- An at-grade signalised LRT/cycleway crossing on the Gold Coast Highway to the south of the Coolangatta Road intersection.

Coolangatta Road / Musgrave Street intersection • Signalised T-intersection configuration with the LRT alignment from the west approach traversing through the intersection and continuing as central running on Coolangatta Road • Dual southbound left turns on Coolangatta Road into Musgrave Street for high left turn volumes • Staggered pedestrian crossing on the Coolangatta Road (south) approach to reduce delays for the light rail, pedestrians (including public transport passengers) and general traffic • Retention of the existing left out movement from Golden Four Drive to Musgrave Street • Existing southbound left-only egress from Coolangatta Road to Musgrave Street retained. Direct access to/from Golden Four Drive / Lang Street has been removed (alternative access provided via Musgrave Street and Pacific Parade) • An integrated active transport network including a shared path on the eastern side of Coolangatta Road connecting to Golden Four Drive, and a connection to the shared path/Coolangatta Road cycleway at the Musgrave Street/Coolangatta Road intersection • Formalisation of the on-street parking on Golden Four Drive.
Heavy Vehicle Inspection Sites (Ch 51500) Relocation of the existing heavy vehicle sites is required as a result of the project. Spatial provision has been included in the design drawings to the south of the Gold Coast Highway/LRT crossing point for each direction (refer to Inset E above). Further consultation will be required with TMR's Transport Inspection Team to confirm the specific requirements for these sites in the BC phase.
Musgrave Street Station and Coolangatta Road / Charlotte Street (Ch 51700 – Ch 51800) The design has improved access to the Musgrave Street station by including signalised pedestrian crossings on both ends of the platform. As a result of including the signalised crossing on the southern side of the platform, all movements to and from Charlotte Street have been retained in the design.
Coolangatta Road Cycleway (Ch 50400 – Ch 52600) A new 3m wide separated cycleway has been included in the design on the western side of Coolangatta Road. This cycleway would connect to the cycleway in the cutting at Ch 52700, the Gold Coast Airport and Southern Cross University at Ch 51500 and link to the future Coolangatta Road Cycleway to the north, providing a continuous link between Coolangatta and Tugun. This cycleway has been included as part of the scope of the LRT project.
Coolangatta Road Intersection with Ocean St/Haig St (Ch 52200) The design for the Ocean Street/Haig Street intersection has been developed generally as per the MMCS design. The key design refinements were: • Removal of on-road cycle facilities due to the inclusion of the Coolangatta Road Cycleway • Provision of staggered pedestrian crossings on both the northern and southern legs of the intersection. • A separated pedestrian / cyclist crossing providing connection to the Coolangatta Road Cycleway on the western leg.
Coolangatta Road Intersection with Appel St/Lord St (Ch 52400 to Ch 52500) The preferred option for the Miles Street Station has been developed generally as per the MMCS design. Several options were investigated following the outcomes of the MCA as discussed in Section 5.3.3.5, but these were later discounted due to the additional property impacts outside the Category C boundary. The design of the Appel Street/Lord Street was developed generally as per the MMCS design. The key design refinements were: • Removal of on-road cycle facilities due to the inclusion of the Coolangatta Road Cycleway

• Provision of staggered pedestrian crossings on both the northern and southern legs of the intersection. • A separated pedestrian / cyclist crossing providing connection to the Coolangatta Road Cycleway on the western leg.
Coolangatta Road Intersection with Miles Street (Ch 52650) The design for the Miles Street intersection has been developed generally as per the MMCS design. The key design refinements were: • Removal of on-road cycle facilities due to the inclusion of the Coolangatta Road Cycleway • Inclusion of a through a left lane on the southern leg of the intersection leading to a zip merge on the northern side of the intersection.
LRT rail cutting, and interface with Gordon Lane (Ch 52700 – Ch 53100) The alignment of the LRT has been revised slightly in the rail cutting to provide additional space to Gordon Lane to improve constructability of the retaining wall. In addition, the LRT and paths have been regraded to maximum longitudinal grade of 3.3% to improve accessibility through the cutting (existing path grades is up to 9%)
Lanham Street / Musgrave Street intersection with McLean Street (Ch 53150) The design of the Lanham Street intersection has been revised from the MMCS design to maximise the use of the existing pavement.
Chalk Street carpark and LRT Terminus (Ch 53400) The design of the LRT Terminus Design and Chalk Street Carpark has been developed as per the MMCS design. Additional raised pedestrian crossing on Chalk Street have been added to improve pedestrian accessibility and reduce vehicle speeds.

5.3.4.2.6 All Locations

ALL LOCATIONS
Intersection Safety Treatments (chainage varies) Intersection safety treatments have been nominated on the drawings as 'Raised Safety Platforms' to improve vulnerable user safety. Some sites on curves may not be appropriate for the raised treatment and alternative treatments could be applied that are not raised (for example, texture changes). TMR's E&T will needed to provide guidance on their application in the next project phase.
Raised Safety Crossings (chainages varies) Raised pedestrian crossings have been nominated on the drawings to improve vulnerable user safety. Their design and location will need to be verified using survey and understanding the impacts to local levels and drainage catchments and their overflows. For these reasons, some sites may not be appropriate for the raised pedestrian crossings and alternative treatments could be applied that are not raised (for example, kerb build outs, texture changes or signal crossings).

Figure 26 provides a schematic of the refined LRT alignment and station locations.

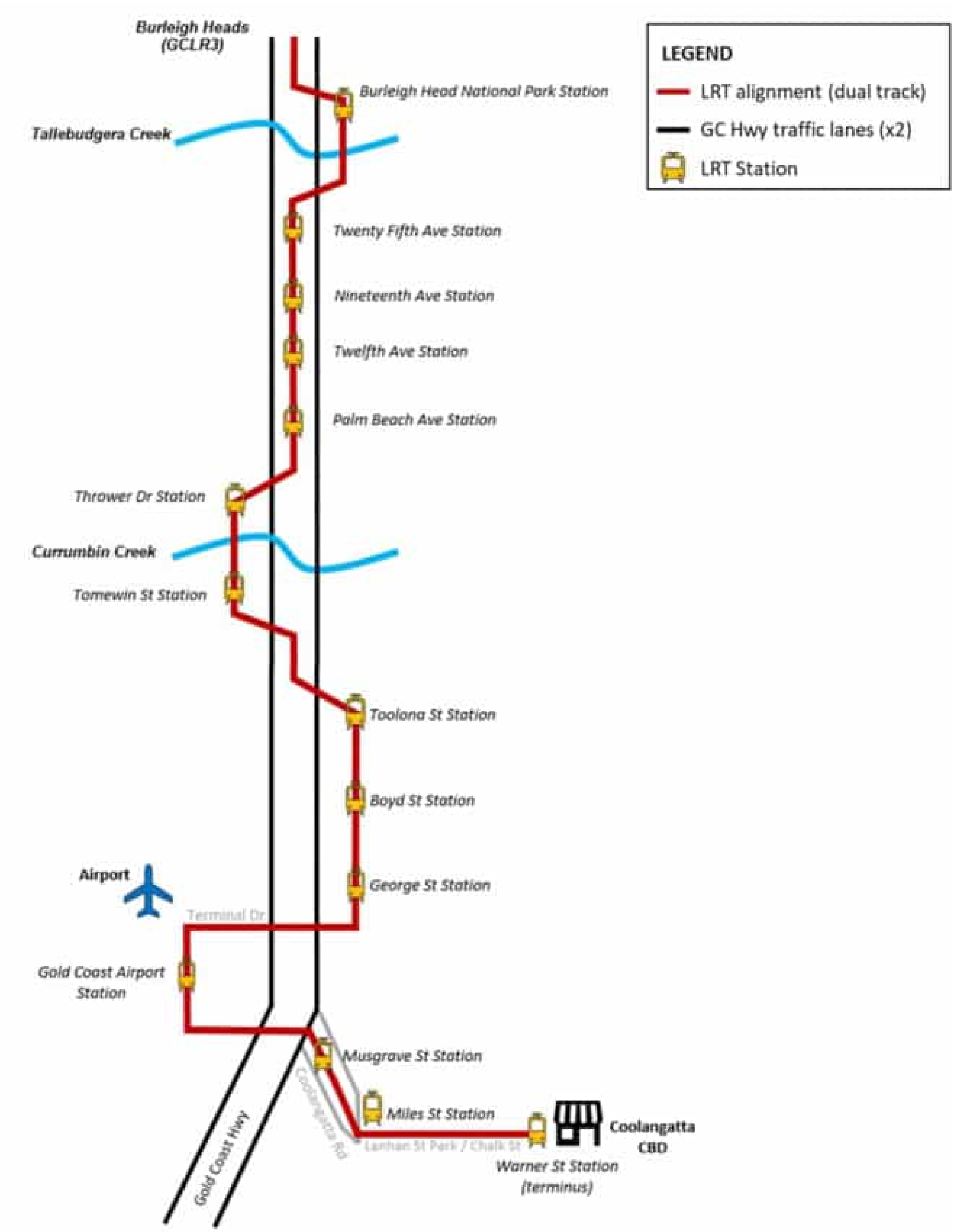


Figure 26 Schematic of the PE LRT alignment and station locations

5.3.5 Property Requirements

An assessment of property requirements was undertaken based on a combination of “full” and “partial” resumptions. A “full” property resumption occurs where a building or structure (such as a carport/pool) is impacted by the design, whereas a “partial” resumption occurs where no building or structure is proposed to be impacted. Additional land requirements for drainage and relocation of PUP were also considered as a part of the assessment.

Table 24 below highlights the number of properties identified for a full or partial property acquisition for the LRT Option. TMR will be required to undertake consultation with these property owners in subsequent phases.

Table 24 Option 1 LRT – Property Impacts

Segment	Full	Partial	Total
1 - Burleigh Heads	6	6	12
2 - Palm Beach	42	138	170
3 - Currumbin	21	11	32
4 - Tugun / Bilinga	3	1	4
5 - Coolangatta	6	1	7
TOTAL	**78**	**157**	**235**

5.3.6 Car Parking Impacts

The LRT Option results in loss of on-street parking along the project corridor. The design intent has been to aim for a zero net-loss in parking to minimise disruptions for local businesses, residents and the community that rely on parking. This is proposed through offsetting loss of parking along the project corridor with provision of new carparks (where required).

The following approach has been adopted to minimise parking impacts, based on TMR advice:

1. Zero net-loss of parking at Tallebudgera Creek via the upgraded carparks adjacent to the Jellurgal Cultural Centre (Ch. 41000) and Tallebudgera Recreation Camp (Ch. 41300)
2. Palm Beach and Currumbin – the majority of on-street parking is required for the LRT Option, with the focus on achieving the critical project requirements (i.e. LRT, four general traffic lanes and active transport facilities, where feasible), with a lesser priority given to on-street parking. Throughout the PE, opportunities have been investigated to retain on-street parking (where possible), however, parking offsets (at off-site carparks) will be required to achieve a zero net-loss outcome. Carpark locations will require further investigation during the BC phase utilising properties identified for full resumption property (from the property impact assessment – refer to Section 0) or by converting existing at-grade carparks into multi-storey carparks.
3. Zero net-loss of parking at the Palm Beach Parklands located to the north of Currumbin Creek
4. Zero net-loss of parking along Golden Four Drive at Tugun
5. Minimise parking loss along Golden Four Drive through Bilinga (through Segments 3 and 4). There is opportunity to offset parking loss at locations along the road where there is currently no parking is provided.
6. Minimise parking loss along Coolangatta Road through Bilinga (Segment 5). There is opportunity to offset parking, subject to CoGC’s cycle track planning.
7. Minimise parking loss along Coolangatta Road through Kirra (Segment 5). Most of the parking is removed at the Musgrave Street end (near Ch. 53000).
8. Minimise parking loss in Coolangatta CBD (Segment 5). CoGC’s 2019 Parking Study suggested a there was an over-supply of available parking, therefore, total parking in the Coolangatta CBD could be reduced with minimal impact in amenity (in terms of finding a car park). The design as aimed to retain as much parking as possible, however, there will be parking impacts to the Chalk

Street carpark to accommodate the Warner Street Station, which could be offset with a multi-storey carpark.

A parking strategy followed by a parking assessment for the project extent will need to be developed for the BC phase to determine the loss parking impacts and identify locations where parking will need to be replaced or offset.

A summary of the number of the parking impacts is provided in Figure 30Table 25.

Figure 30Table 25 Option 1 LRT - Parking Impacts

Segment	Existing	Residential	PWD	Commercial	Commercial loading zones	Recreational	Remaining
1	353	-107	3	0	-2	-46	201
2	641	-385	0	-63	-6	14	201
3	122	-64	0	-54	0	0	4
4	250	-77	0	-12	-1	0	160
5	708	-79	-4	-159	0	0	466
TOTAL	**2074**	**-712**	**-1**	**-288**	**-9**	**-32**	**1032**

5.3.6.1 Park ‘n’ Ride Opportunities

Opportunities for potential park ‘n’ ride sites have been investigated during the PE phase to offset the loss of parking as described above. Three potential park ‘n’ ride sites are currently under investigation at the following locations:

- Near Thrower Drive Station: 100 spaces using informal on and off-street parking and the Palm Beach Parklands car park
- Near Boyd Street Station: 300 spaces using a formal park ‘n’ ride facility
- Near Musgrave Street Station: 200 spaces using a formal park ‘n’ ride facility.

Further investigation on these potential park ‘n’ ride sites will need to be undertaken during the BC phase, in consultation with CoGC.

5.3.7 Geometric Compliance

Following the design development process (discussed above), a number of design compliance issues were identified. Key outstanding issues are noted in Table 26.

Table 26 LRT Design Compliance

Segment	Element	Design Non-conformance	Recommendation
Segment 1	Sight Distance	Sight lines around barriers and bridge piers	Geometry to be reviewed and refined to ensure sight lines are achieved in next design phase
Segment 2	Lane Widths	3.1m Traffic Lane (Extended Design Domain)	Extended Design Domain report to be completed and endorsed by TMR South Coast at next design phase
Segment 3	Sight Distance	Crest curves less than minimum required.	Geometry to be reviewed and refined in

Segment	Element	Design Non-conformance	Recommendation
			next design phase to ensure Safe Intersection Sight Distance (SISD) and Approach Sight Distance (ASD) can be achieved
Segment 4	Vertical Alignment	Vertical geometry is still to be applied	Full geometric design to be undertaken at next design phase
Segment 5	Vertical Alignment	Vertical grades vary between less than 1% and matching existing at 15%	Geometric review and refinement to be undertaken at next design phase

An initial geometric review was undertaken and non-standard (non-conforming) items have been highlighted further within the *Geometric Report - B2CTS-PE-430-REP-00003* (refer to Appendix K). Figure 27 shows the geometric alignment for the LRT Option. For further detailed information refer to the *LRT Option Concept Designs - B2CTS-PE-431-DWG-00001* in Appendix I.

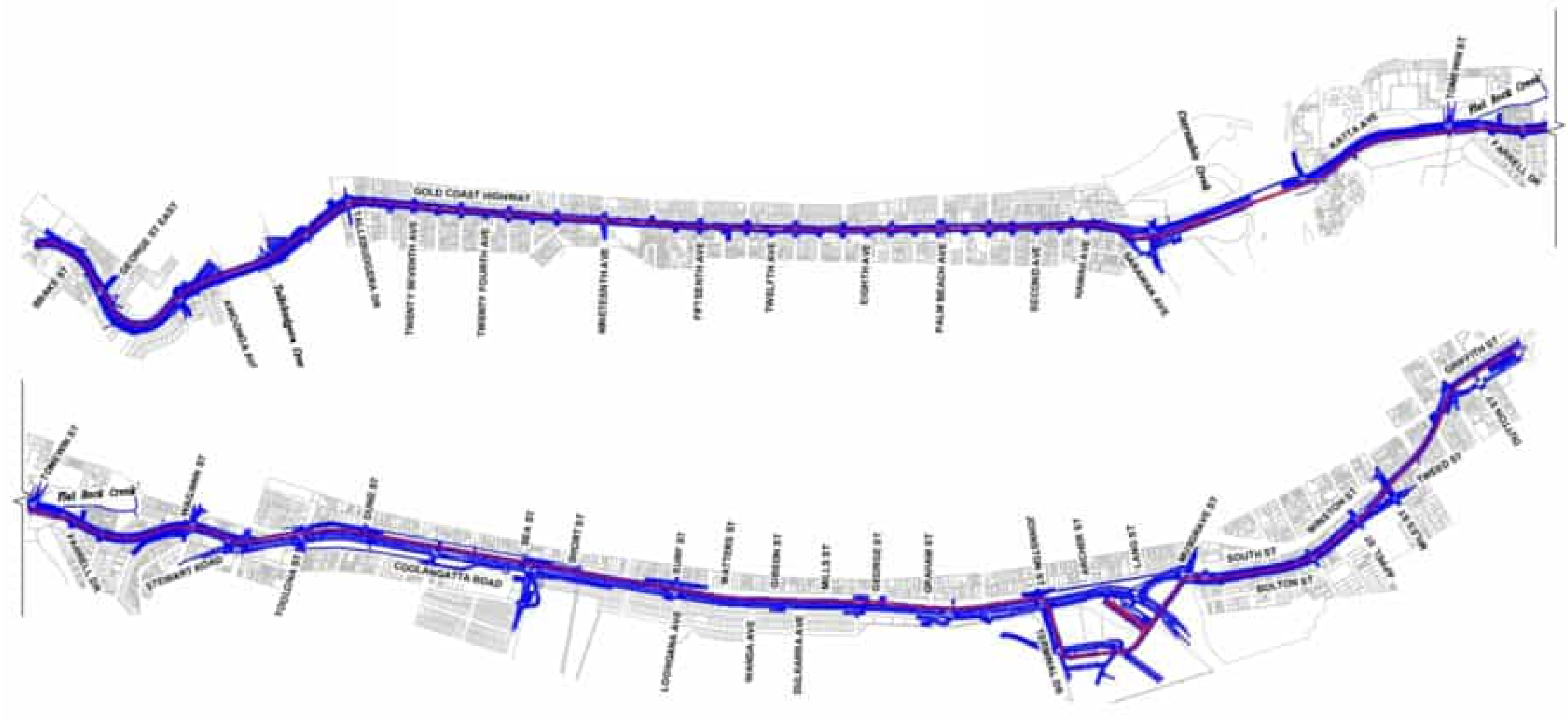


Figure 27 LRT Option alignment (LRT alignment shown in red, associated road works shown in blue)

5.4 Rail Infrastructure Design

Light rail spatial and alignment requirements are defined in the following sections.

5.4.1 Track Form

A track form design has been adopted from previous GCLR stages and includes the following different pavement types:

- Embedded track design for single track and dual tracks
- Embedded track with urban design at pedestrian crossings
- Embedded track with urban design at stations, and
- Embedded track with Turf finish
- Plinth track across bridges.

The track form design parameters are listed in Table 27.

Table 27 Track Form Design Parameters

Design Element	Parameter
Track Form	Embedded track with encased rail consisting of either concrete, asphalt, blocks, pavers or grassed finishes.
Track Form (bridges)	Plinth track with exposed rail
Rail Type	Embedded track – 51R1 Grooved rail Exposed Track – 49E1 Vignole rail
Rail Gauge	1435mm (standard gauge) – measured between the running edge on the inside of the rails
Track Design Loading	LRV track system in areas of road intersections or where maintenance vehicles are permitted to access the slab, it must be designed as a minimum in accordance with the highest standard of either Austroads, AS 5100 or the department of Transport and Main Roads' (TMR) design requirements for pavement design and be structurally reinforced.
Mainline Turnouts	1 in 6, R50m min
Depot Turnouts	1 in 4, R25m min

For all embedded track locations grooved rail is proposed. Grooved rail has both a running head and a keep creating a protected area for the flange of the wheel to run. This enables the rail to be embedded without installing a guard rail or similar protection to provide the space for the flange of the wheel to safely pass. The bridge lengths in the corridor are sufficiently long enough to change to Vignole rail (rail profile normally used for heavy rail) using a transition rail.

The rail is to be embedded in the track slab surrounded by a material that provides support for the rail vertically and horizontally, electrical insulation (as the first defence in management of stray current), resilience for mitigation of noise and vibration, surface friction (for road vehicles at intersections).

There are a number of options to be considered for the finished surface of the track slab including:

- Concrete slab: The slab has a finished level at the same height as the adjacent rail. A brushed finish is normally provided to have a suitable slip resistance. The concrete can have alternative colours or surface treatments to better match with the surrounding urban treatments in areas of high amenity if needed.
- Paved finish: Provides a more aesthetically pleasant finish to the track slab to integrate with the surrounding urban treatments. The concrete track slab has a finished level below the top of rail to allow a mortar bed and topping paver to be installed level with the top of rail.

- Asphalted finish: The concrete slab is similar to the paved treatment but with an asphalt topping. The interface between the concrete slab at the rail and the asphalt and drainage of the asphalt need to be carefully designed and constructed to ensure the durability of the asphalt.
- Grassed or planted track: Natural vegetation reduces the scale of hard finishes providing the benefits of increasing permeability, noise mitigation, and mitigation of urban heat. Grassed track Could be used in light rail only sections of the corridor. Each of the rails are embedded in a concrete beam. The concrete beams are either connected by a concrete slab or horizontal supports to maintain the gauge of the track. Soil and the selected plants or grasses can be placed between each of the rail beams.

Consideration of maintenance and durability is important in selecting the appropriate grass or plants to be used within the light rail corridor. The edge of the swept path will need to be marked through a change in height of planting (such as shrubs), a strip of different material, or a change of material at the interface. Alternative stray current treatments would need to be part of the design treatments for this type of light rail corridor.

5.4.1.1 End of line restraint device

The LRT extension will require a number of new end of line restraints. It is recommended that restraint treatments at the following locations be explored further in the detailed design stage:

- Thrower Drive turnback: installation of similar fixed concrete restraint as Broad Beach siding.
- The new stabling yard at the Gold Coast Airport: installation of similar fixed concrete restraint as the existing stabling yard at Southport
- Coolangatta Station end of line: installation of a sand bed similar to the Burleigh Heads end of line restraint treatment proposed for GCLR3.

When designing the treatment, there are a number of options considered for the restraint device at the end of line. These include:

- Friction only – rigid frame system with friction sliding shoes to decelerate train impact at an allowable rate
- Hydraulic friction combination – rigid frame system with friction sliding shoes and hydraulic ram for extra retardation at higher impact forces
- Fixed hydraulic – End of line fixed position stop with hydraulic ram for vehicle impact reduction
- Fixed only – End of line fixed position stop for low speed impacts
- In selecting of a suitable restraint device, the following factors were taken into consideration:
- Alignment geometry and likely LRV speed
- Application environment
- Space
- LRV crash-worthiness - Specification for the crumple zone performance to dissipate energy at various speeds
- LRV overspeed and vigilance systems
- Driver behaviour.

A thorough risk assessment for each location will be required to show evidence of the appropriate selection and application of the end of line restraint device.

5.4.2 Stations

5.4.2.1 Station Design

Two station platform types are proposed for the LRT corridor:

- Island platforms – single platform with faces to tracks on each side

- Side platforms – two platforms at each stop either adjacent to each other or staggered.

General requirements for both island and side platforms are provided in Table 28.

Table 28 Station Design Platform Criteria

Design Parameter	Value	Comment
Stop platform length (nominal LRV length)	45.0 m	Plus DDA compliant access at one end
Island Platform width	4.8m	To be assessed with passenger demand in further detail at each station during the BC phase
Terminating Island Platform width	5.8m – 8.0m	To be assessed with passenger demand in further detail at each station during the BC phase
Side Platform width	3.6m	To be assessed with passenger demand in further detail at each station during the BC phase
Platform height	285mm	
Coping to track centreline	1.375m nominal	Will be LRV specific to manage step gap
Horizontal Alignment through Platform	Straight through platform and for 12m either side	
Platform Crossfall	1.0% desirable	Sloping away from the track
Platform Access	DDA Compliant	

It is assumed that the station design will take a similar form to the existing GCLR system stations. The following general requirements are to be provided at each station:

- Station lighting
- CCTV cameras with full coverage for stations and approaches
- AVVM ticketing machines
- Passenger information displays
- Station cabinets
- Way finding signage
- Off-platform bicycle storage racks as per landscape design.

On-platform public toilet facilities are typically not considered in the design of light rail infrastructure due to the nature of the urban environment which it services. Such facilities are mostly available in the surrounding public domain.

Detailed architectural and urban design will be developed for each station in the next stage of the design process to achieve an outcome based on Crime Prevention Through Environmental Design (CPTED).

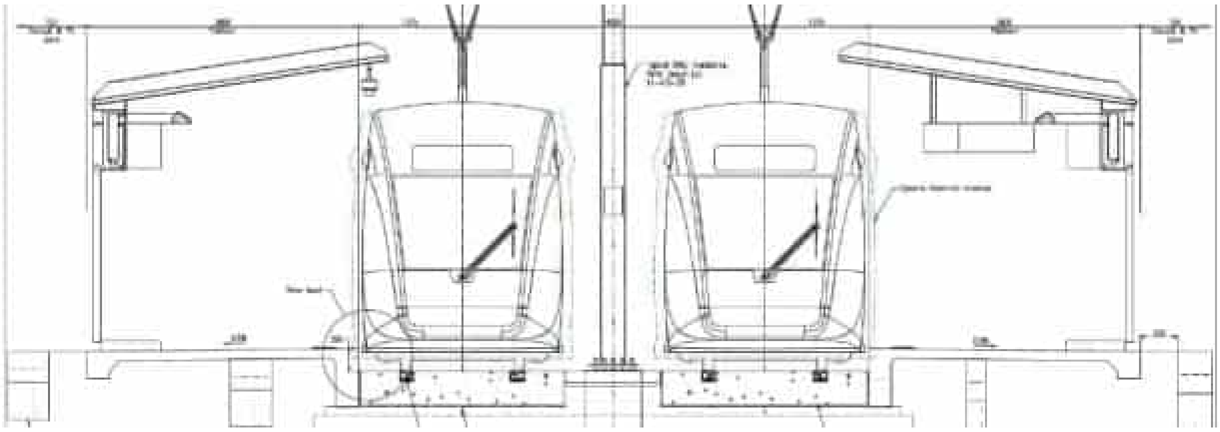


Figure 28 Typical side platform cross section

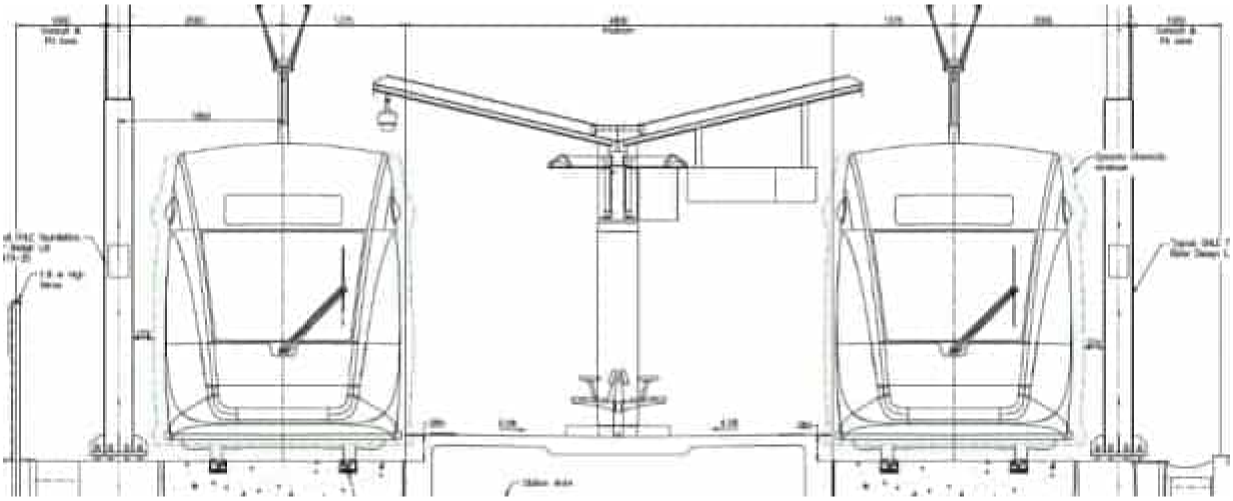


Figure 29 Typical island platform cross section

5.4.2.2 Station Locations

The concept design includes 14 LRT stations along the project corridor, as detailed in Table 29. The station locations were identified during the GCH MMCS based on a 950m desirable spacing near key trip attractors, generators and east-west connections (as discussed previously in Section 5.1).

The station locations are generally fixed, however, minor refinements to the locations of the following stations were undertaken during this design phase based on community consultation feedback and technical investigations (refer to Section 5.3 for further information):

- Twenty Fifth Avenue – relocated approximately 230m south due to geometric near Twenty Eighth Avenue
- Palm Beach Avenue Station – relocated approximately 130m south to allow a southbound right-turn at the Gold Coast Highway / Palm Beach Avenue intersection.
- Toolona Street Station – relocated approximately 100m north to improve pedestrian connectivity and accessibility to the Tugun Central Business District (CBD) and bus stops on Golden Four Drive.

