5.3 Project features

The concept design for the upgrade project has been prepared using the current design standards for the Pacific Highway (RTA, October 2009). The design features described below are indicative only and, should the project be approved, would be refined during detailed design.

5.3.1 Project boundary

The upgrade of the highway to a full motorway standard would be accommodated within the boundary of the project. The project boundary includes space for:

- Dual carriageways
- Service roads
- Changes to local access roads
- Road embankments and cuttings
- Interchanges
- Rest areas
- Bridge and drainage structures
- Fauna crossing structures
- Water quality control ponds
- Tie-ins to the existing Pacific Highway
- Landscaping
- Fencing.

The project boundary would cover an area of around 2220 hectares. An additional 233 hectares outside of this project boundary would be required for construction ancillary facilities. This is discussed further in Chapter 6 (Description of the project – construction).

The width of the project boundary would vary depending on the shape and size of road embankments and road cuttings, and the locations of interchanges, water quality control ponds and highway related infrastructure (such as rest areas).

In locations where the upgrade would be limited to new northbound and southbound carriageways, the project would be up to 150 metres wide. Where interchanges or rest areas are proposed, the project may be about 200 to 400 metres wide.

The project boundary would generally be set in accordance with the following parameters:

- The boundary would be 10 metres from the top of the cutting or toe of the embankments. With larger cuttings (greater than 10 metres deep) the boundary would be 15 metres from the top of the cutting. With cuttings over 20 metres deep the boundary would have a setback of 25 metres
- The boundary would be 10 metres from the edge of bridge structures
- The boundary would be along the boundaries of existing local roads (outside the project boundary), or offset by 10 metres
- The boundary would have 10-metre offsets around water quality ponds, and include space for access
- The boundary would be confined to the minimum possible width through national parks, nature reserves and State conservation areas.

The project boundary would include the permanent works footprint required for the motorway standard upgrade. It would also include activities required for the construction of the project (access for construction of embankments, temporary and permanent fencing, temporary sedimentation basins, access roads and construction side-tracks). As such, it represents a notional limit of the construction footprint.

However, a number of potential ancillary facilities have been identified that fall outside of the project boundary. These facilities include main site compounds, batch plants and stockpile sites. These are identified separately in Chapter 6 (Description of the project – construction).

5.3.2 Property acquisition

The project would require the acquisition of 564 properties, comprising 381 land owners. This would comprise both publicly (State government agencies, local councils) and privately owned land. As at September 2012, 64 per cent of acquisitions had commenced or were being processed. While some would require total acquisition, the majority would require only partial acquisition.

If a property was totally acquired, but not all of the land is required for the project, the excess land would be either:

- Sold after completion of construction
- Kept by RMS for future use
- Transferred to the local council or another government agency.

All land acquisitions would comply with RMS' Land Acquisition Policy (RTA, 1999) and the *Land Acquisition (Just Terms) Compensation Act 1991*. It is RMS' preferred approach to complete all acquisitions by negotiation without the need for compulsory acquisition.

A remnant land strategy has been developed for the project. Details on property acquisition and the remnant land use strategy are included in Chapter 16 (Land use and property).

5.3.3 Road gradient and lane widths

The gradient of the upgraded highway would generally be up to 4.5 per cent, but in places it could reach a maximum of six per cent. The higher road gradients would apply to isolated locations including the approach to Dirty Creek Range (Section 1).

The dual carriageways of the upgraded highway would have:

- Two lanes per carriageway, each lane 3.5 metres wide
- A typical median width of about 12 metres between edge lines (this would divide the carriageways and allow for future widening of the highway within the median to three lanes per carriageway, when required)
- A left shoulder, generally 2.5 metres wide and three metres wide adjacent to barriers
- A right shoulder 0.5 metres wide.

5.3.4 Interchanges

Between the interchange at Arrawarra and the interchange with the Bruxner Highway at Ballina, the project would feature ten interchanges:

- Range Road, Corindi (full interchange)
- Eight Mile Lane, Glenugie (two half-interchanges)
- Sheehys Lane, Tyndale (two half-interchanges)
- Goodwood Street, Maclean (full interchange)
- Yamba Road, Harwood (half-interchange)
- Watts Lane, Harwood (half-interchange)
- Iluka Road, Woombah (full interchange)
- Trustums Hill Road, Woodburn (full interchange)
- Evans Head Road, Broadwater (one half-interchange)
- Coolgardie Road, Wardell (full interchange).

These interchanges would provide access to and from the project. The locations of interchanges are shown in Figure 5-83 and described below. Figure 5-84 to Figure 5-97 show the function of each interchange.

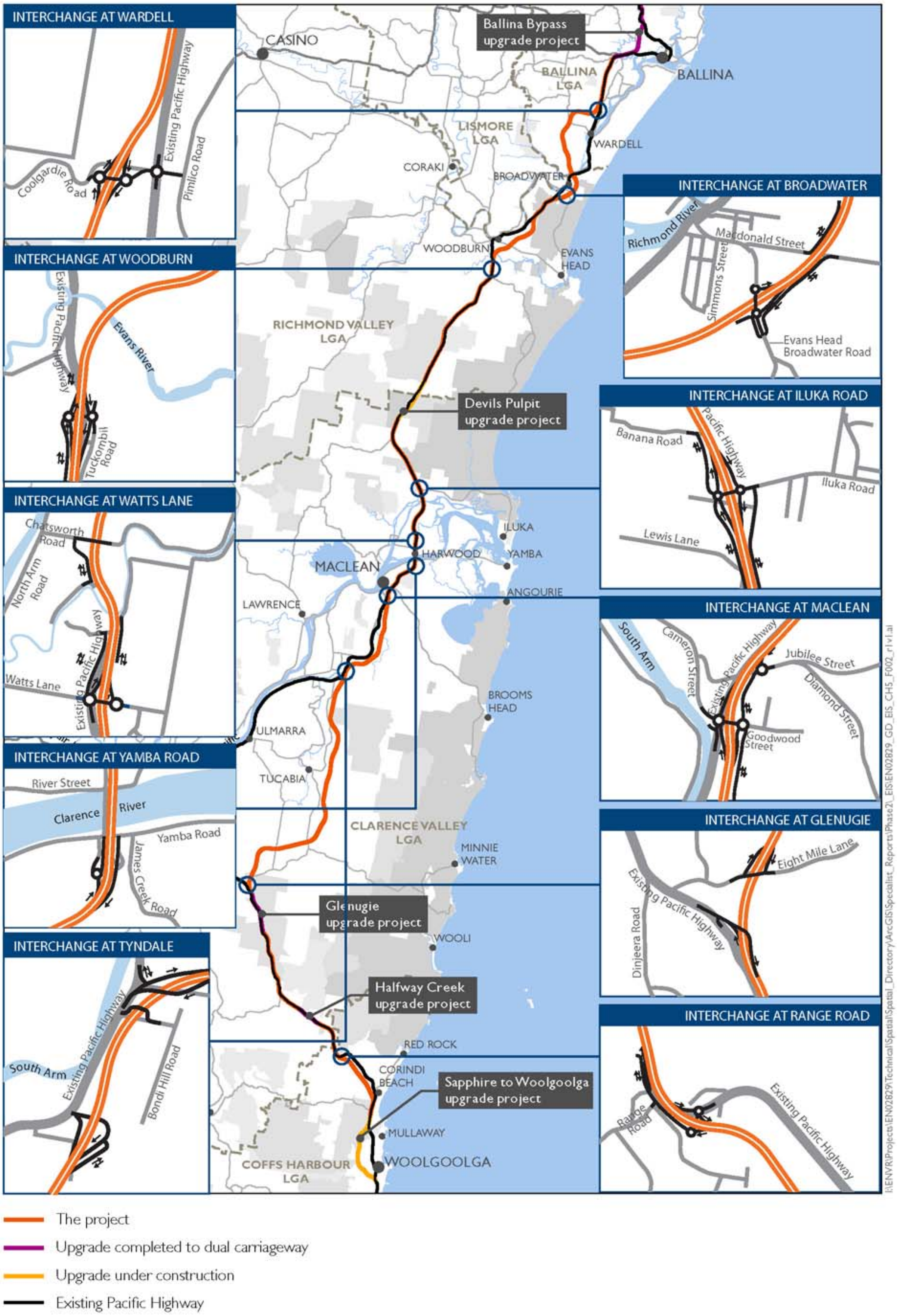

Figure 5-83: Summary of interchange locations

Interchange at Range Road, Corindi

The interchange at Range Road would be located in Section 1, about three kilometres north of Corindi, near Flinty Road.

As shown in Figure 5-84, this interchange would be a dumbbell design comprising two roundabouts located each side of the upgraded highway and connected by an underpass. Both southbound ramps and the northbound off-load ramp would connect to these roundabouts.

A fourth ramp (northbound on-ramp) would be located along the two-way service road from the western roundabout heading north. This service road would provide access to properties on Range Road, Halfway Creek and Wells Crossing to form the alternative non-motorway route.

On the eastern roundabout, the service road would continue south on the existing Pacific Highway, providing access to Corindi, Corindi Beach and to the interchange at Arrawarra Beach Road (part of the Sapphire to Woolgoolga upgrade).

In the initial upgrade, the layout and function of the interchange would be the same as for the ultimate motorway upgrade, with the exception of the service road, which would terminate at the northbound on-ramp. North of Range Road, the upgrade would be constructed to an arterial road standard which would not require a service road arrangement.

The design of this interchange differs from the concept design that was displayed in 2008. Improvements were made to improve function and ensure the structures and roundabouts could be built offline.

In addition, to cater for commercial horticultural uses on adjoining land, this interchange has been designed to accommodate heavy vehicles (B-double trucks).

Photo 3: Location of the interchange at Range Road (in foreground)

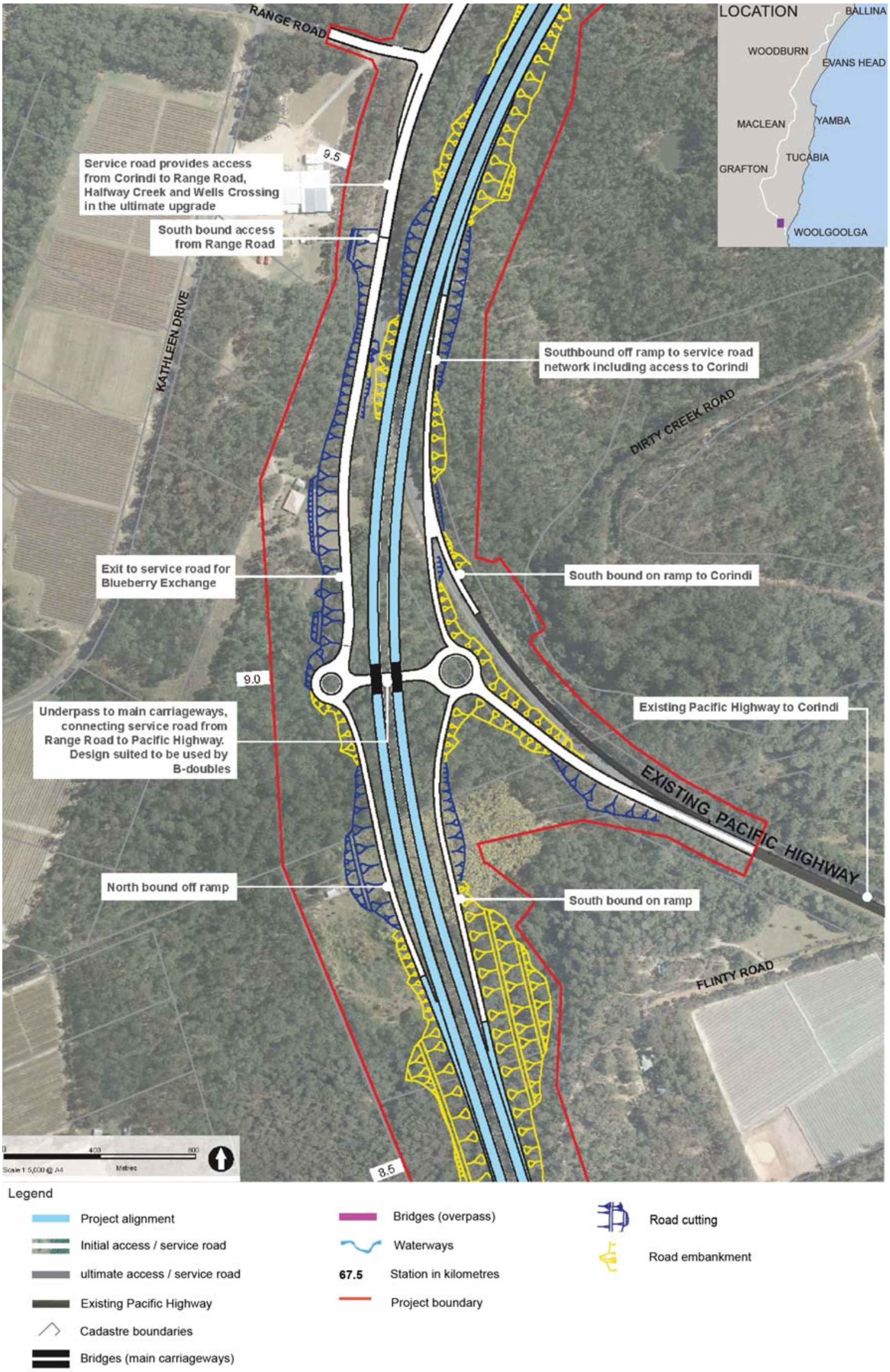

Figure 5-84: Interchange at Range Road, Corindi

Interchange at Eight Mile Lane, Glenugie

The interchange at Glenugie would be located at the start of Section 3 and consist of two half-interchanges (refer to Figure 5-85). These would be at:

- The tie-in with the existing Glenugie upgrade (station 34.6): The half-interchange would consist of two south-facing ramps that would provide for traffic using the service road to and from Grafton to access the upgraded highway to and from Coffs Harbour
- Eight Mile Lane (1.5 kilometres further north of the Glenugie upgrade): The half-interchange would include two north-facing ramps to provide access from Grafton and Eight Mile Lane to the upgrade to and from Ballina.

These two half-interchanges would work together to allow full access north and south for motorists.

The existing Pacific Highway would become the service road and would directly connect to the Glenugie south-facing ramps. The connection north would be via Eight Mile Lane with the ramps connecting to two T-intersections. The existing function of Eight Mile Lane as a connection to Wooli Road would remain unchanged.

In the initial upgrade, the layout and function of the interchange would be the same as for the ultimate motorway upgrade, except for the service road south, which would be terminated at Well Crossing. Access beyond that point under the initial upgrade would be via the south-facing ramps at Glenugie.

The design of this interchange differs from the concept design that was displayed in 2009. The alignment has been moved east with a reconfiguration of the highway's on-ramps and off-ramps, with Eight Mile Lane passing over the upgraded highway. The functionality of the interchange remains unchanged. This revised design would have the following benefits:

- Less impact on Picaninny Creek, with the length of realignment required greatly reduced
- Reduced volumes of earthwork materials required
- Fewer bridging structures required.

To cater for commercial horticultural uses, the interchange at Glenugie and Eight Mile Lane has been designed to accommodate heavy vehicles (B-double trucks).

Photo 4: Location of the interchange at Eight Mile Lane, looking towards the Glenugie upgrade

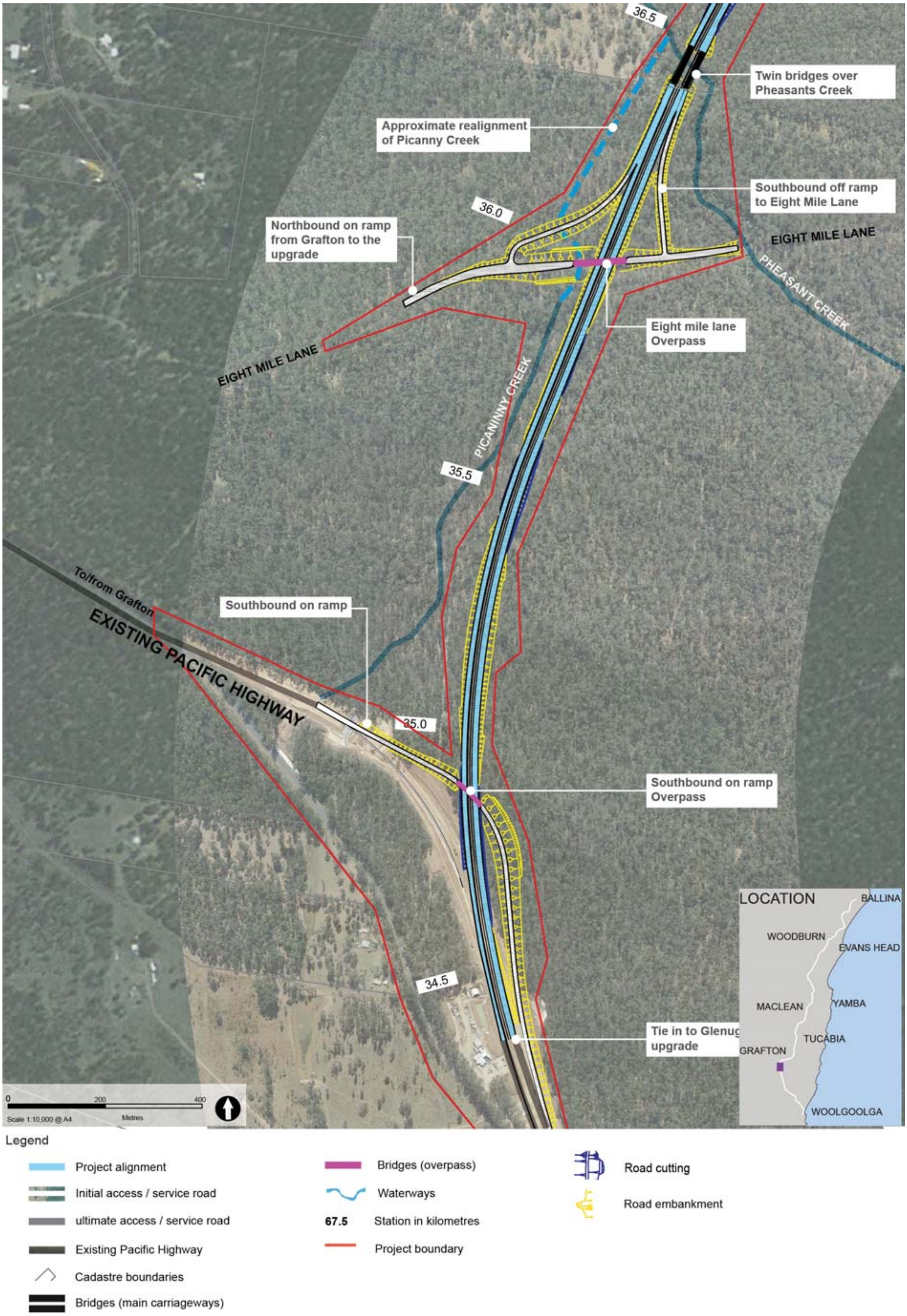

Figure 5-85: Interchange at Eight Mile Lane, Glenugie

Interchange at Sheehys Lane, Tyndale

The interchange at Tyndale would be located at the interface between Section 3 and Section 4, between station 67.5 (Tyndale south) and around station 69.0 (Tyndale north). The interchange would provide access to Tyndale, Ulmarra and Grafton, via the existing highway (which would become a service road) for both northbound and southbound motorists. Access to Maclean and Shark Creek would also be possible should motorists choose to exit from the upgraded highway to continue north on the existing highway (which would be a service road).

As shown in Figure 5-86 and Figure 5-87, the interchange would consist of two half-interchanges, as follows:

- North of Sheehys Lane: This half-interchange would provide a connection to the upgrade to/from the south via south-facing ramps. Very low traffic volumes are expected on this half-interchange so this would connect to the service road via an access road and T-intersection
- A half-interchange further north of the Sheehys Lane half-interchange. This would provide a connection to/from the highway from the north to Grafton. This half-interchange would provide a 'northern gateway' to Grafton and other Clarence River towns, with more than 70 per cent of traffic from north of the interchange expected to access the existing highway south of Tyndale via this interchange exit. These two half-interchanges work together to allow full access north and south for motorists.

The design of this interchange differs from the concept design that was displayed in 2009. The alignment and overbridge arrangements have been refined to improve the functionality and safety of the interchange. This revised design would have the following benefits:

- Improved function and traffic flow on the main on-ramps and off-ramps, which would increase safety
- Improved connections (via a seagull intersection) to the existing highway
- Reduced bridging structures (from seven to two)
- Reduced footprint of the interchange overall, which would reduce property impacts and lessen the volumes of earthwork materials required.

An indicative visualisation of the interchange at Tyndale is shown in Figure 5-88.

