4. Road design

The purpose of the concept design is to:

- Prepare a preliminary design of the arterial road standard arrangement such that it can be issued to tenderers as part of the tender documents. The concept design provides details of the new highway alignment, intersection locations and configurations, access provision, structure location and geometry and other minimum requirements to be provided by tenderers;
- Carry out enough design of the motorway standard upgrade to:
  - Set property boundaries to allow land to be identified (for future acquisition) for the ultimate arrangement.
  - Minimise future redundant works when the ultimate upgrade to a motorway standard road is undertaken.

Section 3 of this report outlined the works proposed in the first phase (upgrade to arterial standard) of the highway upgrade. This section provides the parameters used in developing the concept design. Typical cross sections along with the overall design for the highway are shown in the concept design drawings.

4.1 Design standards

The relevant standard for the design of this project is the RTA's document titled "Upgrading the Pacific Highway - Upgrading Program beyond 2006 - Design Guidelines, July 2005, Issue 2.1". In addition to these standards, the RTA's Road Design Guide and Austroad's Guide to Traffic Engineering Practice has been used.

The highway is to be ultimately upgraded to a motorway standard road. The design standards adopted for the initial upgrade to an arterial standard road have been set accordingly.

The design has been reviewed in accordance with the Pacific Highway Design checklist.

4.2 Design life

The infrastructure elements included as part of this concept design have been designed to comply with the required design life outline in Section 3.5 of the "Upgrading the Pacific Highway - Upgrading Program beyond 2006 - Design Guidelines, July 2005, Issue 2.1." These are shown below in Table 4-1.

Table 4-1 Asset design lives

Asset	Minimum design life (years)
Inaccessible drainage element	100
Drainage elements that are accessible for refurbishment including sedimentation and detention ponds	20
Sign faces	5
Sign support structures and other roadside furniture	40
Fences, including fauna fences	20
Lighting and electrical equipment	20
Bridge structures, including underpasses and wildlife tunnels	100
Retaining walls including reinforced soil walls	100
Dual carriageway and ramp pavements	40
Local road embankment and support structures	100
New local road pavement	20
Reconstructed local road pavements	10
Embankments, including reinforced embankments	100
Cut batters, including batter treatments	100

4.3 Highway design

4.3.1 Design and performance requirements

General

The main geometric design characteristics of the proposed indicative upgrade are summarised in Table 4-2.

Table 4-2 Engineering design criteria

Design parameters	Proposed upgrade
Design speed	110 km / hr
Minimum "K" value	95 (crest) / 35 (sag)
Stopping sight distance	
Horizontal	210 m
Vertical	210 m
Reaction time	2.5 sec
Number of lanes	Two lanes per carriageway[1]
Traffic lane width	3.5 m
Carriageway type	Divided
Carriageway width	Varies cut: 14.6 m Fill: 11.0 m
Outside shoulder widths	2.5 m – with no safety barrier 3 m – with safety barrier
Inside shoulder widths	0.5 m
Median width	12 m
Clear zone	11 m
Formation, drainage and road reserve widths	In accordance with the RTA's document titled "Upgrading Program beyond 2006 - Design Guidelines, July 2005, Issue 2.1".
Minimum horizontal radius	1200 m desirable 750 m minimum
Maximum superelevation	3%
Max vertical grade	4.5% desirable 6.0% maximum[2]
Vertical clearance to overhead bridges	5.5 m desirable 5.3 m minimum
Design vehicle	19.5 m semi-trailer / 25m B-double
Flood immunity	One carriageway flood free for the 100 year ARI event.

[1] Consideration has been made for future widening to 3 lanes in each direction, when required.
[2] Desirable maximum length for 6.0% grade is 500m.

4.3.2 Sight distance

Sight distance requirements on the highway have been provided in accordance with the design guidelines, in particular:

- Stopping sight distance at all locations on the highway, including adjacent to barriers.
- Entering sight distance or safe intersection sight distance on the highway approaches to all at grade intersections.
- Approach sight distance for 100 km/h was achieved at all at-grade intersections. Where possible, approach sight distance for 110 km/h has been provided.
- Headlight sight distance in sags.