Table 29 LRT station locations

Ch.	Station Name	Station Platform Type	Location
40985	Burleigh Head National Park	3.6m side platforms	Adjacent to the Jellurgal Aboriginal Cultural Centre and National Park
42106	Twenty-Fifth Avenue	4.8m island platform	North of Twenty-Fifth Avenue (relocated from initial location at Twenty-Eighth Avenue due to geometric constraints)
42860	Nineteenth Avenue	4.8m island platform	South of Nineteenth Avenue
43493	Twelfth Avenue	4.8m island platform	Adjacent to Twelfth Avenue
44255	Palm Beach Avenue	4.8m island platform	South of Palm Beach Avenue
45047	Thrower Drive	3.6m side platforms	North-west of the Gold Coast Highway / Thrower Drive intersection (opposite Palm Beach Parklands and Palm Beach Currumbin High School). The LRT station includes a bus interchange
46492	Tomewin Street	3.6m side platforms	South of Tomewin Street and opposite the Currumbin Wildlife Sanctuary entrance
47552	Toolona Street	4.8m island platform	North of Toolona Street and adjacent t Golden Four Drive
48667	Boyd Street	3.6m side platforms	South-east of Gold Coast Highway / Boyd Street intersection (adjacent to Golden Four Drive)
50042	George Street	4.8m island platform	Adjacent to Golden Four Drive / George Street intersection (east of Gold Coast Highway)
51107	Gold Coast Airport	3.6m side platforms	West of Tom Norris Road (within Airport precinct). LRT station includes a proposed bus interchange and future provision for heavy rail transfer
51757	Musgrave Street	4.8m island platform	South of Coolangatta Road / Musgrave Street intersection
52588	Miles Street	3.6m side platforms	North-east of Coolangatta Road / Miles Street intersection
53437	Warner Street	8.0m island platform	North of Chalk Street / Warner Street intersection. Connecting bus stops proposed on Warner Street (west of Chalk Street)

Key interchange locations between bus and light rail are proposed at the Thrower Drive, Toolona Street, Boyd Street and Warner Street LRT stations (refer to Section 5.5.6 for further information).

5.4.3 Overhead Line and Traction Power

The LRT vehicles are powered through an overhead line (OHL) centenary powered by a series of Traction Power substations, which are supplied by the Energex Network. The concept OHL design was developed utilising the proposed street lighting pole locations in the median with a maximum spacing of 40m. The following aspects of the alignment design will also influence the OHL pole location design:

- Station platform location
- Sharp horizontal rail geometry
- Intersection layouts and traffic turning movement
- Overhead Energex power lines along Gold Coast Highway verge (for OHLE stay pole locations)
- Rail crossovers

- Spur line locations.

The space proofing of the Traction Power Substations (TPS) along the length of the LRT corridor are influenced by a number of factors detailed in Table 30.

Table 30 TPS design inputs

Design Parameter	Value	Comment
Traction Power	750V DC	
Traction Power system supply spacing	1.5 to 2.0km	Additional Consideration required for steep grades and regenerative braking power collection
Traction Power Substation Compound	25 x 25m OR 16 x 40m	Orientation may vary to suit site (refer to Figure 30 below)
Traction Power Substation	10.4 x 4.5m	
Harmonic Filter	5 x 5m	
Energex Supply (Ring Main Unit)	4.2 x 4m	
TPIS Switchgear	5 x 5m	
Overall Site Size	40 x 16m or 25 x 25m	Based on typical equipment requirements from GCLR3

At the key areas along the project corridor, various property sites were identified for possible resumptions and construction of the TPS compounds. These sites vary in size and require unique TPS layouts.

The following general requirements were followed when creating the TPS Layouts:

- Ring Main Unit (RMU) Earth grid to be 5m from TPS Earth grid
- TPS to be 3m from the compound fence if possible
- 2m offset from TPS to Harmonic filter.

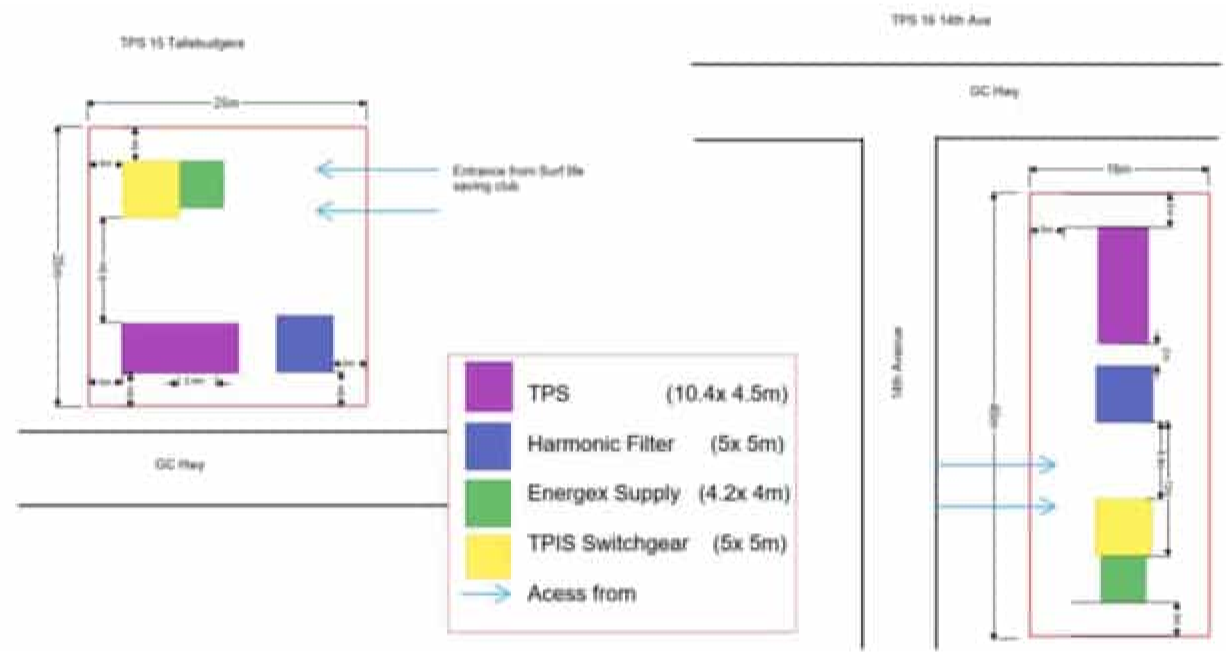


Figure 30 Example TPS Compound Layouts

Operational performance of the TPS requirements were assessed for the LRT to operate in accordance with a 6 minute headway, but with future provision for a 3 minute headway.

In the event of a TPS being out of service and bypassed, extended operation (N-1) were also considered. Loading on a TPS is at its worst during an N-1 scenario operating under a 3 minute headway. This is due to the longer feeding section and the likelihood of more LRVs being in it. The number of LRVs in a feeding section for normal and extended operation has also been estimated for a 3 minute headway. This estimation is based upon a simple "speed = distance / time" calculation. Accurate timetable data is required for further detailed modelling.

Initial TPS locations identified for the concept design in are shown in Table 31.

Table 31 Concept TPS Locations

TPS Number	Chainage (km)
TPS 14 (Stage 3)	40.005
TPS 15	41.600
TPS 16	43.500
TPS 17	45.160
TPS 18	46.680
TPS 19	48.550
TPS 20	50.300
TPS 21	51.400
TPS 22	53.000

The concept traction power modelling that was undertaken is static and very high-level to help place more technical analysis around the initial identified TPS locations.

The traction power assessment undertaken considers individual feeding sections, but due to the traction power arrangement of a single DC rectifier feeding two sections, the system is interconnected. As such, an adjacent rectifier is able to help support the loading of a feeding section. This has been considered with a 50% rectifier sharing factor. It is highly recommended that more accurate and dynamic time-based traction power modelling is carried out to confirm the results from the concept assessment.

There is also a good opportunity to consider regenerative braking or an energy capture system for the downhill sections as an innovation to be considered during the next design phase. Refer to the *Traction Power Technical Note - B2CTS-PE-431-MEM-00002* (see Appendix J) for further information.

5.4.4 Rail Systems (Communications and ITS)

The rail system and communication network design has not been undertaken for this concept design stage. Some space proofing to allow for conduit requirement for TMR Communications, Traction Power, Stray Current and Rail Systems has been considered in the LRT Corridor typical cross section.

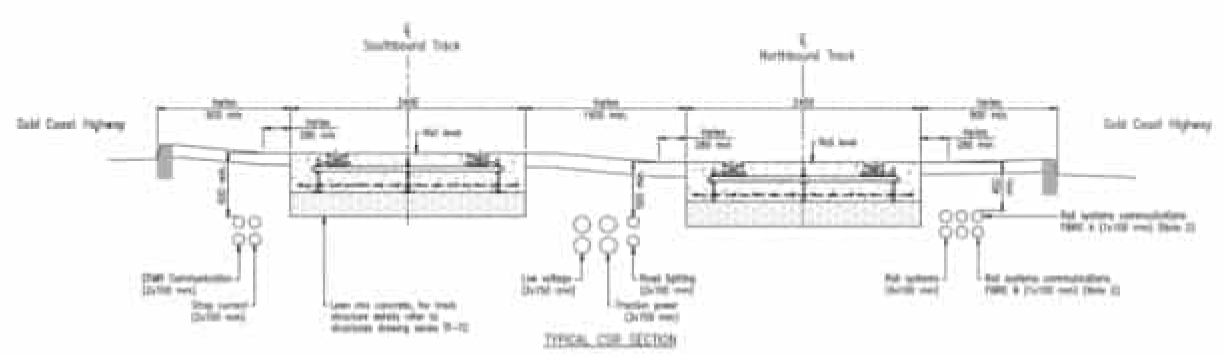


Figure 31 Typical Combined Services Route Conduit requirements

The extended network should consider support of the following systems established in the existing LRT system:

- Station Field Cabinet with house fibre optic terminations and copper cable terminations that run to all station systems (Space proof allowance has been included at each proposed station location).
- New radio towers to extend the existing digital TETRA radio coverage
- Emergency Help Telephone System (EHTS) with dedicated Hearing Augmentation Loop at each station
- New CCTV at each station with platform coverage and specific coverage of ticketing and help phones
- CCTV coverage for the new light rail stabling facility
- TransLink ticketing infrastructure at each station
- Wi-Fi coverage at the depot is required to download data from the LRV's from the new stabling facility
- Passenger Information Displays
- Public Address with Platform Hearing Augmentation loops
- The new systems will synchronise with the existing Master Clock
- Upgrades would also be expected at the Southport depot to support the new equipment, including expanding the CCTV storage and network interfacing. The existing Operations Management and Communications System components will require upgraded including:
- Upgrades to the Plant Management Control System are required to support the new Traction Power Substations (TPS)
- Upgrading the Real Time Monitoring Control System (RTMCS) including changes to the Automatic Vehicle Location System (AVLS) and Transit Signal Priority System (TSPS)
- Integration of Control Monitoring System (ICMS) items listed above.

Details relating to the rail systems and communications requirements and design will be determined and confirmed during the next phase of the design.

5.4.5 Satellite Depot and Stabling

The GCH MMCS identified a requirement for a new LRT satellite and stabling yard to support GCLR4 operations. Currently, all operations for GCLR (including the future Stage 3 extension) are managed from the Southport depot which includes a stabling yard for 18 LRVs. The GCLR3 works include upgrade of the Southport stabling yard for an additional six LRVs, increasing the total capacity of the stabling yard to 24 LRVs.

A high level assessment of the location, function, requirements and layout of the proposed Bilinga light rail satellite depot was undertaken as part of the T2C MMCS, in consultation with Translink and Keolis Downer—the current GCLR O&M operator. The preferred site is located on vacant TMR road reserve located west of the Gold Coast Highway and adjacent to the Airport, as shown in Figure 32. This site was identified as the preferred location to avoid impacts to the Gold Coast Airport land and operations.

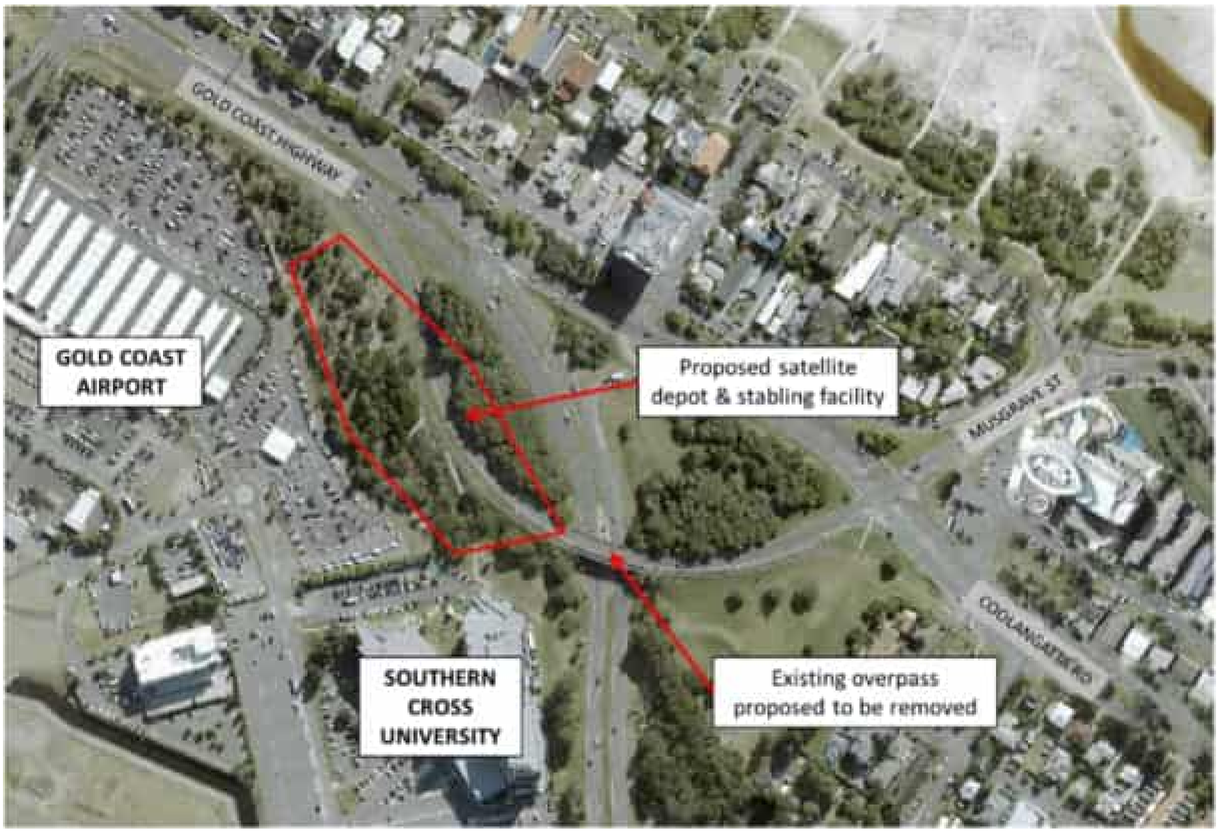


Figure 32 Location of proposed light rail satellite depot and stabling facility

Vehicular access to the depot is proposed on the Gold Coast Highway – via a fourth leg at the new Gold Coast Highway / Coolangatta Road intersection, as shown in Figure 33. Access to/from the satellite depot is provided from all three directions (i.e. Gold Coast Highway northbound, southbound and Coolangatta Road westbound) including provision of auxiliary right and left turn lanes on the Gold Coast Highway for improved road safety.

The light rail alignment through this area and the revised configuration of the Gold Coast Highway / Coolangatta Road intersection (which includes removal of the existing northbound flyover to the Gold Coast Highway) was refined during the PE based on the LRT sub-options analysis outcomes and traffic modelling recommendations (refer to Section 5.3 for further information).

Figure 33 Bilinga LRT satellite depot and stabling yard

The *Public Transport Operational Assessment - B2CTS-PE-440-REP-00001* (refer to Appendix G) provides further information on the functional requirements and design development undertaken for the proposed satellite depot and stabling yard. It also provides a summary of the previous investigations undertaken during the GCH MMCS including feedback provided by Translink and Keolis Downer to inform the design development.

The GCH MMCS identified the following requirements for the new satellite depot and stabling yard based on stakeholder feedback:

- Secure overnight LRV stabling
- Facilitate the internal cleaning of LRVs and allow undertaking of minor LRV maintenance (consumable replacement)
- Driver sign on/off facility, driver and ancillary staff messing and personal needs facilities
- Staff car parking for up to 20 vehicles (if space permits).
- Driver change facility adjacent to depot.

The configuration of the satellite depot and satellite yard is consistent with the GCH MMCS design based on Keolis Downer's feedback and constraints imposed by the available area adjacent to the Airport and need to avoid property impacts. This arrangement has been taken forward in the PE phase and refined to include a north-facing track access for improved operational flexibility (discussed further in Section 5.5). A preliminary assessment of the depot building requirements and layout was undertaken in the PE and discussed in the *Public Transport Operational Assessment - B2CTS-PE-440-REP-00001* (refer to Appendix G).

The Public Transport Operational Assessment identified that 31 LRVs in total are required to operate GCLR Stages 1-4 based on the current 7.5 minute peak period headway, a total travel time of 92.2 minutes between Helensvale and Coolangatta, and on the assumption that 6 LRVs are required to provide spare capacity for normal fleet management (e.g. breakdowns, vehicle maintenance etc.) GCLR3 includes purchase of five new LRVs, increasing the total fleet size to 23 LRVs. Therefore, eight new LRVs are required to operate GCLR4. These LRVs are proposed to be stored overnight at the Coolangatta stabling yard which has capacity for eight LRVs based on four rows of LRT track with stabling for two LRVs each (assuming shared stabling is permitted), as shown in Figure 33.

Translink's Operations and Maintenance team advised that a more detailed assessment of the GCLR4 operational requirements will need to be undertaken in the BC phase to confirm whether additional LRVs are required to enhance the fleet's spare capacity and if additional LRV stabling is required at the Bilinga depot for operations during peak times (such as special events) or breakdowns. It also noted a potential maintenance and operational fleet risk of extending the GCLR network by 14 kilometres (for GCLR4) with no increase in spare fleet capacity; and operational limitations of the network (post GCLR3) to meet the first, last and emergent services from a southern depot that has no spare capacity.

It is therefore recommended that the proposed number of LRVs required for GCLR4 operations and total LRV stabling required at the Bilinga depot be revisited during the BC phase, in consultation with Translink and Keolis Downer.

5.4.6 Corridor Fencing Requirements

Typically, the LRT corridor is not fenced due to its urban setting and interface with roads and private accesses. Previous stages of GCLR have introduce fencing where the corridor is away for road corridors and interfaces to properties with no specific access requirements or is an adjacent transport corridor such as the Queensland Rail corridor.

The extension of the light rail from Burleigh Heads interfaces with two sensitive National and State parkland areas. As such standard TMR Fauna fences have been allowed for in these areas to ensure existing fauna to separate of guided across the rail and road corridors where necessary.

Balustrade fencing at stations is required to control pedestrian movements across the road corridors safely into the rail environment. The requirement for pedestrian fences outside of the station has not been considered as part of this phase. Further consideration should be given to pedestrian movements across the road and rail corridor at sensitive locations such as schools and areas of public gathering in the next design phase.

All traction power substations require high security fencing to ensure public safety. This is in line with previous phases of GCLR.

5.5 Operations

5.5.1 Service Frequency and Journey Time

The estimated light rail travel time in 2041 for the B2C corridor is 30.2 minutes, based on the GCAMSE microsimulation model (refer to the *Traffic Modelling Report - B2CTS-PE-433-REP-00002* in Appendix F) for further information). Once complete, the total travel time for the entire GCLR system between Helensvale and Coolangatta will be approximately 92 minutes.

The LRT is proposed to operate on a 7.5 minute headway during weekday peak periods from 7am-7pm on weekdays, and 10 minute headway on weekends from 7am-7pm as summarised below. This is consistent with the service frequency proposed for GCLR3.

- Weekday services:
  - 10 minute headways during early morning (5am-7am)
  - 7.5 minute headway during peaks (7am-7pm)
  - 15 minutes during evenings (7pm-12am)
  - No operations from 12am-5am (service replaced by 700 night bus).
- Weekend services:
  - 10 minute headway during early mornings and peaks (5am-7pm)
  - 15 minute headway during evenings (7pm-12am)
  - 30 minute headways during early mornings (12am-5am).

5.5.2 Rail Operations Flexibility

A number of strategic locations were chosen to allow flexibility and segregation of the LRT network to maintain operations during an incident or maintenance periods. The following locations were identified to include rail infrastructure that provide the ability to change tracks, turn back light rail vehicles, store out of services vehicles, or segregate operations for short running lengths of the network.

- Burleigh Heads scissor crossover
- Nineteenth Ave double crossover
- Thrower Drive layover and turnback facility for short term storage
- Boyd Street double crossovers
- Bilinga LRT Satellite Depot crossovers (including driver change over location)
- Coolangatta scissor crossover.

Figure 34 Nineteenth Avenue Crossovers

This image has been removed as it contains property impacts that are not approved.

Figure 35 Boyd Street Crossovers

Further details of proposed network operations can be found in the *Public Transport Operational Assessment - B2CTS-PE-440-REP-00001* in Appendix G). Detailed assessment of the system operation requires should be reviewed during the next stage of the design for maintenance and operational requirements of the LRV O&M Contractor.

5.5.3 Provision for Future Extensions

The concept design near the Thrower Drive Station includes provision for a future spur line connection to facilitate a potential LRT extension to Elanora (as indicated in CoGC's *Gold Coast City Transport Strategy 2031*). A dual track connection of the spur is feasible, however an assessment of the available corridor along the existing Thrower Drive / Sarawak Avenue corridor and Guineas Creek Road was not undertaken as part of the PE. This will require further investigation in future phases, including interface to the proposed bus interchange station at Thrower Drive.

The concept design can also accommodate a future southern extension of the light rail at the Warner Street terminus in Coolangatta across the NSW border into Tweed Heads. The *North Coast Regional Plan 2041* (NSW Department of Planning and Environment, 2022) states "In the future, the Gold Coast Light Rail could extend from the Gold Coast Airport into Tweed Heads and Tweed Heads South, changing the way people access jobs, education and services."

TfNSW has conducted planning studies for the future light rail extension (including the Tugun to Tweed Heads MMCS currently), however, there is currently no funding commitments for this project.

5.5.4 LRT Single Track Running

The PE project scope and requirements specify consideration of a fully integrated design that provides a dual track light rail system. This is based on the GCH MMCS which confirmed that a dual track was the most appropriate light rail configuration for GCLR4, consistent with the look, feel and functionality of previous (and planned) GCLR phases.

A high-level assessment of potential locations where short sections of single track running may be suitable was undertaken. The assessment considered highly constrained sections such as Burleigh Hill, Currumbin Hill, Tugun Hill and Coolangatta where single track operations may provide acceptable value-for-money by reducing the corridor width requirements. The following key criteria have used to prepare cross sections for two single-track LRT arrangements based on a centre and side running LRT:

- LRV Dynamic Kinematic Envelope (DKE) (80 < R <200) – 3.25m
- Horizontal offset from LRV DKE to the edge of traction pole – 0.275m
- Horizontal offset from LRV DKE to fences and continuous structures – 1m
- Horizontal offset from LRV DKE to roads, shared paths and footpaths (>40km/h) – 0.550m.

Figure 36 illustrates a cross-section of this configuration, for reference.

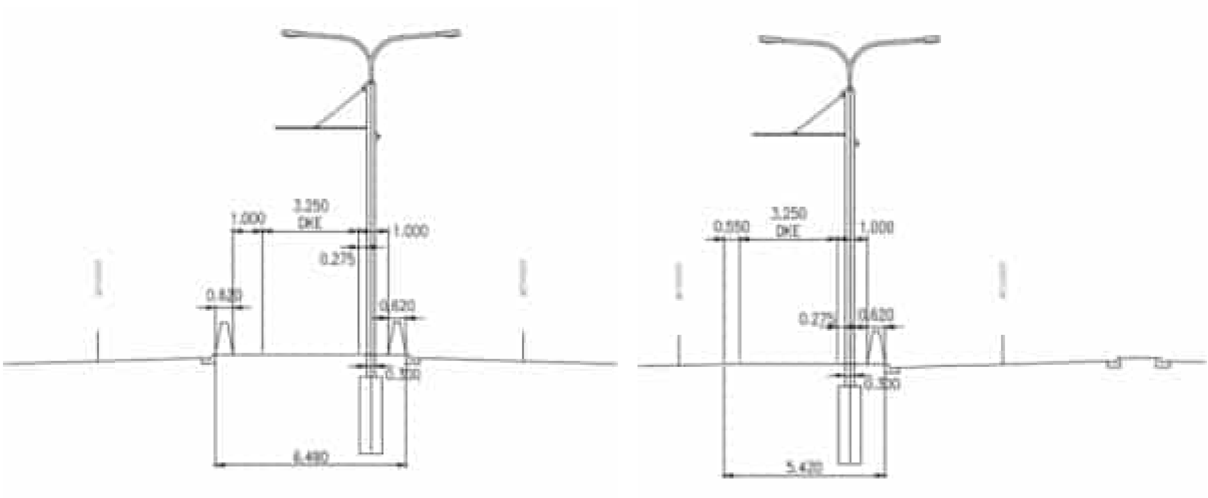


Figure 36 Single Track Rail Corridor – Centre and Side Running LRT

The assessment concluded that short sections of single-track were not desirable due to the following:

- Inherent safety risks associated with:
  - Potential head-on LRV collisions which would need to be managed by implementation of a specialised rail signalling system
  - Additional LRV driver training as there are no other sections on the existing (or future) GCLR network with single track
  - Increased risk of LRV-pedestrian collisions and LRV-vehicle collisions, requiring road user and community education when crossing the single LRV track (as road users and pedestrians would not be accustomed to crossing a single track and the collision risk from LRVs approaching from both directions.
- Impacts to LRT operations and timetable performance:
  - LRV waiting times of 1-2 minutes on each approach to the single track section, which can be exacerbated in situations where an LRV is running behind schedule

  - Higher delays to the entire GCLR system in the event of LRV breakdowns on a section of single track.
  - Limits operational flexibility for future increases in service frequencies (i.e. reducing headways to less than 7.5 minutes) or for special events.
- Increased infrastructure maintenance on single track sections (due to increased use of rail track, OHL and turnout equipment) requiring more regular maintenance than the dual track sections.

Refer to the *Public Transport Operational Assessment - B2CTS-PE-440-REP-00001* (Appendix G) for more detailed information on the single track assessment.

5.5.5 Maintenance Provisions

The maintenance provisions for traffic signals, services and stations has not been considered in the PE concept design.

Due to the highly constrained and congested corridor, dedicated maintenance bays are difficult to achieve. It is proposed that parallel parking along the Gold Coast Highway or existing parking along the side streets, can be used to park maintenance vehicles and maintenance personnel can access the relevant work site on foot. Other system-based maintenance activities can also be undertaken by accessing the light rail corridor during engineering hours. The maximum walking distance to any given site is assumed to be less than 50m.

For operational, safety and maintenance requirements, service pits are proposed to be located outside of the light rail corridor. The only exception are the signal pits that are located close to pedestrian access ramps adjacent to station areas. As the signal posts are located in the middle of the light rail corridor, this arrangement was unavoidable in the design due to the space constraints.

The underground service pits such as water, sewer, electricity and telecommunication, are proposed to be in the existing Gold Coast Highway verges for easy access. The existing pits located within the verges are proposed to be retained providing the proposed works do not impact on them.

Due to the complexity in stormwater network pipe connections, it is difficult to locate the access chambers completely outside of traffic lanes and intersection areas. In these instances, pit should be considered in the design in such a way that traffic lanes can operate with an approved traffic management plan in place to access the chambers.

There are locations where traffic lanes have been proposed adjacent to the existing Gold Coast Highway kerb and channels. At these locations, there is insufficient space for a maintenance vehicle to park without impacting on the highway traffic flow. The maintenance access options available at these areas include:

- Parking the maintenance vehicle on the verge and undertake the maintenance activity
- If the verge is inaccessible:
  - For an emergency maintenance, close the kerbside lane under an approved traffic management plan and undertake the work
  - For and non-urgent maintenance, undertake the maintenance activity during off-peak or night under an approved traffic management plan.

During operational hours, maintenance access to the stations can be gained by a maintenance vehicle parking adjacent to the station locations (using on-street parking, where available) and accessing the station on foot.

5.5.6 Public Bus Operations

A public transport operational assessment was undertaken to conduct a preliminary assessment of the proposed bus network services (including route and timetable changes) for each project option and inform the concept designs (including provision for bus stops, interchanges, turnaround areas and driver facilities). The analysis was undertaken based on initial GCLR3 planning undertaken by TransLink, preliminary bus network assessment undertaken by others and stakeholder engagement with Translink, CoGC and TfNSW (for NSW bus routes that pass through the study area).

The *Public Transport Operational Assessment - B2CTS-PE-440-REP-00001* (refer to Appendix G) provides detailed information on the operational changes associated with each project option including consideration of the following:

- All project options:
  - Changes to the supporting bus networks (in terms of route and scheduling changes and total service kilometres) to inform the operational cost estimate
  - High-level assessment of the light rail/bus interchange facilities (including interchange locations and functional requirements terms of number of bus stops, layover facilities etc.) and bus turnaround areas to inform the concept design and cost estimate
  - Operational cost estimate to inform the economic appraisal.
- LRT Option only:
  - Functional requirements of the Bilinga satellite depot and stabling yard including number of additional LRVs required for GCLR4.

A summary of the key changes proposed to the public transport network for the LRT Option (compared to the Base Case network i.e. post-GCLR3) is provided below. Refer Appendix G for more detailed information.

- GCLR network extended 13.4 kilometres from Burleigh Heads to Coolangatta with 14 new LRT stations including an Airport connection (as summarised in Table 18). The proposed LRT service frequency and timetable is summarised in Section 5.5.1.
- The 700 (day service) and 777 (which are the primary trunk routes servicing the project corridor) will be removed given the functions of these routes will be replaced by GCLR4. The 700 night bus will continue to operate in place of the LRT from 12am-5am.
- The following east-west bus feeder services are proposed to be truncated at the Gold Coast Highway to remove duplication with GCLR4:
  - Route 701 truncated at the Burleigh Heads LRT Station
  - Route 760, 771 and 773 truncated at the Thrower Drive LRT Station (note 760 route is subject to further investigation in the BC phase including consideration options to retain the Airport connection)
  - Route 768 and 774 truncated at Boyd Street LRT Station (note 774 route is subject to further investigation in the BC phase including consideration options to retain the Coolangatta connection)
  - Route 600 extended to the Warner Street LRT Station, Coolangatta from the current Tweed Heads start/terminus.

The 600, 760 and the majority of feeder services are proposed to operate as high-frequency services (with a 15 minute or less headway) during peak periods. Refer to Appendix G for further information on the proposed service scheduling for all routes.