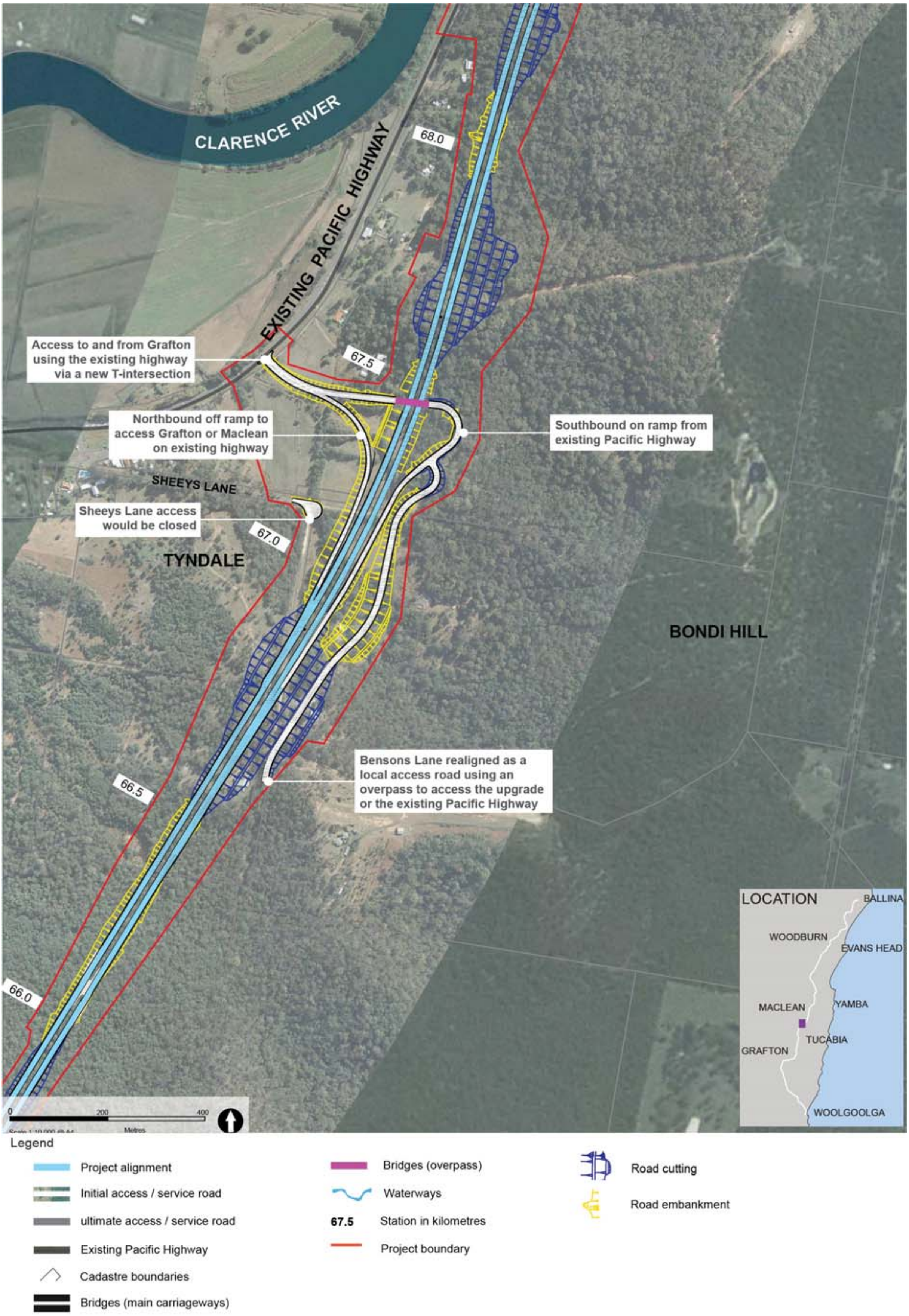

Figure 5-86: Interchange at Tyndale (South)

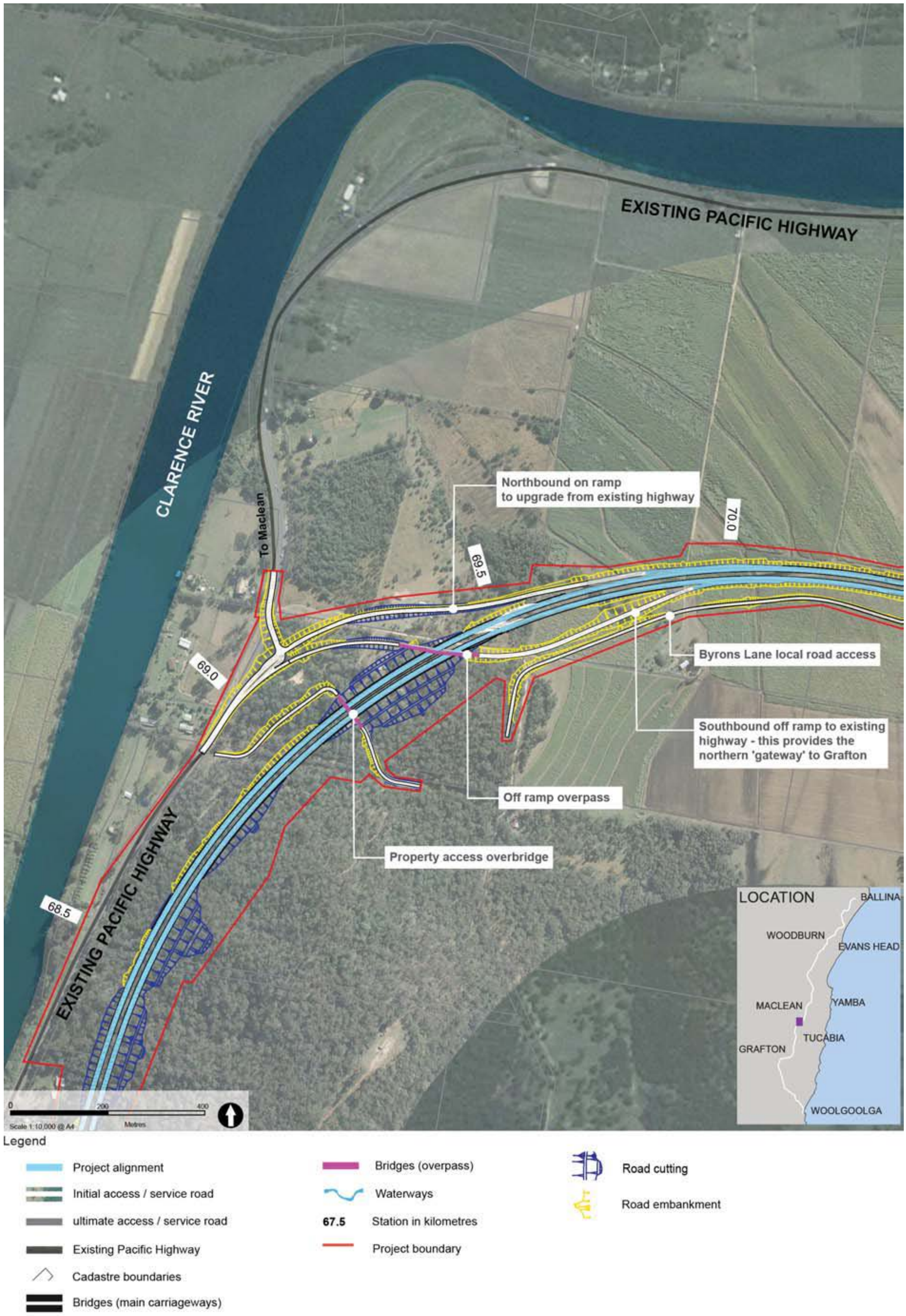

Figure 5-87: Interchange at Tyndale (North)

Figure 5-88: Indicative visualisation of the interchange at Tyndale (view east to Bondi Hill)

Interchange at Goodwood Street, Maclean

The interchange at Maclean would be located at the northern end of Section 4 (station 80.5) near the existing ferry park and Maclean turn-off. The interchange would form the southern access to Maclean and the connection to the service road south to Shark Creek. The interchange would also provide access to Townsend, Gulmarrad, Brooms Head and Yuraygir National Park.

As shown in Figure 5-89, the interchange at Maclean would be a dumbbell design interchange comprising two roundabouts located either side of the upgraded highway and connected by a bridge over the main alignment. Both the south-facing ramps and the north-facing on-load ramp would connect directly to the roundabouts at the interchange. Access from the north-facing off-ramp from Harwood would be via a two-way service road connecting Jubilee Street to the eastern roundabout, which would also provide access to Cameron Street to the east, and an access road to properties to the south.

The western roundabout would enable access to Maclean, Ferry Park and the existing highway.

Jubilee Street would not have vehicular access under the upgraded highway, but pedestrian and cycle facilities would be provided. On the western side, access to Maclean would be unchanged. On the eastern side, Jubilee Street would connect to the interchange at Maclean via the two-way connection road to the eastern roundabout. The area surrounding the interchange has been considered as a location for a potential highway service centre, but this does not form part of this project.

The design of this interchange differs from the concept design that was displayed in 2010 as part of the Shark Creek alternative route display. It includes a roundabout at the intersection of the north-facing off-ramp and Jubilee Street to improve road safety.

An indicative visualisation of the interchange at Maclean is shown in Figure 5-90.

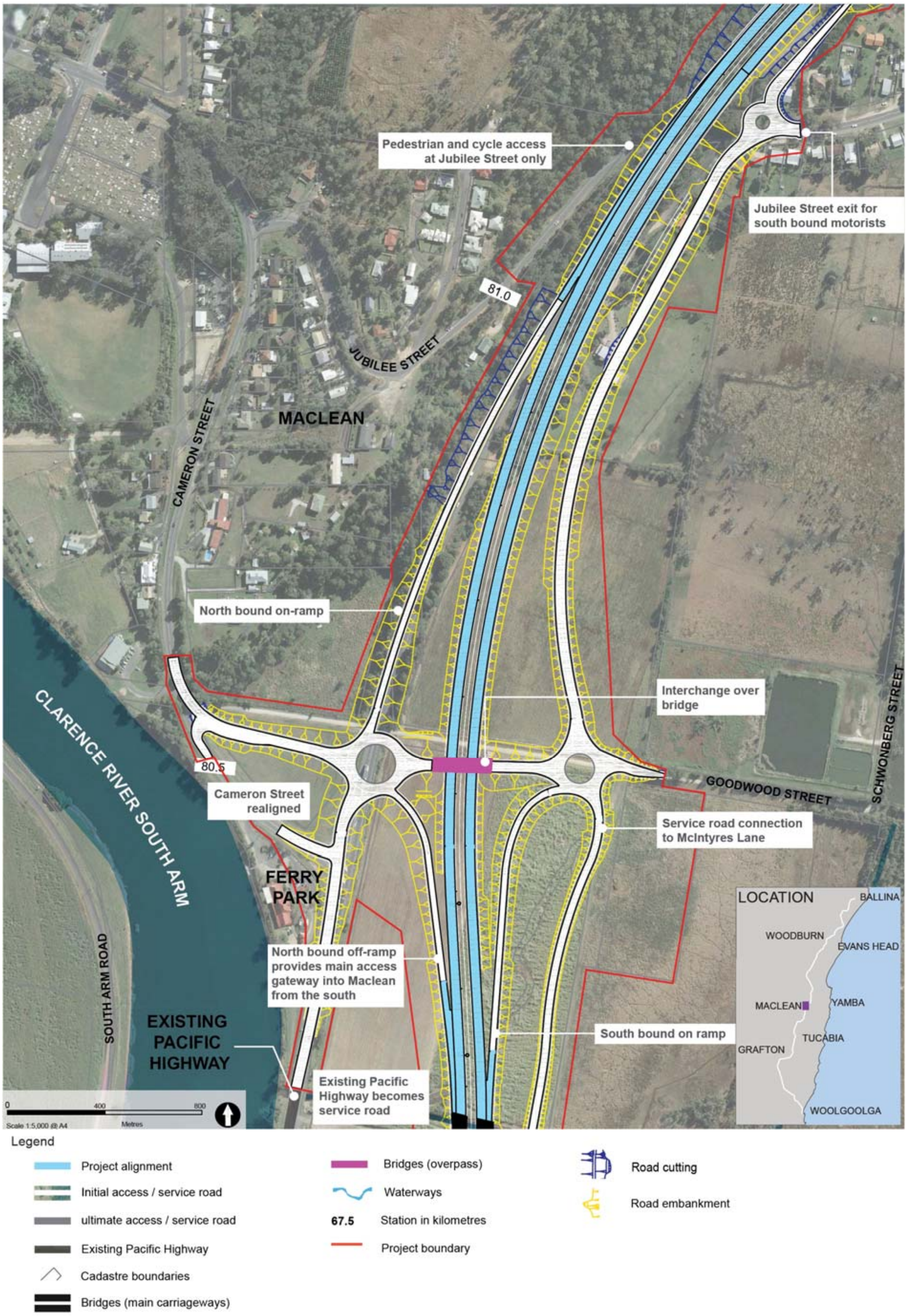

Figure 5-89: Interchange at Goodwood Street, Maclean

Figure 5-90: Indicative visualisation of the interchange at Maclean (view north)

Interchange at Yamba Road and Watts Lane, Harwood

The interchange at Harwood would comprise two half-interchanges at:

- Yamba Road, which would comprise ramps only
- Watts Lane, which would have a dumbbell arrangement.

The half-interchanges would be located within Section 5 either side of the Clarence River (station 85.7 and station 87.8) to enable access in all directions from Harwood, Yamba and Maclean (refer Figure 5-91 and Figure 5-92).

The Yamba Road half-interchange would provide access to and from Yamba and Maclean for northbound motorists. Motorists travelling north would be able to access Harwood by exiting the upgraded highway at Yamba Road and continuing across the existing Harwood Bridge.

Access to the upgraded highway for motorists travelling south from Yamba Road would be possible though a southbound on-ramp off Yamba Road.

At Yamba Road, south-facing ramps would enable access to and from the upgrade either directly from Yamba Road or via a short connection road that would form part of the service road.

This service road would continue north over the existing Harwood Bridge to enable access to the north-facing ramps at the dumbbell interchange at Watts Lane, which would comprise two roundabouts located either side of the upgraded highway and connected by a bridge. Both the southbound off-ramp and the northbound on-ramp would connect to the roundabouts at the interchange. This would remove any height restrictions for traffic on Watts Lane. There would be no south-facing ramps at Watts Lane.

The Watts Lane interchange would be the entry to Harwood from the north and provide access to local roads such as River Street and Morpeth Street. This interchange would also be important for access to the Harwood Sugar Mill located in east Harwood.

These half-interchanges would work together to allow full access north and south for motorists. Local traffic between Harwood and Yamba Road would use the existing Harwood Bridge, while through traffic would separately use the proposed four-lane dual carriageway bridge over the Clarence River.

The design of the interchange at Yamba Road differs from the concept design that was displayed in 2009. The interchange design previously provided access on and off the upgraded highway for both northbound and southbound motorists and used the existing Harwood Bridge as the northbound carriageway. Combining the function of this interchange with that of Watts Lane has provided the following benefits:

- Reduced footprint of the intersection, which would reduce impacts on biodiversity and property
- Separation of local traffic and through traffic, which would improve traffic flow and increase safety
- Seamless flow of motorway traffic via a high-level bridge over the Clarence River.

Under the initial upgrade to arterial standard, the service road would terminate at the interchange at Watts Lane, and the upgrade to the north would be arterial standard.

An indicative visualisation of the interchange at Watts Lane is shown in Figure 5-93.

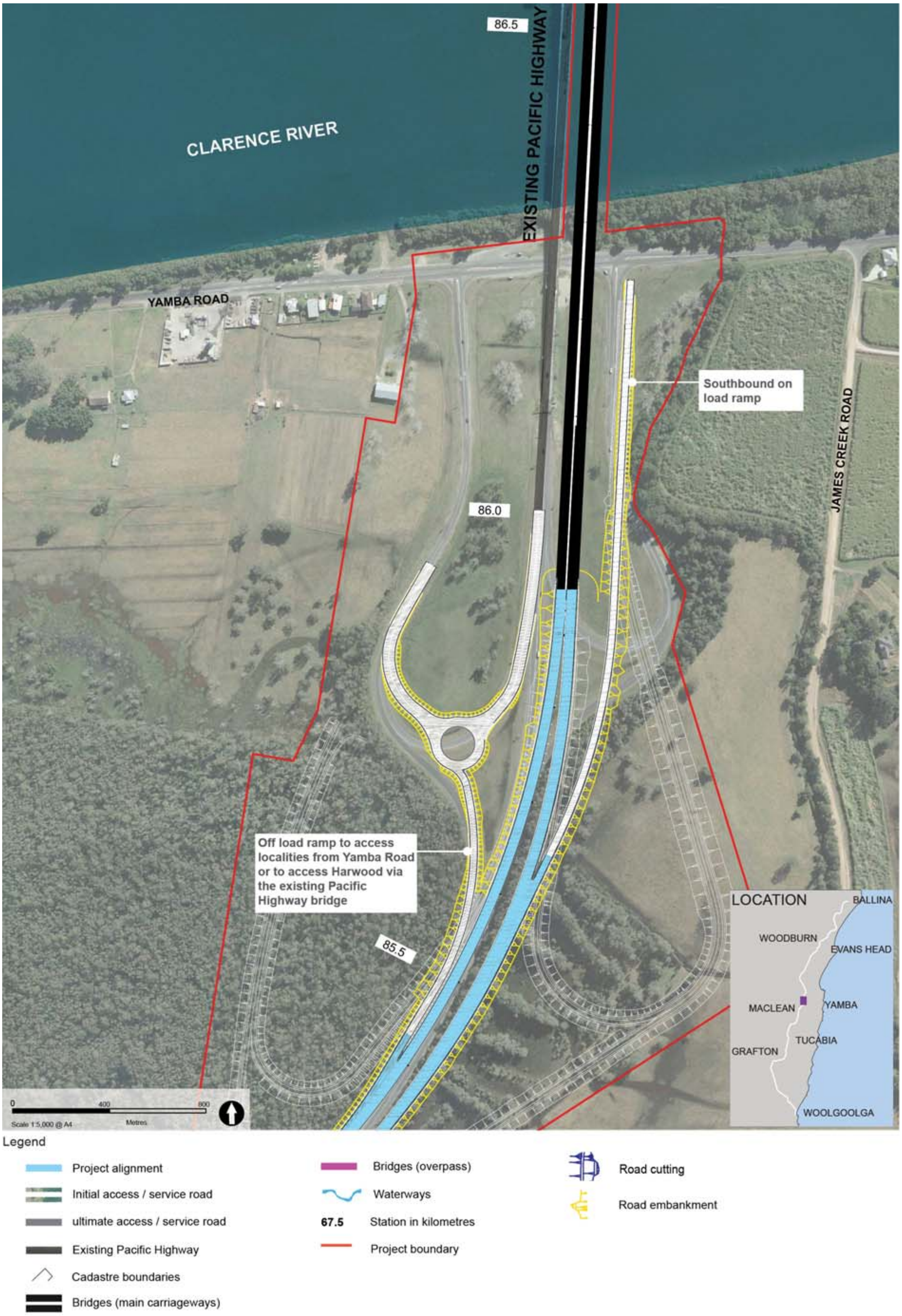

Figure 5-91: Interchange at Yamba Road, Harwood

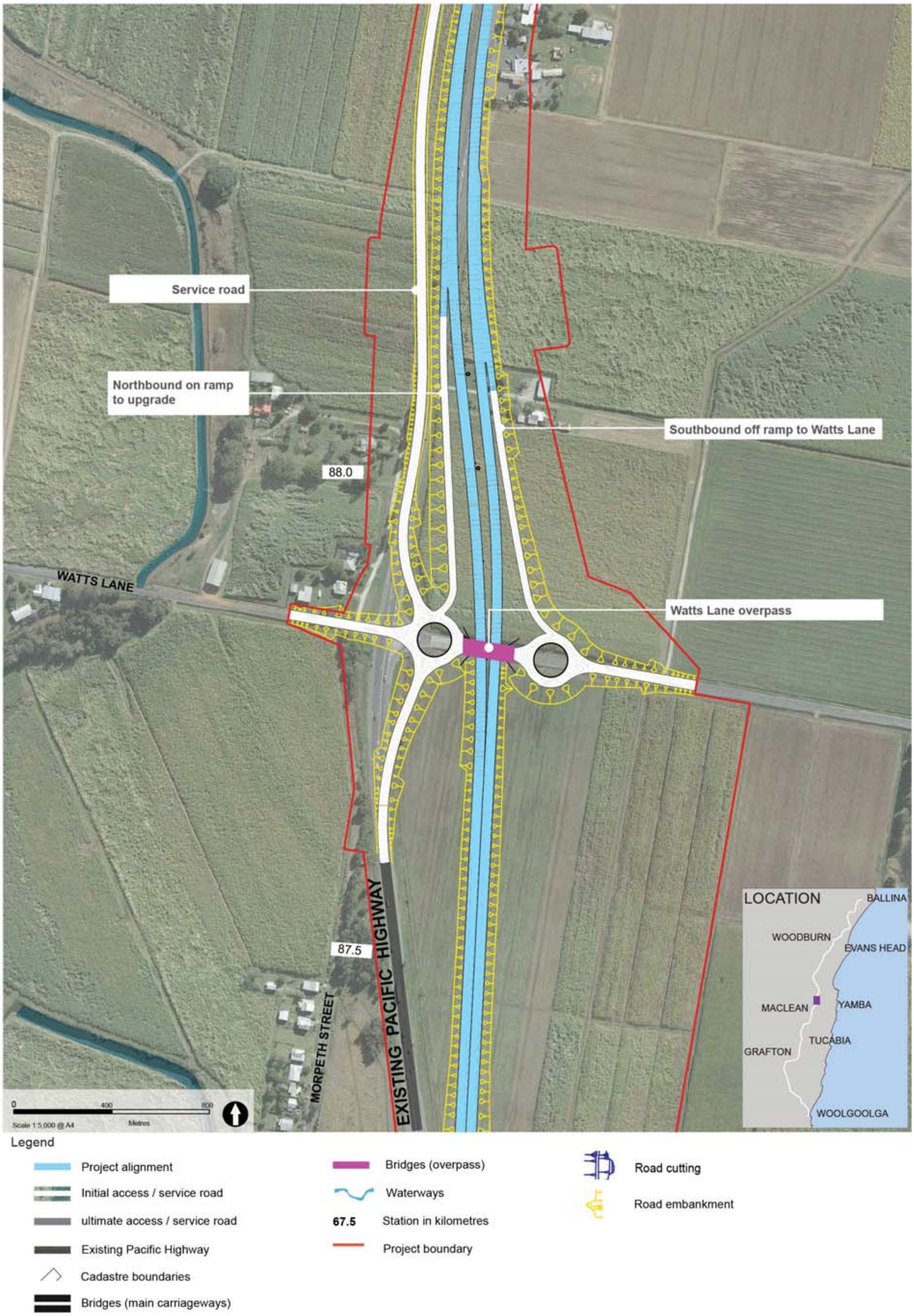

Figure 5-92: Interchange at Watts Lane, Harwood

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Figure 5-93: Indicative visualisation of the interchange at Watts Lane

Interchange at Iluka Road, Woombah

The interchange at Iluka Road the northern end of Section 5 (station 95.5) would enable access to Iluka to the east, Woombah Holiday Park and the southern end of Bundjalung National Park.

As shown in Figure 5-94, the interchange would be a dumbbell design comprising two roundabouts located each side of the upgraded highway and connected by a bridge over the upgrade, as follows:

- The western roundabout would connect the ramps from the northbound carriageway and service road from Harwood and Chatsworth in the south and north to New Italy and Woodburn
- The eastern roundabout would connect the ramps from the southbound carriageway and existing Iluka Road, Woombah. Access to Garrets Lane would deviate to connect just to the east of this roundabout.

The design of the interchange differs from the concept design that was displayed in 2008. It now includes the two roundabouts in lieu of two cross-roads arrangements. This was introduced to improve function and safety.

Under the initial upgrade, the service road would connect to the western roundabout from connecting roads only. To the south it would serve an access road to Carrols Lane only; to the north it would serve an access to Banana Road only

Photo 5: Location of the interchange at Iluka Road, looking towards the Clarence River (North Arm)

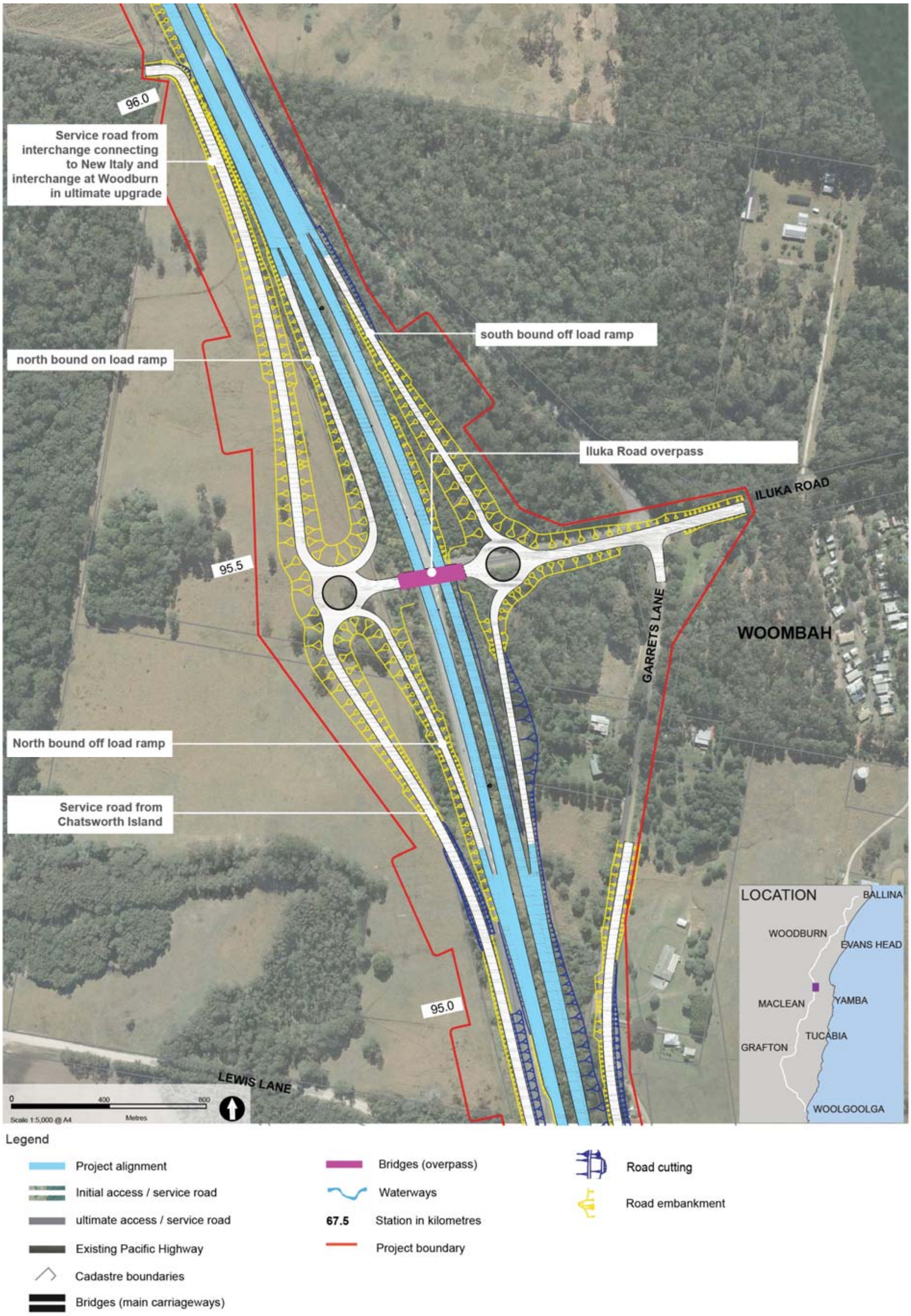

Figure 5-94: Interchange at Iluka Road, Woombah

Interchange at Trustums Hill Road, Woodburn

The Woodburn interchange would be located at the southern end of Section 8 (station 128.5) near Trustums Hill Road. The interchange would be the entry to Woodburn to the west for northbound and southbound motorists. The interchange would provide access north towards Broadwater, Wardell, Casino and Coraki and south towards New Italy and the interchange at Iluka Road, Woombah.