Because of the large radius bends used in the design, benching for sight distance is generally not required.

4.3.3 Cross section

The road cross-section for the proposed upgrade comprises a dual (divided) carriageway with:

- Two 3.5 m wide lanes per carriageway.
- A wide median of a minimum of 12 m between edge lines.
- A left shoulder 2.5 m wide generally – 3.0 m wide adjacent to barriers.
- A right shoulder 0.5 m wide.

Typical road cross sections are shown on the concept design drawings. The superelevation throughout the project has generally been limited to 3 per cent. A crossfall of 4 per cent has been adopted in areas where the longitudinal grade is less that 0.5 per cent.

Provision for Cyclists

The cross section for the highway includes allowance for cyclists in accordance with Upgrading the Pacific Highway - Upgrading Program beyond 2006 - Design Guidelines, July 2005, Issue 2.1, which requires a minimum outside shoulder of 2.5 m with a maximum of 3 m adjacent to safety barriers.

4.3.4 Horizontal geometry

General

The likely horizontal alignment geometry is shown in the concept design drawings.

In accordance with clause 4.2b of the Upgrading the Pacific Highway - Upgrading Program beyond 2006 - Design Guidelines, July 2005, Issue 2.1, the adopted desirable minimum radius is 1200 m, with an absolute minimum of 750 m.

Departures from the desirable minimum horizontal curve radius requirements

Apart from four locations, the desirable horizontal curve radius of 1200 m specified in the Pacific Highway Design Guidelines has been achieved. The four locations where the horizontal radius is less than 1200 m and reasons for the departures are summarised Table 4-3 below. In all locations the radii used are significantly larger than the minimum radius of 750 m promoted by the guidelines.

Table 4-3 Summary of departures from desirable horizontal curve requirements

Section	Chainage	Preliminary horizontal curve radius	Reason for departure
C	9570 to 10,500	1081 m	To avoid impact on Lot 74 DP 731384 located immediately to the west of the cutting at Ch 9700. Also helps in reducing the depth of cutting by avoiding the highest peak (elevation) of Dirty Creek Range.
C	10,600 to 12,000	1101 m	Constraints in this location include the Blueberry Farm to the west and a steep vegetated valley to the east of the existing Highway (particularly north of Ch 11,500). The design intent has been to minimise impacts to both the Blueberry Farm and vegetation in the valley north of Ch 11,500. A horizontal curve radius of 1101 m achieves these outcomes.
D	16,470 to 16,930	1160 m	This radius forms part of the southern end of the already completed upgraded section of the Pacific Highway through Halfway Creek. By using a horizontal curve radius of 1,160m the extent of reconstruction work on the already upgraded section of Highway at Halfway Creek is minimised.
E	24,150 to 24,700	1100 m	This radius has been reduced to slightly below the desirable minimum to facilitate the reuse of the existing highway as the northbound carriageway (if required in the future) by shifting the new carriageways clear of the existing bridge over Wells Crossing.

4.3.5 Vertical geometry

General

In general the terrain traversed is gently undulating. The significant constraints on the vertical geometry are as follows:

- Section B — Flood levels on the flood plain between Ch 5500 and Ch 7200. There is also a requirement in this area to provide access beneath the highway to minimise the severance impacts on the farms adjacent to the realignments.
- Section C — Depth of cutting at Dirty Creek range (approximate Ch 9800) and at Falconers Lane (Ch 13,500).

The likely vertical alignment geometry is shown in the concept design drawings.

Departures from the desirable maximum vertical grade requirements

The desirable maximum grade of 4.5 per cent has been exceeded at only one location.

The preliminary grade between Ch 13,000 and 13,450 varies between 5.6 and 6.2 per cent. This grade has been adopted to facilitate the reuse of approximately 900 m of the existing highway as the southbound carriageway.

Departures from the desirable minimum vertical crest curve requirements

The desirable minimum vertical crest curve value of K=95 (110 km/h) was not achieved in one location.