Key light/rail bus interchanges are proposed at the below locations with the following supporting facilities:

- **Thrower Drive, Palm Beach** – interchange with a bus turnaround area for east-west services and bus stop capacity for three buses (operating in a nose-to-tail arrangement). The bus station is proposed on Sarawak Avenue to consolidate interchanging services to a single location which improves legibility and amenity for the customers. Further consideration of layover areas and driver facilities will need to be undertaken during the BC phase, in consultation with Translink.
- **Toolona Street / Golden Four Drive, Tugun** – interchange with bus stops on Golden Four Drive and bus stop capacity for 1-2 buses (to be confirmed).
- **Boyd Street, Tugun** - interchange with bus stops on Boyd Street and bus stop capacity for 1-2 buses (to be confirmed). A potential park ‘n’ ride site is also under consideration at this location, for

further assessment during the BC phase (refer to Section 5.3.6.1 for further information). Further consideration of layover areas, driver facilities and alternative locations for bus turnaround will need to be undertaken during the BC phase, in consultation with Translink.

- **Gold Coast Airport** – interchange with bus stops on a new access road (south of Terminal Drive / Tom Norris Road). The PE design includes two 90m long indented bus stops (provides capacity for 4-8 buses, depending on the proposed type of operation i.e. nose-to-tail or independent). However, further review/refinement of this interchange is required in subsequent phases based on outcomes from the Airport masterplan revision (refer to Section 2.5.5) and confirmation of the preferred 760 route option, and potential consideration of layover and driver facilities.
- **Warner Street, Coolangatta** - interchange with the Warner Street (south of Chalk Street) bus stops with capacity for one bus. The Griffith Street bus stops are also located 130m walking distance to the Warner Street LRT Station for connections to the Route 601.

These interchanges will require further investigation during the BC phase pending the outcomes of other TMR planning studies (currently underway) and refinement of bus network changes for the LRT Option (including confirmation of the preferred routes for the 760 and 774). Further consultation with Translink and CoGC is required in the BC phase to confirm the interchange facilities and functional requirements.

Burleigh Heads (south of Goodwin Terrace) is also a key LRT/bus interchange. However, this interchange is included in the GCLR3 scope and includes a bus turnaround area on the Gold Coast Highway (southbound) at the Brake Street intersection which is retained in all project options.

5.5.7 Traffic Signal Priority

LRVs are given priority at all traffic signals to prioritise public transport and minimise delays for passengers. This is typically provided through pre-emptive signal priority where LRVs are detected approaching the traffic signals (through detectors) and ‘calls’ the LRV priority phase at the downstream traffic signals to terminate the active (general traffic) signal phase and activate the light rail movement signal phase through the intersection to avoid (or minimise) delays for LRVs.

The traffic signal phasing to returns to normal operation once LRVs have safely cleared the intersection before the next signal phase commences (as per typical operational requirements). LRV drivers also have the ability to call the LRV priority phase (at downstream traffic signals) when departing the station.

5.6 Construction Activities

5.6.1 Construction Methodology

A high-level construction methodology has been prepared based on the concept design. The approach typically involves five phases as follows:

- Investigation and Design
- Utilities
- Civil works (road)
- Civil works (rail)
- Testing and commissioning.

After further site investigation utilities is constructed first, predominantly at night under single lane closure. This will minimize disruption to the travelling public and adjoining residents.

Road and Rail civil works will occur concurrently to reduce the duration of the overall construction period. Significant temporary pavement works will be required across the alignment to manage traffic whilst civil and rail works is under construction. A significant portion of the civil works will be constructed in day hours behind barriers, whilst construction through an intersection will be at night.

Tallebudgera Creek and Currumbin Creek bridge construction has been priced working from a barge as negative environmental impact from a pushed rock working platform will be significant.

Testing and commissioning will be approached in stages, starting from the north at Burleigh and working towards Coolangatta.

A construction program for the LRT Option has been prepared and can be viewed in Fission's *B2C PTS Option 1 Cost Estimate Report*. Table 32 highlights the key durations from the construction program.

Table 32 LRT Option – Construction Program

Construction Phase	Duration
Mobilisation	2 weeks
Design	31 weeks
Construction (including inclement weather allowance)	200 weeks
Total inclement weather allowance in the construction duration	32 weeks
Total	**233 weeks**

5.6.2 Early Works

With the significant PUP impacts, it would be recommended that as much of the PUP relocations be undertaken as early works as possible. As the design is developed, there may be the opportunity to construct offline infrastructure as early works, however, this will need to be investigated during BC phase.

5.6.3 Preliminary Project Timeframes

To determine escalation allowance, it is necessary to develop a project delivery program. The project timeline used in preparing this estimate is presented in Table 33.

Table 33 LRT Option – Preliminary Project Timeframes

Stage	Start	Finish
Scoping	Ongoing	Q4 2022
Development	Q1 2023	Q2 2026
Delivery	Q3 2023	Q4 2030
Finalisation	Q1 2031	Q2 2031

6.0 Option 2: Dedicated Bus Lanes

Option 2: Dedicated Bus Lanes (DBL) proposes new dedicated bus lanes on the Gold Coast Highway (Burleigh Heads to Coolangatta) and Coolangatta Road (to Tweed Heads), with the exception of the Tallebudgera Creek and Currumbin Creek bridges where the buses are required to merge into the general traffic lanes. This option includes improvements to the bus network in terms of frequency and connectivity. The kerbside bus lanes are proposed to operate 24/7 with bus pre-emption.

The key components of the Option 2: Dedicated Bus Lanes are shown in Table 34.

Table 34 DBL Components

Component	Description
System	Kerbside bus transit lanes suitable for standard single unit bus vehicles
Route length	13.4km
Stops	New bus stops, including premium bus stop infrastructure, to generally match the existing bus stop locations. New bus stops are proposed on the Gold Coast Highway (south of Tomewin Street, Currumbin) and on Coolangatta Road. • 29 indented bus stops provided at key locations • 21 in line bus stops in corridor constrained locations
Cross section	Two kerbside dedicated bus lanes with four general traffic lanes on the Gold Coast Highway. Two kerbside dedicated bus lanes with two general traffic lanes on Coolangatta Road, and segregated bus
Vehicles	No specific changes to the bus fleet are proposed as part of this option.
Vehicle size/ length	14.5m standard bus vehicles
Depot location	No new depot infrastructure is required for this option
Key traffic interactions	29 signalised at-grade intersections, including major intersections at Tallebudgera Drive, Thrower Drive, Tugun Currumbin Road, Toolona Street, Boyd Street and Musgrave Street
Indicative Property impacts	78 full property impacts, 168 partial property impacts
Bridges and structures	One new active transport bridge at Tallebudgera Creek (note the Currumbin Creek active transport bridge is currently being designed by others)
Active transport	Improved active transport provisions for the length of the corridor as recommended by the Active Transport Strategy
Power System	No specific changes to the bus fleet are proposed as part of this option.
Bus network	Bus interchanges at Thrower Drive, Gold Coast Airport and Coolangatta CBD (Warner Street). Changes to bus routes and timetables with more higher frequency services on the B2C corridor and east-west feeder services (refer to Section 6.4.1 for further detail)
Running time	2041 forecast bus journey time of 27-33 minutes from Burleigh Heads to Coolangatta
Service hours	24/7

6.1 Project Scope Exclusions

The following exclusions are specific to DBL Option:

- Upgrades to the bus fleet (including electrification)
- New bridge crossings at Tallebudgera and Currumbin Creeks
- Consolidation or rationalisation of bus stops
- Full integration of the DBL design with the Option 1 LRT design as a potential 'interim' project.

6.2 Design Parameters

6.2.1 Bus Lane Design Criteria

Based on the general design parameters listed in Table 12, the applicable road design criteria for the DBL Option is presented in Table 35 below.

Table 35 DBL Option – Bus Design Parameters

Design Item		Desirable	Min. / Abs. Min.	Project Target Standard	Reference	Comments
Bus Lanes (Kerbside)	60km/h Design Speed	4.5m	3.3m	3.5m to kerb face	Table 4.22 AGRD3 (2021)	Nominally match light rail width
	80km/h Design Speed	4.5m	3.5m	3.5m to kerb face	Table 4.22 AGRD3 (2021)	Plus shoulders (as required)
	At bus stop	5.7m	5.5m	5.7m to kerb face	Table 4.22 AGRD3 (2021)	
	Including parking	7.8m	6.7m	7.8m to kerb face	Table 4.22 AGRD3 (2021)	
	Other bus lanes	3.5m	3.5m	3.5m to kerb lip	Table 4.22 AGRD3 (2021)	May be adopted for Bus Queue Bypasses as part of the Enhanced Bus Provision option
Cross Fall	Bus Lanes	3% nominal		3% nominal		

6.2.2 Bus Stop Design Parameters

Table 36 summarises the general approach and design standards that will be adopted for the bus stop design as part of the DBL Option.

Table 36 DBL Option – Bus Stop Parameters

Design Item		Desirable	Min. / Abs. Min.	Project Target Standard	Reference	Comments
Bus Stop Locations	**KEY ASSUMPTION:** All current bus stops will be retained in their general location along the Gold Coast Highway.					
Intermediate bus stop hardstand dimensions	Width	4.2m	3m	4.2m	PTIM DRG 5-0025	
	Length	9.5m	9.5m	9.5m	PTIM DRG 5-0025	
Premium bus stop hardstand dimensions	Width	4.2m	4.2m	4.2m	PTIM DRG 5-0031	May vary based on existing conditions
	Length	25m	25m	25m	PTIM DRG 5-0031	
Intermediate Indented bus bay dimensions	Width	3m	3m	3m	PTIM DRG 5-0014	
	Storage Length Intermediate	14.5m	12.5m	14.5m	PTIM DRG 5-0014	
	Storage Length Premium	25m		25m	PTIM DRG 5-0032	
	Entry Vert. Gradient	1:7	1:7	1:7	PTIM DRG 5-0014	
	Exit Vert. Gradient	1:5	1:5	1:5	PTIM DRG 5-0014	
	Entry Length	21m	21m	21m	PTIM DRG 5-0032	
	Exit Length	15m	15m	15m	PTIM DRG 5-0032	
Inline bus bay dimensions	Width	2.5m	2.5m	2.5m	PTIM DRG 5-0013	
	Storage Length	25m	25m	25m	PTIM DRG 5-0013	
	Entry Bus Zone Length	20m	20m	20m	PTIM DRG 5-0013	
	Exit Bus Zone Length	10m	10m	10m	PTIM DRG 5-0013	

6.2.3 Road Corridor Configuration

For the DBL Option, the following key design parameters shown in Table 37 were adopted for the general road corridor configuration.

Table 37 DBL Option – Key Road Design Parameters

Design Item	Applicable Design Standard	Comments
General Traffic Lanes	3.5m	Reduced to 3.3m for constrained areas and 3.1m (EDD) through Palm Beach
Footpath	2.0m nominal	High pedestrian volumes 2.5m preferred width
Shared Path	3.0m	2.5m min
AT Path	3.0m	2.0m where one-way
On-Road Cycle Lane	1.5m	Through vehicle traffic speed = 60km/h

The applicable design standards are discussed further in the *Basis of Design Report - B2CTS-PE-430-REP-00001* (see Appendix B).

6.2.4 Design Elements Based on the LRT Design

The following design elements were incorporated into the DBL Option concept design based on the LRT Option concept design:

- Where road widening is required due to technical requirements of the DBL design, the design should widen to the side of the road in line with LRT Option
- The fauna bridge is to be included in the design due to similar impacts to the Burleigh Hill
- Active Transport facilities will be similar to the LRT Option (i.e. off road cycleways and shared paths at Burleigh and Currumbin Hills) and will be included in the DBL design
- The Oceanway is to be included in the project
- Similar provision for the Coolangatta Cycleway are to be included in the design
- Adopt a similar approach to the LRT design which uses the rail cutting.

The following items—which formed part of the LRT Option—are not required as part of the concept design for the DBL Option:

- Bus interchange at the Gold Coast Highway / Thrower Drive intersection as passengers on east-west bus routes are not required to interchange with a different transport mode to travel north-south along the Gold Coast Highway.
- Reprioritisation the Gold Coast Highway at the Gold Coast Highway/Tugun Currumbin Road intersection.
- Relocation of the Gold Coast Highway from Tugun to the Airport as the dedicated bus lanes can be accommodated on the highway by shoulder widening.
- Additional interchange/ turn around areas within the Gold Coast Airport as there are already suitable bus facilities at this location.

6.3 Design Development

6.3.1 Methodology

The overall design approach of the DBL Option was developed using a similar methodology to the LRT Option. Figure 37 shows a flowchart of the design development process undertaken during the PE phase to develop the DBL Option including overarching activities.

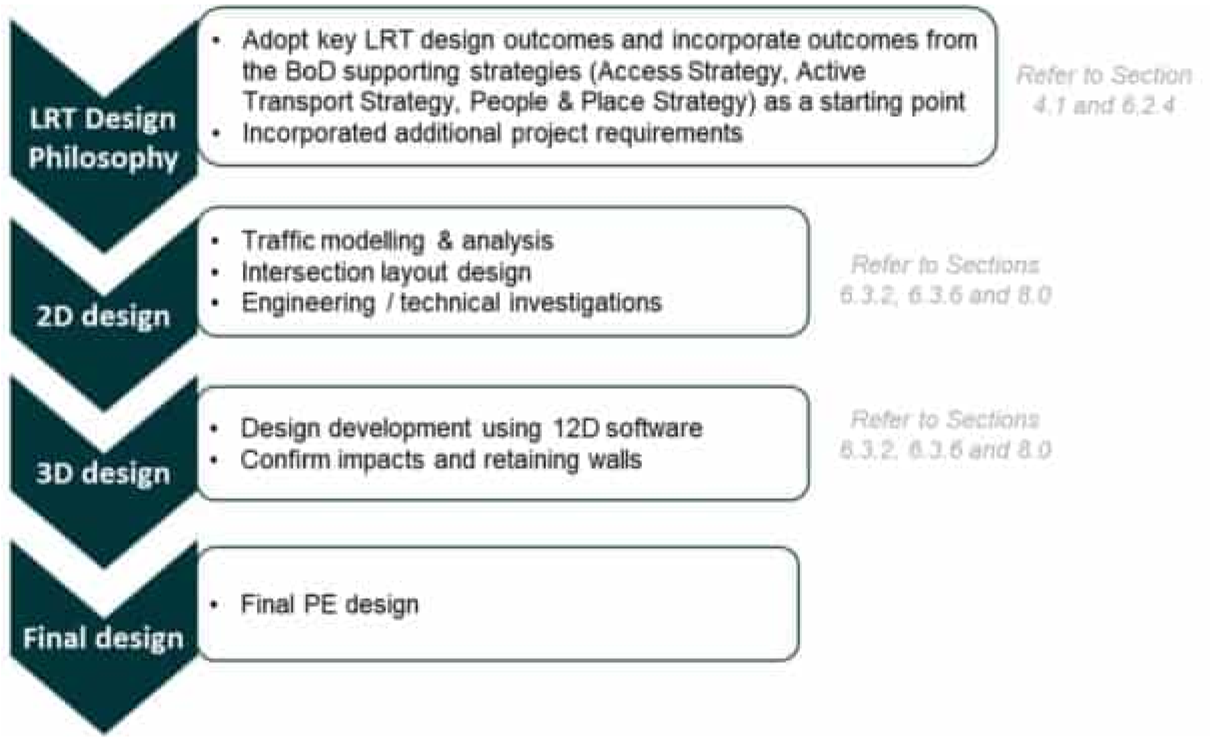


Figure 37 DBL Option – Design Development Methodology

The *DBL Option Concept Designs - B2CTS-PE-432-DWG-00001* are provided in Appendix L.

6.3.2 Road Alignment Refinement

The following sections outline design refinements undertaken for the DBL Option. The concept designs for the DBL Option are provided in Appendix L.

6.3.2.1 Methodology

Similar to the LRT Option, traffic modelling and analysis was undertaken to refine the initial DBL concept design and assess the operational performance of the project corridor (and surrounding study area). The traffic modelling was used to refine the concept design (including intersection layouts), identify any key traffic operational risks and ensure the transport network continues to operate efficiently to a 2041 design horizon.

Additional traffic modelling/analysis was undertaken to support the GCAMSE network modelling including SIDRA intersection analysis and turn warrants assessment to inform the intersection configurations (such as number of lanes/turn bays, storage lengths, lane allocation, geometry, signal phasing and timings etc.) Refer to the *Traffic Modelling Report - B2CTS-PE-433-REP-00002* (Appendix F) for detailed information regarding the traffic modelling and analysis findings.

Intersection design layouts were developed based on the traffic modelling/analysis outcomes and outcomes from the Access Strategy and Active Transport Strategy with respect to pedestrian and cyclist provisions. These intersections were checked using V-paths and spatial provisions were made for traffic signals and pram ramps in the confined locations.

A preliminary 12d model was developed to further assess the design to identify areas of cut/fill and retaining walls. Geometric compliance checks were undertaken on the major horizontal and vertical road alignments.

Engineering and technical investigations were carried out throughout the PE to identify key project risks and considerations, and to inform the concept design and cost estimate. Further information on these investigations is provided in Section 8.0 and more detailed information can be found in the report appendices.

6.3.2.2 Key Design Refinements

6.3.2.2.1 Segment 1: Burleigh Heads

SEGMENT 1 – BURLEIGH HEADLAND
GCLR3 Interface (Ch 40052) As per the LRT design, the tie-in for GCLR3 was included in the design based on the Detailed Design (as of December 2022). The interchange arrangement and requirements between the bus lane option and GCLR3 will need to be further investigated in the next phase of the project.
Brake Street (Ch 40052 – Ch 40300) Similar to the LRT Option (discussed in Section 3.3.4.1), the through function of Brake Street will need to be maintained which requires further property impacts outside of the Category C boundary to the caravan park on the eastern side of the Gold Coast Highway.
George Street East intersection and Cotton Street (Ch 40400 – Ch 40500) For the DBL Option, all movements to both George Street East and Cotton Street are retained. The existing section of the Gold Coast Highway between the Brake Street intersection (with the GCLR3 tie-in at Ch 40100) and George Street East intersection has split level carriageways with the southbound carriageway up to 2.5m lower than the northbound carriageway. The split level has been retained, however, the road widening for the bus lanes and active transport corridor whilst maintaining standard crossfall ultimately means that the southbound carriageway sits almost 2.5m higher than existing. This does not allow for property access in this location and therefore a significant increase to the carriageway split levels will need to be introduced in the next design phase in order to bring the southbound carriageway lower and closer to existing surface levels.
Horizontal Curve at Burleigh Headland / Fauna Bridge (Ch 40500 – Ch 40800) Additional curve widening is required for the horizontal curve compared to the LRT Option due to the swept path requirements for bus vehicles. Further the pier for the Fauna bridge is required to be placed in the centre median between traffic lanes, which increases the requirement for widening for to achieve sight distance around the corner. This results in an increased impact to the national park and additional property impacts compared to the LRT Option.

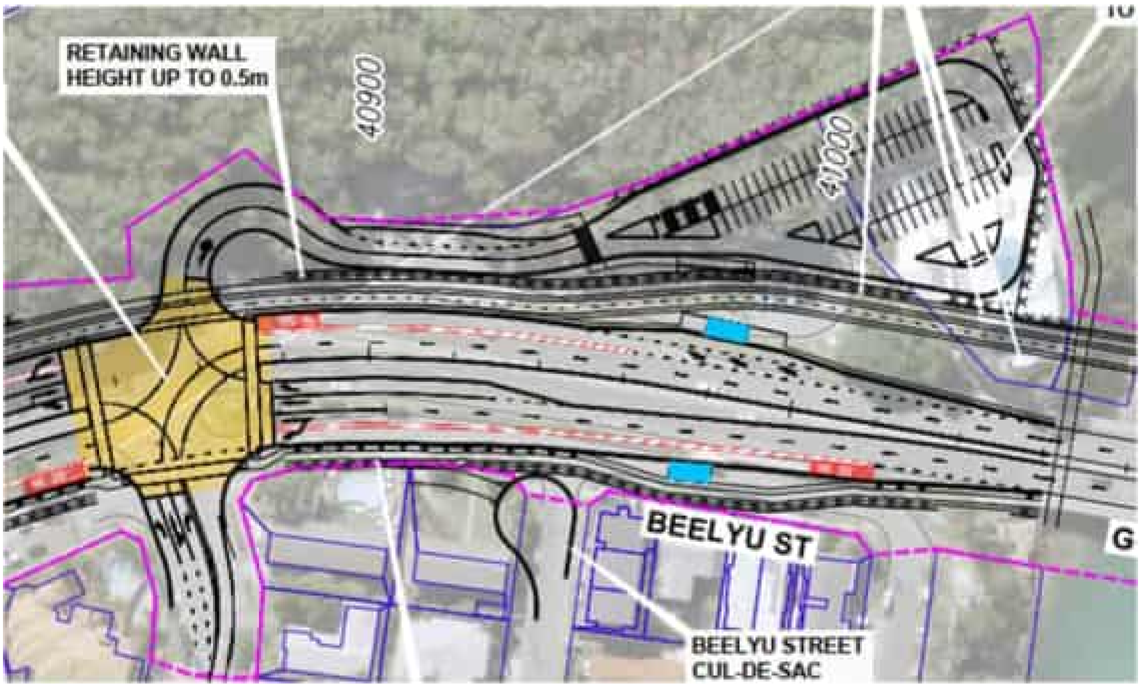
This image has been removed as it contains property impacts that are not approved.

Ikkina Road/Jellurgal Cultural Centre (Ch 40850)

Similar to the LRT design, the existing Aboriginal Cultural Centre was to be retained. A new access road and carpark has been included in the design. With the level differences, a large retaining wall is required around the carpark.

Bullimah Avenue and Awoonga Avenue (Ch 40900 – Ch 41000)

To accommodate the alignment widening as well as the indented bus stop, Beelyu Street, which runs parallel with the Gold Coast Highway, could not be retained. As a result, cul-de-sac turnarounds have been provided to at the eastern end of Bullimah Avenue and Awoonga Avenue.



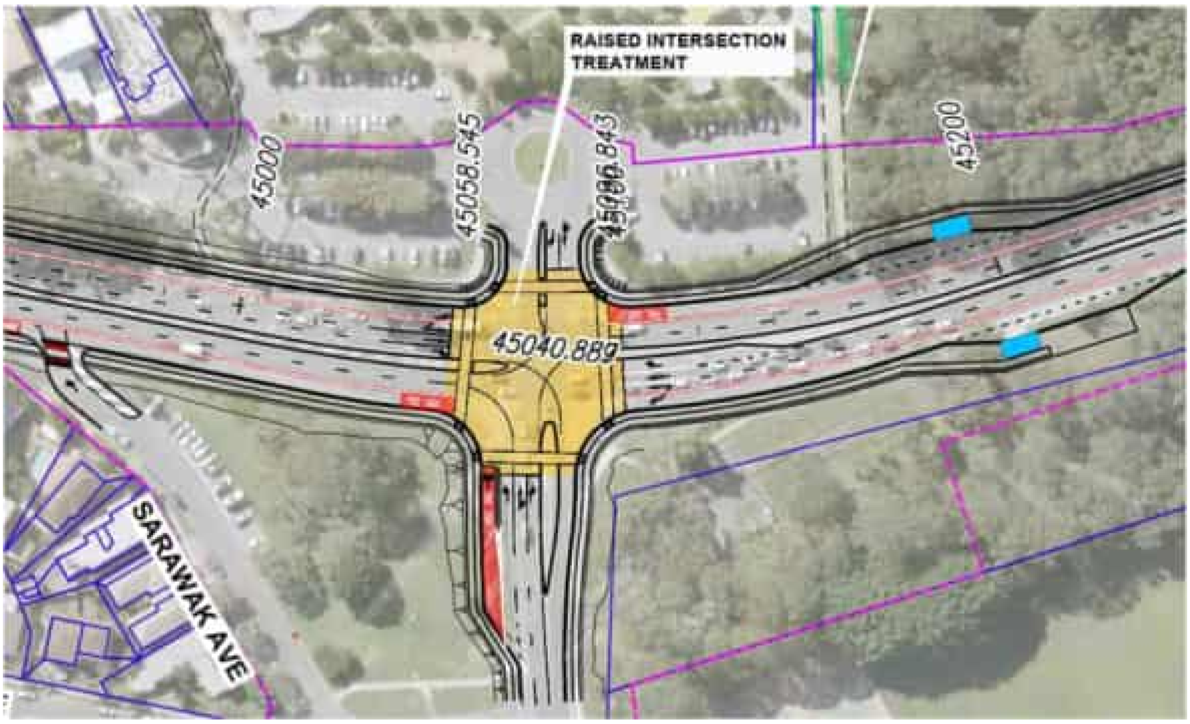
Active Transport Bridge over Tallebudgera Creek (Ch 41000 – Ch 41250) A standalone Active Transport bridge has been provided in the same location as the proposed LRT bridge. The alignment of the bridge has been offset from the existing bridge to allow for improved constructability and flexibility with future upgrades to the Gold Coast Highway.
New Bus Stops for Tallebudgera Recreation Centre (Ch 41300) New higher order indented bus stops to service the recreation centre have been provided in the design due to primary location for potential users. This has resulted in additional property impacts on both the east and west sides of the Gold Coast Highway.

6.3.2.2.2 Segment 2: Palm Beach

SEGMENT 2 – PALM BEACH
Tallebudgera Drive Intersection (Ch 41500 – Ch 41800) The Tallebudgera Drive intersection has been developed in line with the LRT design and includes dual southbound right turns from the Gold Coast Highway to Tallebudgera Drive (to cater for high right turn demand in the afternoon peak) and separated/protected treatments for active transport users.
Seventeenth Avenue intersection (Ch 43000) The Gold Coast Highway / Seventeenth Avenue intersection has been converted to a LILO arrangement with the northbound right turn into Seventeenth Avenue and southbound U-turn movements banned to remove uncontrolled movements on the Gold Coast Highway (based on the Access Strategy recommendations). U-turn movements are provided at adjacent signalised intersections to maintain vehicle accessibility.
Third Avenue intersection (Ch 44500) The Gold Coast Highway northbound right turn to Third Avenue has been removed to improve safety and remove uncontrolled right turn movements on the Gold Coast Highway. The design assumes northbound U-turns are permitted on the Gold Coast Highway at the Fourth Avenue intersection, as an alternative detour route to maintain accessibility.
First Ave intersection and Hawaii Ave pedestrian crossing (Ch 44650 – Ch 44900) The mid-block signalised pedestrian crossing at Ch 448200 (near Hawaii Avenue) is retained, (similar to the LRT Option) based on the Active Transport Strategy recommendations. The emergency vehicle cross-over on the Gold Coast Highway at Ch 44800 is also retained for right turn access in/out of the QPS Palm Beach Station. Further consultation with QPS should be undertaken in the next phase regarding specific access requirements for this crossover to refine the vehicle cross-over design.
Thrower Drive intersection (Ch 44900 – Ch 42500) The Thrower Drive intersection layout for the DBL Option generally matches the existing arrangement and caters for all existing traffic movements. Continuous bus lanes with new indented higher-order bus stops are provided on the Gold Coast Highway, and a bus queue jump from Thrower Drive (west) approach is proposed to improve travel time reliability and reduce delays buses travelling east-west along Thrower Drive. This bus queue jump will require a dedicated advanced green signal (“B-light”) to ensure buses can safely turn left or right onto the Gold Coast Highway without conflicts with general traffic turning onto the highway from this approach. The existing bus stops on Thrower Drive are located to the south of Luzon Parade, while the Gold Coast Highway bus stops are located south of Thrower Drive. Opportunities could be explored in the BC phase to optimise interchanges between these stops including consideration of layover areas, bus turnaround provisions (on Thrower Drive) and driver facilities, in consultation with Translink. These opportunities were not explored in the PE phase as the scope assumes all bus stops are retained in their existing location. It is also noted there are a number of key project

requirements at this location which constrain these opportunities, specifically retaining efficient traffic operations through this busy intersection (to avoid delays to the highway traffic flows), minimising parking impacts and retaining the drainage function of the Thrower Drive/Sarawak island.

Sarawak Avenue is proposed to be retained as a left out only (northbound) egress onto the Gold Coast Highway.



Currumbin Creek AT bridge (Ch 45400 – Ch 45700)

The proposed AT bridge (and connecting paths) across Currumbin Creek are currently being designed by others with tie-ins to the B2C project. As such, the connecting AT path on the southbound approach will need to be reviewed further once the design for the new AT bridge is finalised during future design phases.

6.3.2.2.3 Segment 3: Currumbin Headland

SEGMENT 3 – CURRUMBIN HEADLAND

Duringan Street Intersection (Ch 45750)

The Gold Coast Highway/Duringan Street intersection has been reconfigured f to a signalised intersection with right turn movements in/out of Duringan Street connection permitted and a pedestrian crossing for access to the adjacent bus stops (similar to the LRT Option). Additionally, the northbound on-ramp has been removed (replaced by the northbound right tur movement) and the southbound on and off-ramps removed and replaced with stand-up lanes on the east approach to allow both north and southbound turns onto the highway.

Millers Drive to Wagawn Street (Ch 46750 – Ch 47100)

A similar approach was required for the DBL Option as the LRT option, however with as there is no fixed LRT corridor in the centre of the road, this option has more scope to increase the split carriageway to retain access to the existing properties on both sides of the corridor.