As shown in Figure 5-95, the interchange would be a dumbbell design comprising two roundabouts located either side of the upgraded highway and connected by a bridge over the upgrade, as follows:

- The eastern roundabout would connect the ramps associated with the southbound carriageway and the service road from New Italy and The Gap, which is formed by Tuckombil Road
- The western roundabout would connect the ramps associated with the northbound carriageway and would enable access to the Wondawee Way area and properties further south on the west of the highway for about three kilometres. It would also provide the continuation of the service road by connecting to the existing highway near Trustums Hill and onto Woodburn.

The design of this interchange differs from the concept design that was displayed in 2008. The interchange previously did not have north-facing ramps, but only south-facing ramps. Following the refinement of the concept design, north-facing ramps were added to the design. These would allow southbound motorists to access Woodburn north from the interchange, and allow motorists from Woodburn going north to access the upgraded highway. The addition of these ramps would also greatly improve accessibility of the upgraded highway to emergency crews from Woodburn wanting to go north and would also enable more direct access from Coraki to the upgraded highway.

Under the initial upgrade, the service road from Woodburn would terminate at Wondawee Way and not continue south to New Italy. This interchange would form the end of the arterial standard from the south and the start of the motorway standard to the north.

Photo 6: Location of the interchange at Woodburn, looking north.

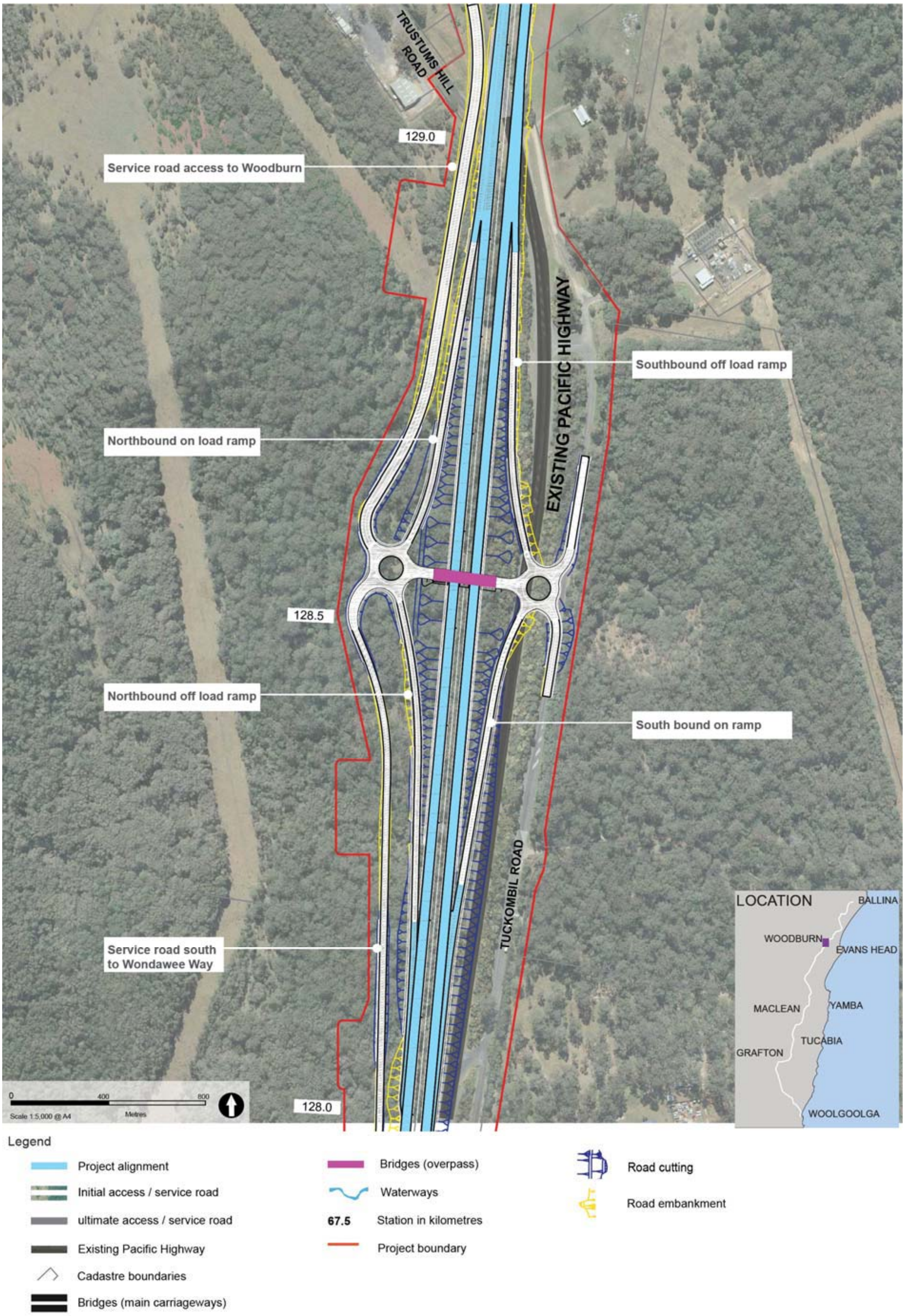

Figure 5-95: Interchange at Trustums Hill Road, Woodburn

Interchange at Evans Head Road, Broadwater

The interchange at Broadwater would be located within Section 9 (station 142.7) where the alignment would intersect with the current Evans Head – Broadwater Road. The interchange would enable access to Broadwater and to Evans Head from the north. It would also form an important entry to Broadwater National Park to the south.

As shown in Figure 5-96, the interchange would be a dumbbell design comprising two roundabouts located either side of the upgraded highway and connected by a bridge over the upgrade. The interchange would have only north-facing on- and off-ramps providing access from the north only.

Access from the interchange roundabouts would be to Evans Head along the Evans Head – Broadwater Road south, and north to Broadwater to the existing highway. Rifle Range Road would be connected to the interchange, as would local access to the west of the interchange.

The western roundabout would provide access to the northbound on-load ramp and to Broadwater. The eastern roundabout would collect the southbound off-load ramp from Ballina and Broadwater – Evans Head Road. Local properties and access to Rifle Range Road are also nearby and would use this roundabout.

Access off the upgraded highway would not be available for motorists travelling to or from the south. Instead, motorists would use the service road to the Woodburn interchange. Traffic from Evans Head would travel via Woodburn.

The design of this interchange differs from the concept design that was displayed in 2008. The main change since 2008 has been the inclusion of the two roundabouts in lieu of two T-intersections. This was introduced to improve function and road safety.

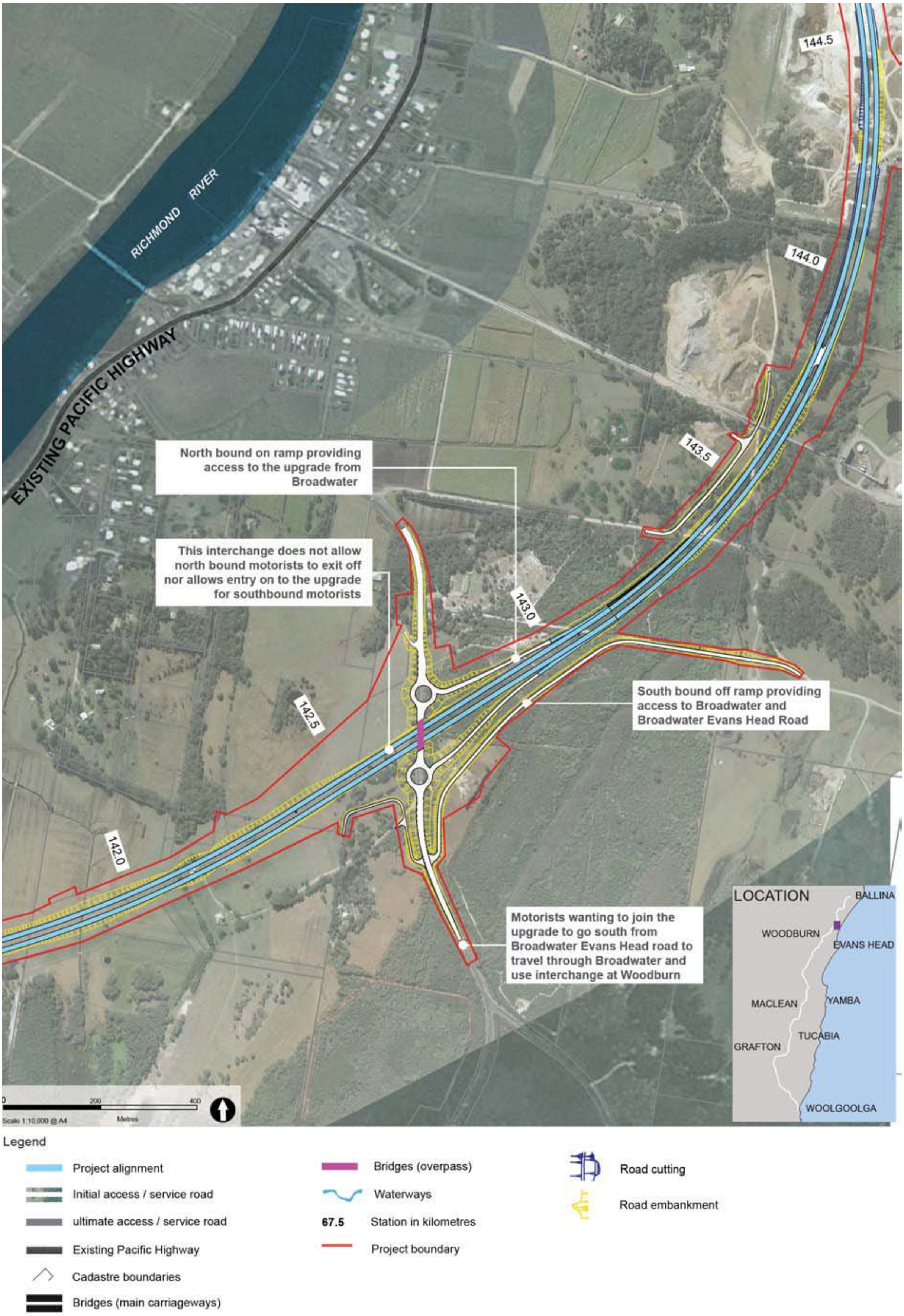

Figure 5-96: Interchange at Evans Head Road, Broadwater

Interchange at Coolgardie Road, Wardell

The interchange at Wardell would be located at the northern end of Section 10 (station 157.5) at Coolgardie Road. The interchange would provide access to Wardell, Pimlico and Coolgardie.

As shown in Figure 5-97, the interchange at Wardell would be a dumbbell design comprising two roundabouts located either side of the upgraded highway and connected by an overbridge.

North-facing and south-facing ramps would provide access to the interchange and connections to Coolgardie Road and Wardell.

The western roundabout would connect the ramps associated with the northbound carriageway and Coolgardie Road. The eastern roundabout would connect the ramps associated with the southbound carriageway and a connector road to a third roundabout at the existing highway, which would become a service road. The service roads would provide access to Wardell to the south or Pimlico to the north and ultimately connect to adjacent interchanges.

The design of this interchange differs from the concept design that was displayed in 2008. The main change since 2008 has been the inclusion of the two roundabouts in lieu of two cross-roads at the top of the ramps. This was introduced to improve function and road safety.

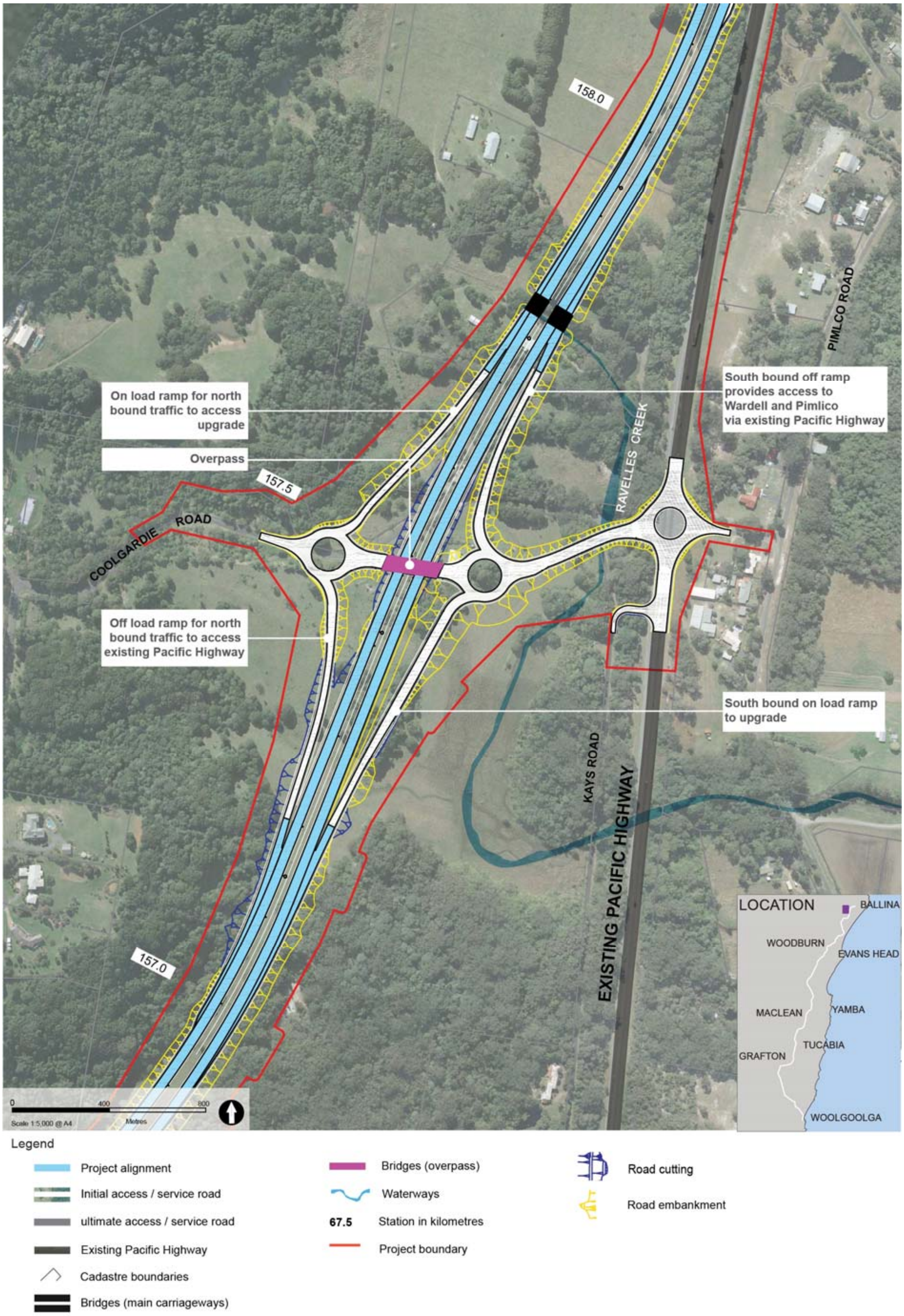

Figure 5-97: Interchange at Coolgardie Road, Wardell

5.3.5 Bridges

The project would include 95 bridges of varying sizes. The concept designs for the bridges are indicative and would be refined during detailed design, when urban design, functionality and cost (amongst other things) would be considered in more detail.

The concept design for the bridges has considered:

- The size requirements for each carriageway
- The provision of footpaths or cycle paths, where required
- Constructability and construction techniques
- Visual impact on the surrounding area
- The need to avoid piers in watercourse and damage to riparian vegetation, where possible
- The need for adequate capacity at waterways, with minimal increase to water levels upstream of the structure
- The provision of fauna access under bridges, by considering abutment and pier locations
- The integration of safety screens and handrails into the design, where they are required.

The project includes:

- Bridges over rivers, creeks and major floodplains (45 in total)
- Bridges over local roads or underpasses to allow local roads or service roads (including the existing highway) to pass underneath the main carriageways
- Overpasses to carry local traffic over the main carriageways
- Overpasses to provide fauna passage over the main carriageways.

Proposed bridges are listed in Table 5-5 together with an indication of whether the bridge would be built for the initial upgrades or as part of the ultimate upgrade, when all arterial standard sections would be upgraded to the full motorway standard.

All bridges crossing waterways on the project would meet the following performance criteria:

- Meet RMS standards in terms of sight lines, structural performance and maintenance
- Ensure that maximum flow velocity would not cause scour
- Allow future widening in the median with minimal additional ground disturbance
- Meet expectations for bridge aesthetics and visual requirements, while addressing the urban design and landscape design principles and objectives (described in Chapter 11 (Visual amenity, urban design and landscape)).

Urban design principles for bridges

A key urban design objective for the Pacific Highway is the integrated design of road infrastructure elements as a series of related elements that present a consistent design while responding to different settings and functions. Bridge structures would be designed in accordance with the Bridge Aesthetic Guidelines (RMS 2012). The general principles for bridge elements are:

Bridge and pier form

- Minimise the number of bridge piers by maximising span lengths
- Minimise the thickness of bridge superstructures and bridge decks
- Bridge design, including the parapets and other critical elements, to address the slenderness ratio of the structures
- Pile caps would be concealed below finished surface levels
- Reverse tapers recommended on short elevation of piers
- All bridge elements, including piers, sill beams, abutments and leading edges, would be fully integrated.

Abutments

- Spill through abutments, aligned with adjacent batters, would be provided in preference to walled abutments
- Where retaining wall abutment structures are used, they would return back to the bridge alignment to form buttresses
- Abutments would be designed for ease of maintenance
- Spill through abutments would adopt a maximum slope of 1:2 where achievable and be lined with an appropriate hard surfacing material that is consistent with the bridge setting
- Shotcrete would not be used.

Soffits

- Where soffits are visible, careful consideration would be employed to produce clean, uncluttered soffits with neat connections and simple layout of girders.

Safety screens

- Safety screens would be integrated with overall bridge design
- Screen posts would be spaced to provide a pleasing and ordered visual relationship with other bridge details
- Screens and posts would not be attached to or obscure the outer face of bridge parapets
- Screens would be terminated by tapering down towards bridge parapets and would match the extent of bridge parapets
- Tops of safety screens would be parallel to bridge alignment without stepping.

Bridge barriers

- Parapet, bridge barriers/rails and throw screens would be designed as integrated elements
- Designs would maximise visual transparency to the landscape beyond
- Bridge barriers would continue past the abutments to anchor the bridge to the surrounding landscape
- Where possible, a constant height between bridge barriers and adjacent road barriers would be maintained
- At creek and river crossings, two-rail bridge barriers or other similar bridge barriers that maximises views out would be provided.

Table 5-5: Details of bridges on the project

Station	Bridge location	Bridge type	Approximate length (metres)	Delivered under initial or ultimate upgrade
Project Section 1: Woolgoolga to Halfway Creek				
1.1	Sherwood Creek Road	Overpass	50	Initial (class M)
2.5	Kangaroo Trail Road	Overpass	80	Initial (class M)
3.5	Corindi Creek	Highway twin bridges	90	Initial(class M)
4.0	Corindi floodplain	Highway twin bridges	300	Initial (class M)
4.7	Cassons Creek	Highway twin bridges	75	Initial (class M)
6.1	Corindi local access road	Highway twin bridges	80	Initial (class M)
9.0	Range Road interchange	Highway twin bridges	30	Initial (class A)
13.6	McPhillips Road	Overpass	60	Ultimate (class A/M)
15.7	Grays Road	Overpass	65	Ultimate (class M)
Project Section 2: Halfway Creek to Glenugie upgrade				
17.8	Lemon Tree Road	Overpass	65	Ultimate (class M)
20.7	Halfway Creek	Highway twin bridges	50	Initial (class A)
20.7	Halfway Creek	Overpass	65	Ultimate (class M)
21.3	Luthers Road	Highway twin bridges	65	Ultimate (class M)
22.4	Wells Crossing	Highway twin bridges	60	Initial (class A)
25.1	Bald Knob Tick Gate Road	Overpass	75	Ultimate (class M)
28.0	Franklins Road	Overpass	65	Ultimate (class M)
Project Section 3: Glenugie upgrade to Tyndale				
34.8	Glenugie southbound loading ramp	Overpass	60	Initial (class M)
36.0	Eight Mile Lane	Overpass	100	Initial (class M)
36.4	Pheasant Creek	Highway twin bridges	75	Initial (class M)
38.3	Old Six Mile Road	Overpass	60	Initial (class M)
41.4	Avenue Road	Overpass	60	Initial (class M)

Station	Bridge location	Bridge type	Approximate length (metres)	Delivered under initial or ultimate upgrade
42.5	Coldstream River 1	Highway twin bridges	135	Initial (class M)
43.1	Coldstream River 2	Highway twin bridges	315	Initial (class M)
43.9	Coldstream River 3	Highway twin bridges	180	Initial (class M)
45.5	Wooli Road	Overpass	60	Initial (class M)
46.1	Pillar Valley Creek 1	Highway twin bridges	100	Initial (class M)
46.3	Pillar Valley Creek 2	Highway twin bridges	100	Initial (class M)
46.7	Pillar Valley Creek 3	Highway twin bridges	75	Initial (class M)
47.7	Pillar Valley Creek 4	Highway twin bridges	75	Initial (class M)
48.8	Mitchell Road	Highway twin bridges	36	Initial (class M)
49.3	North of Pillar Valley 1	Highway twin bridges	120	Initial (class M)
50.3	North of Pillar Valley 2	Highway twin bridges	45	Initial (class M)
51.9	Firth Heinz Road	Overpass	60	Initial (class M)
52.4	Chaffin Creek	Highway twin bridges	75	Initial (class M)
54.7	North of Chaffin Creek	Highway twin bridges	90	Initial (class M)
55.5	Bostock Road	Overpass	60	Initial (class M)
56.9	Somervale Road	Highway twin bridges	30	Initial (class M)
57.0	Champions Creek	Highway twin bridges	90	Initial (class M)
58.6	North of Champions Creek	Highway twin bridges	75	Initial (class M)
61.0	Property access	Highway twin bridges	35	Initial (class M)
63.6	Property access	Overpass	100	Initial (class M)
64.9	Crowleys Road property access	Overpass	60	Initial (class M)
67.4	Tyndale southbound unloading ramp	Highway twin bridges	40	Initial (class M)