The crest curve at the top of Dirty Creek Range (Ch 13,500) has a K value of 44, which is equivalent to a 100 km/h design speed. This value has been adopted to allow reuse of the existing highway as the southbound carriageway.

Consideration of sheet flow at locations of flat grade

Flow depth of greater than 5 mm during storms can lead to loss of traction and vehicle control, otherwise known as aquaplaning.

Throughout the project a crossfall of 3 per cent has generally been adopted to direct flow towards the road shoulders. However, at a number of locations superelevation transitions are positioned in an area of flat grade. Each of these locations has been checked for flow depth in accordance with the Austroads Guide to the Geometric Design of Rural Roads (2002) which specifies that flow depth be calculated.

The Austroads Guidelines specify a maximum flow depth of 4 mm, however the figure of 5 mm flow depth was adopted following direction from RTA.

4.3.6 Future conversion to six lanes when required

The cross section outlined in Section 4.3.3 includes allowance for a minimum 12.0 m wide median, within which two additional lanes can be constructed should a future upgrade to a six lane highway be required. However, the existing cross section of the Halfway Creek duplication, being retained as part of the project, requires the use of retaining walls, in combination with selected widening to construct additional lanes within the median. Furthermore, the National Park located on the eastern side of the southbound carriageway between Grays Road and Lemon Tree Road extends up to the existing road reserve boundary. The construction of additional lanes in this area will be difficult if impacts to the National Park are to be avoided. Additional lanes would need to be constructed by either:

1. Widening both the existing carriageways on the outside of the slow lane.
2. In order to minimise potential impacts to the National Park, widening the southbound carriageway within the median and widening the northbound carriageway on the western side of the slow lane. For this option, a retaining wall may be required to accommodate the level difference between the widened southbound carriageway and the northbound carriageway.

Option 2 above has been adopted in the concept design as it minimises potential environmental impacts on the adjacent National Park.

4.3.7 Auxiliary lanes

There are no auxiliary lanes required for the upgrade to arterial road standard.

4.3.8 Rest areas and truck stops

Truck stops/rest areas

The existing truck stops on the highway are located on the northbound and southbound carriageways near Lemon Tree Road - Ch 19,500. These truck stops are opposite and adjacent to a new service centre development located adjacent to the southbound carriageway. Drivers currently cross the highway to the service centre in an uncontrolled manner.

The concept design includes the provision for a new truck stop servicing northbound vehicles with a pedestrian underpass or overpass to be provided for access to the service station.

The truckstop for southbound vehicles would be retained with minor changes to the pavement and geometry.

These truck rest areas will complement a facility planned at the Arrawarra interchange as part of the upgrade for the Sapphire to Woolgoolga project.

Truck Stopping Bays

In accordance with the RTA's Pacific Highway Design Guidelines, truck stopping bays are to be provided at approximately 5 km intervals. Truck stopping for northbound and southbound traffic have been provided in conjunction with emergency crossovers / emergency u-turns in the following locations:

- Chainage 5000.
- Chainage 7500.
- Chainage 9000.
- Chainage 13,000.
- Chainage 17,800.
- Chainage 21,500.
- Chainage 26,400.

4.3.9 Emergency u-turn bays, public u-turn bays and crossovers,

Emergency u-turn bays have been provided to allow for u-turns to be executed by RTA, police and emergency vehicles in accordance with the RTA's Pacific Highway Design Guidelines. These facilities will be generally spaced at 2.5 km intervals commencing approximately 3.0 km north of the proposed interchange near Arrawarra Beach Road.

Median crossovers have been provided to allow for switching of traffic flow between carriageways during emergencies or planned maintenance. The median crossovers have been combined with the emergency u-turn bays, and are spaced at approximately 5 km intervals.

Public u-turn bays have been provided as part of the "left in / left out intersections with right turn in". The public u-turn bays have been located to provide improved accessibility for local road users.

The proposed locations of emergency u-turn bays, public u-turn bays and median crossover facilities are shown in Table 4-4.