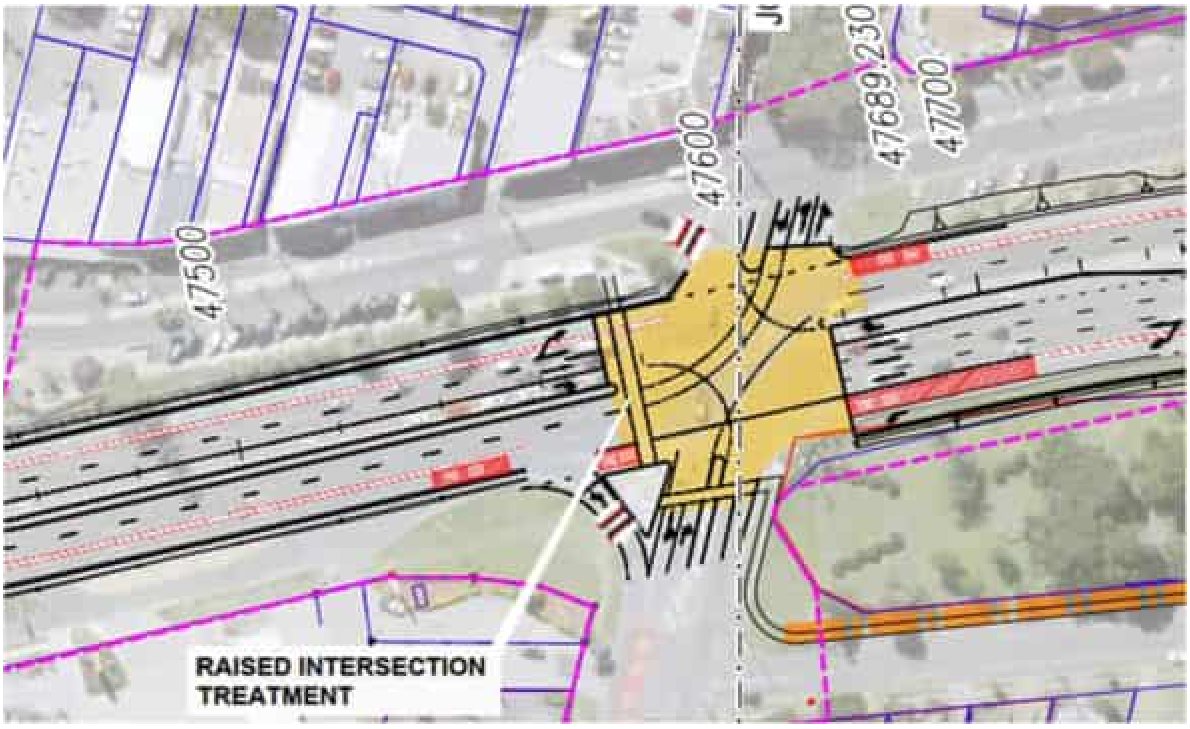
However, the side road access to Winders Avenue was found to be excessively steep (approximate 20%) and was not feasible resulting in significant property impacts on the western side of the Gold Coast Highway (similar to the LRT Option).

Tugun Bus Stops (Ch 47200)
Indented bus bays are proposed near the Tugun CBD in line with the overall design approach and recommendations from the People & Place Strategy. These indented bus stops result in additional property impacts on both sides of the Gold Coast Highway. A further review of the access and egress for the northbound service station between Wagawn Street and Stewart Road will need to be undertaken during BC phase due their close proximity to the new bus stop.

This image has been removed as it contains property impacts that are not approved.

6.3.2.2.4 Segment 4: Tugun to Bilinga

SEGMENT 4 – TUGUN TO BILINGA
Toolona Street intersection (Ch 47600) The Gold Coast Highway / Toolona Street intersection is proposed to be upgraded to include the dedicated bus lanes. The existing intersection configuration has generally to retained to maintain access to the Tugun CBD. As a result of the traffic modelling inputs, three through lanes are provided on the Gold Coast Highway south approach to the intersection to improve capacity and reduce delays. The existing left turn slip lane with a zebra crossing on the Toolona Street west approach has been changed to a raised pedestrian crossings as per TMR’s Road Safety Policy.



Kitchener Street intersections (Ch 48200)

The Kitchener Street intersection is proposed to be signalised to improve safety (for the uncontrolled southbound right turn) including provision of pedestrian crossings for improved pedestrian safety and accessibility to the adjacent bus stops, and given Kitchener Street is a PCN route. The pedestrian crossing provides connections between Coolangatta Road and Golden Four Drive. It is noted that the intersection does not meet the requirements of TMR Road Safety Policy, as it does not include pedestrian crossings on all four legs of the intersection.

At the Kitchener Street / Coolangatta Road intersection, the southern approach of Coolangatta Road has been realigned (to increase the offset to the Gold Coast Highway traffic signals and cater for a future cycleway). A cul-de-sac near the Tugun Village Community Centre is provided for access to local properties and to remove the road connection through Boyd Street. Raised pedestrian crossings have been provided across both northern and southern legs of Coolangatta Road.

Gold Coast Highway / Boyd Street intersection (Ch 48600 – Ch 48800)

The design includes a new signalised intersection at the Gold Coast Highway / Boyd Street, which will become the primary access to the new Cobaki Lakes development. The Boyd Street leg includes four stand-up lanes and two departure lanes (based on the traffic modelling recommendations).

Additionally, the Boyd Street access to Coolangatta Road has been removed, with Coolangatta Road reconfigured as a cul-de-sac on both sides of Boyd Street to improve safety. Gold Coast Highway itself is widened to provide dual southbound right turn lanes into Boyd Street and an additional northbound through lane along with the dedicated bus lanes in each direction. A signalised pedestrian crossing is provided on the southern leg of Gold Coast Highway.

It is noted that the intersection does not meet the requirements of TMR Road Safety Policy, as it does not include pedestrian crossings on the northern approach (to intersection delays).

Similar to the LRT, the Gold Coast Highway / Desalination Plant Road was removed based on the Access Strategy recommendations and the traffic modelling findings (which indicated that permitting southbound right turns from the highway into Desalination Plant Road resulted in traffic disruptions at the Boyd Street intersection). Therefore, a new connection from Coolangatta Road to Boyd Street at Tugun Street has been included in the design, which also provides access to a potential park ‘n’ ride site (to be investigated further in the BC phase).

Gold Coast Highway / Loongana Avenue / Coolangatta Road intersection and Gold Coast Highway / Golden Four Drive / Surf Street intersection (Ch 49250)

The design proposes signalising the existing priority-controlled intersection. The arrangement is highly complicated with three north-south roads and two east-west roads. Additionally, a combination of signalised and raised pedestrian crossings have been included to improve access for pedestrians from east to west.

Further investigation on this intersection arrangement should be considered in the next phase of the project.

Kirribin Street Intersection (Ch 50000)

The design includes the signalising of the existing priority controlled intersection to improve safety and access to the bus stops on either side of the Gold Coast Highway.

Terminal Drive Access (Ch 50500 – Ch 50600)

The Terminal Drive intersection has been designed to generally retain the existing movements to and from the airport precinct. New indented bus bays have been included on the northern side of the signalised intersection.

As a result of these bus stops, the design includes the relocation of the southern service road access to reduce the safety risk of vehicles colliding with a bus exiting the northbound bus stop.

6.3.2.2.5 Segment 5: Kirra to Coolangatta

SEGMENT 5 – COOLANGATTA

Gold Coast Highway / Musgrave Street intersection and Musgrave Street / Coolangatta Road intersection (Ch 51500 to Ch 51700)

A similar approach as the LRT option was adopted for the DBL Option with the intention to improve safety and removing the significant weaving movements between Gold Coast Highway and Musgrave Street flyover on-ramp. The design can be summarised as:

- **Gold Coast Highway / Coolangatta Road intersection**
  - Consolidated T-intersection on the Gold Coast Highway (south of Terminal Drive) with access to Coolangatta Road (extended north to the highway)
  - Provision of a northbound left turn slip lane Coolangatta Road to improve capacity for this high turn movement (based on the traffic modelling recommendations)

- **Coolangatta Road / Musgrave Street intersection**
  - Signalised T-intersection configuration
  - Golden Four Drive / Musgrave Street access retained
  - Alternative alignment of the Coolangatta Road Cycleway to the eastern side of Coolangatta Road (compared to western side in the LRT Option).

This image has been removed as it contains property impacts that are not approved.

Charlotte Street Intersection (Ch 51500)

For the DBL Option, the Coolangatta Road / Charlotte Street intersection is retained as a priority-controlled intersection, with all existing vehicle movements included as per the existing configuration.

Miles Street intersection with busway (Ch 52400)

It is proposed that a new intersection on Miles Street is created for the dedicated busway connection through Lanham Street Park. It has been designed as an uncontrolled intersection with raised pedestrian crossings on the eastern leg to connect for the AT path connection between Miles Street and Lanham Street Park.

Busway and driver layover facilities (Ch 53200)

A bus turnaround and possible location for driver layover facilities has been provided at the Warner Street Bus Station (southern extent of the DBL Option). Further consultation with Translink is required in the next phase of the project to confirm the requirements for this facility.

6.3.3 Property Requirements

Introduction of the DBL Option impacts some of the existing properties along the project corridor. Table 38 below highlights the number of full and partial property impacts.

Table 38 DBL Option – Property Impacts

Segment	Full	Partial	Total
1 - Burleigh Heads	13	6	19
2 - Palm Beach	39	144	183
3 - Currumbin	19	15	34
4 - Tugun / Bilinga	2	1	3
5 - Coolangatta	5	2	7
TOTAL	**78**	**168**	**246**

6.3.4 Car Parking Impacts

Introduction of the DBL Option into the existing road corridor requires changes to the road configuration, resulting in impacts to on-street parking along the project corridor. A summary of the number of the existing parking bays impacted and required offsets is provided in Table 39.

Table 39 DBL Option - Car Parking Impacts

Segment	Existing	Residential	PWD	Commercial	Commercial loading zones	Recreational	Remaining
1	353	-107	-1	0	-2	-35	208
2	641	-354	0	-63	-6	-18	200
3	122	-56	0	-54	0	0	12
4	250	-55	0	0	-1	0	194
5	708	-116	-8	-241	0	0	343
TOTAL	**2074**	**-688**	**-9**	**-358**	**-9**	**-53**	**957**

6.3.5 Bus Stops

Existing bus stop locations have generally been retained in their current location along the corridor, with some minor relocations closer to intersections or places of interest to increase patronage and reduce walking distances which generally have been accommodated in the design.

New bus stop facilities with a mix of indented bus bays at higher order stops (i.e. CBD areas or near key destinations such as schools) and in-line bus stops in other areas.

6.3.6 Geometric Compliance

Following the design development process (discussed above), a number of design compliance issues were identified. Key outstanding issues are noted in Table 40.

Table 40 DBL Design Compliance

Segment	Element	Design Non-conformance	Recommendation
Segment 1	Sight Distance	Sight lines around barriers and bridge piers	Geometry to be reviewed and refined to ensure sight lines are achieved in next design phase
Segment 2	Lane Widths	3.1m Traffic Lane (Extended Design Domain) (EDD)	EDD report to be completed and endorsed by TMR South Coast at next design phase
Segment 3	Vertical Alignment	Vertical grades vary between less than 1% and matching existing at 6%	Geometric review and refinement to be undertaken at next design phase
Segment 4	Vertical Alignment	Vertical grades less than 1%	Geometric review and refinement to be undertaken at next design phase
Segment 5	Vertical Alignment	Vertical grades less than 1% and crest curve less than project standard minimum.	Geometric review and refinement to be undertaken at next design phase

An initial geometric review was undertaken and non-standard (non-conforming) items have been highlighted further within the *Geometric Report - B2CTS-PE-430-REP-00003* (refer to Appendix K).

6.4 Operations

6.4.1 Public Bus Operations

The Routes 700, 777 and 760 will continue to service the Gold Coast Highway as the primary high frequency trunk routes in the DBL Option, supported by a number of east-west local feeder routes. The Route 700 operates between West Burleigh – Tweed Heads, while the 777 will continue to operate as an express service between West Burleigh – Airport. The 760 is the primary trunk route between Robina – Tweed Heads via the Airport.

A summary of the key changes proposed to the public transport network for the DBL Option (compared to the Base Case network) is provided below. Further information is provided in the *Public Transport Operational Assessment - B2CTS-PE-440-REP-00001* (see Appendix G).

- Routes 700 and 760 realigned to remain on the Gold Coast Highway (using the dedicated bus lanes) between Tomewin Street, Currumbin and Coolangatta Road, Coolangatta. Currently, these services divert off the Gold Coast Highway to Golden Four Drive south of Tomewin Street.
- Route 771 and 773 truncated at the Thrower Drive Bus Station (instead of First Avenue, Palm Beach)
- Route 768 truncated at the John Flynn Hospital, Tugun
- Route 600 extended from current Tweed Heads start/terminus to Griffith Street, Coolangatta (east of the Warner Street Bus Station).
- All other routes are assumed to utilise the same alignment as the Base Case (with post GCLR3 changes – refer to the *Public Transport Assessment Report* for further information).

The key trunk routes (600, 700, 777, 760) and east-west feeder services are proposed to operate as high-frequency services (with a 15 minute or less headway) during peak periods. Refer to Appendix G for further information on the proposed service scheduling for all routes.

Key bus interchanges are proposed at the following locations with the following supporting facilities:

- **Thrower Drive, Palm Beach** – existing bus stops on Thrower Drive (south of Luzon Parade) with capacity for two buses, and on the Gold Coast Highway (south of Thrower Drive) with capacity for two buses. Opportunities could be explored in the BC phase to optimise interchanges between these stops including consideration of layover areas, bus turnaround provisions (on Thrower Drive) and driver facilities, in consultation with Translink.
- **Gold Coast Airport** – interchange with bus stops on the Gold Coast Highway with capacity for two buses
- **Warner Street, Coolangatta** – bus station to include capacity for two buses, turnaround, layover area and driver facilities. The Griffith Street bus stops (which service the Route 601 and 760) are also located 130m walking distance to the Warner Street Bus Station.

These interchanges will require further investigation during the BC phase pending the outcomes of other TMR planning studies (currently underway) and refinement of bus network changes for the LRT Option (including confirmation of the preferred routes for the 760 and 774). Further consultation with Translink and CoGC is required in the BC phase to confirm the interchange facilities and functional requirements.

6.4.2 Traffic Signal Priority

It is assumed that all traffic signals on the project corridor will include traffic signal pre-emption for buses travelling in the dedicated bus lanes. This provides priority for buses at signalised intersections through provision of detectors (on the bus lane approaches) which are activated by the approaching bus and 'call' the bus priority signal phase (which is typically combined with the Gold Coast Highway through movement phase) to terminate the active signal phase. This process is subject to the minimum green times green and inter-green phase which are applied to maintain safe operations and are mainly defined by pedestrian protection crossing requirements.

It is noted that left-turning vehicles are legally permitted to enter bus lanes for up to 100 metres when entering/exiting the road, under the QLD Road Rules. At most intersections, dedicated left turn lanes have not been provided (due to the constrained road corridor), therefore, even with traffic signal pre-emption, buses are likely to experience delays from left turning traffic, particularly at intersections with high pedestrian activity. This is because when the pedestrian 'green walk' phase is activated, pedestrian signal protection is applied (in accordance with TMR's Road Safety Policy) to provide an exclusive pedestrian 'green walk' signal phase before left or right-turning vehicles are permitted to turn through the intersection.

The proposed bus queue jump on the Thrower Drive (west) approach to the Gold Coast Highway intersection will require a dedicated advanced green signal ("B-light") to ensure buses can safely turn left or right onto the Gold Coast Highway without conflicts with general traffic turning onto the highway from this approach (as previously noted in Section 6.3.2.2.2).

6.4.3 Vehicles

It is intended that Translink's standard 12.5m and/or 14.5m single axle buses are used. No specific upgrades to the current bus fleet are proposed as part of this option, however the design is compatible with potential fleet upgrades such as articulated buses, double decker buses and electrification of the bus fleet.

6.5 Construction Activities

6.5.1 Constructability

A high-level construction methodology has been prepared based on the concept design. The approach typically involves the following four phases:

1. Investigation and Design

2. Utilities
3. Civil works (road)
4. Testing and commissioning.

After further site investigation utilities is constructed first, predominantly at night under single lane closure. This will minimise disruption to the travelling public and adjoining residents.

Significant temporary pavement works will be required across the alignment to manage traffic whilst civil works is under construction. A significant portion of the civil works will be constructed in day hours behind barriers, whilst construction through an intersection will be at night.

Construction of the Tallebudgera Creek Bridge has been priced working from a barge as negative environmental impact from a pushed rock working platform will be significant.

A construction program for the DBL Option has been prepared and can be viewed in Fission's *B2C PTS Option 2 Cost Estimate Report*. Table 41 highlights the key durations from the construction program.

Table 41 DBL Option – Construction Program

Construction Phase	Duration
Mobilisation	2 weeks
Design	52 weeks
Construction (including inclement weather allowance)	172 weeks
Total inclement weather allowance in the construction duration	28 weeks
Total	**205 weeks**

6.5.2 Early Works

With the significant PUP impacts, it would be recommended that as much of the PUP relocations be undertaken as early works as possible. As the design is developed, there may be the opportunity to construct offline infrastructure as early works, however, this will need to be investigated during the BC phase.

6.5.3 Preliminary Project Timeframes

To determine escalation allowance, it is necessary to develop a project delivery program. The project timeline used in preparing this estimate is presented in Table 42 below.

Table 42 DBL Option – Preliminary Project Timeframes

Stage	Start	Finish
Scoping	Ongoing	Q4 2022
Development	Q1 2023	Q2 2026
Delivery	Q3 2026	Q2 2030
Finalisation	Q3 2030	Q3 2030

7.0 Option 3: Enhanced Bus Provisions

Option 3: Enhanced Bus Provisions (EBP) proposes short sections of dedicated bus lanes/bus jumps on the Gold Coast Highway approaches (both directions) at key locations to improve bus efficiency and reliability at the following intersections:

- Tallebudgera Drive, Palm Beach
- Nineteenth Avenue, Palm Beach
- Palm Beach Avenue, Palm Beach
- Thrower Drive, Palm Beach – plus a bus queue jump on the Thrower Drive (west) approach for buses turning left and right onto the Gold Coast Highway.

Additionally, some minor improvements to the existing bus stops and pedestrian access is included in the option.

Table 43 EBP Components

Component	Description
System	Kerb side bus transit lanes suitable for standard single unit bus vehicles on the approaches to four signalised intersections at Tallebudgera Drive, Nineteenth Avenue, Palm Beach Avenue and Thrower Drive
Route length	13.4 km
Stops	• 37 existing bus stops to remain • 9 bus stops upgraded to premium stops and/or relocated to improve access.
Cross section	• Two kerbside dedicated bus lanes(queue bypass lanes) with four lanes of general traffic at the approaches to selected intersections. • All other areas are to match the existing road formation.
Vehicles	No specific changes to the bus fleet are proposed as part of this option.
Vehicle size/length	14.5m standard bus vehicles
Depot location	Nil
Key traffic interactions	• Short bus lanes on the approaches to four intersections (listed above) • Upgrade of 8 unsignalised intersections to signalised intersections to improve safety and pedestrian crossing opportunities. • 1 signalised mid-block pedestrian crossing
Indicative Property impacts	Nil
Bridges and structures	Nil
Active transport	• Shared path upgrades near bus stops to improve connectivity and access. • Improved cross-corridor connectivity with additional traffic signals provided at key intersections.
Power System	No specific changes to the bus fleet are proposed as part of this option.
Bus network	Minor changes to the ‘Base Case’ bus network (i.e. future bus network post GCLR3) which are primarily scheduling adjustments (refer to Section 7.1.1 for further detail).

Component	Description
Running time	2041 forecast bus journey time of 27-33 minutes from Burleigh Heads to Coolangatta
Service hours	No change to existing service hours

7.1 Project Scope Exclusions

The following exclusions are specific to the EBP Option.

- Upgrades to the bus fleet (including electrification)
- New bridge crossings
- Consolidation or rationalisation of bus stops.

7.2 Design Parameters

7.2.1 Bus Lane Design Criteria

Based on the general design parameters listed in Table 12, the applicable road design criteria for EBP Option is presented in Table 44 below.

Table 44 EBP Option – Bus Design Parameters

Design Item		Desirable	Min. / Abs. Min.	Project Target Standard	Reference	Comments
Bus Lanes (Kerbside)	60km/h Design Speed	4.5m	3.3m	3.5m to kerb face	Table 4.22 AGRD3 (2021)	Nominally match light rail width
	80km/h Design Speed	4.5m	3.5m	3.5m to kerb face	Table 4.22 AGRD3 (2021)	Plus shoulders (as required)
	At bus stop	5.7m	5.5m	5.7m to kerb face	Table 4.22 AGRD3 (2021)	
	Including parking	7.8m	6.7m	7.8m to kerb face	Table 4.22 AGRD3 (2021)	
	Other bus lanes	3.5m	3.5m	3.5m to kerb lip	Table 4.22 AGRD3 (2021)	May be adopted for Bus Queue Bypasses as part of the Enhanced Bus Provision option
Cross Fall	Bus Lanes	3% nominal		3% nominal		

7.2.2 Bus Stop Design Parameters

Table 44 summarises the general approach and design standards that will be adopted for the bus stop design as part of the EBP Option.

Table 45 EBP Option – Bus Stop Parameters

Design Item		Desirable	Min. / Abs. Min.	Project Target Standard	Reference	Comments
Bus Stop Locations	**KEY ASSUMPTION**: All current bus stops will be retained in their general location along the Gold Coast Highway.					
Intermediate bus stop hardstand dimensions	Width	4.2m	3m	4.2m	PTIM DRG 5-0025	
	Length	9.5m	9.5m	9.5m	PTIM DRG 5-0025	
Premium bus stop hardstand dimensions	Width	4.2m	4.2m	4.2m	PTIM DRG 5-0031	May vary based on existing conditions
	Length	25m	25m	25m	PTIM DRG 5-0031	
Intermediate Indented bus bay dimensions	Width	3m	3m	3m	PTIM DRG 5-0014	
	Storage Length Intermediate	14.5m	12.5m	14.5m	PTIM DRG 5-0014	
	Storage Length Premium	25m		25m	PTIM DRG 5-0032	
	Entry Vert. Gradient	1:7	1:7	1:7	PTIM DRG 5-0014	
	Exit Vert. Gradient	1:5	1:5	1:5	PTIM DRG 5-0014	
	Entry Length	21m	21m	21m	PTIM DRG 5-0032	
	Exit Length	15m	15m	15m	PTIM DRG 5-0032	
Inline bus bay dimensions	Width	2.5m	2.5m	2.5m	PTIM DRG 5-0013	
	Storage Length	25m	25m	25m	PTIM DRG 5-0013	
	Entry Bus Zone Length	20m	20m	20m	PTIM DRG 5-0013	
	Exit Bus Zone Length	10m	10m	10m	PTIM DRG 5-0013	

7.2.3 Road Corridor Configuration

For the EBP Option, the following key design parameters shown in Table 46 were adopted for the general road corridor configuration.

Table 46 EBP Option – Key Road Design Parameters

	Applicable Design Standard	Comments
General Traffic Lanes	3.5m	Reduced to 3.3m for constrained areas and 3.1m (EDD) through Palm Beach
Footpath	2.0m nom	High pedestrian volumes 2.5m preferred width
Shared Path	3.0m	2.5m min
AT Path	3.0m	2.0m where one-way
On-Road Cycle Lane	1.5m	Through vehicle traffic speed = 60km/h

The applicable design standards are discussed further in the *Basis of Design Report - B2CTS-PE-430-REP-00001* (see Appendix B).

7.3 Design Development

7.3.1 Methodology

The overall design approach of the EBP Option was developed using the methodology shown in Figure 38.

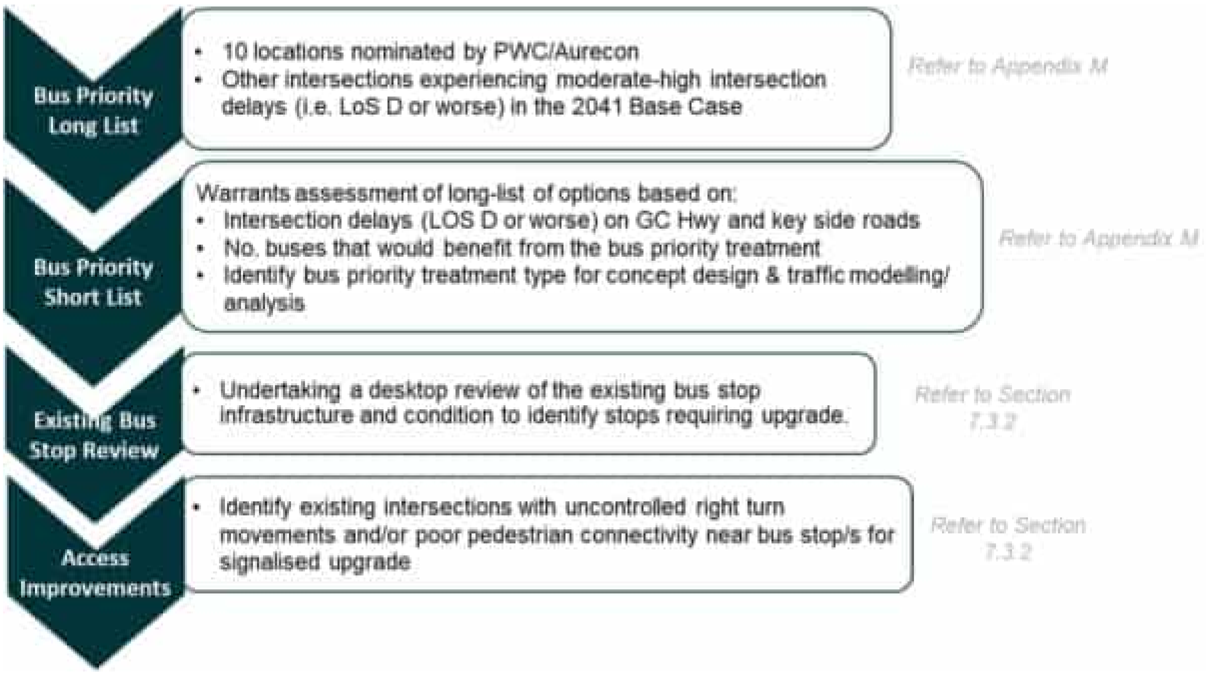


Figure 38 EBP Option – Design Development Methodology

The *EBP Option Concept Designs - B2CTS-PE-432-DWG-00002* are provided in Appendix M.

A summary of the options analysis process to shortlist the preferred sites for design development and technical investigations is found in the *Enhanced Bus Provisions Option Technical Note - B2CTS-PE-432-MEM-00003* (refer to Appendix N) for further information on the assessment.

The analysis recommended that bus priority treatments be investigated on the Gold Coast Highway at four Palm Beach intersections (Tallebudgera Drive, Nineteenth Avenue, Palm Beach Avenue and Thrower Drive), in addition to bus priority on the Thrower Drive (west) approach to the Gold Coast Highway intersection. These locations were progressed for design development including more detailed traffic modelling and technical investigations to refine the concept design.

7.3.2 Road Alignment Refinement

The following sections outline design refinements undertaken for the EBP Option. The concept designs for the EBP Option are provided in Appendix M.

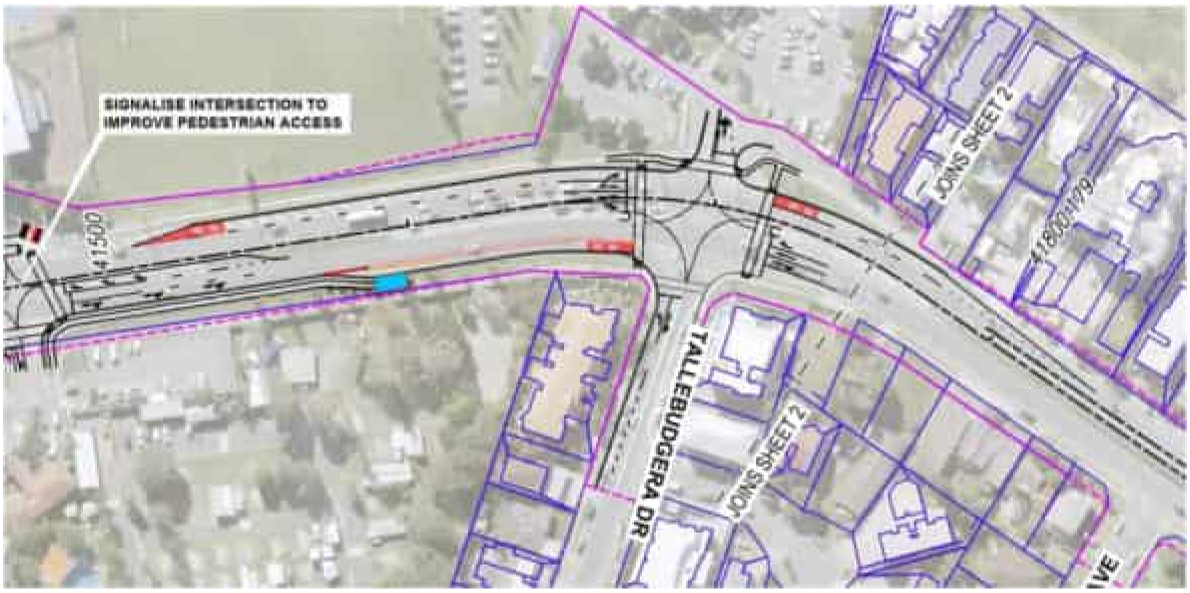
7.3.2.1 Key Design Refinements

7.3.2.1.1 Segment 1: Burleigh Heads

SEGMENT 1 – BURLEIGH HEADLAND
Brake Street (Ch 40052 – Ch 40300) A new pedestrian crossing is proposed on the intersection's north approach for improved pedestrian accessibility across the highway and the Burleigh Heads bus stops located south of the intersection (based on the Active Transport Strategy recommendations given this location is a high pedestrian activity environment and there are no nearby pedestrian crossing south of the Goodwin Terrace intersection). This intersection is proposed to be signalised as part of GCLR3 for the bus turnaround, however, the current GCLR3 design does not include pedestrian crossings.
George Street East intersection Upgrade of this intersection to traffic signals is proposed to improve safety (by removing the uncontrolled right and U-turn movements) and improve pedestrian connectivity and accessibility to the existing bus stops north of intersection.
Tallebudgera Recreation Camp / Tallebudgera Creek Tourist Park intersection (Ch 41200 – Ch 41500) Upgrade of the intersections to traffic signals (with pedestrian crossings) is proposed to remove uncontrolled right turns on the Gold Coast Highway and side roads, improve safety and improve pedestrian connectivity/accessibility across the highway and nearby bus stops. The new pedestrian crossings will also replace the existing underpass at Ch. 41372 which is not DDA compliant and has poor CPTED outcomes for pedestrians.