Station	Bridge location	Bridge type	Approximate length (metres)	Delivered under initial or ultimate upgrade
Project Section 4: Tyndale to Maclean				
69.1	Local road	Overpass	70	Initial (class M)
69.4	Crown road	Overpass	120	Initial (class M)
70.4	Tyndale cane drain 1	Highway twin bridges and access road bridge	15	Initial (class M)
71.1	Byrons Lane	Overpass	60	Initial (class M)
73.4	Tyndale cane drain 2	Highway twin bridges	15	Initial (class M)
74.8	Shark Creek crossing	Highway twin bridges	450	Initial (class M)
80.2	Edwards Creek	Highway twin bridges and access road bridge	16	Initial (class M)
80.6	Maclean interchange	Overpass	60	Initial (class M)
81.2	Jubilee Street	Highway twin bridges	15	Initial (class M)
Project Section 5: Maclean to Iluka Road				
83.1	Koala Drive	Highway twin bridges	30	Initial (class A)
86.2	Bridge over Clarence River	Highway 2-lane bridge	1320	Initial (class A)
87.9	Watts Lane	Overpass	40	Initial (class A)
89.3	Serpentine Channel	Highway northbound bridge	80	Initial (class A)
89.4	Serpentine Channel	Highway service road bridge	60	Ultimate (class M)
89.4	Serpentine Channel	Highway southbound bridge	60	Ultimate (class M)
90.8	Serpentine Channel Road North	Overpass	60	Initial (class A)
93.3	Carrols Lane	Overpass	70	Initial (class M)
94.0	Clarence River North Arm	Highway southbound bridge	220	Initial (class M)
95.5	Iluka Road interchange	Overpass	55	Initial (class M)

Station	Bridge location	Bridge type	Approximate length (metres)	Delivered under initial or ultimate upgrade
Project Section 6: Iluka Road to Devils Pulpit upgrade				
101.5	Tabbimoble Creek	Highway northbound bridge	130	Initial (class A)
101.5	Tabbimoble Creek	Service road bridge	130	Ultimate (class M)
102.3	Tabbimoble overflow	Service road bridge	90	Ultimate (class M)
102.9	Tabbimoble overflow	Highway northbound bridge	90	Initial (class A)
102.9	Tabbimoble overflow	Highway southbound bridge (widening only)	65	Initial (class A)
102.9	Tabbimoble overflow	Access road bridge	90	Ultimate (class M)
103.4	Bee keepers access	Overpass	90	Ultimate (class M)
Project Section 7: Devils Pulpit upgrade to Trustums Hill				
113.9	Bridge across drainage line	Highway twin bridges	15	Initial (class A)
114.3	Serendipity Road	Overpass	60	Ultimate (class M)
115.3	Tabbimoble Floodway No 1	Highway northbound bridge	90	Initial (class A)
115.3	Tabbimoble Floodway No 1	Highway southbound bridge	90	Ultimate (class M)
118.8	Tabbimoble Nature Reserve	Overpass (Land bridge)	75	Initial (class A)
121.1	Swan Bay New Italy Road	Overpass	55	Ultimate (class M)
Project Section 8: Trustums Hill to Broadwater National Park				
128.6	Woodburn interchange	Overpass	65	Initial (class M)
130.1	Tuckombil Canal	Highway twin bridges	150	Initial (class M)
131.1	Woodburn Floodway Viaduct 1	Highway twin bridges	75	Initial (class M)
132.2	Woodburn – Evans Head Road	Overpass	60	Initial (class M)
136.7	McDonalds Creek	Highway twin bridges	20	Initial (class M)

Station	Bridge location	Bridge type	Approximate length (metres)	Delivered under initial or ultimate upgrade
Project Section 9: Broadwater National Park Richmond River				
138.8	Broadwater National Park	Overpass (Land bridge)	90	Initial (class M)
139.9	Broadwater National Park	Overpass (Land bridge)	80	Initial (class M)
142.2	Bridge across drainage line	Highway twin bridges	15	Initial (class M)
142.7	Broadwater – Evans Head Road	Overpass	60	Initial (class M)
Project Section 10: Richmond River to Coolgardie Road				
145.1	Broadwater Viaduct 3	Highway twin bridges	75	Initial (class M)
145.3	Richmond River Bridge	Highway twin bridges	800	Initial (class M)
148.9	Old Bagotville Road	Overpass	55	Initial (class M)
149.2	Wardell Viaduct 4 Bingal Creek	Highway twin bridges	20	Initial (class M)
151.9	Wardell Viaduct 6	Highway twin bridges	20	Initial (class M)
152.8	Wardell Road	Overpass	80	Initial (class M)
155.4	Property access	Highway twin bridges	15	Initial (class M)
156.0	North Wardell	Overpass (Land bridge)	60	Initial (class M)
157.5	Coolgardie Road	Overpass	60	Initial (class M)
157.8	North Wardell Viaduct 7 Ravelles Creek	Highway twin bridges	20	Initial (class M)
Project Section 11: Coolgardie Road to Ballina bypass				
159.8	Whytes Lane	Overpass	55	Initial (class M)
164.7	Emigrant Creek: Smith Drive	Service road 2-lane bridge	220	Initial (class M)

Typical features of an overpass are provided in Table 5-6.

Table 5-6: Typical features of an overpass

Feature	Details
Bridge length	60 to 90 metres
Typical number of spans	2 to 4
Typical span length	12 to 30 metres
Vertical clearance	5.3 metres (minimum), 5.5 metres (desirable)
Bridge width	8 to 12 metres
Lane width	3 to 3.5 metres (x 2 lanes), shoulders 600 mm to 2 metres left and right
Pedestrian / cycleway width	1.8-metre footway (as required) to 3-metre shared path

The bridge crossings of the Clarence and Richmond rivers would have two lanes northbound and two lanes southbound. Each has been designed to accommodate three lanes of northbound and southbound traffic by upgrading the road shoulder and median if required in the future. All other bridges for the project would allow two lanes of northbound and southbound traffic but would require widening to accommodate any future upgrade to three lanes.

Cross-sections of typical waterway bridges are shown in Figure 5-98 and Figure 5-99.

Table 5-11 summarises the typical features of the proposed bridges over 300 metres long for crossings over the Corindi floodplain, Coldstream River, Shark Creek, Clarence River, and Richmond River.

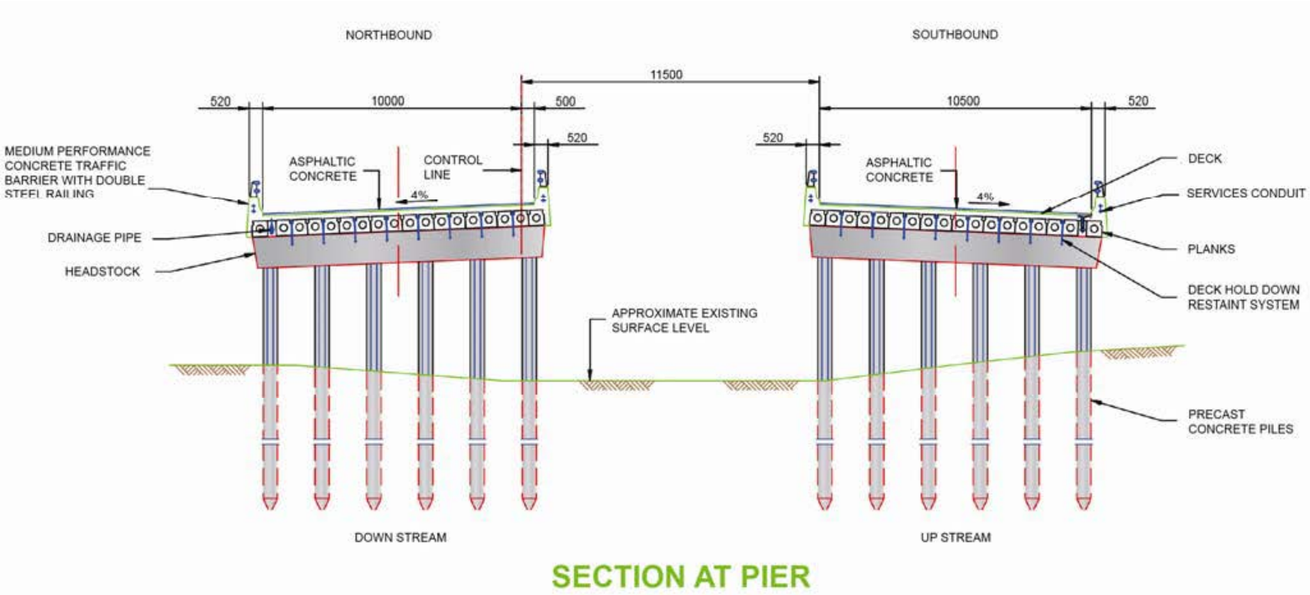

Figure 5-98: Typical plank bridge cross-section (indicative only)

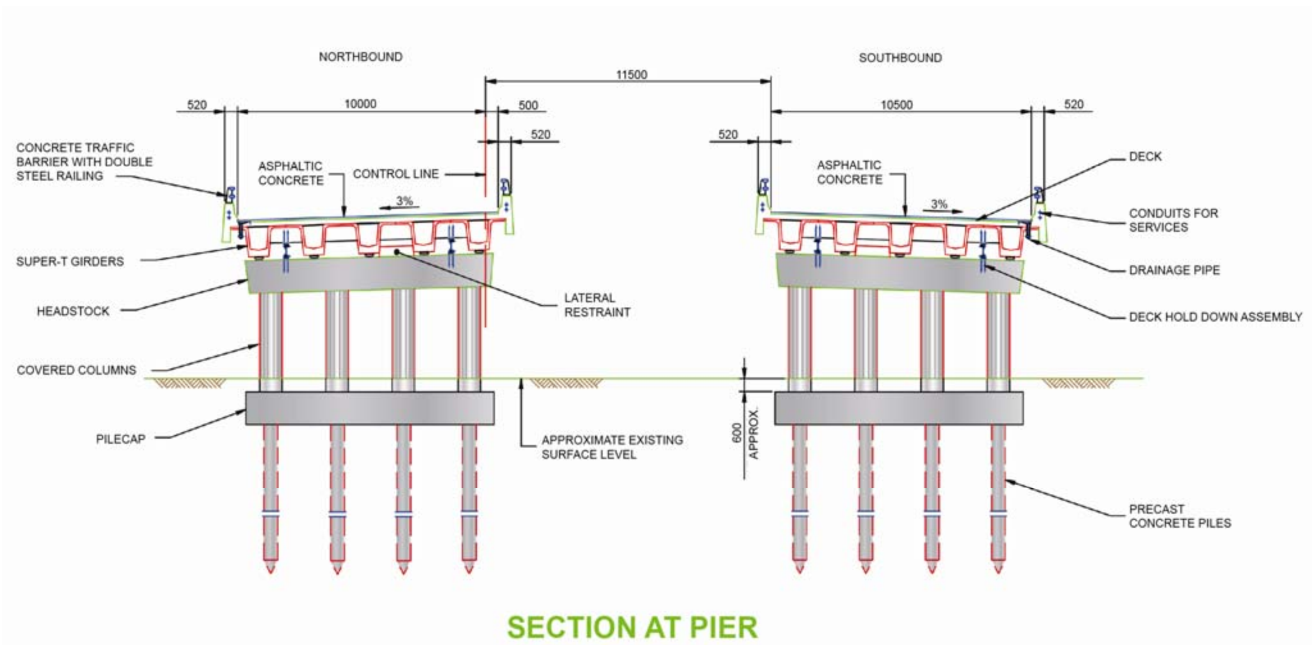

Figure 5-99: Typical Super T bridge cross section (indicative only)

Table 5-7: Typical features of the major bridges over 300 metres in length

Features	Corindi floodplain	Coldstream River No 2	Shark Creek	Clarence River	Richmond River
Approximate bridge length	300 m	316 m	450 m	1.32 km	800 m
Indicative umber of spans	20	21	14	25	11
Indicative span length	15 m	15 m	32 m	43–45 m	40.5 x 50 m approach spans to 70 m and 115 m main spans
Vertical clearance	2.2–4 m (northern end)	5.4–6.3 m	5.5 m 4.6 m minimum at local road	30 m	15 m
Lanes and lane width	2 x 3.5 m lanes 3 m outside shoulder 0.5 m median shoulder	2x 3.5 m lanes 3 m outside shoulder 0.5 m median shoulder	2 x 3.5 m lanes 3 m outside shoulder 0.5 m median shoulder	4 x 3.5 m lanes 3 m outside shoulder 0.5 m median shoulder	4 x 3.5 m lanes 3 m outside shoulder 2 m median shoulder
Indicative number of piers in waterway	No	Yes (around 10)	No	Yes (around 13)	Yes (around 6)
Pedestrian facilities	No	No	No	No	No
Bicycle facilities	Accommodated within the 2.5 m road shoulder	Accommodated within the 2.5 m road shoulder	Accommodated within the 2.5 m road shoulder	Accommodated within the 2.5 m road shoulder	Accommodated within the 2.5 m road shoulder
Other notes	Twin bridges – planks	Twin bridges – planks	Twin bridges – Super-T	Twin two-lane bridge – Super-T (over waterway) and box girder (over land)	Twin bridges – balanced cantilever

Corindi floodplain

The twin bridges across the Corindi floodplain would be about 300 metres long, with 20 spans, each 15 metres long. Each bridge would have two 3.5-metre lanes, a three-metre outside shoulder, and a 0.5-metre median shoulder.

Although the bridges would span a floodplain, there would be no permanent watercourse beneath; the bridges are required across the floodplain to allow floodwaters to pass under the highway during flood events.

Coldstream River No.2

The twin bridges over Coldstream River No.2 would be about 315 metres long, with 21 spans, each 15 metres long. The bridges would have about 10 piers within the waterway and 30 located on land. Each bridge would have two 3.5-metre lanes, a three-metre outside shoulder, and a 0.5-metre median shoulder.

(There would be two other twin bridges across the Coldstream River, as the project would cross the river in three separate locations.)

Shark Creek

The twin bridges over Shark Creek would be about 450 metres long, with 14 spans each 32 metres long. The bridges would span Shark Creek and two local access roads. No bridge piers would be located within the creek. Each bridge would have two 3.5-metre lanes, a three-metre outside shoulder, and a 0.5-metre median shoulder. The bridge would have a minimum clearance of 4.6 metres at each local access road to the underside of the structure, with about 5.5 metres over Shark Creek.

Clarence River crossing (South arm)

The proposed bridge across the Clarence River at Harwood would be located to the east of the existing bridge. The bridge would be a four-lane bridge about 1.32 kilometres long. It would have a vertical clearance about 30 metres above the river. The road level would be about 12 metres below the top of the twin towers of the existing bridge. The bridge would extend from the southern side of the river at Yamba Road. To the north of the bridge the upgraded highway would be located to the east of the existing highway and connect with the proposed interchange at Watts Lane, Harwood.

There are three options for the bridge design, which would be considered further in detailed design:

- Option 1: Precast and prestressed (super-T) concrete superstructure. This would consist of twin structures, with precast Super-T girders on the smaller 31-metre approach spans. The main spans would be between 43 metres to 45 metres long, formed from two prestressed box girders up to 2.9 metres deep. The main spans would be launched into position across the river from the northern bank. An alternative would be to use a multi-cell box girder bridge structure for the full width of 28 metres, allowing for future lanes
- Option 2: Balanced cantilever superstructure. The superstructure would be made up of either a large post-tensioned multi-cell box girder on a pier 22 metres wide, or twin box girder sections on two piers eight metres wide with a shared foundation (pile-cap and piles). The box girder would vary in depth from 3.2 to eight metres if constructed as one section 28 metres wide, or alternatively smaller twin box sections three to seven metres deep. The span lengths would match the existing bridge, with three 129.5-metre main spans and balancing outer spans 87.5 metres long

- Option 3: Cable stay superstructure. This would have a main span 270 metres long, and back spans 131 metres long, formed of a single multi-cell post-tensioned box girder about 32 metres wide. Two piers 28 metres high and 22 metres wide would support the deck. Two towers, up to 60 metres high, would accommodate the multiple cable anchorages and be formed integrally on top of the pier. The main structure would nearly cross the Clarence River in its entirety allowing Super-T girders to be used for the remaining approach span superstructures. The span lengths would be sized to coincide with the pier positions of the existing bridge (about every 43 metres). The approach spans would need to be 22 metres wide, as they would not have to accommodate the tower section.

Any bridge design that is proposed would need to meet a set of performance criteria and achieve a balance between engineering, urban design, environmental and cost considerations. The performance criteria are as follows:

- Meet RMS design standards in terms of desirable horizontal and vertical alignment
- Provide a cross-section for four lanes and consideration of future six lanes to optimise future needs
- Meet RMS standards for structural performance and maintenance
- Ensure that maximum flow velocity would not cause scour
- Consider the needs of pedestrians and bicycle users, where required
- Provide maritime navigational clearance of 30 metres
- Meet expectations for bridge aesthetics and visual requirements, while addressing the urban design and landscape design principles and objectives (described in Chapter 11 (Visual amenity, urban design and landscape))
- Be economically feasible, with costs able to be justified
- Provide an optimal construction duration with manageable construction impacts on the surrounding environment and community.

The three options represent the bridge design options that would most likely ensure the performance criteria and functional requirements could reasonably be achieved for each bridge type.

All options would have super-T approach spans for part of the structure length and post-tensioned concrete superstructures for the main spans and spill-through abutments with a batter slope of 2:1. Piers would be formed on pile-caps situated below existing ground levels for visual enhancement. Bored piles are nominated for the main spans to support the significant bridge loads, whereas either bored or driven piles can be adopted for the approach spans. Piles are required to be at least 40 metres deep due to the soft alluvial layers within the area.

In terms of spans, the main differences between the options would be that:

- Option 1 bridges would be limited to maximum spans of about 35 metres but may have cost savings
- Option 2 bridges offer the potential for longer spans of up to about 129.5 metres where necessary to meet functional requirements
- Option 3 bridges would maximise the main span to 296 metres and have towers that may reach as high as 60 metres.

All decks include three lanes in each direction for future traffic volumes. Approach spans on all options would remain as Super-T girder construction.

These bridge types would be reviewed during the detailed design stage, which may also investigate bridge types beyond those listed above. The final choice of bridge type would be based on achievement of the abovementioned performance criteria.

Cross-sections of the Clarence River crossing is shown in Figure 5-100 and Figure 5-101.

Indicative visualisations of the Clarence River crossing bridge are provided in Figure 5-102 to Figure 5-104.

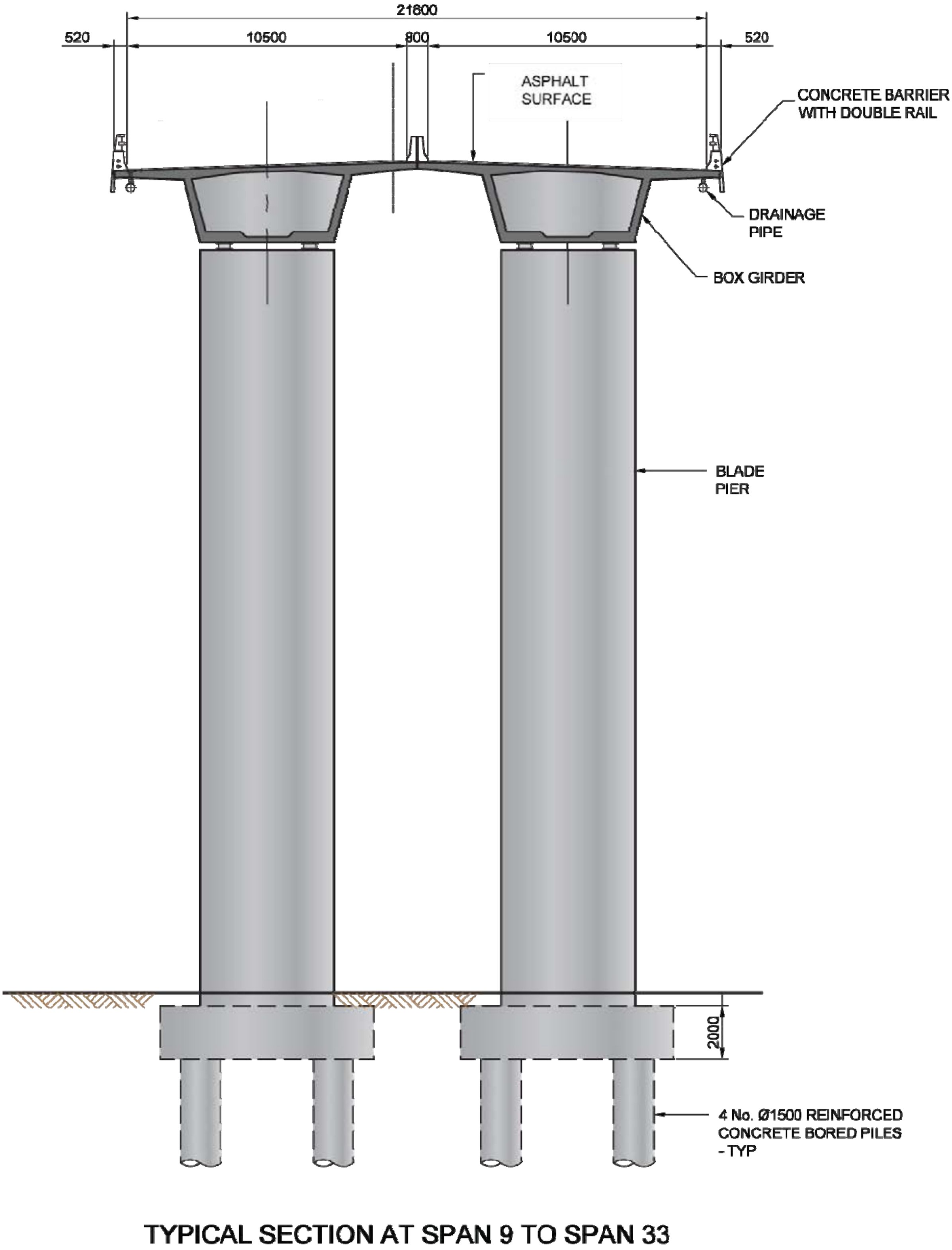

Figure 5-100: Clarence River bridge cross-section (super-T overwater span) (indicative only)

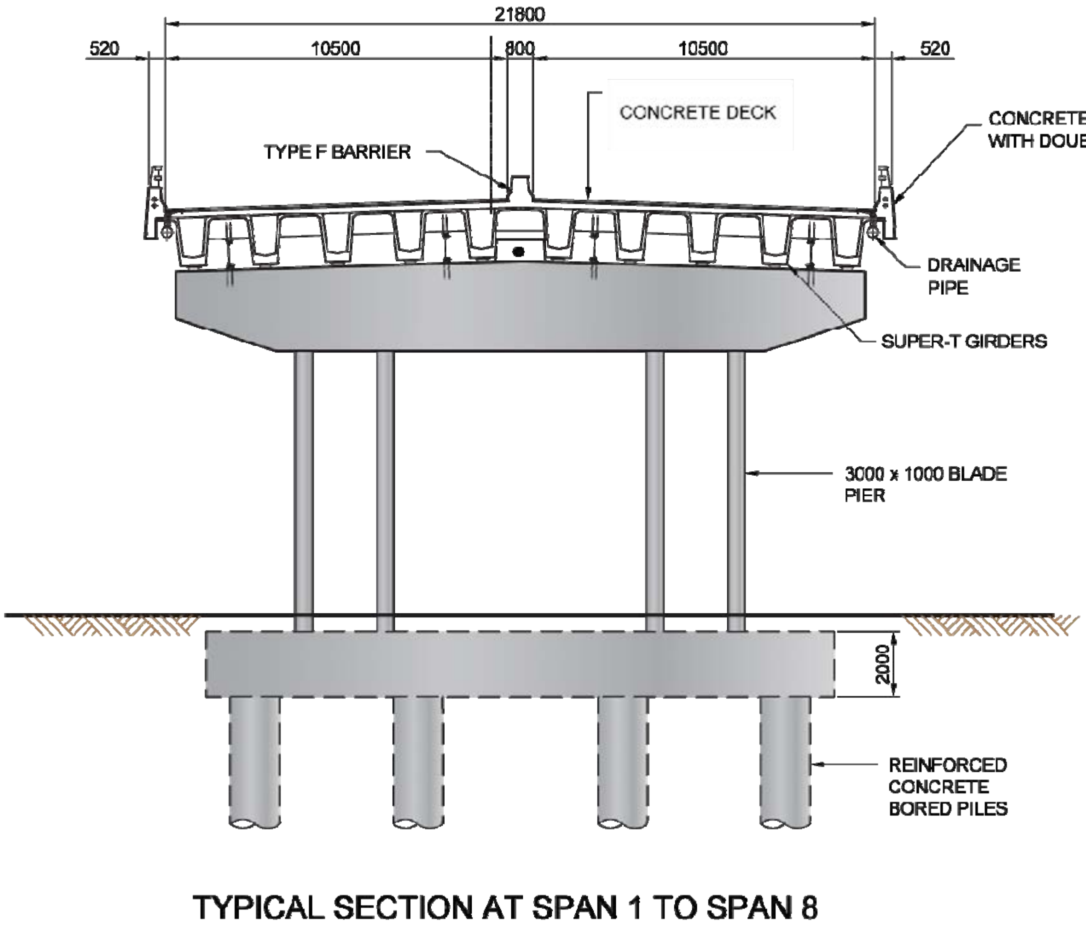

Figure 5-101: Clarence River bridge cross-section (super-T over land span) (indicative only)

Figure 5-102: Indicative visualisation of bridge structure over Clarence River (super-T option)

Figure 5-103: Indicative visualisation of bridge structure over Clarence River (super-T option) view southwest

Figure 5-104: Indicative visualisation of bridge structure over Clarence River (super-T option) view southeast

Richmond River crossing

The proposed bridge over the Richmond River would typically be a single structure about 800 metres long. The length of the bridge has been selected to keep the abutments out of the floodplain and soft soils.