Table 4-4 Emergency u-turn bays, public u-turn bays and median crossovers

Chainage	Road	U-turn direction[a]	Treatment
5000	N/A	Both	Emergency crossover and u-turn
7500	N/A	Both	Emergency u-turn
9000	N/A	Both	Emergency crossover and u-turn
13,000	N/A	Both	Emergency crossover and u-turn
14,150	Falconers Lane	South	Combined public road and u-turn
15,250	McPhillips Road	North	Combined public road and u-turn
17,160	N/A	South	Public u-turn
17,760	Grays Road / Rediger Close	Both	Existing four-way intersection to be closed at the median to provide left in/left out only movement.
20,500	Lemon Tree Service Road	North	Combined public road and u-turn
21,000	N/A	Both	Emergency crossover and u-turn
22,390	Kungala Road	South	Combined public road and u-turn
23,550	Luthers Road	North	Combined public road and u-turn
25,550	Parker Road	South	Combined public road and u-turn
26,300	N/A	Both	Emergency crossover and u-turn
27,350	Bald Knob Tick Gate Road	North	Combined public road and u-turn

a The listed direction refers to the direction that the vehicle is travelling prior to performing a u-turn.

4.4 Service road and access road design

4.4.1 Design criteria

Geometry

Service road and access road design has been prepared in accordance with the Pacific Highway Design Guidelines, the RTA's Road Design Guide and Austroads Specifications. The service and access road design is based upon the design criteria in Table 4-5 below.

Table 4-5 Service road and access road design criteria

Design element	Service road design criteria	Access road design criteria
Horizontal alignment	80 km/h	70 km/h
Vertical alignment	80 km/h	70 km/h
Stopping sight distance (reaction time)	100 m (1.5 sec)	45 m (1.5 sec)
Lane width	3.5 m	3.0 m
Flood immunity	20 year ARI event	10 year ARI event (Desirable)

Sight distance

Sight distance requirements on the side roads and access roads will be provided in accordance with the design guidelines. In particular:

- Stopping sight distance at all locations.
- Intersection sight distance on the approaches to all at grade intersections.
- Headlight sight distance in sags.

4.4.2 Cross section

Service roads will generally comprise two 3.5 m wide defined lanes with:

- Sealed shoulders 2 m wide where the road is deemed to be a cycle route (based on Austroads Guideline Part 14 for an 80 km/h design speed).
- Sealed shoulders 1 m wide elsewhere.

Service roads will generally not have kerb and channel.

Access roads will generally comprise two 3.0 m wide lanes with 0.5 m unsealed shoulders, and no kerb and channel.

4.4.3 Horizontal alignment

The horizontal alignment for service roads and access roads has been designed in accordance with the Pacific Highway Upgrade Program Design Guidelines, the RTA's Road Design Guide and local council standards. The design speeds for the alignment are as shown in Table 4-5. There are no known non-conformances in the horizontal alignment.

4.4.4 Vertical alignment

The vertical alignment for the service roads and access roads has been designed in accordance with the Pacific Highway Upgrade Program Design Guidelines, the RTA's Road Design Guide and local council standards. The design speeds for the alignment are as shown in Table 4-5. There are two vertical curves that do not conform with the required standards as follows:

1. The vertical crest curve on the access road parallel to the highway adjacent to Ch 8000 is adequate for a 60 km/h design speed. This has been adopted to minimise the amount of cut required for construction of the access road.
2. The short vertical curve at the intersection of McPhillips Road and the proposed access road has a K-Value of 8.6, which is less than the K-Value of 14 required for 70 km/h design. This value has been adopted to match into the existing surface on McPhillips Road and to minimise the volume of fill and extent of fill batters required.

4.4.5 Allowance for cyclists and pedestrians

The concept design allows for the possible future provision of a shared footpath / cycleway on the eastern side of Eggins Drive. This may be provided if it is determined that it is required to improve amenity for cyclists and pedestrians adjacent to the Lorikeet Tourist Park and Darlington Beach Resort.

Pedestrian and cyclist facilities are not warranted on any other service or access roads. Refer Section 7 for further information.