7.3.2.1.2 Segment 2: Palm Beach

SEGMENT 2 – PALM BEACH
Tallebudgera Drive Intersection (Ch 41500 – Ch 41800) The Tallebudgera Drive intersection has been developed in line with the DBL design, with the exception of a single southbound right turn lane from the Gold Coast Highway to Tallebudgera Drive (west) and standard crossings for pedestrians and active transport users. Due to the requirement to avoid property assumptions (refer to Table 2) for this option, a bus lane on the Gold Coast Highway northbound approach could not be accommodated within the Category C boundary whilst maintaining other key design requirements (i.e. two northbound through lanes for general traffic, right turn lane and footpaths). Therefore, only a northbound bus lane on the departure side is proposed to the northbound bus stop. Similarly, whilst separated active transport crossings and a second southbound right turn lane was desirable to improve the project outcomes, these were not included in the design due to property impacts. A southbound bus lane is proposed on the Gold Coast Highway to reduce bus delays on this approach. The bus lane comments on the departure side of the Tallebudgera Recreation Camp access and terminates to the south of Tallebudgera Drive, as shown below.



Twenty Fifth Avenue intersection (Ch 42170)

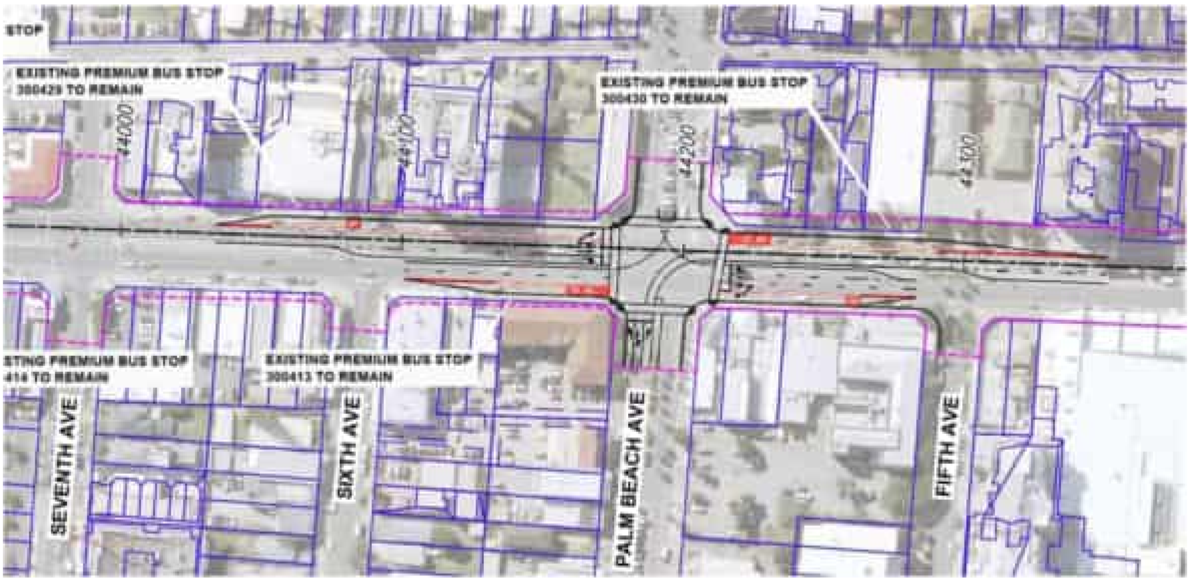
The Gold Coast Highway / Twenty Fifth Avenue intersection is proposed to be signalised to improve safety (by removing the uncontrolled right and U-turn movements) and improve pedestrian connectivity and accessibility to the existing bus stops immediately south of the intersection.

Nineteenth Avenue intersection (Ch 42800)

The Gold Coast Highway / Nineteenth Avenue intersection is consistent with the DBL design, albeit with short sections of bus lanes proposed on the highway north and south approaches and departures. The northbound bus stop (stop 300417) is proposed to be relocated closer to the Nineteenth Avenue intersection.

Palm Beach Avenue intersection (Ch 44180)

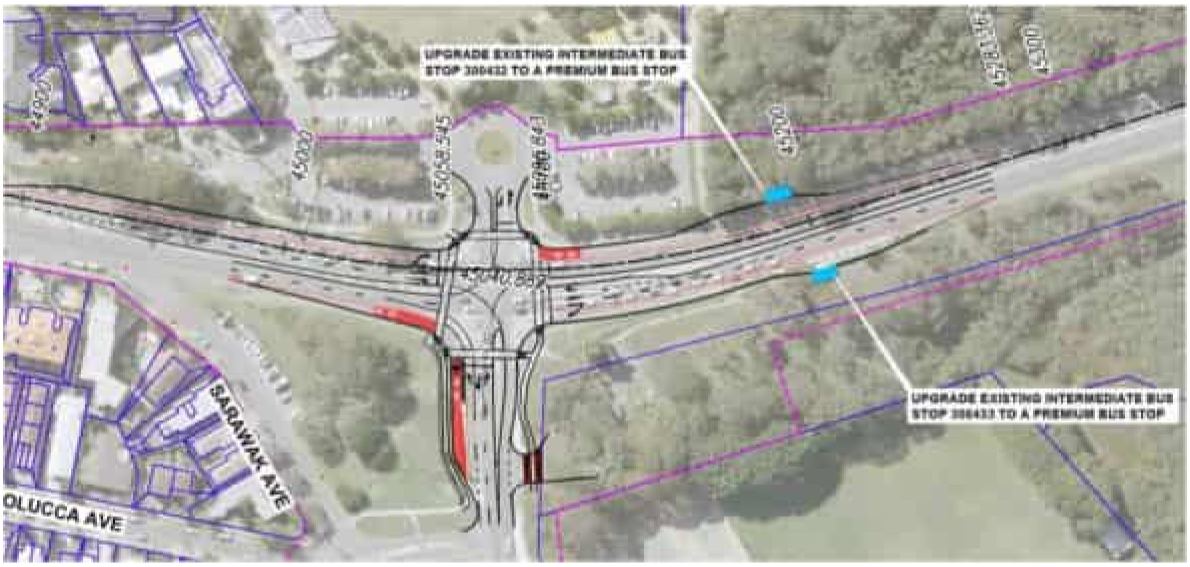
The Gold Coast Highway / Palm Beach Avenue intersection is consistent with the DBL design, however with short sections of bus lanes proposed on the highway north and south approaches and departures (rather than continuous bus lanes along the entire corridor).



Thrower Drive intersection (Ch 44900 – Ch 42500)

The Gold Coast Highway / Thrower Drive intersection includes short sections of bus lanes on the highway intersection approaches and departures, and a bus queue jump on the Thrower Drive (west) approach for buses turning left and right onto the highway (consistent with the DBL Option) to improve travel time reliability and reduce delays buses travelling east-west along Thrower Drive. The bus queue jump will require a dedicated advanced green signal ("B-light") to ensure buses can safely turn left or right onto the Gold Coast Highway without conflicts with general traffic turning onto the highway from this approach.

No changes are proposed to the Sarawak Avenue or Luzon Parade roads or intersections.



Bus stop infrastructure upgrades (various chainages)

Minor upgrades to existing bus stops are proposed at the following locations:

- Gold Coast Highway northbound and southbound near Twenty Eighth Avenue (stop IDS 300422 and 300420, respectively) – upgraded from intermediate to premium bus stops
- Gold Coast Highway northbound approaching Tenth Avenue (stop ID 300415) – relocated approx. 100m north closer to the Eleventh Avenue signalised intersection (to improve accessibility to the existing pedestrian crossings)

- Gold Coast Highway northbound and southbound near Thrower Drive (stop IDs 300432 and 300433, respectively) – upgraded from intermediate to premium bus stops.

7.3.2.1.3 Segment 3: Currumbin

SEGMENT 3 – CURRUMBIN

Duringan Street connection (Ch 45765)

The existing Gold Coast Highway left turn slip lanes for the southbound exit and entry are proposed to be reconfigured to high-entry angle slip lanes to reduce vehicle speeds and improve safety.

The design also includes provision of a mid-block signalised pedestrian crossing approximately 130m south of the intersection for improved safety and accessibility to the existing bus stops on the highway. There are currently no pedestrian crossings located in proximity to these bus stops, which reduces the safety and accessibility of public transport options. The southbound bus stop (currently situated between the two slip lanes) is proposed to be relocated approximately 90m south, closer to the new pedestrian crossing to improve safety and accessibility.

Wagawn Street intersection (Ch 47130)

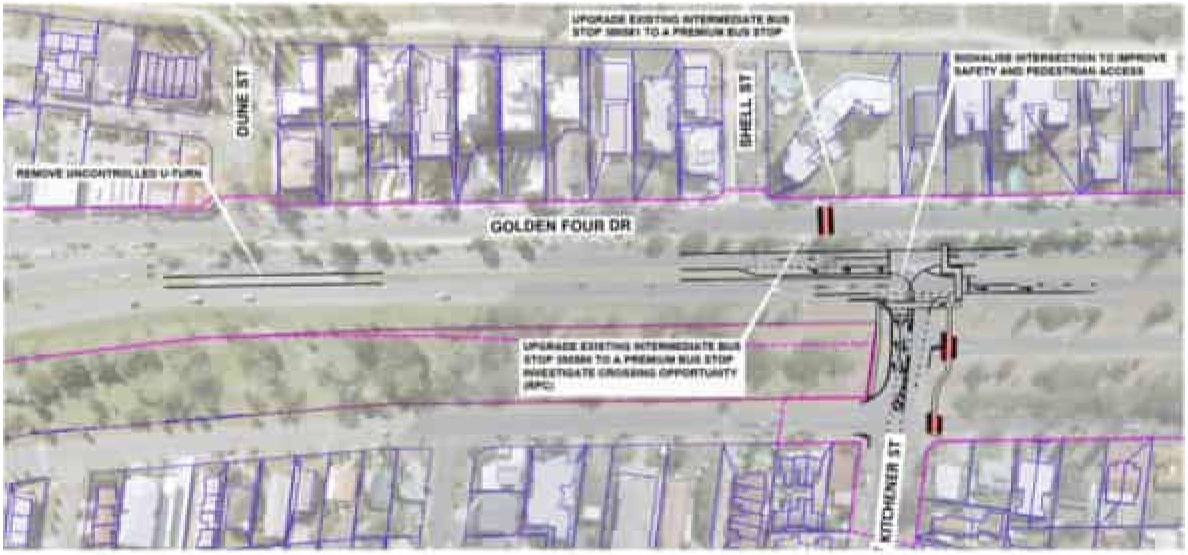
The Gold Coast Highway / Wagawn Street intersection is proposed to be signalised to improve safety (by removing the uncontrolled right and U-turn movements) and improve pedestrian connectivity and accessibility across the highway to the Tugun CBD. The intersection upgrade provides an opportunity to improve vehicle accessibility to/from the Tugun CBD by permitting the northbound right turn and westbound right turn movements (which are currently prohibited).

7.3.2.1.4 Segment 4: Tugun to Bilinga

SEGMENT 4 – TUGUN TO BILINGA

Kitchener Street intersection

The Gold Coast Highway / Kitchener Street intersection is proposed to be signalised (with pedestrian crossings) to improve remove the uncontrolled right turns and improve pedestrian connectivity and accessibility to the existing bus stops on Golden Four Drive and AT connectivity given Kitchener Street is a principal cycle route. There is an existing uncontrolled midblock U-turn facility on the Gold Coast Highway (approx. 300m north of this intersection) which is proposed to be removed given right turn egress will be permitted at the new Kitchener Street traffic signals for vehicles exiting Kitchener Street. Similarly, the existing mid-block pedestrian crossing located 160m south of Kitchener Street is proposed to be removed given pedestrian crossings will be provided at the Kitchener Street and Boyd Street intersections.



Gold Coast Highway / Golden Four Drive/ Coolangatta Road / Desalination Plant Road intersection (Ch 48800)

The Gold Coast Highway intersection with Golden Four Drive, Coolangatta Road and Desalination Plant Road intersection is proposed to be signalised to improve safety and remove uncontrolled right turn movements at this intersection. Consideration of consolidating this access with the adjacent intersections (at Boyd Street and Loongana Avenue) or refining the intersection layout (to reduce conflicts) was not undertaken as general traffic improvements are not in scope for this project option. However, these options should be explored as part of other projects/studies.

Gold Coast Highway / Golden Four Drive/ Coolangatta Road / Loongana Avenue intersection (Ch 49200)

The Gold Coast Highway intersection with Golden Four Drive, Coolangatta Road and Loongana intersection is proposed to be signalised (with pedestrian crossings) to improve safety and pedestrian accessibility to the nearby bus stops on Golden Four Drive and Coolangatta Road.

Consideration of refining the intersection layout (to reduce conflicts) was not undertaken as general traffic improvements are not in scope for this project option. However, these options should be explored as part of other projects/studies.

Bus stop infrastructure upgrades (various chainages)

Golden Four Drive northbound and southbound bus stops near Shell Street (stop IDS 300581 and 300580, respectively) – upgraded from intermediate to premium bus stops.

7.3.2.1.5 Segment 5: Kirra to Coolangatta

There are no intersection upgrades (including bus priority treatments) proposed on this segment for the EBP Option, therefore, no road design refinements were undertaken. Minor upgrades to existing bus stops are proposed at the following locations:

- Golden Four Drive southbound approaching Lang Street (stop ID 300131) – upgraded to intermediate bus stop
- Miles Street northbound approaching Winston Street (stop ID 300736) – provide a regular shelter at existing bus stop.

7.3.3 Property Requirements

The EBP Option does not impact any existing properties within the study area as all works are generally within the existing road carriageway.

7.3.4 Car Parking Impacts

Introduction of the B2C PTS – EBP (Option 3) into the existing road corridors requires changes to the existing on street parking to provide space for the bus priority lanes. This has resulted in the loss of some of the on-street parking provided. A summary of the number of the car park offset is provided in Table 47.

Table 47 EBP Option – EBP Car Parking Impacts

Segment	Existing	Residential	PWD	Commercial	Commercial loading zones	Recreational	Remaining
1	353	-15	0	0	0	-2	336
2	641	-63	0	-24	-3	-18	533
3	122	0	0	-7	0	0	115
4	250	-2	0	-2	0	0	246
5	708	0	0	0	0	0	708
TOTAL	2074	-80	0	-33	-3	-20	1938

7.3.5 Station / Stops

In the EBP Option, the existing bus stops are generally retained in their current locations with some minor upgrades to improve pedestrian accessibility in some locations. These locations are summarised in Section 7.3.2.1.

7.3.6 Geometric Compliance

The concept design for the EBP Option has been undertaken in plan (2D) only. Although there is some minor widening at some intersections to accommodate the bus lane, the works can generally be contained within the existing pavement/kerb lines with the use of the existing shoulders/parking lanes or widening into the median. As such, the design will generally match the existing and would suggest minimal geometric alignment issues, but further investigations will be required for the EBP Option during future design phases if the option is to progress through to the Business Case phase.

7.1 Operations

7.1.1 Public Bus Operations

Minimal changes to the bus network are proposed in the EBP Option (compared to the Base Case bus network), with the exception of the Route 768 (discussed further below).

The Routes 700, 777 and 760 will continue to service the Gold Coast Highway as the primary high frequency trunk routes in the EBP Option, supported by a number of east-west local feeder routes. The Route 700 operates between West Burleigh – Tweed Heads, while the 777 will continue to operate as an express service between West Burleigh – Airport. The 760 is the primary trunk route between Robina – Tweed Heads via the Airport.

A summary of the key changes proposed to the public transport network for the EBP Option (compared to the Base Case network) is provided below. These changes mainly relate to minor adjustments to the scheduling (such as reduced headways and service window changes) – refer to the *Public Transport Operational Assessment - B2CTS-PE-440-REP-00001* (see Appendix G) for further information.

- Route 771 and 773 truncated at the Thrower Drive Bus Station (instead of First Avenue, Palm Beach, consistent with the DBL Option))
- Route 768 truncated at the John Flynn Hospital, Tugun (consistent with the DBL Option)

- Increased service windows proposed for the routes above
- All other routes are assumed to utilise the same alignment as the Base Case (with post GCLR3 changes – refer to the *Public Transport Assessment Report* for further information).

The key trunk routes (700, 777, 760, 600) are proposed to operate as high-frequency services in 2041 (with a 15 minute or less headway) during peak periods. While most of the east-west feeder routes (such as the Routes 768, 771, 772, 773 and 774) are proposed to operate on a 30 minute headway during the 2031 and 2041 peak periods. Refer to Appendix G for further information on the proposed service scheduling for all routes.

Key bus interchanges are proposed at the following locations with the following supporting facilities:

- **Thrower Drive, Palm Beach** – existing bus stops on Thrower Drive (south of Luzon Parade) with capacity for two buses, and on the Gold Coast Highway (south of Thrower Drive) with capacity for two buses. Opportunities could be explored in the BC phase to optimise interchanges between these stops including consideration of layover areas, bus turnaround provisions (on Thrower Drive) and driver facilities, in consultation with Translink.
- **Gold Coast Airport** – interchange with bus stops on the Gold Coast Highway with capacity for two buses.

These interchanges will require further investigation during the BC phase pending the outcomes of other TMR planning studies (currently underway) and refinement of bus network changes for the LRT Option (including confirmation of the preferred routes for the 760 and 774). Further consultation with Translink and CoGC is required in the BC phase to confirm the interchange facilities and functional requirements.

7.1.2 Traffic Signal Priority

It is assumed that all traffic signals on the project corridor will include traffic signal pre-emption for buses travelling in the bus lanes (similar to the DBL Option). This provides priority for buses at signalised intersections through provision of detectors (on the bus lane approaches) which are activated by the approaching bus and 'call' the bus priority signal phase (which is typically combined with the Gold Coast Highway through movement phase) to terminate the active signal phase. Refer to Section 6.4.2 for further information on the bus priority signal phasing at signalised intersections.

7.1.3 Vehicles

It is intended that Translink's standard 12.5m and/or 14.5m single axle buses are used. No specific upgrades to the current bus fleet are proposed as part of this option. However, the design is compatible with potential fleet upgrades such as articulated buses, double decker buses and electrification of the bus fleet.

7.2 Construction Activities

7.2.1 Constructability

A high-level construction methodology has been prepared based on the concept design. Given the relative simplicity of the EBP option the general approach is to construct each individual site (intersection) sequentially.

A construction program for the EBP Option has been prepared and can be viewed in Fission's *B2C PTS Option 1 Cost Estimate Report*. Table 48 highlights the key durations from the construction program.

Table 48 EBP Option – Construction Program

Construction Phase	Duration
Mobilisation	2 weeks
Design	28 weeks
Construction (including inclement weather allowance)	82 weeks

Construction Phase	Duration
Total inclement weather allowance in the construction duration	13 weeks
Total	**112 weeks**

7.2.2 Early Works

Given the relative simplicity of the works associated with the EBP Option, early works are not required.

7.2.3 Preliminary Project Timeframes

To determine escalation allowance, it is necessary to develop a project delivery program. The project timeline used in preparing this estimate is presented in Table 49.

Table 49 EBP Option – Preliminary Project Timeframes

Stage	Start	Finish
Scoping	Ongoing	Q4 2022
Development	Q1 2023	Q2 2026
Delivery	Q3 2026	Q3 2028
Finalisation	Q3 2028	Q3 2028

8.0 Technical Investigations

The following section provides a summary of the technical investigations undertaken to support all options of the concept design and inform the preliminary cost estimate and risk analysis. More detailed information is contained in the appendices for the respective technical report.

8.1 Public Utilities and Plant

Desktop public utility investigations were undertaken for the PE phase. Assessment of utilities within the corridor and impacted area was undertaken through Dial Before You Dig (DBYD) searches along with collating further information from utility owners GIS information. Utilities were separated into categories based on service providers identified within the Study area DBYD searches. The following providers were identified:

- AARNet - Telecommunications (Cable, Optic Fibre, Conduit)
- APA – Gas
- CoGC W&W- Potable Water, Recycled Water and Wastewater Infrastructure
- Energex – Electricity
- Essential Energy – Electricity
- GCCC - Stormwater / Drainage
- NBN - Telecommunications (Cable, Optic Fibre, Conduit)
- Nextgen - Telecommunications (Cable, Optic Fibre, Conduit)
- Optus - Telecommunications (Cable, Optic Fibre, Conduit)
- SEQ Water - Raw water and Potable water
- Telstra - Telecommunications (Cable, Optic Fibre, Conduit)
- TPG - Telecommunications (Cable, Optic Fibre, Conduit)
- Veolia Water - Raw water and potable water.

Utilities crossing the corridor have been assessed into three groups: utility renewal, realignment and protection (retain). Under the light rail corridor, the treatment is based on the depth of the top of the utility from the surface level of the track slab. The closer to the surface the more likely the service will need to be relocated. Any service crossing (overhead) over the track slab has been identified to be placed underground for electrical safety.

Services running along the corridor have been assessed based on their location and if they have been impacted by the project. Services along the light rail corridor have been identified for relocation outside the corridor to allow safe access for maintenance. In areas where the existing kerbs are being moved, services that are under new road are identified for relocation into the new verge. Where there is a change in the use of a traffic lane to bring the through traffic closer to power poles, they have been assessed for appropriate clearances and relocated if needed.

The PUP investigation has concluded the following:

- Approximate 1,090 known services impacted by the transport alignment
- Of these 731 were buried with 359 interfaces being above ground electrical
- 560 services were identified to require relocation / augmentation to facilitate construction and ultimate works
- 386 services were identified to require protection to facilitate construction and ultimate works
- 144 services were identified that require monitoring during design development to determine if they require treatment type escalation (relocation / augmentation or protection)

- Pipelines associated with the Gold Coast Desalination Plant interface with the proposed transport alignments
- Neither the Light Rail or Dedicated Bus alignment reduces likelihood of impact to existing services due to known positions, alignments and materials as well as conservative approach to unknown information
- There is a lack of available information to accurately apply required treatment to services.

Confirmation of exact service size, material, alignment and position is recommended will be required as the preferred option is progressed to provide confidence in the treatment solution identified and rationalise the preferred methodology.

Further information including a detailed Utility Impact Register is provided in the *Public Utility Plant Report - B2CTS-PE-435-REP-00001* (refer to Appendix O).

8.2 Geotechnical Analysis

8.2.1 Geotechnical Factual Reporting

The published regional geology provided by the Queensland Government (Queensland Globe) indicates that the region comprises both Quaternary and Holocene age materials comprising coastal plain deposits (undifferentiated swamps, tidal flats, beach-ridges, and dunes) and coastal beach ridges. The geology between Burleigh Heads to Coolangatta aligns with that of GCLR3 whereby the alignment is dominated by coastal plain deposits, with areas of higher elevation comprising of Neranleigh-Fernvale Beds.

The topography along the project alignment can be characterised as generally flat and low-lying with isolated areas of higher elevation around Burleigh Headland (CH40300 to CH40850) and Currumbin Hill (Ch. 45650 to Ch. 46500). The topography along each segment off the project alignment is summarised below

Table 50 Topography

Location	Topography
Burleigh Heads to Palm Beach	Varies in elevation from low lying to high ranging. At Burleigh Head Station elevation starts at ~ 4m AHD and increases to ~ 20m AHD around the Burleigh Headland.
Palm Beach to Currumbin	Relatively low lying along the coastline with at ~5m AHD.
Currumbin to Tugun	Varies in elevation from low lying to high ranging. Increases in elevation from 4m AHD North of Currumbin Creek up to 30m AHD at Currumbin Hill.
Tugun to Coolangatta	Relatively low lying along the coastline at ~7m AHD.
Coolangatta	Varies in elevation from low lying to high ranging. Increases in elevation from 6m AHD at Charlotte Street up to 18m AHD at Gordon Lane.

The historical investigations do not contain data on ASS; hence the presence of ASS was inferred through published information. ASS mapping was sourced from the Australian Soil Resource Information System (ASRIS) mapping database.

Table 51 Probability of Occurrence of Acid Sulfate Soils

Location	Acid Sulfate Soils Probability of Occurrence
Burleigh Heads to Palm Beach	Ranges from Extremely Low Probability of Occurrence (confidence level 4) to a high probability of Occurrence (confidence level 4) at Tallebudgera Creek
Palm Beach to Currumbin	Low Probability of Occurrence (confidence level 3)
Currumbin to Tugun	High probability of occurrence (confidence level 4) around Currumbin Creek and Currumbin Hill to a low probability of occurrence (confidence level 4) around Tugun
Tugun to Coolangatta	Low Probability of Occurrence (confidence level 4) tending to High Probability of Occurrence (confidence level 4 at Bilinga)
Coolangatta	Extremely Low Probability of Occurrence (confidence level 4)

A summary of the ground conditions along the project site has been provided below. These ground conditions have been inferred from the geotechnical long sections provided. The reader should make note of the offset distance from a number of the available data points, and treat the interpretation as estimated at this stage. For further information, refer to the *Geotechnical Factual Report - B2CTS-PE-437-REP-00001* (see Appendix P).

Table 52 Subsurface Conditions

Location	Summary of Ground Conditions
Burleigh Heads to Palm Beach	Generally, comprises a layer of fill material associated with existing roadway, underlain by 4.5-9m layer of natural granular/ cohesive material. 5m XW Greywacke underlain by HW-MW Greywacke.
Palm Beach to Currumbin	Generally, comprises a layer of fill material associated with existing roadway, underlain by a 2-8m layer of VL - MD granular material underlain by clay/ sandy clay layer 2-10m thick. Cohesive layer comprises of soft to firm material. Greywacke, argillite and mudstone are present at depth. Towards Currumbin Creek L – D sandy material is dominant underlain by greywacke.
Currumbin to Tugun	Generally, comprises 10m thick layer of VL – MD granular material underlain by a 7-9m thick layer of cohesive material. Cohesive material ranges in consistency from VS – VSt. This is underlain by a 5m thick layer of VL – D granular material. Argillite and Greywacke are present at elevations of -20 to -25m AHD.
Tugun to Coolangatta	No geotechnical investigation available, however it is likely subsurface conditions will be similar to that in Segments 30 and 50.
Coolangatta	Predominant presence of L – D granular material. Rock not encountered within 24m bgl of available data in this section.

A preliminary geotechnical gap analysis was conducted by reviewing the existing data and assessing its quality for all sections of the project. From the review of existing geotechnical data, it is evident that much is offset from the project alignment and therefore gaps in data are prevalent.

8.2.2 Retaining Structures

As part of the preliminary evaluation, retaining structures are required at various locations. The following types of retaining structures were considered in this analysis:

- Reinforced concrete cantilever retaining walls (RC walls)
- Embedded piled retaining walls
- Soil nails walls, rock bolts and dowels
- Reinforced soil structures.

Retaining structures have been suggested based on available data to inform ground conditions and available regional geology maps. A summary of the number of retaining structures proposed for each project option is provided below. Refer to the *Geotechnical Analysis Report - B2CTS-PE-437-REP-00002* (see Appendix Q) for more detailed information.

In total the following number of retaining structures were identified during the PE Concept Design with walls ranging from 1m to 6m in height.

- 32 retaining structures for the LRT Option
- 23 retaining structures for the DBL Option
- No retaining structures for the EBP Option.

8.2.3 Bridge Foundations

Both the LRT and DBL Options includes three bridge structures at Burleigh Hill (new fauna bridge), Currumbin Creek bridge and Tallebudgera Creek bridge. Preliminary geotechnical analysis were undertaken to estimate pile toe levels based on preliminary loads and current interpretation of ground conditions. In relation to this assessment, the following key points are highlighted:

- Rock socketed cast-in-place (CIP) piles were considered for all the new bridges.
- Limited geotechnical information is available at the time of this assessment. No geotechnical investigations were available at the Burleigh Hill or Tallebudgera Creek proposed bridge locations. Details of geotechnical investigations were available at the proposed location of the Currumbin Creek bridge; however, rock testing information was not available. Therefore, subsurface interpretations for this assessment were undertaken by referring to regional geology, limited existing geotechnical investigations/testing and based on the information presented in existing bridge drawings.
- A geotechnical strength reduction factor (φ_g) of 0.55 was considered for CIP piles. This φ_g value was adopted based on anticipated ground conditions, referring to TMR Geotechnical Design Standard requirements and assuming sufficient geotechnical investigations will be completed during future design stages.
- In the absence of sufficient geotechnical data, the design rock strengths were inferred based on anticipated rock types and past project experience on similar rock types.
- Only the axial capacity checks under preliminary ultimate limit state (ULS) loadings were undertaken as a part of this assessment. Soil structure interaction checks and lateral load carrying capacity checks were not undertaken.

The design for the EBP Option is largely limited to pavement and minor road widening works. Therefore, this option should not require retaining walls of any major cut of fill areas. Furthermore, there are no design elements associated with the bridges.

It is noted that there was limited existing geotechnical information made available for the Project. Therefore, the confidence level of current subsurface interpretation is low. The following investigations are recommended to be undertaken in the BC phase to assist with the geotechnical assessments:

- Obtain all available historical geotechnical investigations within the project corridor, particularly at proposed bridge sites.
- Undertake additional geotechnical investigations to obtain initial geotechnical data to refine current assessments for all critical locations identified above.

8.3 Pavement Design

The desktop review has necessarily been very high level and will benefit greatly from the addition of site-specific investigation information once the desired alignment is confirmed. Refer to the *Pavement Design Report - B2CTS-PE-444-REP-00001* (see Appendix R) for further details.

In summary, when considering the asphalt requirements by option for each segment, there is little variation in the asphalt depths as shown in Figure 3 below. The asphalt depth for the dedicated bus lane for Option 2 is not shown in the figure and remains constant for all the segments. The variation in traffic volumes does affect the improved layers composition though. For segments where the Equivalent Standard Axle (ESA) in the design traffic lane in the year of opening is more than 1000, the improved layer must consist of lightly bound material. With regards to the subgrade treatment, this will be consistent for all options.