The initial bridge would have two lanes each way, an outside shoulder three metres wide, two lanes 3.5 metres wide, and a median shoulder two metres wide.

The vertical alignment would provide for a 15-metre navigational clearance over the mean high water springs tide. This, together with urban design considerations, requires a more complex structure type than the other bridges.

The actual bridge arrangements would be dependent on the construction techniques of the contractor. However the bridge would be either one 60-metre opening or two 35-metre openings over the navigable channel. A feasible arrangement for this structure would be a combination of a 300-metre incrementally launched precast box girder approach viaduct with 50-metre spans on the southern bank, connecting to a main balanced cantilever structure with 115-metre main spans (70-metre back spans).

The northern abutment of the bridge would be located on the western side of Laws Hill and would have a clearance of about seven metres over Back Channel Road. The abutment has been set back from Back Channel Road to allow fauna access beneath the bridge.

A typical cross section of the crossing over Richmond River is provided in Figure 5-105.

An artist's impression of this structure is shown in Figure 5-106 and an indicative visualisation of the Richmond River with the proposed bridge is shown in Figure 5-107.

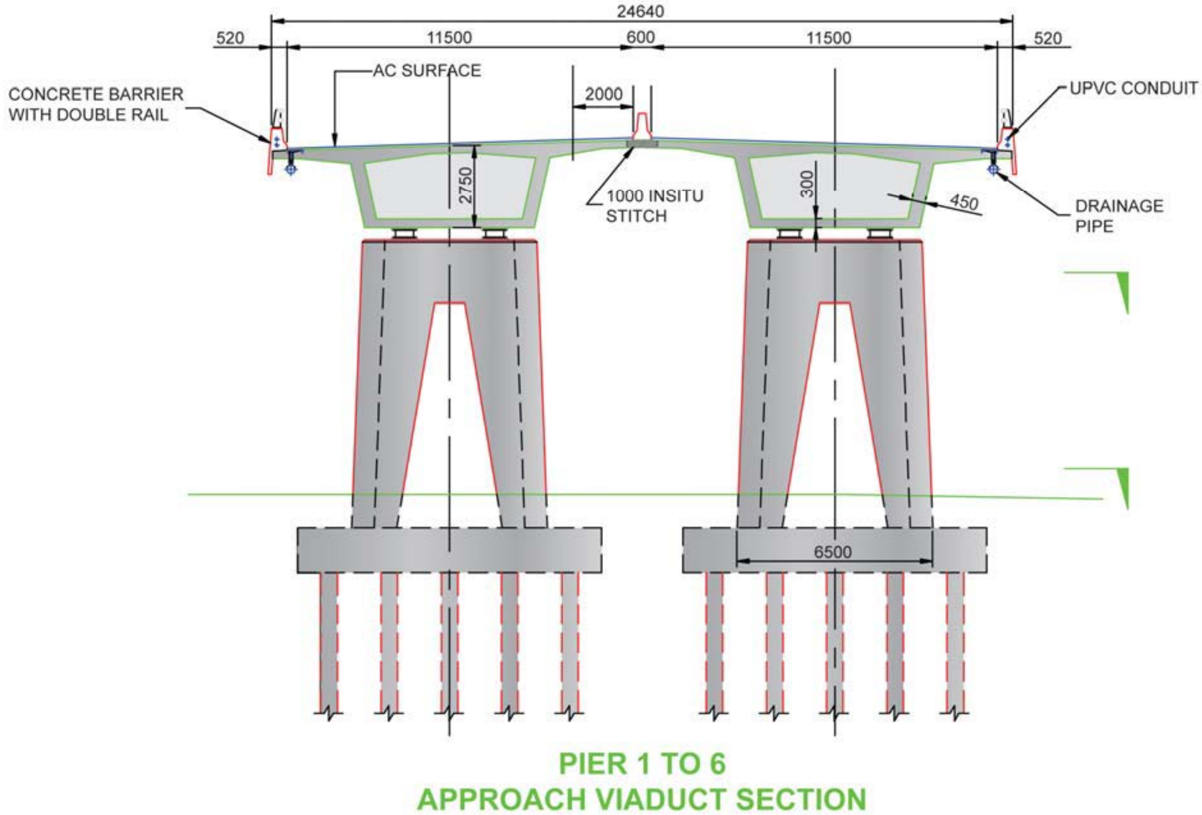

Figure 5-105: Richmond River bridge – typical cross-section (indicative only)

Figure 5-106: Artist’s impression of bridge structure over Richmond River

Figure 5-107: Indicative visualisation of bridge structure over Richmond River

5.3.6 Service roads

Service roads would provide continuous alternative routes for local and regional traffic, and access to and from the upgraded highway at interchanges. They are suitable for all classes of vehicles except oversized vehicles and B-double trucks.

Service roads would normally include two lanes, each 3.5 metres wide, with:

- Sealed shoulders 2.5 metres wide where the road is also a cycle route
- Sealed shoulders one metre wide where the road is not a cycle route
- No kerbs or gutters
- A separation distance of 25 metres (edge line to edge line) when parallel to the upgraded highway.

Service roads would generally have a posted speed limit of 80 kilometres per hour. However, posted speeds could be lower in some areas (eg in school zones). Where the existing highway becomes a service road, the posted speed limit could be up to 100 kilometres per hour. The posted design speed would be agreed with local councils.

5.3.7 Access roads

Access roads would be built to maintain access to local roads and properties that currently have direct access to the existing highway. These access roads would connect to a service road or local road, but would not have direct access to the upgraded highway.

Access roads would generally comprise two sealed travel lanes three metres wide with unsealed shoulders 0.5 metres wide.

Access roads would be signposted at either 50 or 60 kilometres per hour; the speed limit would be determined after assessing the local road environment and in consultation with local councils.

Sight distance

'Sight distance' is how far a vehicle driver can see before the line of sight is blocked by a hill crest, or an obstacle on the inside of a horizontal curve or intersection. Insufficient sight distance can have implications for the safety or operations of a roadway or intersection.

Sight distance requirements on service roads and access roads would be in accordance with the Austroads, RMS and council design guidelines, in particular:

- Stopping sight distance at all locations. (Stopping sight distance is the distance travelled while the vehicle driver perceives a situation requiring a stop, realises that stopping is necessary, applies the brake, and comes to a stop.)
- Approach sight distance to all at-grade intersections (as related to design speed)
- Headlight sight distance: The limitations of headlights on high beam of modern vehicles restrict the sight distance that can be safely assumed for visibility of an object on the roadway, to about 120 – 150 m.

Local road alterations and access details are provided in Table 5-8.

Table 5-8: Proposed alterations to local roads, and new access roads

Station	Road name and location	Proposed alteration
Project Section 1: Woolgoolga to Halfway Creek		
0.6	Sherwood Creek Road, Arrawarra	The connection to the existing Pacific Highway would be closed. The road would be deviated to the north and over the upgraded highway to a proposed service road.
0.1	Eggins Drive connection to Pacific Highway near Eggins Close	The connection to the existing Pacific Highway south of Eggins Close would be closed. Eggins Drive would form part of the service road, connecting with the service road north of Eggins Close. This would provide a connection to the upgraded highway via interchanges at Arrawarra Beach Road and Range Road.
2.5	Kangaroo Trail Road, Corindi Beach	The road would pass over the upgraded highway via a newly constructed overpass.
6.2	Corindi access road	A new access road would be provided to connect the service road to properties to the west.
4.8-7.0	Paper road along western side of project starting south of Post Office Lane, Corindi Beach, to just north of the Corindi Access Road	A new paper road would be provided to connect properties to the west of the project to the new Corindi access road. This would then connect to the service road.
9.6	Range Road, Dirty Creek	The Range Road intersection with the existing Pacific Highway would remain open. The existing highway would become the service road. Under the initial arterial road upgrade, this would provide access to the upgraded highway via the interchange at Range Road. Under the ultimate motorway upgrade, the service road would provide access to the interchange at Range Road and Glenugie.
9.6	Range Road East, Dirty Creek	Range Road East does not currently have Pacific Highway access. This would not change under the project, but the end of Range Road East would be relocated about 100 metres to the east of the project.
10.5	Dundoo Reach Road, Dirty Creek	The connection to the existing Pacific Highway would be closed. Dundoo Reach Road would connect to the interchange at Range Road to the south under the initial arterial road upgrade. In the ultimate motorway upgrade, Dundoo Reach Road would connect to the proposed service road.
11.95	Falconers Lane, Milleara	Under the initial arterial road upgrade, an intersection would be provided for Falconers Lane and the upgraded highway. This would allow left-in, left-out and right-in turns from the highway. Under the ultimate motorway upgrade, this intersection would be closed and Falconers Lane would become part of the service road.
12	The Siding, Milleara	Under the initial arterial road upgrade, The Siding would connect to the Falconers Lane intersection. Under the ultimate motorway upgrade, it would connect to the service road.

Station	Road name and location	Proposed alteration
13.2	McPhillips Road, Milleara	In the initial arterial road upgrade, an intersection would be provided for McPhillips Road and the upgraded highway. This would allow left-in, left-out and right-in turns from the highway. A new T-intersection with a northern property access road would be created about 50 metres east of the upgraded highway, Under the ultimate motorway upgrade, the intersection would be closed and the road deviated along the property access road to an overpass over the upgraded highway to the service road. The property access road would remain and connect directly to the overpass.
13.2-14.5	Property access road	A new access road would be created to provide property access to properties to the east of the project. It would run to the north of McPhillips Road and connect to McPhillips Road via an intersection. Under the ultimate motorway upgrade, it would connect directly to the overpass over the upgraded highway to the service road.
14.3	Dunmar Lane, Milleara	Under the initial arterial road upgrade, an intersection would be provided for Dunmar Lane with the upgraded highway. This would allow left-in, left-out turns to and from the highway. Under the ultimate motorway upgrade, this intersection would be closed and Dunmar Lane would connect to the western service road.
15.65	Grays Road, Milleara	There would be no change to Grays Road under the initial arterial road upgrade. Under the ultimate motorway upgrade, the intersection with the Pacific Highway would be closed, and Grays Road would be deviated to the south, crossing over the highway to connect to the service road.
15.75	Rediger Close, Milleara	Under the ultimate motorway upgrade, the Rediger Close intersection with the Pacific Highway would be closed and would connect to the western service road.
Project Section 2: Halfway Creek to Glenugie upgrade		
17.5	Lemon Tree Road, Halfway Creek	Under the initial arterial road upgrade, Lemon Tree Road would only have a left-in, left-out intersection. The left-out traffic movement would be provided by a new access road to the south-east that would connect into an existing merge lane to the southbound carriageway. A new intersection to a property access road to the north-east would also be created. Under the ultimate motorway upgrade, access to the upgraded highway would be removed. Lemon Tree Road would be deviated along the property access road to an overpass over the upgraded highway. This would connect with the western service road.
17.5 -18.5	Property access road	A new access road would be created to provide property access to properties to the east of the project. It would run to the north of Lemon Tree Road and connect to Lemon Tree Road via an intersection. At station 18.4 on the property access road, another left-in, left-out, right-in connection would be provided. Under the ultimate motorway upgrade, the road would connect directly to the overpass over the upgraded highway to the service road, with the intersection to the highway at station 18.4 removed.
20.3	Kungala Road, Halfway Creek	Under the initial arterial road upgrade, Kungala Road would connect with the upgraded highway through a left-in, left-out and right-in arrangement. Under the ultimate motorway upgrade, the intersection would be closed, and Kungala Road would form a T-intersection with the western service road.
20.8	Luthers Road, Halfway Creek	Under the initial arterial road upgrade, Luthers Road would be deviated to the north, with a left-in, left-out and right-in intersection with the upgraded highway. Under the ultimate motorway upgrade, the intersection would be closed and the road would pass under the upgraded highway via an underpass to the western service road.

Station	Road name and location	Proposed alteration
23.5	Parker Road, Wells Crossing	Under the initial arterial road upgrade, Parker Road would connect with the upgraded highway with a left-in, left-out and right-in intersection. Under the ultimate motorway upgrade, the intersection would be closed and the road would connect via a T-intersection to the western service road.
25.1	Bald Knob Tick Gate Road, Wells Crossing	Under the initial arterial road upgrade, Bald Knob Tick Gate Road would be deviated to the north, with a left-in, left-out and right-in intersection with the upgraded highway. Under the ultimate motorway upgrade, the intersection would be closed. Bald Knob Tick Gate Road would be straightened to pass over the upgraded highway via an overpass. This would connect to the western service road.
28	Franklins Road, Glenugie	Under the initial arterial road upgrade, Franklins Road would be deviated to the north, with a left-in, left-out and right-in intersection with the upgraded highway. Under the ultimate motorway upgrade, the intersection would be closed. Franklins Road would be straightened to pass over the upgraded highway via an overpass to the western service road.
31.2	Old Pacific Highway (southern connection), Glenugie	The left-in, left-out intersection with the Glenugie upgrade would be closed and realigned. It would form part of the service road.
Project Section 3: Glenugie upgrade to Tyndale		
36	Eight Mile Lane, Glenugie	The road would be straightened to pass over the upgraded highway via a newly constructed overpass.
38.3	Old Six Mile Lane, Lavadia	The road would pass over the upgraded highway via a newly constructed overpass. To the west of the upgraded highway, a new access road would connect to the existing Old Six Mile Lane near Chevalley Lane. A new access road to run alongside the northern extent of the project would be constructed, connecting with the existing Avenue Road. To the east, a new access road would realign the road for about one kilometre, connecting back into the existing Old Six Mile Lane.
41.4	Avenue Road, Lavadia	The road would pass over the upgraded highway via an overpass. Two new intersections would be created. One would connect the access road to the north of the project with Avenue Road and the other would connect Wants Lane to the east.
41.8	Wants Lane, Lavadia	Wants Lane would be realigned to the south and connect to Avenue Road.
45.5	Wooli Road, Pillar Valley	The road would pass over the upgraded highway via an overpass.
48.8	Mitchell Road, Pillar Valley	The road would pass under the upgraded highway and would be realigned slightly south.
51.9	Firth Heinz Road, Tucabia	The road would pass over the upgraded highway via an overpass. The road would be realigned east of the project.
55.5	Bostock Road, Tucabia	The road would pass over the highway via an overpass.
56.9	Somervale Road, Tucabia	The road would pass under the highway via an underpass.
58.6	Property access road	The road would pass under the highway via an underpass.

Station	Road name and location	Proposed alteration
61.0	Property access road	The road would pass under the highway via an underpass.
63.6	Property access road	The road would pass over the highway via an overpass.
64.9	Crowley Road, Tyndale	The road would pass over the highway via an overpass. A minor realignment would be provided.
66.6	Benson Lane, Tyndale	Bensons Lane would be realigned to the east of the project, with a new intersection at the interchange at Tyndale. This would provide access to the upgraded highway and the existing Pacific Highway (which would become the service road).
67.2	Sheehys Lane, Tyndale	Sheehys Lane would become a cul-de-sac at the Benson Lane intersection. Access to the existing highway would remain unchanged.
Project Section 4: Tyndale to Maclean		
69.4	Connection to Bondi Hill Road, Tyndale	The road would pass over the upgraded highway via an overpass. The road would be deviated to the north.
69.4- 71.1	Bondi Hill Road, Tyndale	A new connection to Byrons Lane would be provided south of the upgraded highway to provide access to properties to the south of the project.
71.2	Byrons Lane, Tyndale	The road would pass over the upgraded highway via an overpass.
74.05-74.95	Norleys Lane, Shark Creek	Norleys Lane would not have access to the project. The connection would be closed either side of the highway. Norleys Lane to the west of the project has direct access to the existing Pacific Highway. To the east, Norleys Lane would be realigned along the project length, before connecting to Gallaghers Lane in the north.
74.95	Gallaghers Lane, Shark Creek	Gallaghers Lane would pass under the bridge at Shark Creek.
75.2	Shark Creek Road, Shark Creek	Shark Creek Road would pass under the bridge at Shark Creek.
77	McIntyres Lane, Gulmarrad	McIntyres Lane would be closed either side of the project, with no access to the highway. To the west of the project, McIntyres Lane would still have direct access to the existing Pacific Highway. To the east, McIntyres Lane would connect to an eastern access road, which would connect to the interchange at Maclean.
77.8	Clyde Essex Drive, Gulmarrad	The paper road ends about 160 metres east of the project and would therefore remain unchanged.
80.45	Cameron Street, Maclean	The Cameron Street intersection with the existing highway would be realigned slightly to the north.
80.55	Goodwood Street, Maclean	Goodwood Street would be realigned south, connecting to the east and west of the interchange at Maclean, and passing over the highway.
81.2	Jubilee Street, Maclean	Jubilee Street would be closed either side of the upgraded highway. However, pedestrians and cyclists would be able to pass under the highway via an underpass. To the west of the project, access to Maclean would be unchanged. On the eastern side, Jubilee Street would connect to the interchange at Maclean.

Station	Road name and location	Proposed alteration
Project Section 5: Maclean to Iluka Road		
83.1	Koala Drive/Farlows Lane, Maclean	Koala Drive/Farlows Lane would pass under the upgraded highway via an underpass.
86.2	Yamba Road, Maclean	There would be no change to Yamba Road, which would pass under the bridge over the Clarence River.
86.9	River Street, Harwood	There would be no change to River Street, which would pass under the bridge over the Clarence River.
87	Petticoat Lane, Harwood	Petticoat Lane would be closed where it meets the upgraded highway.
87.8	Watts Lane, Harwood	Watts Lane would pass over the upgraded highway, forming part of the interchange at Harwood.
89.06	Anderson Lane, Harwood	Under the initial arterial road upgrade, the Andersons Lane intersection with the Pacific Highway would be removed. A new southern access road would connect the road to the interchange at Harwood. Under the ultimate motorway upgrade, it would connect to the service road, following the alignment of the southern access road and new road north of the intersection.
89.3	Serpentine Channel Road South, Harwood	Under the initial arterial road upgrade, Serpentine Channel Road South would have a left-in, left-out intersection with the Pacific Highway. A new property access road would be constructed south of the intersection to provide access to properties to the east of the project. Under the ultimate motorway upgrade, the southern access road would be continued to the interchange at Harwood to provide access to the project.
90	Ryans Lane, Chatsworth	Under the initial arterial road upgrade, Ryans Lane would connect to a new northern access road, connecting it to Chatsworth Road and to the highway via a left-in, left-out intersection. Under the ultimate motorway upgrade, the access road would be extended further south to form the service road and the left-in, left-out intersection with the highway would be removed. Ryans Lane would then connect to the service road.
90.8	Chatsworth Road/Serpentine Channel Road North, Chatsworth	Chatsworth Road would pass over the upgraded highway. Under the initial arterial road upgrade, two new left-in, left-out intersections would be created with the highway (one for the northbound carriageway and one for the southbound carriageway). A new access road to the west of the highway would connect Chatsworth Road with the Ryans Lane northern access road. Under the ultimate motorway upgrade, another intersection would connect Chatsworth Road to the service road.
93.3	Carrols Lane, Chatsworth	Carrolls Lane would pass over the upgraded highway, and connect to a proposed service road. To the east of the project, an access road would be constructed to connect to Fischers Road. Under the initial arterial road upgrade, this access road would also provide a left-in, left-out intersection with the highway. Under the ultimate motorway upgrade, the intersection would be removed. To the west of the project, a southern intersection would provide a left-in, left-out intersection with the highway. This would be removed as part of the ultimate motorway upgrade. Under the ultimate motorway upgrade, Carrols Lane would connect with the service road.
93.85	Chatsworth Road, Chatsworth	Chatsworth Road would connect to the service road.
93.85	Fischer’s Road, Chatsworth	Fischers Road would be deviated to the south and connect to Carrols Lane.
94.5	Garretts Lane East, Woombah	Garretts Lane East would deviate to the north along a new access road and the Old Pacific Highway to connect to Iluka Road.

Station	Road name and location	Proposed alteration
94.7	Garretts Lane/Lewis Lane, Mororo	Garretts Lane would connect to the western service road.
95.45	Iluka Road, Woombah	Iluka Road would pass over the upgraded highway, forming part of the interchange at Iluka Road and the access road / service road to the west.
96.05	Banana Road, Mororo	The existing intersection with the Pacific Highway would be closed. The road would be deviated along a new access road to the south, connecting to the interchange at Iluka Road. Under the ultimate motorway upgrade, a service road would be constructed to the west of the highway and form an intersection with Banana Road.
Project Section 6: Iluka Road to Devils Pulpit upgrade		
98.4	Mororo Road, Mororo	Under the initial arterial road upgrade, Mororo Road would have a left-in, left-out, right-out turn intersection. A formalised bus turning bay would be provided to the north of the intersection. Under the ultimate motorway upgrade, Mororo Road would connect to the western service road.
102.5	Property access road	This road would have a left-in, left-out intersection with the highway under the initial arterial road upgrade, which would be closed under the ultimate motorway upgrade, and would connect with the service road.
102.7	Tullymorgan – Jacky Bulbin Road	Under the initial arterial road upgrade, Tullymorgan – Jacky Bulbin Road would connect to the highway via an intersection providing left-in, right-in, left-out traffic movements. This would be removed under the ultimate motorway upgrade and would connect to the service road.
102.7-103.4	Old Pacific Highway, Mororo	Under the ultimate motorway upgrade, Old Pacific Highway would form part of the service road.
Project Section 7: Devils Pulpit upgrade to Trustums Hill		
114.3	Serendipity Road, Tabbimoble	Under the initial arterial road upgrade, Serendipity Road would be deviated south, connecting with the highway at a left-in, right-in and left-out intersection. This intersection would be removed as part of the ultimate motorway upgrade. Serendipity Road would be straightened and pass over the upgraded highway, to connect to the service road.
114.5	Glencoe Road, Tabbimoble	Under the initial arterial road upgrade, Glencoe Road would connect to the highway via a left-in, left-out intersection. Under the ultimate motorway upgrade, this intersection would be closed and the road would connect to the service road to the south.
118.8	Minyumai Road, New Italy	Under the initial arterial road upgrade, Minyumai Road would be deviated to the north along a new access road to a left-in, left-out intersection with the highway. Under the ultimate motorway upgrade, Minyumai Road would connect to the service road.

Station	Road name and location	Proposed alteration
119.5	Cypress Road, New Italy	Under the initial arterial road upgrade, Cypress Road would connect to the highway via a left-in, right-in, left-out intersection. Under the ultimate motorway upgrade, this intersection would be removed. Cypress Road would connect with Swan Bay New Italy Road via an access road on the western side of the upgrade.
121.1	Swan Bay New Italy Road, New Italy	Under the initial arterial road upgrade, Swan Bay New Italy Road would connect to the highway via a left-in, right-in, left-out and right-out intersection. Under the ultimate motorway upgrade, this intersection would be removed. Swan Bay New Italy Road would connect to the service road on the eastern side of the upgrade via an overpass.
122.8	Whites Road, New Italy	Under the initial arterial road upgrade, the road would be deviated to the west to a left-in, right-in and left-out intersection with the highway. Under the ultimate motorway upgrade, this intersection would be removed. Whites Road would connect to Swan Bay New Italy Road via an access road on the western side of the upgrade.
122.9	Red Gate Road/Turners Road, New Italy	Under the initial arterial road upgrade, these roads would maintain their existing intersections with the Pacific Highway, which becomes an access road and closed at the southern end. Access onto the upgraded highway would be via a left-in, left-out intersection to the north. Under the ultimate motorway upgrade, the intersection would be removed and the roads would connect directly to the service road on the eastern side of the upgrade.
124.8	Nortons Road, New Italy	Under the initial arterial road upgrade, Nortons Road would connect to the highway via a left-in, left-out, right-out intersection. Under the ultimate motorway upgrade, this intersection would be removed. Nortons Road would connect to the service road on the eastern side of the upgrade.
Project Section 8: Trustums Hill to Broadwater National Park		
127	The Gap Road, Woodburn	Under the initial arterial road upgrade, The Gap Road would maintain its existing intersection with Tuckombil Road. Under the ultimate motorway upgrade, Tuckombil Road would form part of the service road. The road would connect to the proposed service road.
127.5	Wondawee Way, Woodburn	The road would connect to a western access road and the interchange at Woodburn.
127.5	Sharpe Road, Woodburn	Under the initial arterial road upgrade, Sharpe Road would maintain its existing intersection with Tuckombil Road. Under the ultimate motorway upgrade, Tuckombil Road would form part of the service road.

Station	Road name and location	Proposed alteration
127.3	Tuckombil Road, The Gap	At Tuckombil Road, a minor realignment would be required.
129	Trustums Hill Road, Woodburn	The end of Trustums Hill Road would be relocated about 100 metres to the north of the project. No direct access would be provided to the upgraded highway.
129.3	Pacific Highway, Trustums Hill/Woodburn	This section of the Pacific Highway would form part of the service road and would connect via an access road to the interchange at Woodburn.
132.1	Woodburn – Evans Head Road, Woodburn	Woodburn – Evans Head Road would deviate slightly to the north and pass over the upgraded highway.
Project Section 9: Broadwater National Park to Richmond River		
137.2-140.7	Pacific Highway, Woodburn, Rileys Hill and Broadwater (through Broadwater National Park)	The project would deviate this section of the highway to the north. This existing highway would then become part of the service road.
142.7	Evans Head – Broadwater Road, Broadwater	The road would pass over the upgraded highway, forming part of the interchange at Broadwater. A new intersection to the north would be provided to connect to Rifle Range Road, which would be closed to the east of the project.
143.4	Broadwater Quarry Road, Broadwater	Broadwater Quarry Road would be closed west of the project. A new access road north would connect the road to operating quarries.
145.6	Pacific Highway, Broadwater	The existing highway would pass under the bridge over the Richmond River.
Project Section 10: Richmond River to Coolgardie Road		
146	Back Channel Road, Wardell	Back Channel Road would pass under the bridge over the Richmond River.
148.9	Old Bagotville Road	Old Bagotville Road would be deviated along the western side of the project to an overpass over the highway.
149	Montis Road	Montis Road would be deviated along the western side of the project to connect with the overpass over the highway and Old Bagotville Road.
151.25	Thurgates Lane	To the west of the project, an access road would be constructed to connect Thurgates Lane, Hillside Lane, Lumley Lane and Wardell Road. To the east of the project, Thurgates Lane would be closed with no access to the highway.
152.8	Hillside Lane	To the west of the project, an access road would be constructed to connect Thurgates Lane, Hillside Lane, Lumley Lane and Wardell Road.
152.9	Wardell Road	Wardell Road would be deviated slightly north and over the upgraded highway via an overpass.
154.35	Lumleys Lane	To the west of the project, an access road would be constructed to connect Thurgates Lane, Hillside Lane, Lumley Lane and Wardell Road. Lumleys Lane would be closed to the east of the project. The existing connection to Wardell from the east of the project would remain.

Station	Road name and location	Proposed alteration
157.5	Kays Road	The Kays Road intersection with Coolgardie Road would be closed and a new intersection constructed with the existing Pacific Highway.
157.5	Coolgardie Road, Wardell	Coolgardie Road would pass over the upgraded highway via an overpass, forming part of the interchange at Wardell.
Project Section 11: Coolgardie Road to Ballina bypass		
159.83	Whytes Lane, Pimlico	Whytes Lane would be realigned to the south, connecting with the service road. A new intersection would be created to an overpass to provide connection to McAndrews Lane to the west.
159.8	McAndrews Lane, Pimlico	The road would pass over the upgraded highway, connecting to Whytes Lane and the service road. To the west of the project, McAndrews Lane would have a new intersection connecting to Whytes Lane West.
160	Whytes Lane West, Pimlico	The road would be deviated to a southern access road to provide a connection to McAndrews Lane.
164.3	Pimlico Road, Pimlico	Pimlico Road would not connect with the highway and would be closed. A new bridge across from Smiths Drive would provide an intersection with Pimlico Road.
164.7	Smiths Drive	Smiths Drive would cross Emigrant Creek to Pimlico Road to form part of the service road.

5.3.8 Drainage and flood protection

Drainage

The project would include a longitudinal system of drains, pits and pipes designed to remove surface water from the travel lanes as quickly as possible. Cross-drainage (to transfer surface water under the project) would be provided by box or pipe culverts or bridges. Culverts have generally been designed to follow the existing waterway alignment to minimise potential for bank erosion, which could result from culverts being set on a skewed alignment to the project.

Appropriate scour protection would be provided on both upstream and downstream ends of all structures where increased velocities have the potential to cause scour. Scour protection measures would be designed during the detailed design phase based on peak inlet/outlet velocity and would be dependent on the characteristics of the culvert flows. Typically, a headwall and apron would be sufficient to protect against scour when the outlet velocities are low. However, watercourses with high velocity flows may require devices to slow the flow at the culvert entry or outlet and protect the streambed.

Runoff entering the project would be collected in a catch drain at the top of cuttings, or a toe drain at the bottom of batters, and diverted to a watercourse or culvert.

The highway pavement drainage system would cater for runoff from the pavement surface, cut batters and the median.

Bridge deck drainage systems would discharge to the highway pavement drainage system and would avoid direct discharge into the watercourse. Piped drainage in the bridge superstructure would provide adequate drainage of surface water from the bridges.

Flood relief structures

A flooding and hydrology assessment has been undertaken to inform the concept design (see Working Paper – Hydrology and flooding).

Drainage beneath the project would convey surface water runoff with sufficient capacity to convey floodwaters up to a certain level. Drainage has been designed to cater for a 1 in 20-year flood across the Clarence and Richmond river floodplains (for at least one carriageway). At all other locations across the project, drainage has been designed to cater for a 1 in 100-year flood.

In addition to the major bridge structures across the main watercourses, the project would include flood relief structures on the Clarence and Richmond river floodplains. The type of structures to be installed in these areas may be pipe or box culverts or bridge structures or a combination of these. These structures would act as cross-drainage features conveying flood waters from one side of the upgraded highway to the other. Table 5-9 identifies the location of major flood relief culvert structures. These are shown in Figure 5-108 and Figure 5-109.

Across the project, other smaller culverts would also perform the same function. Bridge structures across floodplains are identified in Table 5-5.

Table 5-9: Flood relief structures: culvert banks

Project section	Approximate station	Location
5	87.5 to 94.3	On the Chatsworth Island floodplain
8, 9, 10	131.2 to 136.8	On the mid Richmond River floodplain
11	162.7 to 164.0	On the lower Richmond River floodplain

The final size, location and type of structure would be refined during the detailed design stage. The potential flooding impacts and associated management measures are discussed in Chapter 8 (Hydrology and flooding).

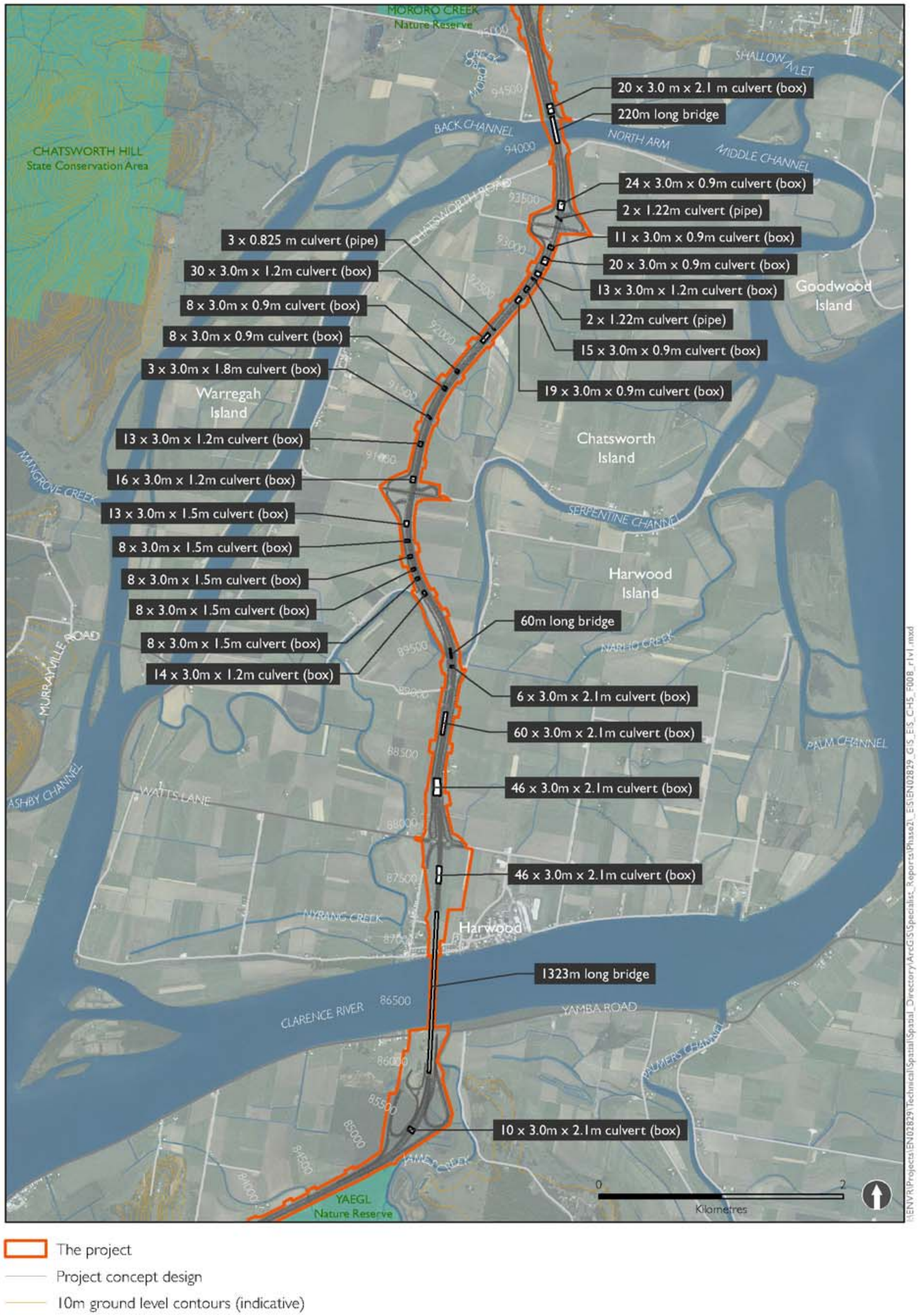

Figure 5-108: Location of typical flood relief structures- Chatsworth Island floodplain

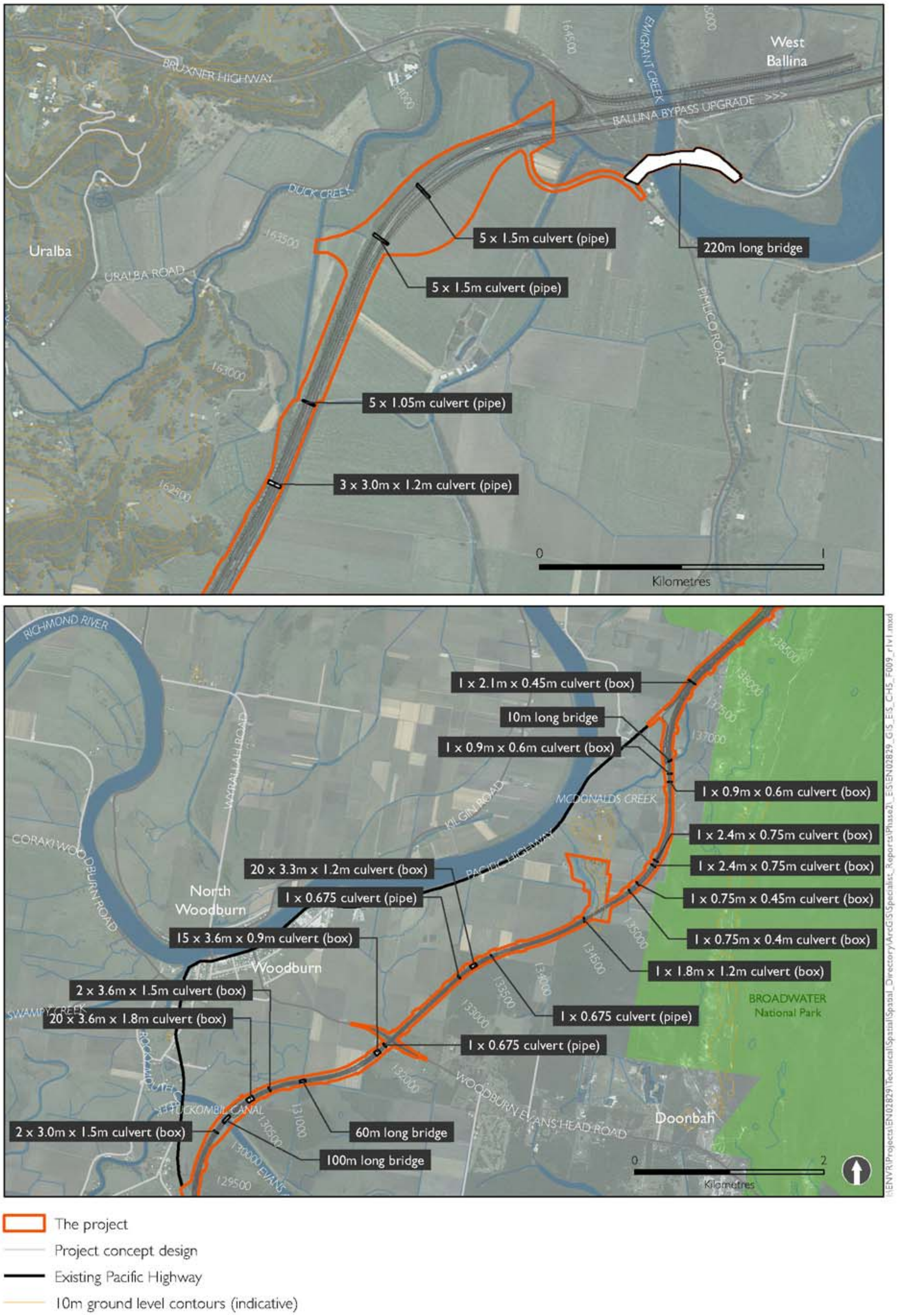

Figure 5-109: Location of typical flood relief structures- Richmond River floodplain

5.3.9 Fauna crossing structures

Structures would be provided to connect habitat either side of the upgrade and allow fauna to cross under and over the project. The fauna crossing structures would include:

- Dedicated fauna underpasses
- Dedicated fauna overpasses (land bridges)
- Dedicated aerial crossings (rope ladders and glider poles)
- Widened medians
- Combined drainage and fauna crossing structures/culverts. These structures would allow fauna to pass through and convey drainage at the same time and may be bridges, arches or culverts.

The dimensions and general locations of dedicated and combined fauna crossings are listed in Table 5-10. This table also identifies those structures which have been designed in consideration of emu passage.

Table 5-10: Fauna crossing structures

Station	Structure type	Approximate dimensions (m)	Function
Project section 1			
1.5	Rope or timber poles	65 metres long	Dedicated arboreal crossing
2.1	2 cell culvert	3 x 2.4	Combined drainage and fauna structure
3.5	Corindi Creek bridge	90 metres long	Combined drainage and fauna structure
4.0	Corindi floodplain bridge	300	Combined drainage and fauna structure
4.7	Cassons Creek bridge	76 metres long	Combined drainage and fauna structure
5.6	1 cell culvert (service road)	2.4 x 1.2	Combined drainage and fauna structure
5.7	2 cell culvert (highway)	2.4 x 0.9	Combined drainage and fauna structure
6.8	1 cell culvert	3 x 3	Dedicated fauna underpass
7.3	1 cell culvert	3 x 3	Combined drainage and fauna structure
8.5	1 cell culvert	3 x 3	Dedicated fauna underpass
10.7	2 cell culvert	3 x 3	Combined drainage and fauna structure
11.8	1 cell culvert	3 x 3	Dedicated fauna underpass
12.3	1 cell culvert	3 x 3	Combined drainage and fauna structure
12.8	Rope or timber poles	65 metres long	Dedicated arboreal crossing
12.9	1 cell culvert	3 x 3	Combined drainage and fauna structure
13.3	2 cell culvert	3 x 3	Combined drainage and fauna structure
13.8	1 cell culvert	3 x 3	Combined drainage and fauna structure
14.3	2 cell culvert	3 x 3	Combined drainage and fauna structure
Project section 2			
17.0	Rope or timber poles	65 metres long	Dedicated arboreal crossing
20.7	4 cell culvert	3 x 2.4	Combined drainage and fauna structure
20.7	Halfway Creek bridge	50 metres long	Combined drainage and fauna structure
20.9	1 cell culvert	3 x 2.4	Combined drainage and fauna structure
21.3	1 cell culvert	3 x 3	Combined drainage and fauna structure
22.4	Wells Crossing bridge	60 metres long	Combined drainage and fauna structure
23.1	1 cell culvert	3 x 2.4	Dedicated fauna underpass
24.6	1 cell culvert	3 x 2.4	Combined drainage and fauna structure
26.0	1 cell culvert	3 x 2.4	Dedicated fauna underpass

Station	Structure type	Approximate dimensions (m)	Function
27.4	1 cell culvert	3.6 x 2.4	Combined drainage and fauna structure
Project section 3			
35.2	2 cell culvert	2.4 x 2.4	Combined drainage and fauna structure
36.4	Pheasant Creek bridge	75 metres long	Combined drainage and fauna structure
37.3	2 cell culvert	2.4 x 2.4	Combined drainage and fauna structure
39.7	11 cell culvert	3.0 x 1.2	Combined drainage and fauna structure
42.6	Coldstream River 1 bridge	135 metres long	Combined drainage and Emu structure
43.2	Coldstream River 2 bridge	315 metres long	Combined drainage and Emu structure
43.9	Coldstream River 3 bridge	180 metres long	Combined drainage and Emu structure
45.5	Wooli Road overpass	60 metres long	Incidental Emu Structure (road overpass)
46.1	Pillar Valley Creek 1 bridges (x2)	100 metres long	Combined drainage and Emu structure
46.4	Pillar Valley Creek 2 bridges	100 metres long	Combined drainage and Emu structure
46.7	Pillar Valley Creek 3 bridges	75 metres long	Combined drainage and Emu structure
47.7	Pillar Valley Creek 4 bridge	75 metres long	Combined drainage and Emu structure
48.1	Rope or timber poles	65 metres long	Dedicated arboreal crossing
48.8	Mitchell Road underpass	36 metres long	Incidental Emu Structure (road underpass)
49.3	North of Pillar Valley 1 bridge	120 metres long	Combined drainage and Emu structure
50.3	North of Pillar Valley 2 bridge	45 metres long	Combined drainage and Emu structure
50.5	Rope or timber poles	65 metres long	Dedicated arboreal crossing
51.4	1 cell culvert	2.4 x 3.6	Combined drainage and fauna structure
51.9	Firth Heinz Road overpass	60 metres long	Incidental Emu Structure (road overpass)
52.5	Chaffin Creek bridge	75 metres long	Combined drainage and Emu structure
52.6	6 cell culvert	3.6 x 2.1	Combined (fauna and emu)
53.7	1 cell culvert	3.6 x 3.6	Combined (fauna and emu)
53.9	Rope or timber poles	65 metres long	Dedicated arboreal crossing
54.7	North of Chaffin Creek bridge	90 metres long	Combined drainage and Emu structure
55.5	Bostock Road overpass	60 metres long	Incidental Emu Structure (road overpass)
56.9	Somervale Road underpass	30 metres long	Incidental Emu Structure (road underpass)
57.0	Champions Creek bridge	90 metres long	Combined drainage and Emu structure
58.7	North of Champions Creek bridge	75 metres long	Combined drainage and Emu structure
59.3	1 cell arch culvert	Min 5.5 high	Combined drainage and Emu structure
60.8	1 cell arch culvert	Min 5.5 high	Combined drainage and Emu structure
61.0	Property access bridge	35 metres long	Incidental Emu Structure (road underpass)
63.6	Property access overpass	100 metres long	Incidental Emu Structure (road overpass)
64.5	1 cell arch culvert	Min 5.5 high	Combined drainage and Emu structure
64.9	Crowleys Road property access overpass	60 metres long	Incidental Emu Structure (road overpass)
66.2	1 cell arch culvert	Min 4.0 high	Dedicated Emu Structure

Station	Structure type	Approximate dimensions (m)	Function
Project section 4			
70.5	Tyndale Cane Drain 1 bridge	15 metres long	Combined drainage and fauna structure
74.8	Shark Creek bridge	450 metres long	Combined drainage and fauna structure
75.6	1 cell culvert	3.6 x 2.4	Combined (fauna and emu)
75.9	Rope or timber poles	metres long	Dedicated arboreal crossing
76.5	1 cell culvert	2.4 x 2.4	Combined drainage and fauna structure
Project section 5			
83.1	Koala Drive bridge	30 metres long	Combined access and fauna structure
94.0	Clarence River North Arm bridge	220 metres long	Combined drainage and fauna structure
Project section 6			
99.7	1 cell culvert	3.0 x 2.4	Dedicated fauna underpass
100.6	1 cell culvert	2.4 x 1.8	Combined drainage and fauna structure
101.1	1 cell culvert	3.0 x 2.4	Dedicated fauna underpass
101.5	Tabbimoble Creek bridge	130 metres long	Combined drainage and fauna structure
Project section 7			
111.6	Rope or timber poles	metres long	Dedicated arboreal crossing
113.9	Bridge	15 metres long	Combined (Oxleyan Pygmy Perch)
115.3	Tabbimoble Floodway No 1 bridge	90 metres long	Combined drainage and fauna structure
116.4	Rope or timber poles	65 metres long	Dedicated arboreal crossing
118.8	Tabbimoble Nature Reserve land bridge	75 metres long	Dedicated fauna overpass
122.6	3 cell culvert	3.0 x 2.4	Combined drainage and fauna structure
123.6	4 cell culvert	3.0 x 2.4	Combined drainage and fauna structure
Project section 8			
130.1	Tuckombil Canal bridge	150 metres long	Combined drainage and fauna structure
131.1	Woodburn Floodway Viaduct 1 bridge	75 metres long	Combined drainage and fauna structure
134.6	1 cell culvert	1.8 x 1.2	Combined drainage and fauna structure
136.7	MacDonalds Creek bridge	20 metres long	Combined drainage and fauna structure
Project section 9			
138.4	1 cell culvert	1.2 x 1.2	Dedicated frog and small mammal underpass
138.8	Broadwater National Park land bridge 1	90 metres long	Dedicated fauna overpass
139.4	Culvert	1.2 x 1.2	Dedicated frog and small mammal underpass
139.9	Broadwater National Park land bridge 2	80 metres long	Dedicated fauna overpass
140.6	Rope or timber poles	150 metres long	Dedicated arboreal species
142.2	Twin bridges	15 metres long	Combined drainage and fauna structure
143.2	3 cell culvert	2.4 x 0.45	Combined drainage and fauna structure
143.8	1 cell culvert	3.6 x 1.2	Combined drainage and fauna structure

Station	Structure type	Approximate dimensions (m)	Function
Project section 10			
145.1	Broadwater viaduct 3	75 metres long	Combined drainage and fauna structure
145.3	Richmond River bridge	790 metres long	Combined drainage and fauna structure
146.4	2 cell culvert	3 x 3	Combined (Oxleyan Pygmy Perch)
149.2	Wardell viaduct 4: Bingal Creek	20 metres long	Combined drainage and fauna structure
150.0	3 cell culvert	3.6 x 1.5	Combined drainage and fauna structure
150.5	1 cell culvert	2.4 x 1.5	Combined drainage and fauna structure
150.6	5 cell culvert	3.6 x 1.6	Combined drainage and fauna structure
151.9	Wardell viaduct 6	20 metres long	Combined drainage and fauna structure
155.4	Property access bridge	15 metres long	Combined drainage and fauna structure
156.0	North Wardell land bridge	60 metres long	Dedicated fauna landbridge
156.3	4 cell culvert	3.3 x 1.2	Combined drainage and fauna structure
157.0	3 cell culvert	1.8 x 1.2	Combined drainage and fauna structure
157.6	4 cell culvert	4.2 x 2.1	Combined drainage and fauna structure
157.7	2 cell culvert	3.6 x 1.8	Combined drainage and fauna structure
157.8	North Wardell viaduct 7: Ravelles Creek	20 metres long	Combined drainage and fauna structure
Project section 11			
158.9	4 cell culvert	3.6 x 1.8	Combined drainage and fauna structure
164.7	Emigrant Creek bridge	220 metres long	Combined drainage and fauna structure

The final location and sizing of these crossings would be confirmed with the NSW Environment Protection Authority. The types of fauna structures are described below.