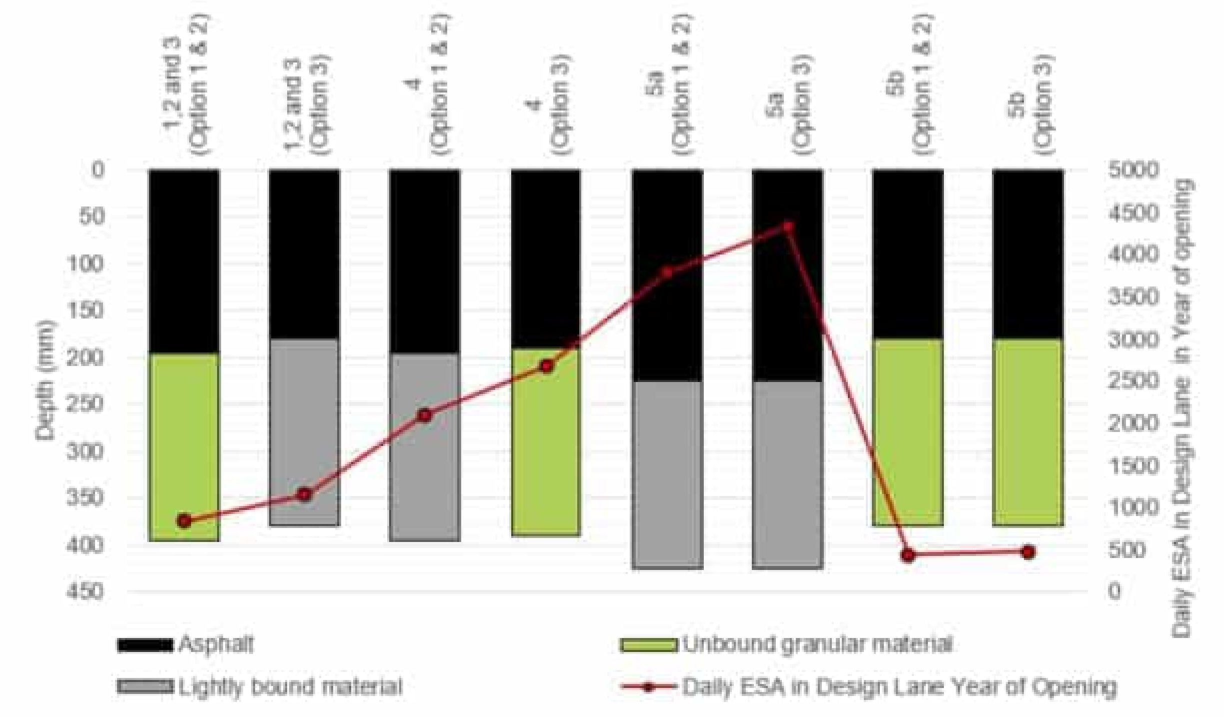


Figure 39 Summary of material type and depths by segment, option and daily ESAs in the design lane in the year of opening

When comparing asphalt requirements, the options can be ranked as follows from least to highest: LRT Option, EBP Option and DBL Option. For the DBL Option, the dedicated bus lane will require full width reconstruction (similar to the LRT Option), however, the dedicated bus lane will require deeper asphalt to accommodate heavier loads from bus traffic.

Full depth asphalt pavements have been recommended for all options throughout as it provides constructability benefits when working in constrained urban environments. Benefits may include: short paving times to allow contractor to maintain traffic flow; asphalt allows for staged construction and staged opening of the final works and in the long term, maintenance of asphalt pavements are easy.

The following items should be investigated during the BC phase:

- For pavements with more than 1000 ESA's in the design lane in the year of opening, consider replacing the lightly bound improved with an unbound granular layer in areas underlain by sand. This will facilitate the subsurface drainage and negate the need for pavement and subsoil drains.
- Reuse of existing pavements. Currently the available data does not support reuse of pavements, however, the data may be incomplete.
- For subsurface drainage of the track slab in areas underlain by clay, consider the use of a drainage blanket or permeable layer to limit clashes of subsoil drains with other services.

The pavement design for the DBL Option is similar to the LRT Option, given these options has a similar road alignment.

8.4 Structures

There are three significant bridge structures along the project corridor at Burleigh Hill, Tallebudgera Creek and Currumbin Creek. Table 53 lists these three bridges including the relevant project options that the bridge structures are applicable for.

As shown, the LRT Option includes all three bridge structures given that new bridges are required for the LRT corridor. For the DBL Option, no new road bridges are proposed at Tallebudgera or Currumbin Creeks as buses will be required to merge into the general traffic lanes. Therefore, the DBL Option includes a new fauna bridge at Burleigh Hill and active transport (AT) bridge at Tallebudgera Creek.

There are no bridges proposed for the EBP Option.

Table 53 Proposed Bridges

No.	Name	Chainage	B2C Project Option
1	Burleigh Hill fauna bridge	Ch. 40550	LRT & DBL Options
2	Tallebudgera Creek bridge	Ch. 41150	LRT Option (includes AT facilities) only
3	Currumbin Creek bridge	Ch. 45600	LRT Option only New AT bridge designed by others

The bridge design criteria are detailed in the *Basis of Design Report - B2CTS-PE-430-REP-00001* (see Appendix B) including details of the bridge design standards and specifications, design life and adopted bridge design criteria.

Further information on the bridge assessment is provided in the *Bridge Appraisal Report - B2CTS-PE-438-REP-00001* (see Appendix S). Other major culvert structures may be required along the project corridor to maintain drainage crossings, however, detailed structural assessments of these culverts were not undertaken during the PE phase.

8.4.1 Burleigh Hill Fauna Bridge

The bridge carries up to 1.0m of soil fill to support medium sized planter beds and AT user paths. The bridge follows a natural ridge line through the surrounding terrain. The existing ground to the west drops sharply away from the ridge line so that following the ridge line is the most effective location for the crossing. However, with this alignment, private property at each end of the deck prevents the free movement of wildlife and will require resumption. Limiting soil depth to 1m gives a modicum of control in that any large trees that might develop cannot reach maturity. But planting with shrubs and small trees should still allow wildlife to use the bridge as a crossing (as opposed to a habitat).

The proposed fauna bridge crosses over the Gold Coast Highway, light rail and active transport corridors in a 2-span arrangement with an overall length of approximately 48 m. A clear bridge width of 30m is proposed to facilitate the passage of wildlife. The bridge will have zero crossfall and a 4.5% longitudinal gradient. A vertical clearance of 6.0m is provided to both the highway and railway corridors. Vertical clearance to the active transport corridor is more than the 2.7m minimum requirement and the path could be raised to reduce the amount of rock excavation as a future design refinement.

Figure 40 and Figure show the proposed Burleigh Hill fauna bridge cross-section for the LRT and DBL Options, respectively. For further information, refer to the *Burleigh Hill Fauna Bridge Assessment - B2CTS-PE-438-MEM-00002* (see Appendix T).

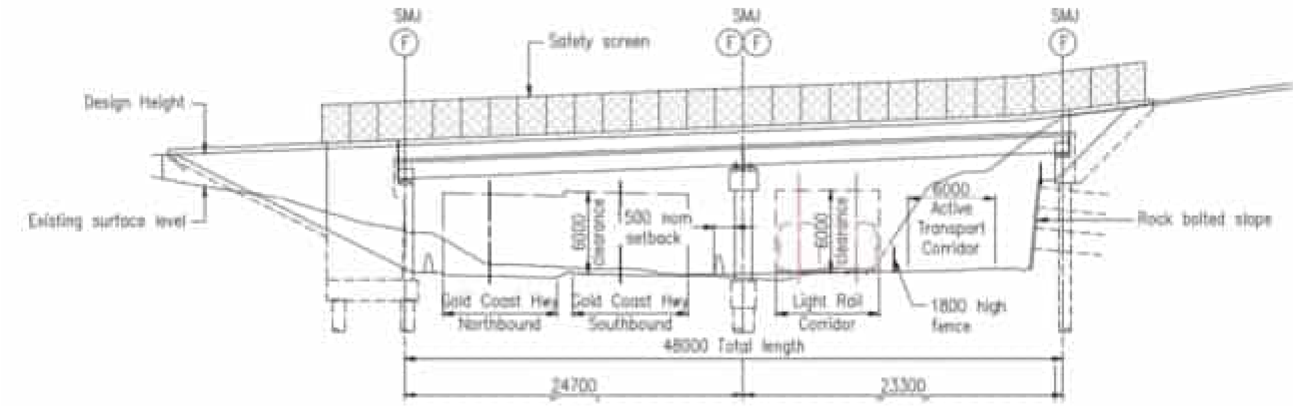


Figure 40 Fauna Crossing for LRT Option

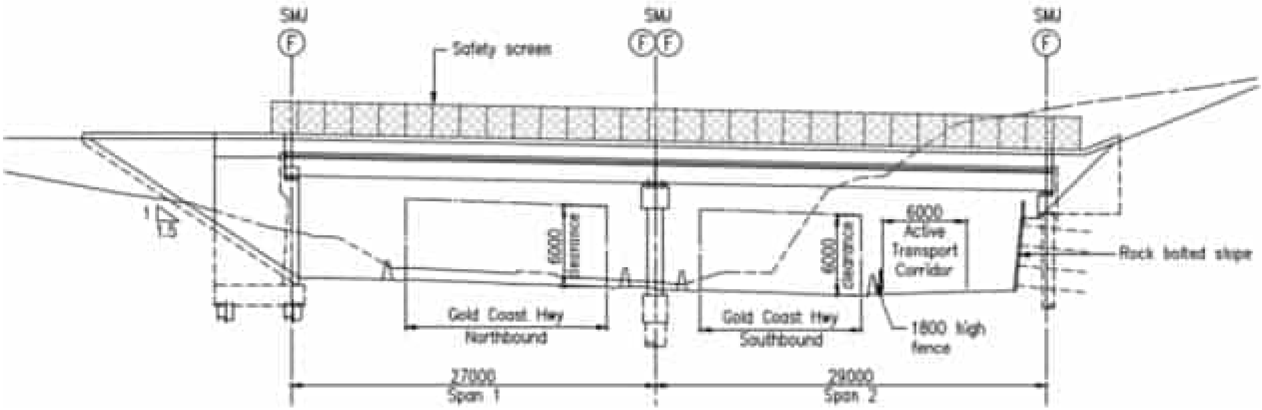


Figure 41 Fauna Crossing for DBL Option

8.4.2 Tallebudgera Creek Bridge

The existing road bridge crossing provides limited capacity to accommodate additional transport modes and previous studies have concluded that the bridge cannot be widened (refer to Section 3.3.3 for further information). As such, a new bridge across Tallebudgera Creek is proposed in the LRT Option with AT provision to improve amenity for all users. There are also significant cultural heritage interfaces at this site, including the Jellurgal Aboriginal Cultural Centre.

The new LRT and AT bridge is proposed to the east of the existing road bridge over Tallebudgera Creek. A 3m separation between the new and existing bridges has been adopted to reflect the constrained nature of this prime recreational area.

The footpath beneath the southern end span of the existing bridge is maintained and diverted beneath the new bridge end span. Whilst the southern path flood immunity is assumed not to meet design criteria, it still provides a level of amenity for recreational users. The existing footpath at the northern end of the crossing is not continued below the new bridge as outcropping rock to the east essentially cuts off potential access to the headland.

The Burleigh Head National Park LRT Station is located approximately 50m to the north and significantly constrains the bridge vertical alignment. The desirable rail alignment through National Park Station is set at the maximum of 1% longitudinal grade, to achieve acceptable road levels at the Ikkina Road intersection to the North, which constrains the achievable vertical height rise over the creek.

The bridge soffit level is set at 3.4m Australian Height Datum (AHD), to be no lower than the existing bridge soffit level and achieve a freeboard of 0.3m in a 1% Average Recurrence Interval (ARI) flood event. The new rail level is significantly higher than the existing road bridge deck due to the heavier rail loading, longer span and greater track depth requiring a greater structural depth, as compared to the road bridge. The longitudinal gradient of the bridge deck is indicated as flat to minimise the effect of the level rise on the bridge approaches. Accordingly, deck drainage provisions will be an area of design refinement during the BC phase.

The proposed bridge has 8 spans of 21.3m long to align piers with every alternate pier of the existing bridge, to help control afflux. The bridge has a straight horizontal alignment. The north abutment is aligned with the existing abutment and the new bridge is approximately 10.7m longer to the south to maintain the presently available beach width. Three resting bays of approximately 6m x 2.5m in area are provided on the eastern side of the AT deck.

The bridge is split into two independent bridge decks for rail and active users, to take advantage of the reduced active transport loading and allow a shallower beam depth on that deck, which in turn allows the active transport path to be lowered relative to the rail to better integrate with the surrounding precinct. The AT path deck is separated horizontally from the rail deck so that the electrical hazard zone (extending 3m from the nearest rail) does not encroach on the AT deck, as indicated in Figure 42 below. Both decks are supported on a common headstock and foundation, which is more efficient in resisting the applied hydraulic loading than separate piers.

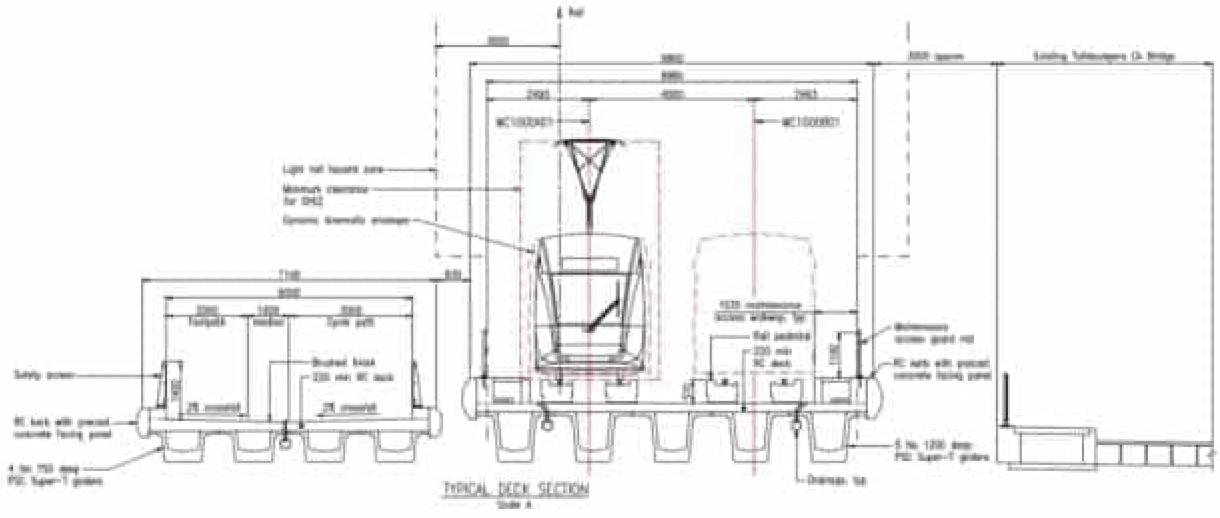


Figure 42 Tallebudgera Creek Bridge Deck Section

In coastal locations, the TMR Guideline *Storm Tide Issues for Design of Road Infrastructure in Coastal Areas* recommends consideration of the interdependency between riverine flooding and oceanic storm surges. No specific oceanic studies have been caried out for the project, but data is available from the Gold Coast City Council (GCCC) *Storm Tide Study* (GHD, February 2013).

It is noted that the TMR supplied hydraulic models contain tailwater assumptions for the creek outlets and include government predictions for a sea level rise of 0.8m in the 2100 climate planning year. The GCCC *Storm Tide Study* estimates of storm tide levels in the planning year 2100 for the appropriate SLS and ULS ARI at Tallebudgera Creek are:

- 100 year ARI storm tide level of 3.6m AHD – 200mm higher soffit level
- 2000 year ARI storm tide level of 3.8m AHD – 400mm higher soffit level.

Tallebudgera Creek is a relatively sheltered estuary so that wave set-up is not considered. Due to the lack of codified design methods and the unknowns in designing for wave loads, bridges are typically set above the ULS Q2000 wave crest height or storm tide level. However, the impacts of further bridge deck level rise on the rail alignment and the surrounding precinct are significant. Until project specific design data is available in future project stages, the bridge deck levels have been set based on the applicable riverine flood levels.

8.4.3 Currumbin Creek Bridge

The existing road bridge crossing provides limited capacity to accommodate additional transport modes and previous studies have concluded that the bridge cannot be widened. A new LRT bridge crossing is provided to the west of the existing road bridge. The LRT alignment over Currumbin Creek has been pushed further west since the last phase of the project, to provide a minimum 10m offset from the existing bridge to maintain sufficient geotechnical separation between new and existing foundations.

The active transport facilities extend across Currumbin Creek on an independent bridge structure to the east of the existing road bridge, which will be designed by others.

The bridge carries the LRT at high level over a local access road at the north bank, Currumbin Creek and Duringan Street at the south bank in a series of 6 simply supported spans.

The bridge soffit level is set to be no lower than the existing bridge soffit level. The bridge has a vertical alignment gradient of 4% to accommodate the significant rise over Currumbin Hill. The northbound on-slip road from Duringan Street is closed by the new LRT corridor but all turning movements are facilitated by the new road intersection design immediately to the south of the bridge.

Large retaining abutments are used to avoid batter slopes encroaching on the existing roads at each bank. The existing 1 in 1 slope at southern abutment requires a large piled wingwall to support the railway above the steep slope. On the north-west approach to the bridge, the abutment wingwall will transition to a new piled retaining wall to avoid the LRT batter slope encroaching on the local access road alongside Lions Park.

The proposed bridge has six spans of 29.6m in length to align piers with those of the existing bridge, to provide clear vessel navigation routes and to help control afflux. The new bridge is approximately 9m longer than the existing road bridge crossing. The simply supported end spans in the new bridge are maintained at a consistent 29.6m span length, which is slightly longer than the continuous end spans of the existing bridge, to better integrate with the existing batter slopes and road geometry. The new bridge has a straight horizontal alignment.

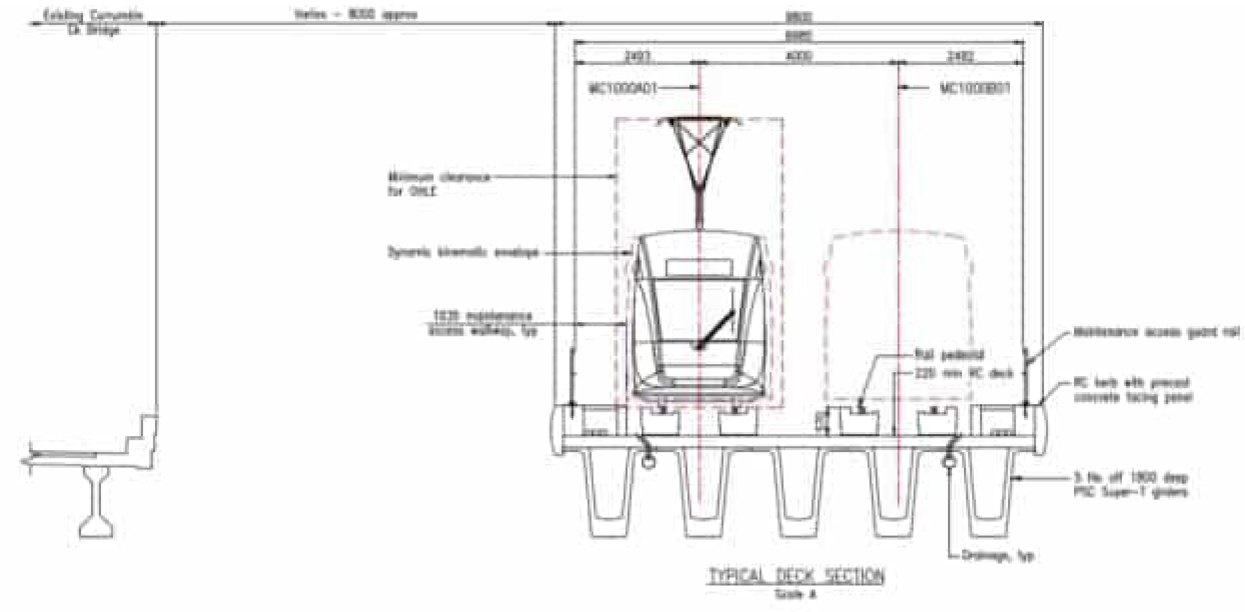
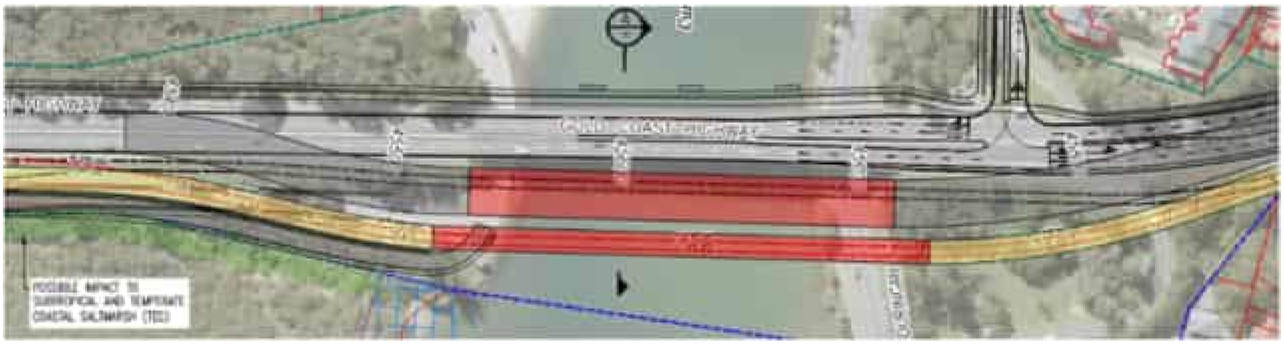


Figure 43 Currumbin Creek Bridge

A hydraulic study has been undertaken to determine project flood immunity and potential afflux, details of which are given within the hydraulic reporting. Deck level is not defined by the hydraulic design conditions. The bridge will provide 9m vertical navigation clearance from HAT, as per the existing bridge, so the deck is well clear of any riverine flooding or storm surge effects.

8.4.3.1 Currumbin Creek – Alternative bridge alignments

An alternate alignment for Currumbin Creek LRT bridge was reviewed to assess the impacts of an future offline road bridge replacement positioned to the west of the existing bridge.



Pushing the LRT alignment west, reduces the available space for required retaining walls and an under-bridge access road and causes encroachment on the Category C boundary at approximate CH45.40km and impact to nearby coastal saltmarsh

While impact to the wetlands will not require an approval, all reasonable efforts will be required to be made to ensure that development activities are carried out to avoid or minimise harm to the wetland. Appropriate impact assessments and mitigation must be considered during design and construction.

In addition to the above, the following regulated matters are also present:

- Coastal Management District
- Declared Fish Habitat Management Area (B)
- Tidal waterway for relevant to fish passage and waterway barrier works.

Further investigations will be required during subsequent stages of the project to determine impacts to sensitive areas and any approvals that may be required.

8.5 Hydraulic Analysis

The two major creeks – Currumbin Creek and Tallebudgera Creek and smaller creeks at Flat Rock Creek (Currumbin) and Coolangatta Creek located in the study area were previously discussed in Section 3.3.2.

Hydraulic modelling was undertaken to assess flooding from Currumbin Creek, Tallebudgera Creek and the Flat Rock Creek floodplain in the vicinity of Gold Coast Highway bridge crossings; and overland and creek flooding within the Coolangatta Creek catchment, predominantly in the vicinity of the Gold Coast Airport and Coolangatta Creek. An overland flow assessment was also undertaken for the Palm Beach area. Hydraulic analysis was undertaken to:

- Identify any significant existing creek, open channel or overland flow path crossings of the proposed transport corridor that will need to be considered in project design stages.
- Identify overland flood depths in vicinity of proposed light rail stations to inform siting and concept design of light rail stations.
- Identify potential existing stormwater network capacity constraints to inform the desktop assessment of road surface and subsurface drainage.
- Longitudinal drainage calculations were based off the 10% AEP with a 10% increase in rainfall intensity for climate change as per the technical specifications.

The hydraulic assessment was undertaken to establish a baseline flood level, depth and velocity information to inform alignment options, hydraulic structure design considerations, and to assess the hydraulic impacts of project. The hydraulic analysis included:

- Hydraulic modelling of Tallebudgera Creek, Currumbin Creek, Flat Rock Creek, and Coolangatta Creek 50%, 20%, 10%, 5%, 2%, 1% and 0.05% AEP design flood events and estimation of flood levels, depths and velocities for existing (baseline) and design floodplain conditions for each project option for a year 2100 future climate scenario.

- Hydraulic modelling of overland flow flooding within the Palm Beach and Coolangatta study areas for the 50%, 20%, 10%, 5%, 2%, 1% and 0.05% Annual Exceedance Probability (AEP) design flood events, and estimation of flood depths and flood hazard for existing (baseline) and design floodplain conditions for a year 2100 future climate scenario.

A creek and overland flooding hydraulic modelling assessment was undertaken for existing (baseline) floodplain conditions and each project option, which is summarised briefly below. For further details, refer to the *Hydraulics Analysis Report - B2CTS-PE-436-REP-00001* (see Appendix U).

8.5.1 Baseline Hydraulic Modelling Assessment

The baseline hydraulics assessment was undertaken using the existing hydraulic models listed previously in 4.2.2. The key findings for the Tallebudgera, Currumbin and Coolangatta Creeks and overland flow path assessment at Palm Beach is summarised below.

8.5.1.1 Tallebudgera Creek Flooding

The results of the Tallebudgera Creek baseline flood assessment indicate:

- The 50% AEP, 20% AEP, 10% AEP, 5% AEP, 2% AEP, 1% AEP peak floods (as simulated) do not reach the Gold Coast Highway Tallebudgera Creek Bridge soffit and do not overtop the existing bridge deck.
- The 0.05% AEP design flood event (as simulated in the TMR TUFLOW model) does reach the elevation of the bridge soffit but does not overtop the existing Tallebudgera Creek Bridge deck.
- The 2% AEP Tallebudgera Creek design flood event does not encroach on the existing Gold Coast Highway corridor and so the highway has 2% AEP flood immunity to Tallebudgera Creek flooding.
- The 1% AEP design event encroaches on the north bound shoulder of the Gold Coast Highway at the following locations:
- On the western side of Tallebudgera Creek in the vicinity of Beelyu Street (opposite side of highway to the Jellurgal Aboriginal Centre).
- On the eastern side of Tallebudgera Creek in the vicinity of the Tallebudgera Creek Tourist Park and the intersection of Tallebudgera Drive and the Gold Coast Highway.
- The 0.05% AEP design event overtops the Gold Coast Highway on the western side of Tallebudgera Creek in the vicinity of Beelyu Street and the Jellurgal Aboriginal Centre, and on the eastern side of Tallebudgera Creek in the vicinity of Tallebudgera Creek Tourist Park and the intersection of Tallebudgera Drive and the Gold Coast Highway.
- Tallebudgera Creek flood events have the potential to inundate large areas of the floodplain which contain urban land use. Consistent with the performance criteria nominated in the Technical Specification and design of Burleigh Heads to Coolangatta public transport options will need to minimise any afflux to within acceptable limits in these areas.

8.5.1.2 Currumbin Creek Flooding

The results of the Currumbin Creek baseline flood assessment indicate:

- The 50% AEP, 20% AEP, 10% AEP, 5% AEP, 2% AEP, 1% AEP and 0.05% AEP peak floods (as simulated) do not reach the elevation of the existing Gold Coast Highway Currumbin Creek Bridge soffit and do not overtop the bridge deck.
- Design flood events more frequent than the 0.05% AEP design event do not inundate the Gold Coast Highway within the Currumbin Creek floodplain. Therefore, the Gold Coast Highway is immune from 2% AEP and 1% AEP Currumbin Creek design flood events.
- Model results indicate that the 0.05% AEP design flood event (as simulated in the TMR TUFLOW hydraulic model) inundates the existing Gold Coast Highway in the vicinity of the highway intersection with Thrower Drive in Palm Beach.
- Currumbin Creek flood events ≥ 10% AEP are estimated to inundate large areas of the floodplain which contain urban land use. Consistent with the performance criteria nominated in the Technical

Specification, design of Burleigh Heads to Coolangatta public transport options will need to minimise any afflux to within acceptable limits in these areas.

8.5.1.3 Flat Rock Creek Flooding

A hydraulic assessment of flooding in Flat Rock Creek was undertaken for the 20% AEP, 10% AEP, 5% AEP, 2% AEP, 1% AEP and 0.05% AEP design flood events. The 270-minute storm duration was identified as the predominant critical storm duration at this location. Model results indicate that the Gold Coast Highway:

- Experiences a shallow depth (82mm) of overtopping in the 2% AEP design event at the sag point located to the south of the Flat Rock creek crossing.
- Is overtopped by a combination of creek and overland flow flooding in the 1% AEP design event to a depth of up to 228mm.
- Is overtopped by a combination of creek and overland flow flooding in the 0.05% AEP design event to depth of up to 342mm.

In order to achieve a 2% AEP flood immunity in this section of the transport corridor, this section may need raising with treatment of associated flood afflux.

It is highlighted that CoGC are currently undertaking a Flat Rock Creek Improvement Project with Water Technology currently developing a hydraulic model of Flat Rock Creek, and CoGC/TMR have plans to upgrade the existing waterway crossing of Flat Rock Creek at Teemangum Street. In future project stages, further consideration will need to be given to the TMR upgrade of the Teemangum Street crossing of Flat Rock Creek and to any other material changes to the Flat Rock Creek waterway.

8.5.1.4 Palm Beach Overland Flow Path Flooding

Overland flow path flood modelling for the Palm Beach area was completed using CoGC's existing Palm Beach SDS TUFLOW model for design flood events ranging from 50% AEP to 1% AEP. There were no significant overland flow paths identified within the proposed transport corridor. However, the low-lying sag point and flood storage function formed by the existing park reserve adjacent to the intersection of Thrower Drive and the Gold Coast Highway will need to be considered in the assessment of B2CPTS options.