Design principles for fauna crossing structures

Design principles for fauna crossing structures have been identified for the project and identify the form, sizing and intent of structures including bridge and instream structures, dedicated and combined underpasses, land bridges, glider poles and widened medians. Principles are also provided for furniture and landscaping at these structures, as well as specific principles for fauna exclusion fencing.

These design principles aim to meet the ecologically sensitive design principles, including:

- Minimal impact on existing vegetation
- Maximising use of combined drainage and fauna passage structures by including raised and/ or inverted cells and adding fauna exclusion fencing
- Maximising use of dedicated structures through appropriate plantings and use of fauna furniture in the structure, and natural materials in the structure
- Design of bridges to avoid interruption to fish passage
- Incorporating appropriate fauna friendly landscapes on overpasses
- Use of current scientific knowledge for the design and construction of fauna fencing including frog exclusion fencing for threatened species.

Detailed design principles for fauna crossing structures are detailed in the Working paper – Biodiversity (SKM, 2012).

Dedicated fauna underpasses

Dedicated fauna underpasses would be located to correspond with known wildlife corridors. These dedicated underpasses would be generally larger structures to allow for their use by a range of fauna. Permanent fauna fencing would be installed either side of the underpasses to direct fauna to the structures.

Although, culvert size is dependent upon the target species for that structure, the project has allowed for the appropriate sizing and location of fauna underpasses to the extent possible given the constraint posed by embankment heights. Structures typically would be 3.0 metres by 3.0 metres, but may need to have smaller apertures where embankment design and vertical grade would not permit such a size. Dedicated underpass structures would not be less than 2.4 metres by 2.4 metres.

These structures may range in length from 50 metres to 100 metres. Maximum openness would be a design principle where the culvert length is greater than 50 metres. The need to provide light penetration through the structure would be considered during detailed design. The underpasses would have a natural substrate, with appropriate shelter and fauna furniture features.

Dedicated aerial crossings (rope ladders and glider poles)

Aerial crossings would be installed to allow arboreal (tree-dwelling) fauna to cross the upgraded highway. The location and number of aerial crossings would be agreed in consultation with the Environment Protection Authority at the detailed design stage.

Widened medians

In addition to aerial crossing structures, the project would have three locations where the central median would be widened. This wide median would allow for the retention of existing vegetation in the median. The vegetation would include tall trees (minimum 20 metres in height) that would allow arboreal mammals (threatened glider species) further opportunity to cross the project, in addition to the artificial pole structures provided in the design.

Widened medians would be located in:

- Section 1: Corindi, north of Corindi floodplain (station 4.95 to station 6.9)
- Section 2: Newfoundland State Forest, north of Wells Crossing Creek (station 22.5 to station 23.8)
- Section 7: Doubleduke State Forest, alongside Tabbimoble Nature Reserve (station 114.1 to station 121.1).

The widened medians would have a width of about 50 to 70 metres, under a motorway standard. Should the project be upgraded to six lanes in the future about a 25 metre wide median would remain. This provides sufficient space to retain a protected section of tall trees. As tall trees would be present within the median a wire rope safety barrier system would be provided on the embankment slopes. This would prevent vehicles colliding with trees.

The typical cross-section of a widened median is shown in Figure 5-110.

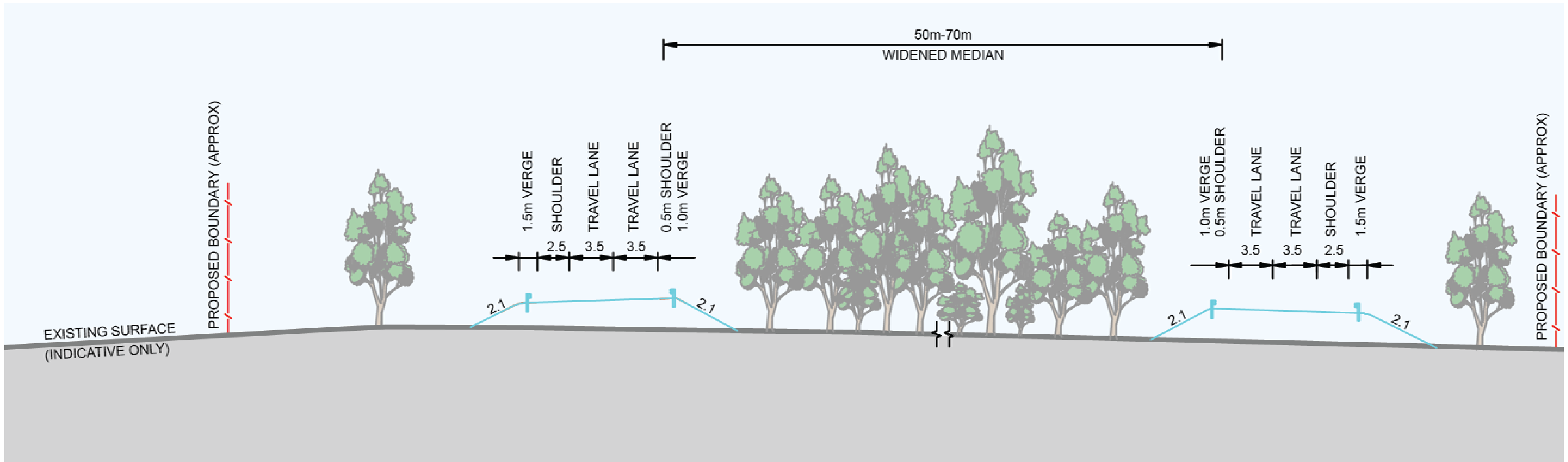

Figure 5-110: Typical cross-section of a widened median for fauna connectivity (indicative only)

Dedicated fauna overpasses (land bridge)

Dedicated fauna overpasses would be located to correspond with known wildlife corridors to allow fauna to cross the project. Fauna overpasses are proposed adjacent to Tabbimoble Nature Reserve, within Broadwater National Park (two bridges) and a further overpass north of Wardell. Appropriate fauna fencing would be installed to prevent fauna obtaining direct access to the highway.

The overpasses through Broadwater National Park would generally be about 70 metres to 90 metres long and about 12 metres wide and provide for emergency access between the national park either side of the project. These structures, as agreed with the former Department of Environment and Climate Change during the previous development project (Woodburn to Ballina) would provide fauna crossing and emergency access, while minimising acquisition from the National Park. The overpass north of Wardell is similar to those ones through the national park.

However, the land bridge in Section 7 associated with Tabbimoble Swamp Nature Reserve would have a minimum width of 30 metres and would exclude vehicle access or fencing on the structure.

Other forms that have been used on other Pacific Highway upgrade projects and could be considered for the project include the use of two bebo arches across the highway (refer to Photo 7 and Photo 8 below). Gabion walls would connect the two arch structures, allowing backfilling with soil to support the growth of mature vegetation. The use of this type of structure would provide a consistent design of fauna land bridge structures across the Pacific Highway.

Photo 7: Existing fauna bridge on the Bonville upgrade section of the Pacific Highway

Photo 8: Existing fauna bridge on the Yelgun to Chinderah upgrade section of the Pacific Highway

Combined fauna crossing and drainage structures

Culverts and bridges would be provided where the project crosses a watercourse. These would primarily allow the passage of surface water under the project, but would be designed to also allow fauna to cross the project. These combined structures would provide further opportunities for fauna to move safely under the project.

The combined structures would comply with RMS requirements for fauna underpasses and related structures. The structures would be fine-tuned during detailed design, which would consider issues such as dry passage for terrestrial fauna, providing openings for light penetration, refuges for native fauna, and fauna fencing.

In general, bridges and arches are preferred over box culverts and would be used where feasible.

In Section 3, many of the bridge structures have been overdesigned to convey floodwaters and cater for the passage of emus under the project. These combined bridge structures have a clearance of at least 3.6 metres from the bridge soffit to existing ground level to provide maximum head clearance for emus. In addition, structures have been provided in Section 3 for dedicated emu passage (between station 59.3 and 66.2) at a minimum height of 5.5 metres.

Many of the other drainage culverts would cater for incidental fauna passage, giving further opportunities for fauna to safely cross the project.

The details of fauna crossing structures, including their locations and design, would be further developed in consultation with the NSW Environment Protection Authority. Further details on the connectivity strategy and fauna crossings are provided in Chapter 10 (Biodiversity).

Biodiversity offset strategy

As part of the project, an offset strategy has been developed to offset the impact of the removal of high conservation vegetation. The strategy aims to put in place a framework to establish and maintain a similar vegetation community at a nearby site.

The strategy has considered both the *Principles for the use of biodiversity offsets in NSW* (NSW Office of Environment and Heritage, 2011) and the Commonwealth Government's Environmental Offsets Policy statement (DSEWPaC, 2012).

The offset ratios proposed for the project include:

- Threatened ecological communities and highly cleared vegetation communities (those with more than 75 per cent cleared in the catchment management area) – ratio of 4:1 (ie for each hectare removed, four hectares would be offset).
- Areas within state forests (Forest Management Zones) – ratio of 4:1
- Other vegetation communities – ratio of 2:1.

The following principles would apply to the offset strategy:

- The vegetation communities and habitat types represented in the offset areas would reflect the vegetation communities and habitat types impacted by the project
- Offset areas would contain habitat for threatened and migratory fauna (TSC Act and EPBC Act) and would contain or be suitable for re-establishing threatened flora (TSC Act and EPBC Act) affected by the project.
- A minimum ratio of 2:1 would be achieved for all remnant vegetation cleared by the project and higher ratios would apply to areas of high conservation value such as endangered ecological communities
- Offset properties would be managed under effective and secure long term management arrangements and could include:
  - Dedication of land under the *National Parks and Wildlife Act 1974*
  - Biobanking Agreements under the *Threatened Species Conservation Act 1995*
  - Conservation Agreements under the *National Parks and Wildlife Act 1974*
  - Trust Agreements under the *Nature Conservation Trust Act 2001*
  - Property vegetation Plans registered on title under the *Native Vegetation Act 2003*
  - Planning agreements under s93F of the *Environmental Planning and Assessment Act 1979*.
- Regardless of the legal mechanism offset properties would be managed:
  - With a principle objective of ongoing site management being biodiversity conservation in perpetuity
  - In accordance with a resourced and implementable Plan of Management
  - With a monitoring and accountability mechanism to ensure management objectives are achieved
- Offset properties would be located as close to the impact site as feasible
- All offset properties would be located within the NSW North Coast Bioregion
- Offset properties would aim to protect larger patches of vegetation and habitat with preference given to sites that are connected to, or provide connectivity to, other core areas of habitat.

5.3.10 Creek realignments

The project would require the permanent realignment of two creeks along its length. These include:

- In Section 3 at Picaninny Creek (approximate station 35.9) at the interchange with Eight Mile Lane
- In Section 9 at Eversons Creek (approximate station 143.7) north of Rifle Range Road.

Picaninny Creek is a tributary of Pheasant Creek which is a small meandering watercourse located within a narrow floodplain. It is an ephemeral creek and therefore does not flow at all times. The creek passes through Glenugie State Forest and is heavily forested on its banks. The existing Picaninny Creek has two gradients. It is fairly gentle for the first 400 metres before steepening slightly as it approaches Pheasant Creek.

The creek currently crosses Eight Mile Lane east of the proposed interchange at Glenugie at station 35.9.

The required creek diversion would be about 500 metres long, which is some two kilometres less than was proposed during the preferred route phase of the project. The creek diversion would seek to mimic the natural watercourse.

Eversons Creek is a tributary of the Richmond River. Eversons Creek is a minor waterway east of Broadwater which drains north into the Richmond River. The adjacent land generally comprises forested valley floors and flats, and alluvial flood plain.

The creek is well-vegetated with good stands of native trees and shrubs growing along the edges and vicinity, which contributes to river health and the stability of banks.

The required creek diversion would be about 200 metres long and would seek to mimic the natural watercourse.

As part of these creek realignments, features such as plunge pools and rock chutes could be provided to control water flow.

The location and extent of the creek realignment at Picaninny Creek and Eversons Creek are shown in Figure 5-111 and Figure 5-112. Further information is provided in the Working paper – Hydrology and flooding.

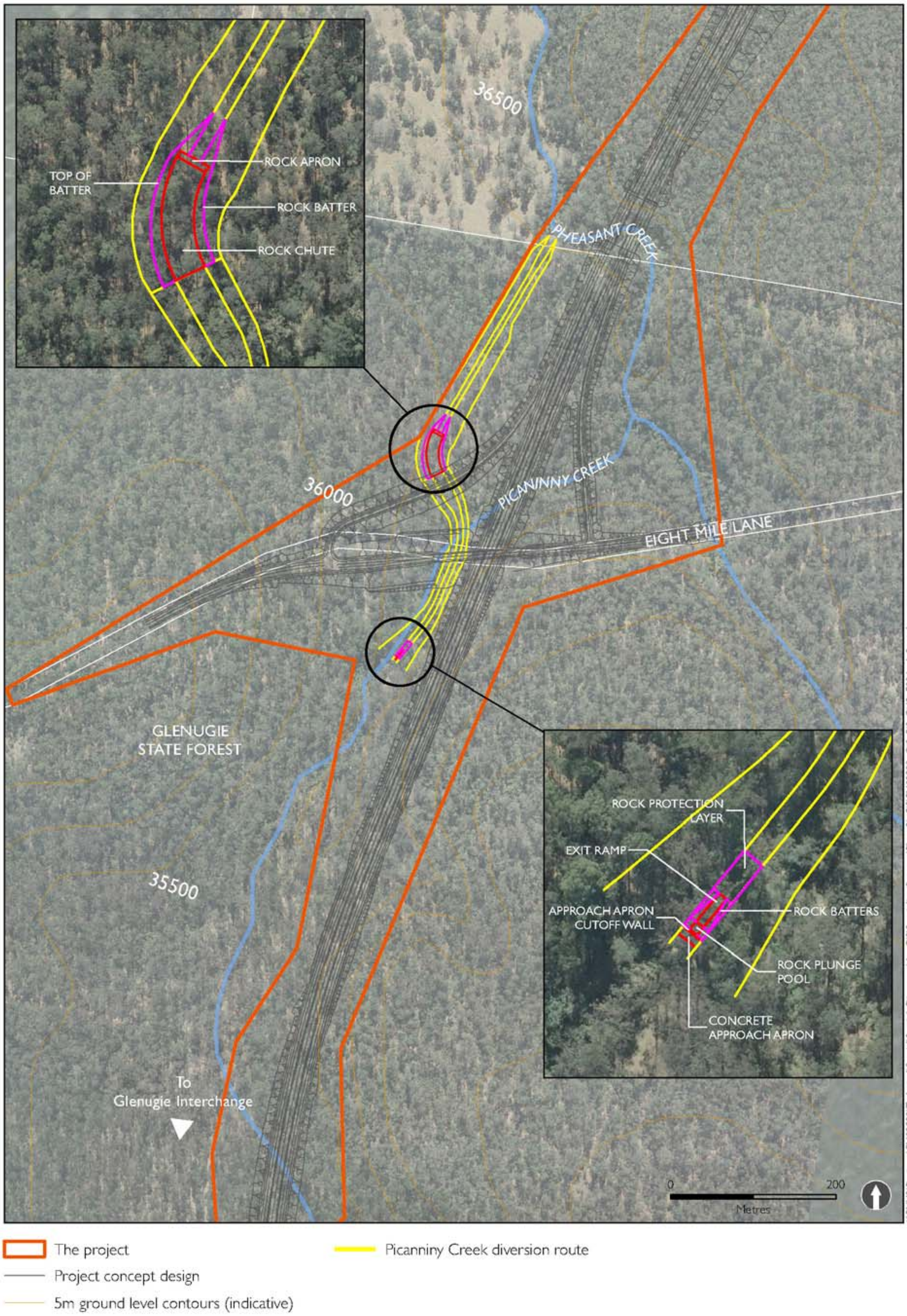

Figure 5-111: Location and extent of creek diversion at Picaninny Creek

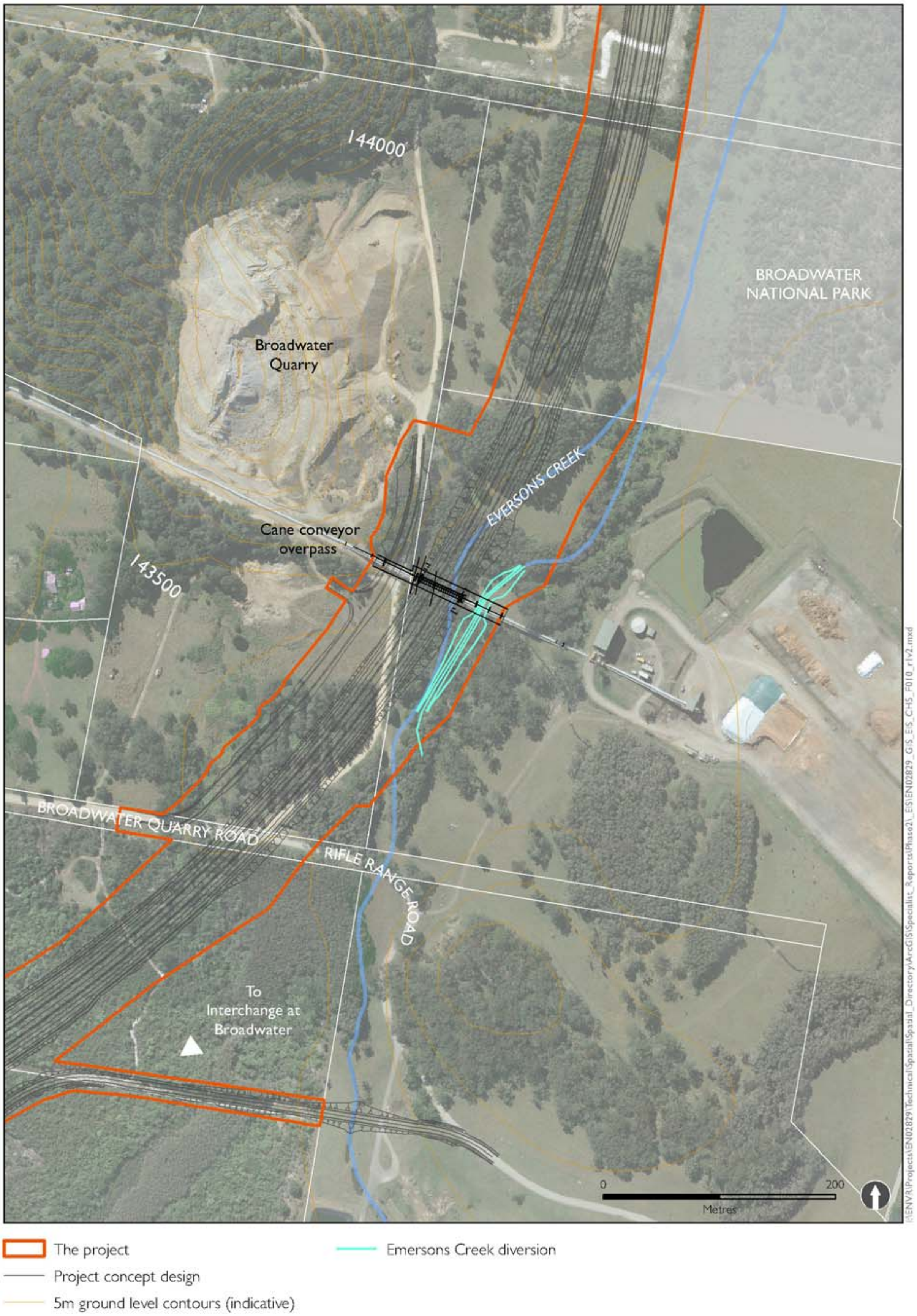

Figure 5-112: Location and extent of creek diversion at Eversons Creek

5.3.11 Water quality ponds

To maintain water quality, the project would include water quality ponds, grassed swales, spill basins and pollutant traps. Water running off the project would be captured before it enters a local watercourse. Runoff would be held in the swales and ponds for a period of time, allowing suspended solids to be removed from the water and deposited on the floor of the basins. The water would then be released into a local watercourse following a period of settlement and treatment.

These ponds would vary in capacity from about 500 cubic metres to 5000 cubic metres depending on the sensitivity of the receiving watercourse. Where required, sediment basins designed for the construction stage would be converted into water quality ponds for the upgraded highway. All water quality ponds would also be able to contain accidental spills of fuel running off the project.

The design features of the water quality ponds are provided in Chapter 9 (Soils, sediments and water) and the Working paper – Water quality (SKM, 2012).

KEY TERM – Swale

A shallow trough parallel to the project used to manage stormwater runoff. These can be used instead of water quality ponds where water quality basins are not a feasible option.

5.3.12 Provisions for pedestrians and cyclists

Pedestrians

For safety reasons, no pedestrian access would be provided to the main carriageways (under either a motorway and arterial standard arrangement).

Access across the project would be provided via overpasses, underpasses and at signal-controlled crossing points. In particular, pedestrian access via an underpass at Jubilee Street would maintain pedestrian connection between Maclean and Townsend and Gulmarrad. This is an important pedestrian route, particularly for school pupils. Pedestrian footways 1.5 metres wide would be provided on bridges where required.

Cyclists

Current NSW legislation would permit cyclists to use the project's road shoulders, including across bridges. In addition, cyclist access would be provided across the interchanges at Maclean, Iluka Road, Woodburn and Broadwater (Evans Head Road).

Signposting and crossing points for cyclists would be provided at interchanges and highway on/off-ramps. Cyclists would also be able to use service roads, where there would be less traffic.