8.5.1.5 Coolangatta Creek and Coolangatta Overland Flow Path Flooding

Overland flow path flood modelling was completed for the Coolangatta area using CoGC's existing Coolangatta SDS TUFLOW model for design flood events ranging from 50% AEP to 1% AEP. Several overland flow paths were identified for assessment of B2C PTS options. These flow paths included overtopping of the Gold Coast Highway in the vicinity of Flat Rock Creek, the heavily modified Coolangatta Creek in the vicinity of Coolangatta Road, overland flow paths passing through the Gold Coast Airport precinct, and significant depths of flooding in the vicinity of Chalk Street, Coolangatta.

8.5.2 LRT Option – Hydraulic Assessment

Hydraulic modelling and preliminary sizing of hydraulic infrastructure was undertaken to inform the LRT design including bridge crossings, cross drainage and stormwater network upgrades was undertaken to minimise impacts with consideration given to flooding from creeks and transverse overland flow paths.

The flood immunity, hydraulic impacts and bridge scour estimated for the LRT Option are summarised for key AEP design events at key locations in the following sections. Refer to Appendix U for more detailed information including flood maps and the desktop assessment of road and rail longitudinal drainage.

<u>Immunity to Creek Flooding</u>

- Tallebudgera Creek crossing:
  - The Option 1 alignment is not expected to be overtopped by 1% AEP Tallebudgera Creek flood events.
  - The Option 1 bridge soffit and deck are estimated to have 1% AEP flood immunity.
  - The Option 1 bridge deck will not be overtopped by the 0.05% AEP design flood event in either the TMR hydraulic model or the CoGC Draft hydraulic model.

  - The Option 1 bridge soffit is not overtopped in the 0.05% AEP design event in the CoGC Draft hydraulic model however, the bridge soffit is reached in the TMR hydraulic model resulting in relatively greater levels of afflux and pressure flow scour.
- Currumbin Creek crossing:
  - The Option 1 alignment is estimated to not overtop in 1% AEP Currumbin Creek flood events.
  - The Option 1 bridge soffit and deck have 1% AEP and 0.05% AEP flood immunity.
- Flat Rock Creek crossing:
  - At the crossing of Flat Rock Creek itself, the proposed road and rail alignment is not overtopped by creek flooding in the 1% AEP or 0.05% AEP design events.
  - Immediately to the south of the Farrell Drive intersection with Gold Coast Highway, a combination of Flat Rock Creek flood breakout and overland flow is estimated to overtop the Option 1 design by up to 0.187m in the 2% AEP design event, and by up to 0.296m in the 1% AEP design event. This section of the Option 1 alignment and associated cross drainage will need to be refined in future stages of design to achieve 2% AEP flood immunity.
- Coolangatta Creek crossing:
  - The 2% AEP design flood event in Coolangatta Creek is estimated to overtop the LRT alignment by up to 0.214m at Chainage 52400m (in vicinity of Ocean Street), by up to 0.160m at Chainage 52500m (in the vicinity of Lord Street), by up to 0.281m in the vicinity of Chainage 52600 (between Coolangatta Road cul-de-sac and Miles Street), and by up to 0.280m in the vicinity of Chainage 52700 (at Miles Street). This section of the Option 1 alignment will need to be refined in future stages of design to achieve 2% AEP flood immunity.

<u>Immunity to Transverse Overland Flows Path Flooding</u>

There are several locations where transverse overland flow paths overtop the proposed rail alignment by more than 30mm in the 2% AEP design flood event. Key locations include:

- Coolangatta area:
  - Chainage 47900m, Gold Coast Highway at Dune Street
  - Chainage 51100m, at Tom Norris Drive
  - Chainage 51500m, at Gold Coast Highway onramp
  - Chainage 51800m, Coolangatta Road at Charlotte Street
  - Chainage 52600m, at Miles Street
  - Chainage 53000m, at Lanham Street
  - Chainage 53400m, at Chalk Street.
- Palm Beach area:
  - Chainage 40900m, Gold Coast Highway at Ikkina Road
  - Chainage 41800m, Gold Coast Highway at Twenty-Eighth Avenue
  - Chainage 45000m, Gold Coast Highway at Thrower Drive.

It is highlighted that the Coolangatta and Palm Beach SDS direct rainfall hydraulic models used to assess transverse overland flow path overtopping depths did not include proposed longitudinal road and rail drainage infrastructure Over 50mm of afflux in buildings adjacent to intersection of Creek Street and Coolangatta Road and this infrastructure is likely to reduce overtopping depths. It is recommended these locations be investigated in more detail in future design stages through incorporation of longitudinal drainage into the SDS hydraulic model.

Hydraulic Impact Assessment at Creek Crossings

The LRT Option generally meets the required afflux performance criteria for creek flood events, with the following exceptions noted at the following locations for the 1% AEP design event:

- Tallebudgera Creek:
  - In the 1% AEP design event, 12mm of afflux in vicinity of Ikkina Road and surrounding Streets. This is only marginally above the 10mm afflux criteria for private properties.
- Currumbin Creek:
  - No exceedances of afflux criteria.
- Flat Rock Creek:
  - For the 1% AEP design flood event, afflux of 56mm is estimated to occur immediately adjacent to chainage 46400 at the two storey Honeyworld Gold Coast building, with 28mm of afflux estimated to occur on Tomewin Street and the edge of Currumbin Wildlife Sanctuary.
- Coolangatta Creek:
  - 2 Creek Street: Afflux > 100mm on public land.
  - Coolangatta Road at Miles Street: >100mm afflux on street.
  - Gold Coast Airport parallel to Gold Coast Highway on road verge: >100mm afflux.
  - C&K Coolangatta Community Kindergarten >10mm afflux on private property.
  - Appel Street at Carpark >10mm afflux on private property.
  - Coolangatta State School >10mm afflux at building.

It is recommended that the hydraulic impacts identified at the above locations be investigated in further detail during the BC phase.

Hydraulic Impact Assessment of Transverse Overland Flow Path Flooding

Hydraulic modelling of overland flow paths was undertaken for a range of AEP design events. There are a number of locations where overland flow hydraulic impacts have the potential to exceed hydraulic performance criteria. However, it is highlighted that these impacts may be reduced when the proposed longitudinal drainage design is included in the Coolangatta and Palm Beach SDS TUFLOW models in future project stages.

The main locations of exceedance include:

- Coolangatta area:
  - Chainage 47200m (Puma Petrol Station at Gold Coast Highway / Stewart Road): >10mm afflux in vicinity of commercial building.
  - Chainage 51500m (Gold Coast Highway near airport on road verge): Afflux > 100mm
  - Chainage 53200m (Chalk Street): Afflux >10mm at commercial premises.
  - Chainage 48300m (Tugun Park): Afflux >10mm on private property.
  - Chainage 51600m (Lang Street): Afflux >10mm on private property.
- Palm Beach area:
  - Chainage 40900m (Gold Coast Highway at Dierral Avenue): Afflux >10mm on private property.
  - Chainage 41800m (Gold Coast Highway at Twenty First Avenue): Afflux >10mm on private property.
  - Chainage 44500m (Jefferson Lane): Afflux >10mm on private property.

It is recommended that the hydraulic impacts identified at the above locations be investigated in further detail during the BC phase.

Bridge Scour

Bridge Scour was estimated for the proposed Gold Coast Highway bridge crossings of Tallebudgera Creek and Currumbin Creek.

- For the proposed Tallebudgera Creek Bridge:
  - Estimated scour depths at the northern abutment for the 1% AEP flood event range from 3.70m to 3.91m, with 0.05% AEP scour depths ranging from 5.47m to 8.58m.
  - Estimated scour depths at the southern abutment for the 1% AEP flood event range from 2.11m to 2.93m, with 0.05% AEP scour depths ranging from 4.10 to 6.90m.
  - Pier scour depths for 1% AEP flood event range from 3.03m to 3.34m, with 0.05% AEP pier scour depths ranging from 4.14m to 8.18m.
- For the proposed Currumbin Creek Bridge:
  - Estimated scour depths at the northern abutment for the 1% AEP flood event range from 1.14m to 1.35m, with 0.05% AEP scour depths ranging from 1.72m to 3.12m.
  - No scour is expected at the southern abutment as it is not expected to be inundated in the 1% AEP and 0.05% AEP design events.
  - Pier scour depths for 1% AEP flood event range from 2.09m to 2.95m, with 0.05% AEP pier scour depths ranging from 2.47m to 4.97m.

8.5.2.1 Sensitivity analysis at Flat Rock Creek and Coolangatta

Following completion of this study, a hydraulic modelling sensitivity analysis was undertaken in the vicinity of the Flat Rock Creek and Coolangatta Creek crossings for the LRT Option to provide further understanding of the alignment immunity, flood impacts, and to identify potential mitigation options to be investigated in future project stages. Key recommendations are as follows:

- **At Flat Rock Creek:** Inundation of the proposed alignment is caused by a combination of local rainfall and creek breakout that results in less than a desired 2% AEP flood immunity. This flooding predominately occurs in a sag point south of the Flat Rock Creek crossing. Additional hydraulic analysis found that provision of additional cross drainage at the creek crossing (and upgrade of Teemangum Street Bridge) provides limited benefit to flood inundation depths at the sag point. It is recommended that hydraulic analysis of additional local drainage infrastructure (including long drainage parallel to the alignment) be undertaken in future project stages to improve the flood immunity of this section of the alignment.
- **At Coolangatta Creek (Miles Street vicinity):** There is significant inundation on the proposed alignment due to a combination of Coolangatta Creek breaking its banks and backwater influence of ocean levels in this area. This results in less than the desired 2% AEP flood immunity. It is recommended that hydraulic analysis of alternate works such as horizontal and vertical realignment of the light rail, buy-back of properties, provision of additional floodplain conveyance capacity and storage, and provision of alternate cross drainage infrastructure be assessed to improve the flood immunity and associated off-site impacts for this section of alignment.
- **Coolangatta (Chalk Street Area):** This is a well-known flooding and drainage hotspot. It is understood that Council are separately investigating drainage upgrades in this vicinity. It is recommended that in future project stages, the drainage infrastructure upgrades proposed by Council in this area be included in the baseline hydraulic model, and consideration be given to the practical level of flood immunity that can be achieved in this area.

8.5.3 DBL Option – Hydraulic Assessment

The DBL Option does not include new road bridges at the Tallebudgera Creek and Currumbin Creek crossings as buses are required to merge into the general traffic lanes at these locations. Hydraulic modelling and preliminary sizing of hydraulic infrastructure including bridge crossings, cross drainage and stormwater network upgrades was undertaken for the DBL Option to minimise impacts with consideration given to flooding from creeks and transverse overland flow paths.

The flood immunity, hydraulic impacts and bridge scour estimated for the DBL Option are summarised below for key AEP design events at key locations. Refer to Appendix U for more detailed information including flood maps and the desktop assessment of road and rail longitudinal drainage for the DBL Option.

Immunity to Creek Flooding

Tallebudgera and Currumbin Creeks Flooding: Option 2 will have the same level of flood immunity to Tallebudgera Creek and Currumbin Creek flood events as Option 1 (i.e., road alignment and bridges immune from 1% AEP creek flooding).

- Flat Rock Creek:
  - At the crossing of Flat Rock Creek itself, the proposed road and rail alignment is not overtopped by creek flooding in the 1% AEP or 0.05% AEP design events.
  - Immediately to the south of the Farrell Drive intersection with Gold Coast Highway, a combination of Flat Rock Creek flood breakout and overland flow is estimated to overtop the Option 2 design by up to 0.368m in the 2% AEP design event, and by up to 0.407m in the 1% AEP design event. This section of the Option 2 alignment will need to be refined in future stages of design to achieve 2% AEP flood immunity.
- Coolangatta Creek:
  - The 2% AEP design flood event in Coolangatta Creek is estimated to overtop the Option 2 alignment by up to 0.690m and 0.733m in the 2% AEP and 1% AEP events, respectively, in the vicinity of Chainage 52600 (between Coolangatta Road cul-de-sac and Miles Street), and by up to 0.584m and 0.620m, respectively, in the vicinity of Chainage 52700 (at Miles Street). This section of the Option 2 alignment will need to be refined in future stages of design to achieve 2% AEP flood immunity.

Immunity to Transverse Overland Flows Path Flooding

There are several locations where transverse overland flow paths overtop the proposed alignment by more than 30mm in the 10% AEP design flood event. These locations include:

- Coolangatta area:
  - Chainage 47900m, Gold Coast Highway at Dune Street.
  - Chainage 51500m, at Gold Coast Highway onramp.
  - Chainage 51800m, Coolangatta Road at Charlotte Street.
  - Chainage 52600m, at Miles Street.
  - Chainage 53000m, at Lanham Street.
  - Chainage 53485m in vicinity of Chalk Street and surrounds.
- Palm Beach area:
  - Chainage 40900m, Gold Coast Highway at Ikkina Road.
  - Chainage 41800m, Gold Coast Highway at Twenty-Eighth Avenue.
  - Chainage 45000m, Gold Coast Highway at Thrower Drive.

It is highlighted that the Coolangatta and Palm Beach SDS direct rainfall hydraulic models used to assess transverse overland flow path overtopping depths did not include proposed longitudinal road and rail drainage infrastructure Over 50mm of afflux in buildings adjacent to intersection of Creek Street and Coolangatta Road, and this infrastructure is likely to reduce overtopping depths. It is recommended these locations be investigated in more detail in future design stages

Hydraulic Impact Assessment at Creek Crossings:

Option 2 meets the required afflux performance criteria for Tallebudgera and Currumbin creek flood events, with the following exceptions noted at Flat Rock Creek and Coolangatta Creek crossings in the:

- Flat Rock Creek:

  2% AEP: 36mm of afflux is estimated to occur immediately adjacent to the two storey Honeyworld Gold Coast building.

  1% AEP: Afflux < 10mm in buildings and <100mm in public land.

  0.05% AEP: Afflux up to 200mm in public land however, afflux up to 50 to 70mm in area from Blamey Drive to Farrell Drive. This is likely due to the increase in vertical profile from Option 1 from chainages 46600m to 47000m. The vertical profile may need to be revised in future project stages to reduce 0.05% AEP impacts with further refinement of the proposed Flat Rock Creek culverts.

- Coolangatta Creek:
  - 2% AEP: Over 40mm of afflux in buildings adjacent to intersection of Creek Street and Coolangatta Road.
  - 1% AEP: Over 40mm of afflux in buildings adjacent to intersection of Creek Street and Coolangatta Road.
  - 0.05% AEP: Over 50mm of afflux in buildings adjacent to intersection of Creek Street and Coolangatta Road.

  Optimisation of the road design and associated cross drainage is required in the next stage of design at this location.

<u>Hydraulic Impact Assessment of Transverse Overland Flow Path Flooding</u>

Hydraulic modelling of overland flow paths was undertaken for a range of AEP design events.

There are a number of locations where overland flow hydraulic impacts have the potential to exceed hydraulic performance criteria. However, it is highlighted that these impacts may be reduced when the proposed longitudinal drainage design is included in the Coolangatta and Palm Beach SDS TUFLOW models in future project stages.

- Coolangatta area:
  - Chainage 47200m (Puma Petrol Station at Gold Coast Highway / Stewart Road): >10mm afflux in vicinity of commercial building.
  - Chainage 50400m (Gold Coast Highway at Graham Street): Afflux >10mm on private property.
  - Chainage 51700m (Gold Coast Highway at Lang Street): Afflux >10mm on private property.
- Palm Beach area:
  - Chainage 40900m (Gold Coast Highway at Djerral Avenue): Afflux >10mm on private property.
  - Chainage 41800m (Gold Coast Highway at Twenty First Avenue): Afflux >10mm on private property.
  - Chainage 44500m (Jefferson Lane): Afflux >10mm on private property.

It is recommended these locations be investigated in more detail in future design stages through incorporation of longitudinal drainage into the SDS hydraulic model.

<u>Bridge Scour</u>

At this stage of concept design, the bridge scour depths estimated for Option 1 Tallebudgera Creek and Currumbin Creek bridge crossings are considered to be an upper limit for the scour depths likely to be experienced at Option 2 bridge crossings. For the purposes of concept design, Option 1 bridge scour depths have been assumed for Option 2.

8.5.4 EBP Option – Hydraulic Assessment

There are no new bridge structures proposed at any of the creeks in the EBP Option. Given that the EBP Option proposes minimal change to the existing road horizontal and vertical alignment, this option will have the same level of flood immunity as the existing Gold Coast Highway and Coolangatta Road corridors under existing and future climate conditions.

Similarly, The EBP Option is expected to have an insignificant impact on existing creek flooding and transverse overland flow path hydraulics (compared to the existing and future baseline conditions), with anticipated creek and transverse overland flow path impacts meeting required hydraulic performance criteria.

There is no additional bridge scour resulting from the EBP Option, given there are no new bridges proposed. However, future climate change may result in increased scour potential at the existing Gold Coast Highway bridge crossings of Tallebudgera Creek and Currumbin Creek.

8.6 Urban Design And Landscape

An Integrated Landscape Assessment Report outlining the overall intent and strategy for each project option in terms of landscape and urban design considerations was developed in accordance with the *TMR – Road Landscape Manual* requirements and based on the Landscape Assessment Process. The process involves a consolidated approach to review and assess the existing condition, road type/hierarchy, complexity of proposed works and the wider corridor.

The outcome provides an overall landscape design strategy for the Project options, primarily focusing on the LRT option given the major opportunity and importance of incorporating integrated urban design outcomes with the LRT Option, when compared to the DBL and EBP options.

For further details, refer to the *Integrated Landscape Assessment Report - B2CTS-PE-434-REP-00002* (see Appendix V).

8.6.1 Landscape Vision and Objectives

The landscape assessment identifies potential mitigation measures to reduce the impacts of the Project on the landscape and visual values of the site. Examining the Project within its context as part of a broader transport corridor, enables development of a clear vision for the project.

Vision: *The Gold Coast will become a connected and liveable city through the delivery of the final link of this world-class transport system, integrating multi-modal public transport opportunities within a sub-tropical coastal setting.*

The following overall landscape objectives further describe the landscape design intentions for the Project:

- Integrate the transport upgrade into the surrounding landscape.
- Create a well vegetated corridor.
- Use primarily native species of local provenance for ecological integration.
- Minimise the removal of existing vegetation. Where existing vegetation is removed both visually and ecologically, mitigation measures should be put in place to replace lost vegetation.
- Soften noise walls and retaining walls (where possible) using appropriate planting techniques.
- Provide vegetation to act as a screen/buffer to areas where there are potentially sensitive receptors or views.
- Use riparian vegetation associated with Currumbin and Tallebudgera Creeks to form the main vegetative treatment along the alignment. This will act as a buffer zone and will protect existing riparian corridors from wind distributed pollutants and trap and filter sediment from surface run-off.
- Complement water quality treatment strategies and measures.
- Use planting that is generally functional, low-maintenance and has low water requirements once established.

- Provide successful cover to cut and fill batters to integrate project with the surrounding landscape of the Gold Coast Highway.
- Recycle removed vegetation and use as site mulch.
- Include detailed mitigation measures in future Construction Management Plans and standard TMR specifications.

8.6.1.1 Key Station Objectives

The vision seeks to integrate the Project and ensure liveability and connectivity. Specific objectives identified for the LRT Stations have been outlined in the People and Place Strategy and are summarised below:

- Station locations have a positive influence on the creation of a place that is bigger than the footprint of the station infrastructure
- They are destinations connected to the surrounding context – woven into the fabric of the environment
- Station environments have a positive impact on the character of the places – specifically to reduce the dominance of cars and the Gold Coast Highway
- Station placement should consider ways to support the development of better places – not avoid or ignore challenges and the local setting
- Stations are defined as enhanced walking environments that stand out as being different from other areas of the corridor due to walking routes, shade, a balanced approach to space and the character and activation of the setting (cars do not catch the light rail – people do)
- Investment in station environments is recognised as an obligation to create a public transport hub within a destination – and to integrate the infrastructure into the setting.

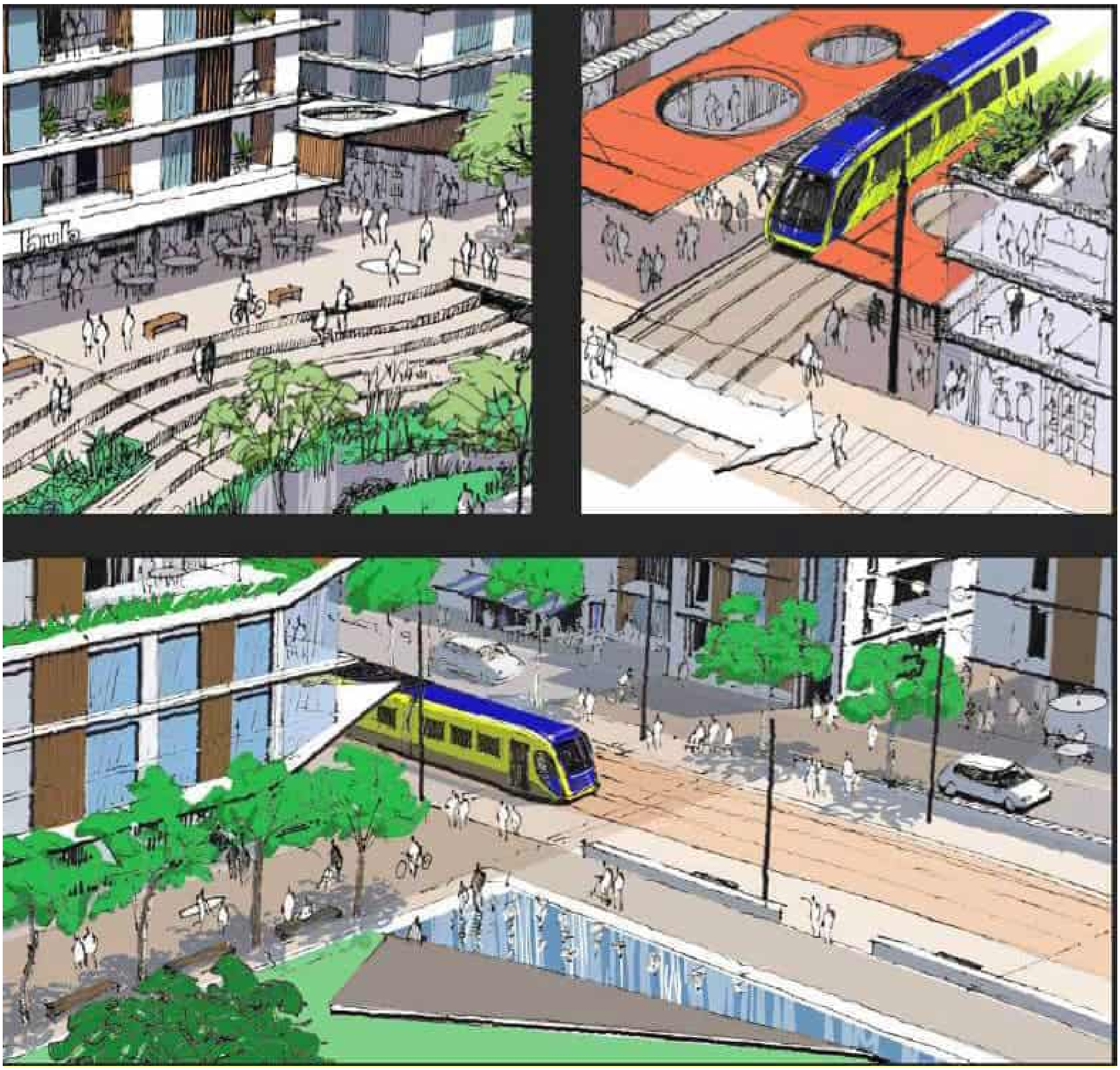


Figure 44 Extract from People & Place Strategy of sketches illustrating possible station precincts

The *Integrated Landscape Assessment Report - B2CTS-PE-434-REP-00002* (see Appendix V) outlines the overall intent and strategy relating to the Project works in terms of landscape, revegetation and urban design considerations.

8.7 Road Safety

The following assessments were undertaken to ensure the safety of the concept designs for each project options for all road users:

- Road Safety Audit
- Safe Systems Assessment
- Roadside Hazard Assessment.

All assessments were undertaken on the 50% concept designs to provide high-level guidance on the design development and enable key findings/outcomes from these assessments to be incorporated in final PE designs or highlighted for further investigation in subsequent phases of the project (where required).

8.7.1 Road Safety Audit

A Stage 1 (Feasibility) Road Safety Audit (RSA) was completed by a team of four accredited TMR Road Safety Auditors from AECOM that were independent to the design team. The audit was undertaken on the 50% concept design drawings in October 2022. The *Road Safety Audit Report - B2CTS-PE-446-REP-00001A* is included in Appendix W which provides further information on the assessment, key findings and includes the designer's response to all findings in the report.

8.7.2 Safe Systems Assessment

A Safe System Assessment (SSA) was conducted of the existing road conditions and B2C project options following the general principles detailed in the Austroads (2016) *Safe System Assessment Framework* (Research Report *AP-R509-16*) and in accordance with the requirements contained in the TMR's *Road Safety Policy* (2022) and Safe System Assessment Guidelines.

The SSA was undertaken by a team from AECOM were independent to the design team. The audit was undertaken on the 50% concept design drawings in October 2022. The *Safe Systems Assessment Report - B2CTS-PE-446-REP-00002* is included in Appendix X and provides further information on the assessment, key findings and recommendations for future phases of the project.

8.7.3 Roadside Hazard Assessment

A Roadside Risk Hazard Evaluation was conducted for the LRT and DBL project options based on the 50% Concept Design drawings to assess the level of risk for roadside and median hazards. The assessment was undertaken in accordance with AGRD *Part 6: Roadside Design, Safety and Barriers* to determine the project risk scores for each road segment (and their Intervention Threshold (NRRIT) of 0.6.

Some of the key findings of the Roadside Hazard Assessment were:

- Road sections that have significant horizontal curves and/or vertical gradients (such as Burleigh and Currumbin Hill) were generally found to amplify the likelihood of an errant vehicle colliding with a roadside hazard and, therefore, return high (non-complying) risk scores.
- For both the LRT and DBL options, the Palm Beach segment (Road Segment 2) returned exceptionally higher risk scores due to the close proximity of the existing power poles (being retained) to the edge of traffic lanes. Possible treatments recommended, involved reducing the posted speed limit of the segment to 50 km/h and moving power lines underground.
- For the DBL option, the existing tree line either side of the Tugun to Bilinga segment (Road Segment 4) acts as a significant background hazard which can be associated to its non-complying risk scores. Potential risk mitigation options evaluated involved adopting guardrail barriers between the bus lanes and the roadside tree line for the southbound carriageway and removing the tree line adjacent to the northbound carriageway.

Further information on the assessment is provided in the *Roadside Hazard Assessment Report - B2CTS-PE-446-REP-00003* in Appendix Y. Note that this evaluation was undertaken to provide high-level guidance on the concept design and to assist TMR in making key decisions regarding design/posted speed for the Business Case. Risks associated with roadside hazards for both LRT and DBL project options should be investigated further in later design stages and including evaluation of suitable treatment options.

8.8 Safety in Design

The development of the PE Concept Design followed the safe design procedures reviewing safety issues associated with project lifecycle of demolition, construction, operation and maintenance stages.

Sustainability, health, safety and wellbeing are increasingly important considerations in delivery of design projects with emphasis on reducing harm to both people and the environment. The best opportunity to eliminate or minimise the risk of harm is early in the project planning and design stages. The earlier the risk is identified and mitigation incorporated, the better integrated the outcome and the lower the cost.

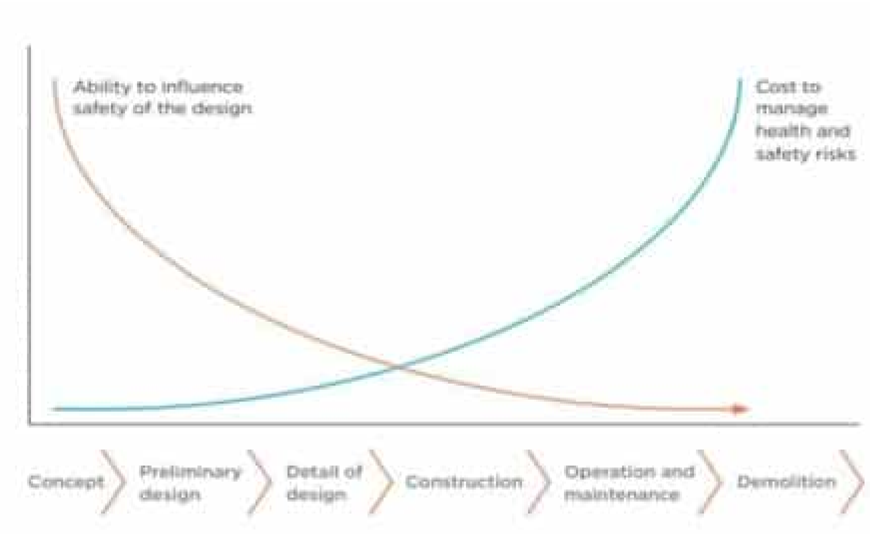


Figure 45 Ability to Influence safety of the design vs cost to manage health and safety risks

Legislation in both Australia and New Zealand requires the mitigation of risks to health, safety and wellbeing "so far as reasonably practicable" to prevent harm through all phases of an asset lifecycle (planning, construction, operation and maintenance and decommissioning). This means the project has a duty to participate in, or provide information for, design activities focussed on risk minimisation.

"As engineering practitioners, we use our knowledge and skills for the benefit of the community to create engineering solutions for a sustainable future." Engineers Australia Code of Ethics.

Eliminating hazards at the design or planning stage is often easier and cheaper to achieve than making changes later when the hazards become real risks in the workplace.

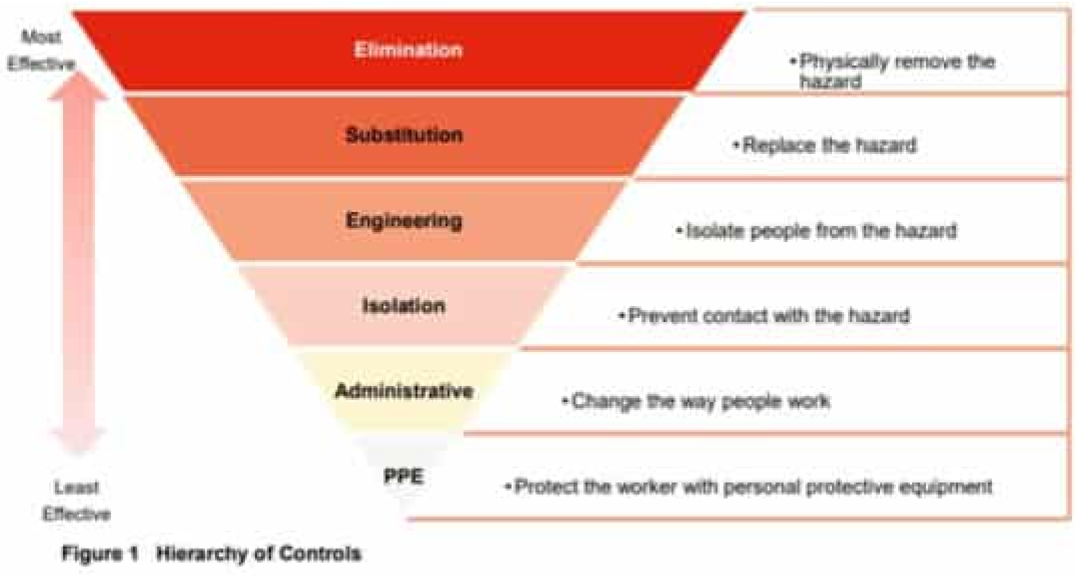


Figure 46 Hierarchy of controls considered during design development

To decide if something is reasonably practicable the concept design considered the following:

- the likelihood of the hazard or the risk occurring
- the degree of harm that might result from the hazard or the risk
- knowledge about the hazard or risk, and ways of eliminating or minimising the risk
- the availability and suitability of ways to eliminate or minimise the risk, and

- after assessing the extent of the risk and the available ways of eliminating or minimising the risk, the cost associated with eliminating or minimising the risk, including whether the cost is grossly disproportionate to the risk.

The lower levels in the hierarchy are less effective because controls that change the hazard or minimise exposure to the hazard can only minimise the risk. You cannot eliminate the risk without eliminating the hazard.

The following areas of safety were considered during the development of the Concept Design:

- Pedestrian Safety
- Passenger movements at interchange locations
- Cyclist Safety and dedicated active transport routes
- Cyclist movements across rail lines
- Vehicle types and clearances
- Intersection safety for road users
- Road user legibility of LRT corridor
- Road user sight distance compliance and Extended Domain Design
- LRT or Bus sight distance compliance
- Steep gradients for LRT vehicles and pedestrian movements
- Fall from heights such as retaining wall and bridges
- LRT corridor trespass
- Corridor fencing considering pedestrian crossing movements and fauna movements
- Pedestrian and cyclist movement at Stations
- Roadside structures and obstructions such as OHLE masts
- Electrified equipment and appropriate Earthing and Bonding of energised materials
- Stray current leakage near pedestrian movements
- Vehicle strike of high voltage overhead power links
- Maintenance access to structures including bridges and retaining walls
- Maintenance access to utilities and drainage lines
- LRT operational movements.

Construction hazards and risks could also include:

- Construction vehicle strikes of public and workers
- Falling of objects from construction vehicles to live traffic
- Proximity of works to live traffic and hit by a vehicle
- Falling from heights during installation of OHLE
- The construction interface with vehicular traffic,
- Eliminating or minimising work at height,
- Built-up corridor - proximity of new foundations to existing PUPs,
- Phasing construction works and traffic management,
- Large and heavy crane lifts in a constrained environment,

- Construction works adjacent to existing structures and underground services,
- Construction works adjacent to high volumes of live traffic,
- Constrained working space and for construction access; and
- Proximity of the construction works to pedestrians, traffic, local residents and businesses.
- Removal of contaminated materials including PFAS and Asbestos.

The PE Phase did not include development of a detailed hazard register, however, as risks were identified by the design team they were considered, mitigated and documented in the design development reporting. During the BC phase, it is recommended that a detailed hazard register be formally prepared documenting all hazards and risks for transfer to detailed design and construction.

9.0 TMR Policy Compliance

Table 54 summarises how the concept designs for each project option have been developed to ensure compliance with the following TMR policies:

- Active Transport Policies – to ensure implementation of active transport in the designs
- Road Safety Policy – to ensure safe system concepts and methodologies in the designs
- Accessibility Compliance – to provide for an inclusive and accessible transport network for everyone
- Network Optimisation Framework Solutions – to ensure value-for-money solutions have been considered throughout the PE phase options analysis.

Table 54 TMR Policy Compliance

Project Option	LRT Option	DBL Option	EBP Option	Comment
Active Transport Policies				
How has the policies been considered and evaluated for the project option (strategic fit)?	✓	✓	✓	An Active Transport Strategy report was prepared as part of the Basis of Design. This strategy referenced the policies and provides specific recommendations which have been incorporated into the designs for the LRT and DBL options for the entire corridor and for the EBP in the locations of the potential works. Refer to Appendix B for more details.
What types of facilities are provided and why is this infrastructure solution appropriate (shared vs separated paths, locality, intended uses)	✓	✓	✓	For the larger infrastructure options (i.e. LRT and DBL) the facilities include a mix of both shared and separated paths, and generally provide an option for each Level of Traffic Stress (LTS) user type. The specific facility types have been included as recommended in Active Transport Strategy. Refer to Appendix B for more details.
How does the project option conform to the PCNP	✓	✓	✓	As outlined in the Active Transport Strategy, facilities have been provided on the routes as identified in the PCNP (i.e. Gold Coast Highway) or adjacent to the corridor (Oceanway, Coolangatta Road). Refer to Appendix B for more details.
Are there sufficient connections to existing paths and cycle networks	✓	✓	✓	Cross corridor and connections to the existing pathway and cycle networks have been included in the designs.

				Refer to Appendix B for more details.
Are there any impacts to existing paths and cycle networks	✓	✓	✓	In general all project options improve the active transport network. Refer to Appendix B for more details.
Road Safety Policy				
Demonstrate compliance with the TMR Safety Policy and documenting any exceptions	✓	✓	✓	Refer to Appendix AA for details
Prepare Safe System Project Management Control Checklist	✓	✓	✓	Refer to Appendix AA for details
Prepare SSA to compare the safe system alignment of the options to demonstrate how the project option provides a safe system outcome	✓	✓	✓	Refer to Section 8.7.2 and Appendix X for the SSA report (*B2CTS-PE-446-REP-00002)*
Accessibility Compliance (providing for an inclusive and accessible transport network for everyone)				
Ensure the framework has been established by showing the purpose	✓	✓	✓	The DDA legislative requirements for accessibility have been applied in the concept designs including design requirements for pathways, and accessibility at LRT stations and bus stops. More detailed assessments will be required in subsequent phases to ensure compliance with the DDA and DSAPT requirements.
How will the design achieve compliance to design standards for the future project stages	✓	✓	✓	
Network Optimisation Framework Solutions				
Ensure the value-for-money and fit-for-purpose has been investigated and achieved	✓	✓	✓	Network Optimisation Framework (NOF) solutions have been considered by TMR and AECOM throughout the options analysis (e.g. public transport priority at signalised intersections (all options), bus priority lanes, enhancements to existing bus services & infrastructure in the EBP Option) to provide value-for-money

10.0 Risk Analysis

A detailed project risk assessment, including two risk workshops were undertaken during the design development phase to inform the project P50 and P90 cost estimates for each option.

The object of risk management is to keep the project's exposure to risk at an acceptable level. Risks will arise from the project's components and their interactions with each other, from technical complexity, schedule and/or cost constraints, and the broader environment in which the project is managed.

The project manages risk following the TMR Risk Management Framework and guidance is provided through TMR's Risk Management Practice Guides that are aligned with International Standard AS/NZS ISO 31000:2018, Risk Management – Guidelines.

TMR's Risk Context Profiling (RCP) tool was used following the TMR Engineering Policy 153 Risk Context Profiles, to identify the main areas of high risk that required further investigations during the subsequent design phase and management into the delivery phase. Risks were rated using the matrix detailed in TMR's guidelines, as shown in Table 55 based on the likelihood of each risk occurring and consequence of each risk.

Table 55 Risk rating matrix

	Rare	Unlikely	Possible	Likely	Almost Certain
Severe	Medium	High	High	Extreme	Extreme
Major	Medium	Medium	High	High	Extreme
Moderate	Low	Medium	Medium	High	High
Minor	Low	Low	Medium	Medium	Medium
Insignificant	Low	Low	Low	Medium	Medium

An RCP was prepared by AECOM to assess the overall risk profile of the Project. The RCP provides an overview of the 10 main areas of high risk for the project that require further investigations as the project progresses. The RCP informed the development of the project risk register and was used as the initial basis for discussion during the Risk Workshop convened on 16 June 2022 with representatives from CoGC, TMR and AECOM. A second risk workshop was held on 14 December 2022 to review and update the risk register (including RCP) based on outcomes from the PE technical investigations and design development.

The key risks identified as part of the overall project risks are summarised below:

- Adverse geotechnical conditions including excavations/embankments, foundation conditions for reinforced soil structures walls, major culverts and structures resulting in consolidation and stability issues requiring additional treatments or protection
- Discovery of contaminated material (e.g. landfill, PFAS, on-site and contaminated groundwater)
- Stakeholder interface, including meeting stakeholder expectations, maintaining access during construction, and the impact of vulnerable road users, associated with works in a heavily congested urban environment.

The RCP summary is provided in Figure 47 which identifies 'High' risk categories for 'Environmental, weather, cultural heritage and native title' and 'Stakeholders'. For further detail refer to the *Risk Assessment Report - B2CTS-PE-443-REP-00001* (see Appendix Z) which includes the risk register with all risks identified throughout the PE phase for the project life (from design to construction). Recommended treatments/measures that can be implemented in subsequent phases to mitigate the risks are also detailed in the risk register. These treatments and controls were developed by AECOM in consultation with TMR and CoGC.

The risk register have been used to determine the unplanned risk contingency for the P90 cost estimate. It is expected that as the concept design is refined (for each project option) in subsequent phases, the residual risk ratings will reduce further which in turn will reduce the cost amount of as unplanned risk allocated.

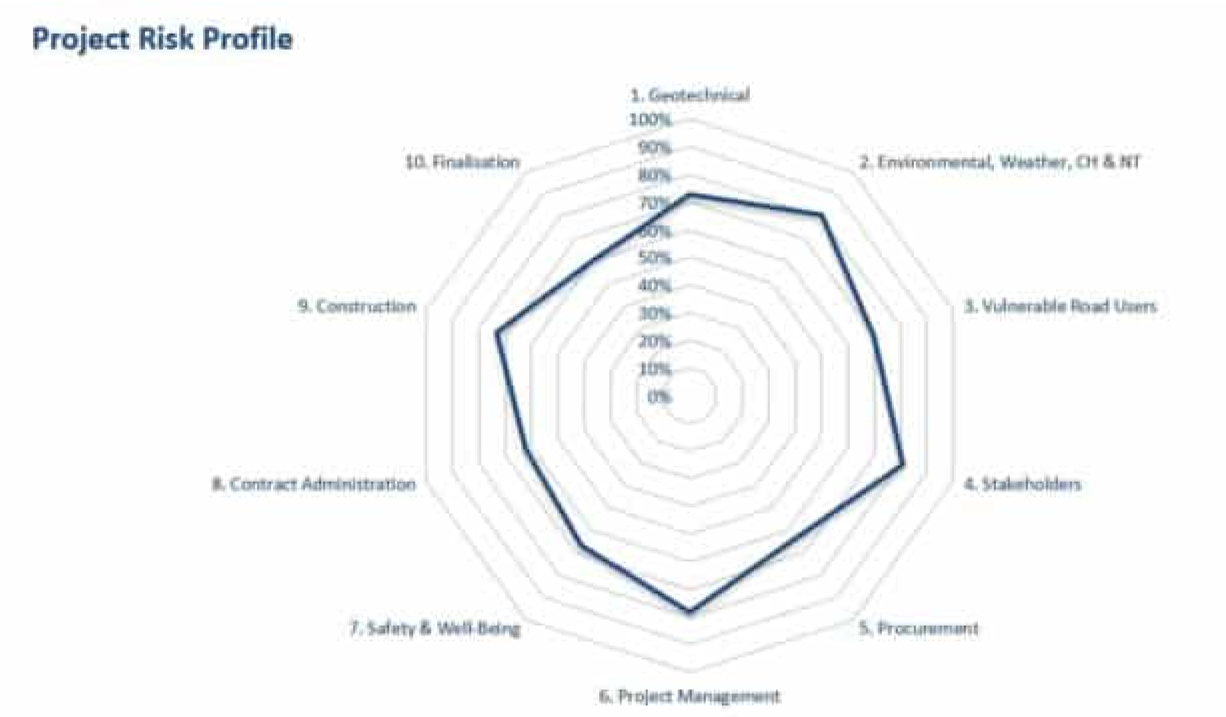


Figure 47 Risk Context Profile Summary

11.0 Recommendations and Next Steps

The following tasks are recommended to inform the design development for all project options under consideration during the BC phase:

- Design geometric refinements to confirm compliances for the entire project corridor length with key locations at: Brake Street/Burleigh Tourist Park, Burleigh Hill alignment, Palm Beach Avenue, Thrower Drive, Gold Coast Airport, and the Gold Coast Highway/Musgrave Street/Coolangatta Road intersection
- Confirm outcomes from the parking studies/assessments
- Review the local area planning and place studies (currently underway) that the Project needs to join into – key locations of particular note are Tallebudgera Creek, Thrower Drive, Tomewin Street, Tugun CBD, Boyd Street, Gold Coast Airport and Chalk Street
- Confirm the active transport strategy with key stakeholders, including disability groups.

The following sections detail the further technical studies and investigations recommended to be undertaken during the BC phase.

11.1 Traffic

It is recommended that the GCAMSE traffic model be updated for the Palm Beach local road network to include all local roads, including connectivity between all of the east-west avenues. These changes are required to the Base Year model and all forecast project option scenarios to facilitate further investigation of the traffic performance of the Palm Beach locality, including detailed assessment of the Gold Coast Highway right turn strategy (listed previously in Table 22). This is of particular importance for the LRT Option which proposes to restrict right/U-turn access at a multiple locations through Palm Beach to accommodate the light rail in a constrained corridor.

These model updates require:

- Collection of traffic counts and STREAMS signal phasing and timing data for all intersections within CoGC's Aimsun Palm Beach Local Area Transport Study (LATS) model extent
- Expand the GCAMSE network to include local roads (such as Cypress Terrace and Jefferson Lane) and include connectivity between all of the east-west avenues.
- Disaggregate the GCAMSE model zones in the Palm Beach locality to represent each of the east-west avenue catchments to enable fine-grain routing from the Gold Coast Highway and along Cypress Terrace, Townson Avenue and Jefferson Lane.
- Create a cordon (subarea) microsimulation model for Palm Beach and refine the zone connections to improve the granularity of vehicle loading onto the local network.
- Recalibrate and validate the GCAMSE base year model for the Palm Beach cordon.

In addition to the above, the travel demands for all of the GCAMSE models will require updating based on the latest travel demand matrices from the GCSTM-MM. Strategic model updates to the GCSTM-MM for each project option were undertaken during the PE phase by others, however, were not available for input into the GCAMSE at the start of AECOM's commission.

The public transport patronage (boarding and alignments) movements for the DBL and EBP Options should also be further refined in the respective GCAMSE model scenario (if these options are progressed).

11.2 Public Transport Operational Assessment

The following items are recommended to be investigated further during the BC phase:

- Consideration of outcomes from related transport studies currently underway, such as the Central Gold Coast East-West Passenger Transport Study (CGCE-WPTS) and Public Transport Access

Study (PTAS), which may require further refinement of the PT services in the study area for the Base Case and B2C project options.

- Stakeholder consultation with Translink, TfNSW, CoGC and Tweed Shire Council regarding the assumptions for the future bus network for the Base Case and all project options under consideration to seek further efficiencies in the operating plan and cost assumptions.
- LRT Option:
  - Confirmation of the preferred 760 and 774 routes, in consultation with Translink and CoGC.
  - A review of the bus stop capacity requirements at all stops for the 760 and 774 (once these preferred routes are confirmed).
  - Review of the LRT/bus interchange requirements (including bus layover area, turnaround, driver facilities etc.) at Thrower Drive, Boyd Street, Warner Street and Gold Coast Airport based on the revised PT network and pending outcomes from the Gold Coast Airport Masterplan revision.
  - Review of the number of LRVs required for GCLR4 operations (including requirement for additional LRVs to increase the fleet's spare capacity for special events, maintenance, breakdowns etc.), in consultation with KD and the LRV O&M Contractor
  - Review of stabling capacity at the Bilinga LRT satellite depot, taking into consideration specific operational requirements for major events, breakdowns etc. in consultation with the LRV O&M Contractor
- DBL Option:
  - Review bus stop capacity requirements, layover areas and driver facilities at the Thrower Drive and Warner Street bus stations, in consultation with Translink.
- EBP Option:
  - Review bus stop capacity requirements, layover areas and driver facilities at the Thrower Drive bus stop, in consultation with Translink.

11.3 Public Utilities and Plant

The following PUP investigations are recommended for the BC phase:

- Detailed survey of identified existing services to confirm position, material and size
- Confirm impacts of 'undergrounding' current above ground electrical infrastructure adjacent to the Gold Coast Highway in Palm Beach
- Confirm protection or replacement requirements associated with Gas transmission (major) infrastructure
- Further liaison with service providers to close gaps within available information
- Condition assessment of critical assets to confirm treatment requirements.

11.4 Geotechnical

A summary of recommended geotechnical investigations for the BC phase is presented in Table 56, noting this is based on the limited understanding of the project design definition. The test locations for recommended geotechnical investigation will need to be finalised once the preferred project option, alignment and associated structures are confirmed.

Table 56 Recommended Geotechnical Investigations

Design Element	Purpose	Recommended Geotechnical Investigations
Near grade embankment (H < 1.5 m)	For subgrade evaluation and reactive soil assessment.	Test pits at 250m intervals
High Embankments	For evaluating stability / bearing capacity and settlement.	Shallow boreholes at 100m intervals
Cuts	Evaluating stability, excavatability and material re-use.	Boreholes and test pits alternatively at 100m intervals
Culverts	Evaluating bearing capacity / settlement / reactive soils.	One test pit per culvert
Bridges	For foundation evaluation and abutment stability.	One borehole per abutment and pier
PUP	Evaluating service protection / relocation.	Shallow boreholes or test pit per service
Retaining Structures	Evaluating external stability and bearing capacity.	Alternating boreholes and test pits every 100 m
Reactive Soils	Evaluating ASS management requirements during construction phase.	Drilling of boreholes / test pits in ‘high risk’ areas

11.5 Pavement

No gap analysis has been undertaken during the PE phase, however, additional testing is required to progress to the next stage.

Once the preferred project option and alignment has been agreed, it is recommended that a falling weight deflectometer survey be conducted prior to undertaking the pavement investigation. The FWD data will be utilised to optimise the pavement investigation and subsequently to analyse existing pavement capacity. Table 57 provides summary of the typical investigations required. Further gaps in the data can be identified using ground penetrating radar, if applicable.

Table 57 Pavement and Geotechnical investigation

Design Element	Purpose	Recommended investigation
Near grade embankment (H < 1.5 m)	For subgrade evaluation and reactive soil assessment.	Test pits at 250m intervals. Data to be obtained shall include soaked CBR values, swell, Atterberg testing and grading
Pavement	Rehabilitation and reuse	Falling weight deflection data Ground penetrating radar Cores and trenches in the pavement Testing will include CBR values, Atterberg Limits and grading depending on the material in the pavement and the subgrade.

The presence of acid sulphate soils has been highlighted as a risk, therefore, limiting the removal of this material from site should be investigated.

11.6 Structures

The following items are recommended for the BC phase for the LRT and DBL Options:

- **General:**
  - Contact Harbourmaster to confirm clearances, operating vessels and design loading (impact)
  - Develop storm surge and wave load design criteria and loading – may require additional engineering study, or inputs and reliance on earlier coastal studies by others
  - Continue development of safety in design, sustainability and risk initiatives/assessments
  - Undertake a more detailed durability assessment
  - Discuss Bridge Design Basis with TMR E&T Structures Branch representatives.
  - Progress constructability reviews
  - Structural assessment of the remaining life of the existing Tallebudgera and Currumbin road bridges to confirm if bridge replacement would provide better value-for-money and confirm the LRT alignments at both creek crossings
- **Burleigh Hill Fauna Bridge (LRT and DBL Options):**
  - Undertake fauna surveys to determine tree/planting and animal species likely to use the crossing, to tailor the solution
  - Confirm central pier sight lines and set-back
  - Confirm requirement for rail deflection walls to protect against pier impacts
  - Confirm Fauna Fencing and bridge screen requirements
- **Tallebudgera Creek Rail and Active Transport Bridges (LRT Option only):**
  - Refine Tallebudgera Creek Bridge LRT option vertical alignment to provide for drainage falls.
  - Conduct scour assessment (subject to hydrological and geotechnical input data) – critical for pile designs
- **Currumbin Creek Rail Bridge (LRT Option only)**
  - Conduct scour assessment (subject to hydrological and geotechnical input data) – critical for pile designs
  - Investigate south abutment geotechnical stability (steep weathered slope)

11.7 Hydraulics

The following hydraulic assessments are recommended to be undertaken in the BC phase:

- Agree on the hydraulics and drainage standards to be adopted for the project, and TMR/CoGC criteria for each event (including afflux, immunity, freeboard, suitable outlet locations, boundary conditions and any sensitive checks)
- Undertake a quality review of existing stormwater network data, and where necessary undertake survey of identified stormwater network infrastructure.
- Update the Palm Beach and Coolangatta SDS TUFLOW models to include road or rail longitudinal drainage infrastructure. The Drainage Technical Note (AECOM, 2022) provided in Appendix N provides an initial (desktop) assessment in this regard.
- Update the baseline hydraulic models to include any significant infrastructure or developments that have been (or are likely to be) constructed since completion of the B2C PTS Preliminary Evaluation.
- It is understood that CoGC/TMR have plans to upgrade the existing waterway crossing of Flat Rock Creek at Teemangum Street. It is recommended that, in future project stages, further

consideration is given to the upgrade of the Teemangum Street crossing of Flat Rock Creek and to any other material changes to the Flat Rock Creek waterway.

- Tallebudgera Creek and Currumbin Creek Bridge design to include an updated assessment of complex pier scour (considering proposed pier, pile cap, pile group and footing design dimensions).
- Undertake further hydraulic analysis and optimisation of design at locations were flood immunity or afflux criteria has not been met.
- It is recommended that future design stages consider adoption of the latest version of the CoGC's TUFLOW hydraulic model of the combined Tallebudgera Creek and Currumbin Creek floodplains for creek hydraulic modelling. This is primarily because the extent of this model facilitates simulation of cross catchment flooding and improved downstream boundary condition locations relative to the existing separate TMR TUFLOW hydraulic models of Tallebudgera Creek and Currumbin Creek. It is recommended that further details regarding the model setup, calibration, and adopted design event parameters be obtained from CoGC in future project stages (e.g. during the BC) to inform the concept design for the preferred project option.
- Flat Rock Creek and Coolangatta Creek recommendations:
    - **At Flat Rock Creek:** It is recommended that hydraulic analysis of additional local drainage infrastructure (including long drainage parallel to the alignment) be undertaken in future project stages to improve the flood immunity of this section of the alignment.
    - **At Coolangatta Creek (Miles Street vicinity):** It is recommended that hydraulic analysis of alternate works such as horizontal and vertical realignment of the light rail, buy-back of properties, provision of additional floodplain conveyance capacity and storage, and provision of alternate cross drainage infrastructure be assessed to improve the flood immunity and associated off-site impacts for this section of alignment.
    - **Coolangatta (Chalk Street Area):** It is recommended that in future project stages, the drainage infrastructure upgrades proposed by Council in this area be included in the baseline hydraulic model, and consideration be given to the practical level of flood immunity that can be achieved in this area.

11.8 Landscape and Urban

A summary of suggested landscaping and urban design recommendations for the BC phase is below.

- Integration of the Project into the existing environment including landscape revegetation and urban design hat are sympathetic to the surrounding land uses.
- Consolidation and rationalisation of landscape treatments to locations where it has the greatest impact; including removal of hardstand areas less than 1.0m wide
- Activation of PT stations at Burleigh Head National Park, Palm Beach Avenue, Thrower Drive, Toolona Street, Miles Street and Warner Street to ensure they are specifically designed as 'places for people'.
- Further analysis of verge widths, grades and level of construction disturbance with the view of retaining some mature vegetation along the corridor (where possible).
- Application of WSUD principles (where practical) to collect and convey stormwater transversely through the site using landscaped swales and depressions.

11.9 Environment

The ESR identified the study area as 'High Risk' for impacts to identified environmental constraints. Regardless of the preferred project option, there are enough high risk constraints within the area assessed to suggest any works within the alignment will require further detailed site investigations. The number of investigations and likely approvals will however be dependent on the option selected.

Recommendations for further investigations are detailed below based on a worst case scenario associated with the LRT Option which requires the largest scope of works and impacts.

Water

- A concept Erosion and Sediment Control Plan should be developed during BC phase once a preferred option has been selected.
- Detailed hydraulic assessment (MUSIC modelling) of expected impacts from new infrastructure to manage operational water quality impacts. Principals detailed in the TMR Road Drainage Design Manual should also be incorporated where possible into the preferred option design.
- Hydrological modelling is required to model the impacts to wetlands and associated groundwater dependent ecosystem.
- The preferred option will need to be assessed against mapped tidal limits and CMDs within the study area to determine appropriate mitigation measures and development approvals.

Soil

- Site investigations in accordance with the Queensland Acid Sulfate Soils Technical Manual are recommended to confirm the presence of ASS in high risk locations.
- A preliminary site investigation is required to determine if contaminated soil/PFAS is present and requires removal from registered EMR lots/high risk PFAS sources.

Flora

- Ecological investigations (including formal protected plant flora surveys) are required to confirm eh presence of threatened flora species once a preferred option is selected and impact areas are confirmed.
- Project planning and design phases should consider mapped biodiversity corridors and ensure connectivity is maintained or improved (where possible).

Fauna

- Ecological investigations (including formal significant impact assessment) are required to confirm the presence and likely impacts to threatened fauna species once a preferred option is selected and impact areas are confirmed.
- Impacts to koala habitat will need to be quantified under both current and Memorandum of Agreement (MOA) -related legislation to understand TMR’s offset liabilities and likelihood for triggering a referral under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).
- Ensure planning and design phases aim to avoid the declared fish habitat areas.

Cultural Heritage

- TMR to consult with the Traditional Owners to survey and develop mitigation measures prior to any construction activities.
- Consult with QLD Parks and Wildlife Service (QPWS) regarding impacts to the Burleigh Head National Park
- Consult with DES regarding impact to state listed infrastructure and obtain Exemption Certificate where required
- Consult with CoGC regarding impact to local heritage places
- Consult with CoGC and family members regarding relocation of TMR listed site Betty Derrick Memorial.

Noise and Vibration

- Upon selection of a preferred option and alignment, a pre-construction road traffic noise assessment in accordance with the TMR Noise Code of Practice Vol 1 and screening assessment in accordance with the TMR Noise Code of Practice (Vol 2) is recommended to be undertaken.
- Additional screening and modelling of impacts to marine fauna is also recommended as part of the above assessments.

Air Quality

- Further qualitative assessment of construction phase air emissions for the preferred option is required in order to recommend mitigation measures and identify requirements for air quality monitoring during the construction phase.
- Undertake further quantitative detailed assessment of road traffic on the Gold Coast Highway for Segment 4 and Segment 5 if the light rail option is progressed.
- Undertake detailed quantitative air quality assessment for the dedicated bus lane option if the peak hourly bus volume is expected to exceed 80 buses per hour, or if daily volumes are expected to exceed 400 buses per day. Confirm the scope of assessment if low emission buses are likely to be used.
- Confirm the requirement for further assessment for the enhancement to bus provisions.

Native Title

- Ensure TMR’s Native Title Unit is engaged to assess the preferred option and expected land requirements.
- Native Title is to be extinguished where required.

Offsets

- Undertake a significant impact assessment for expected impacts to Matters of National Environmental Significance (MNES).
- Undertake a significant residual impact (SRI) assessment for expected impacts to MNES.

Appendix A

Stakeholder Engagement Report

Appendix B

Basis of Design Report

Appendix C

Environmental Scoping Report

Appendix D

Acoustic Assessment

Appendix E

Dune Street / Shell Street Assessment

Appendix F

Traffic Modelling Report

Appendix G

Public Transport Operational Assessment

Appendix H

LRT Sub-Options Analysis Report

Appendix I

LRT Option Concept Designs

Appendix J

LRT Traction Power Technical Note

Appendix K

Geometric Report

Appendix L

DBL Option Concept Designs

Appendix M

EBP Option Concept Designs

Appendix N

EBP Option - Proposed Bus Priority Locations

Appendix O

Preliminary PUP Report

Appendix P

Geotechnical Factual Report

Appendix Q

Geotechnical Analysis Report

Appendix R

Pavement Design Report

Appendix S

Bridge Report

Appendix T

Burleigh Hill Fauna Bridge Assessment

Appendix U

Hydraulics Analysis Report

Appendix V

Integrated Landscape Assessment Report & Master Plan

Appendix W

Road Safety Audit

Appendix X

Safe Systems Assessment

Appendix Y

Roadside Hazard Assessment

Appendix Z

Risk Assessment

Appendix AA

TMR Policy Compliance Checklists