The project includes an additional shoulder at Eggins Drive near Arrawarra (Section 1). This would extend the cycle path network from Coffs Harbour. It would be considered further during detailed design in consultation with bicycle user groups and the local council.

The project includes a new bridge across Emigrant Creek at Smiths Drive. This would allow for an extension to the Ballina section of the NSW Coastline Cycleway towards Pimlico via Pimlico Road. This bridge would have a three-metre wide shared walkway in addition to shoulders on the road for both cyclists.

Table 5-11 lists the location of shared-use facilities across bridges. These paths would provide a three-metre wide shared path with a barrier, for use by pedestrians and cyclists.

Table 5-11: Shared-use facilities for pedestrians and cyclists: bridges

Project section	Location and bridge type	Approximate lengths (metres)	Approximate station
4	Interchange at Maclean: overpass	60	80.5
4	Jubilee Street: pedestrian crossing	15 (northbound) 10 (southbound)	81.2
5	Interchange at Iluka Road: overpass	55	94.4
8	Interchange at Woodburn: overpass	65	128.5
8	Woodburn – Evans Head Road: overpass	60	132.2
9	Broadwater – Evans Head Road: overpass	60	142.7
10	Wardell Road: overpass	80	152.8
10	Coolgardie Road: overpass	60	157.5

5.3.13 Rest areas

Rest areas would generally be located at about 50-kilometre intervals across the project, in line with the RTA Strategy for Major Heavy Vehicle Rest Areas on Key Rural Freight Routes in Rural NSW (2010). Five rest areas would be provided (two for northbound traffic and three for southbound). Rest areas would be generally located on or near the crest of hills to enable easier and safer access, avoiding locations where traffic would be accelerating (such as downhill sections). Rest areas would be located at:

- Pine Brush (for northbound and southbound traffic), from station 63.3 to 64.3
- North of Mororo Road (for southbound traffic only), from station 100.2 to 100.7
- North of Richmond River (for northbound and southbound traffic), from station 147.3 to 148.3.

The proposed locations of rest areas on the upgraded highway are shown on Figure 5-113.

The existing rest area at Halfway Creek on the northbound side would be retained as part of the project.

The rest areas would be designed to accommodate both trucks (up to B-double) and cars, and would provide:

- An area about 500–1000 metres long and 150 metres wide, to accommodate road users taking a break from their journey
- Parking spaces for trucks to simultaneously park and use the facilities without the need to manoeuvre on entering and exiting
- Suitable parking and movement for B-double trucks
- Car parking areas separate from truck parking areas
- Toilets, and water fed by rainwater tanks
- A picnic area
- Maps and information signs.

Delivery of the rest areas would be staged and would allow for the development of the ultimate motorway upgrade. For example, the initial rest areas would provide spaces for 10 B-double trucks, but there would be capacity to expand to up to 20 B-double spaces if required in future.

Typical features and layout of the rest areas proposed at Pine Brush (Tyndale) and north of Richmond River are shown in Figure 5-114 and Figure 5-115 respectively.

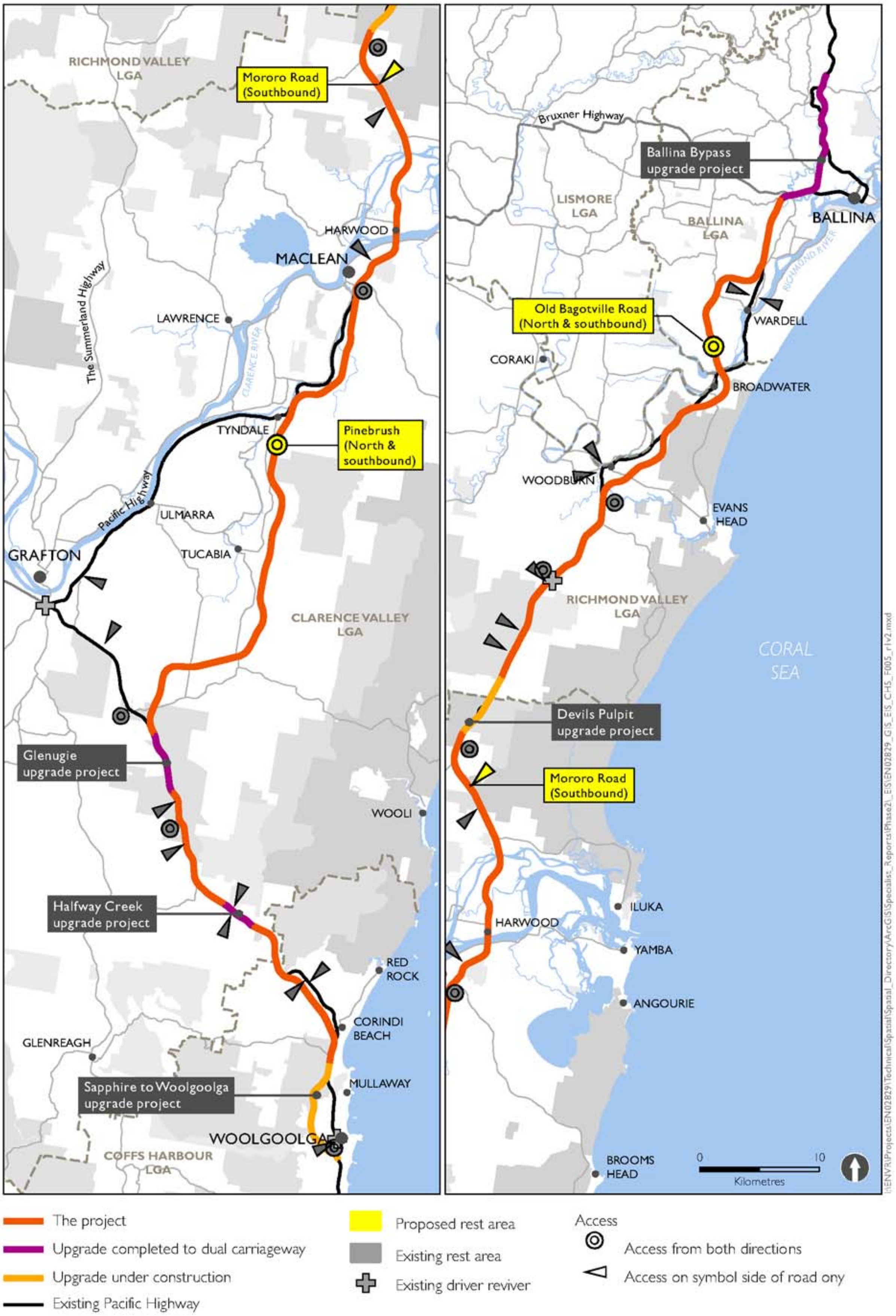

Figure 5-113: Rest areas on the upgraded highway

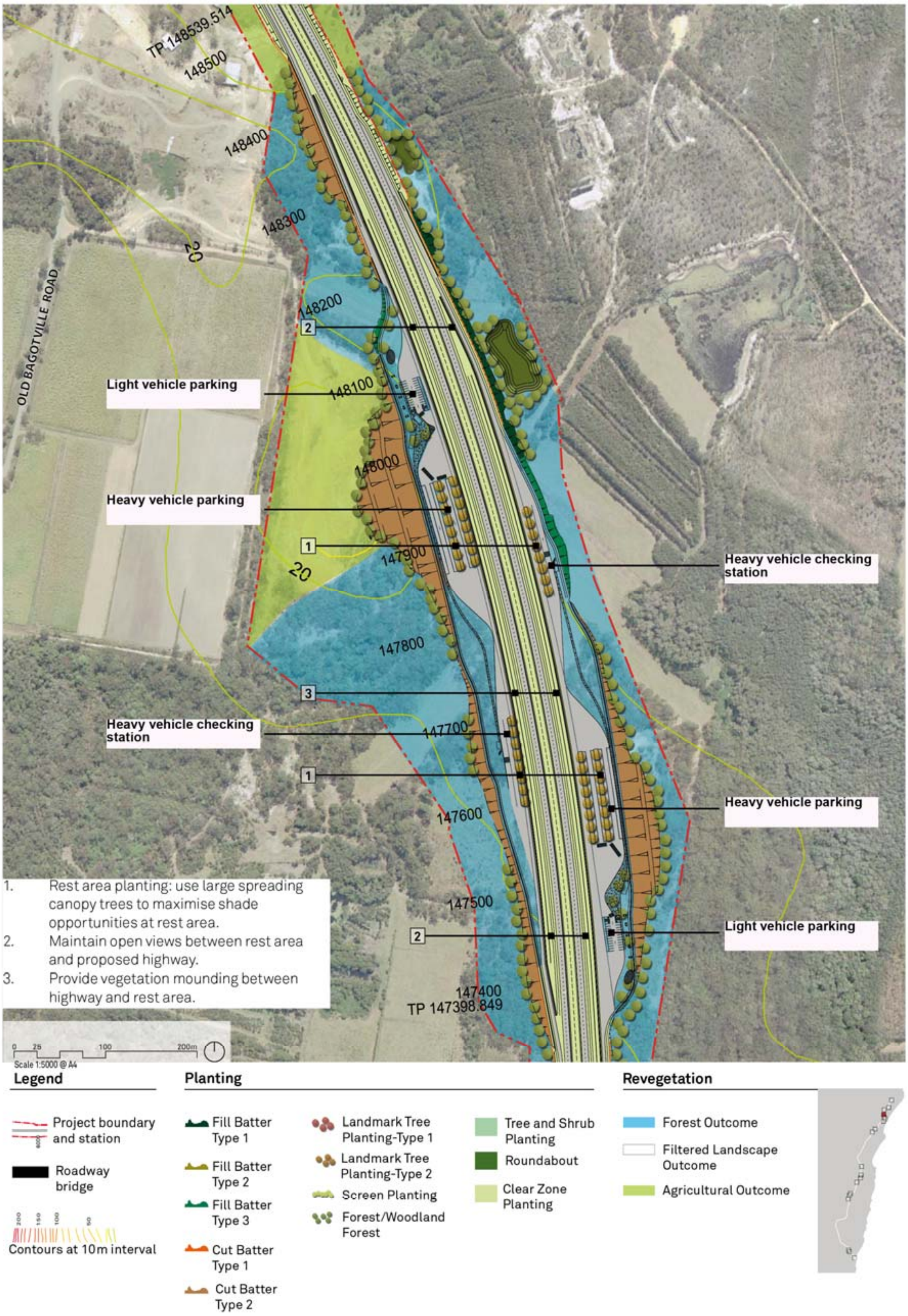

Figure 5-114: Rest area at Pine Brush showing proposed landscape strategy

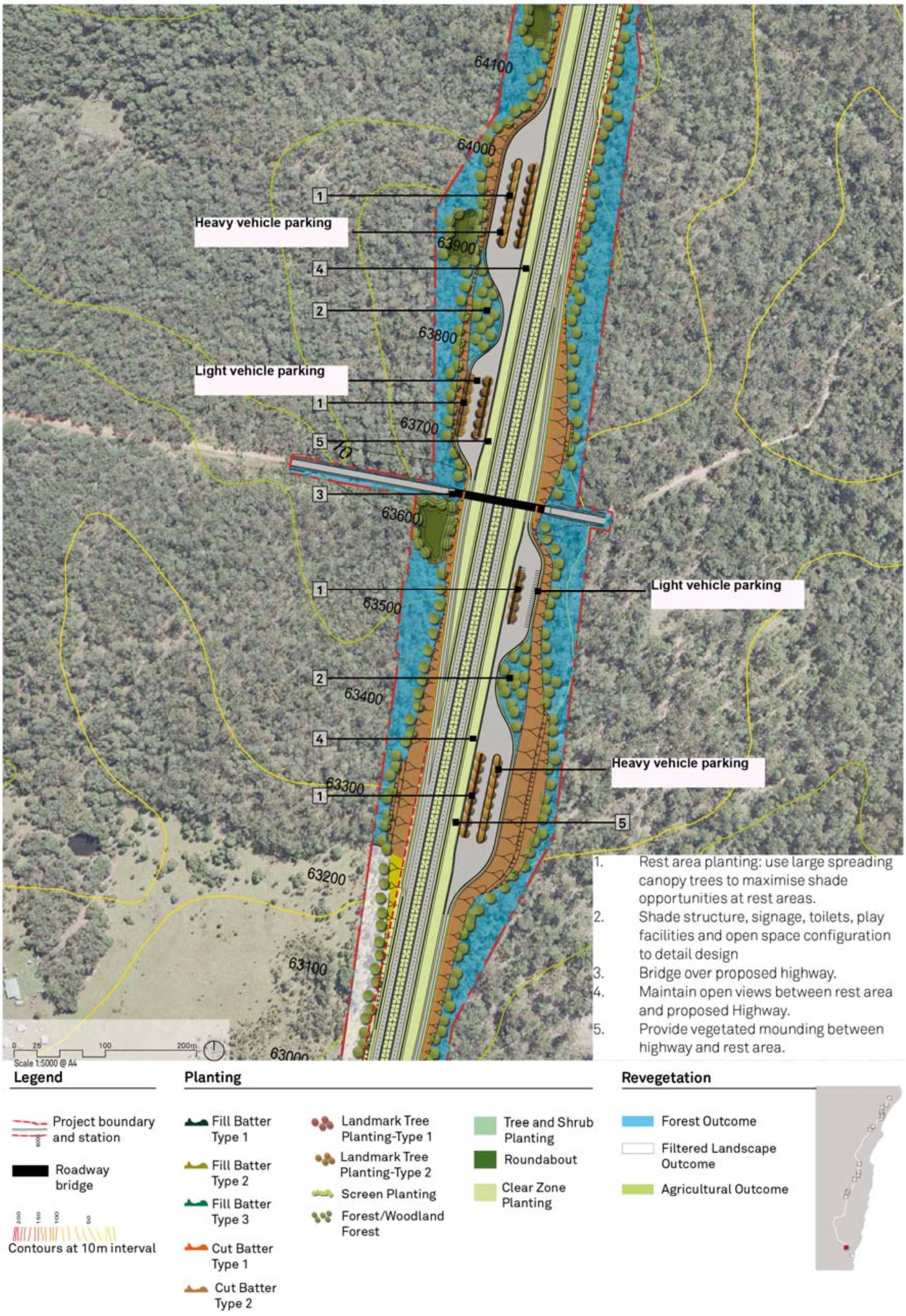

Figure 5-115: Rest area and heavy vehicle checking station at Richmond River showing proposed landscape strategy

Other rest areas near the project include:

- North of Mororo Road, which would be built as part of the Devils Pulpit upgrade (for northbound traffic only)
- At Arrawarra Beach Road, which is being built as part of the Sapphire to Woolgoolga upgrade (for both northbound and southbound traffic). This facility encompasses land that could be developed as a service centre in the future.
- A proposed rest area adjacent to the Teven Interchange, being built as part of the Ballina bypass.

5.3.14 Heavy vehicle checking stations

Heavy vehicles over eight tonnes (gross) are required by law to meet safety and road worthiness standards and drivers are required to comply with road transport laws. This is checked through heavy vehicle checking stations.

RMS operates a heavy vehicle checking station near Glenugie State Forest on the existing Pacific Highway (station 26.6 southbound). This facility would be replaced by a new heavy vehicle checking station between stations 19.1 and 20.0 to the north of the Halfway Creek service station, for southbound traffic. The location of the proposed checking station is shown in Figure 5-116.

This facility would be about 300 metres long and 25 metres wide and include:

- On-load and off-load ramps to exit and re-enter the highway
- An approved concrete barrier to separate the highway from the checking station
- Three inspection lanes
- An office building for inspectors
- A weighbridge plate.

A second heavy vehicle checking station would be located within the northbound and southbound rest areas north of the Richmond River. The checking station at this location would cater for both northbound and southbound traffic. The location of the rest area north of the Richmond River is shown in Figure 5-115.

5.3.15 Section tie-ins

Tie-ins would be required to link the project to the existing Pacific Highway – such as at the Glenugie upgrade and Ballina bypass. Tie-ins would also be required once the upgrades at Arrawarra and Devils Pulpit are finished. The types of section tie-ins include:

- Connection to an existing single carriageway: This tie-in would occur where an upgraded section of the project (with two two-lane carriageways) merges with part of the highway that has not been upgraded (with two single lanes). This may occur where a project section is completed prior to the construction of an adjoining project section
- Connection to an existing dual carriageway: This tie-in would occur where an upgraded section of the project merges with a previously upgraded part of the Pacific Highway (that is, the dual carriageways of the project would merge with the existing dual carriageway). This situation would occur at several locations across the project, such as the connections to the Sapphire to Woolgoolga upgrade, at Halfway Creek, at the Glenugie upgrade, at the Devils Pulpit upgrade and the Ballina bypass
- Temporary tie-ins: Temporary tie-ins would be required at two locations (at Tyndale and east of the proposed bridge across the Richmond River) where the project would deviate from the existing Pacific Highway. Once the adjoining sections of the project are complete, the temporary tie-ins would be removed and the upgraded sections connected.

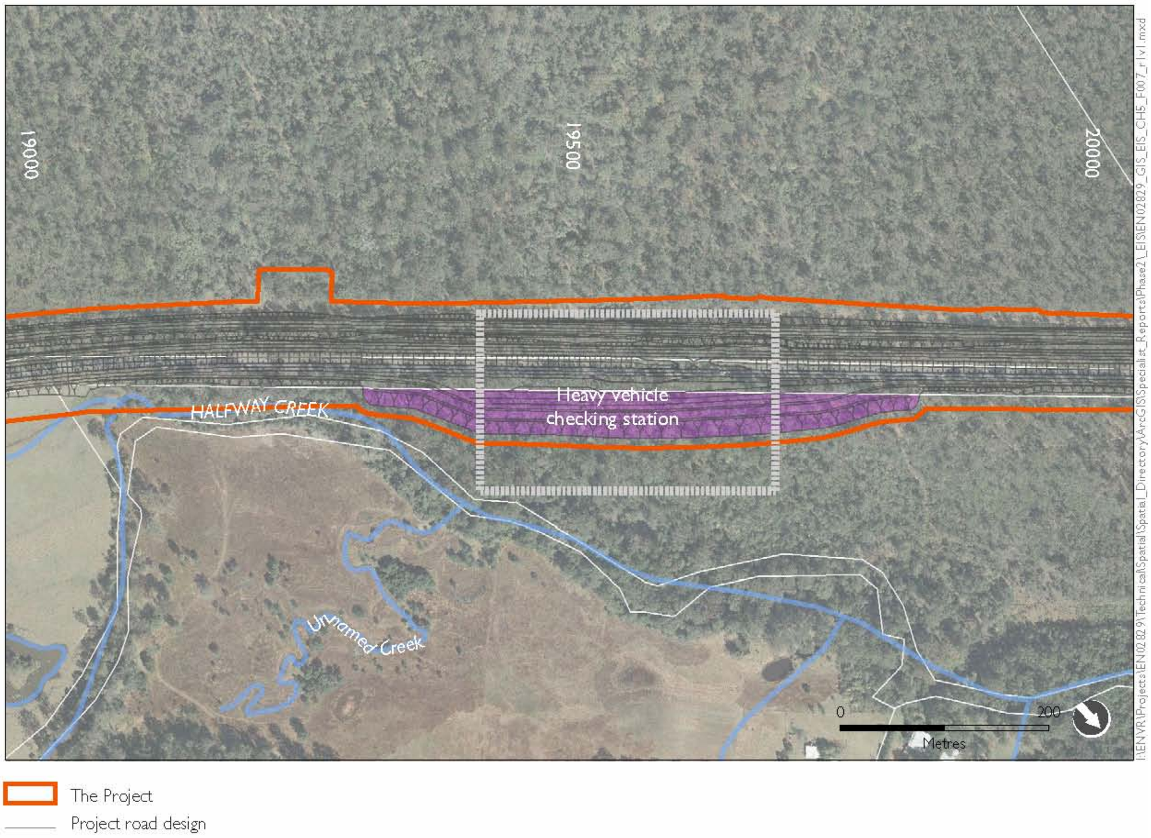

Figure 5-116: Heavy vehicle checking station at Halfway Creek

5.3.16 Cuttings and embankments

Cuttings

The project would have around 157 cuttings and embankments to produce a suitable base for the road pavement. In addition, there would be two cuttings to provide fill for the embankments (these cuttings are called ‘borrow sources’); these cuttings would be in locations owned by RMS and are located next to the project. The main cuttings proposed are listed in Table 5-12.

Cuttings would typically be five to 10 metres deep, but could be up to 26 metres deep in places. The main cuttings have a high risk to interacting with groundwater aquifers. However, there are numerous other cuttings which are not so deep and would have a moderate to low impact on groundwater.

Further information on cuttings is included in Chapter 9 (Soils, sediments and water quality).

RMS would further consider the extent of the cuttings at the two borrow source areas (Lang Hill and West of Wardell). At Lang Hill, this would be undertaken in consultation with Aboriginal stakeholders and in consideration of urban design guidelines.

Table 5-12: Location of main cuttings and approximate depths

Project section	Reference	Location	Approximate cutting depth (metres)
1	C-01	South of interchange at Range Road	Up to 45
3	C-02	Old Six Mile Lane	Up to 10
	C-03	East of Avenue Road	Up to 10
	C-04	South of Bostock Road	Up to 18
	C-05	South of Pine Brush State Forest	Up to 12
	C-06	Pine Brush State Forest	Up to 12
	C-07	East of Tyndale	Up to 24
4	C-08	North of Shark Creek	Up to 26
	C-09	North of McIntyres Lane	Up to 12
8	C-10	South of Woodburn	Up to 15
	C-11	Lang Hill (borrow source)	Up to18
10	C-12	South of Old Bagotville Road	Up to 12
	C-13	West of Wardell / Lumleys Hill (borrow source)	Up to 15

Embankments

Fill embankments would support overpasses, bridges, culverts and other structures. In flood-prone areas where a bridge is not required, embankments would also raise the level of the road pavement.

Table 5-13 summarises the main features of the fill embankments required at the soft soil sites across the project. These areas would require treatment to prepare the ground for construction. Treatment of soft soils would involve two potential options:

- Pre-loading (this can be undertaken prior to main construction)
- Engineered solutions (these can be undertaken as enabling works).

Typical features of cuttings and fill embankments across the project are listed in Table 5-14.

Table 5-13: Features of embankments on soft soil sites

Project section	Reference	Station	Description	Approximate embankment footprint m^2	Final approximate embankment height
4	SS-01	72.9–75.0	South of Shark Creek	90,000	Up to 3.5
	SS-02	77.1–77.5	North of McIntyres Lane	25,000	Up to 4
	SS-03	78.4–80.9	North and south of Edwards Creek, including the interchange at Maclean	250,000	Up to 3.5
5	SS-04	85.0–86.0	Embankment area south of the crossing of the Clarence River at Harwood	60,000	Up to 2
	SS-05	87.2–87.6	Embankment areas north of the crossing of the Clarence River at Harwood and south of Harwood interchange	15,000	Up to 6
	SS-06	89.1–89.6	North and south of Serpentine Channel	10,000	Up to 1.5
	SS-07	92.5–93.3	South of Carrolls Lane	15,000	Up to 2
8	SS-08	130.0–130.4	North and south of Tuckombil Canal	30,000	Up to 5
9	SS-10	145.0–145.5	South of Richmond River Bridge, Broadwater	60,000	Up to 5
11	SS-09	159.9–164.0	North of Whytes Lane and south of Duck Creek	100,000	Up to 2

Table 5-14: Features of cutting and embankment slopes

Description	Cutting slope (horizontal:vertical) (H:V) and depth	Embankment slope (horizontal:vertical) (H:V) and height
Typical alignment	2H:1V	4H:1V where fill height is less than 2.5 metres 2H:1V where fill height is above 2.5 metres
Deep cut (Dirty Creek)	0.7H – 2H:1V Up to 45 metres deep	2H:1V Up to 25 metres high
Deep cut (Tyndale)	0.7H – 2H:1V Up to 24 metres deep	2H:1V Up to 10 metres high
Deep cut (Lang Hill)	0.7H – 2H:1V Up to 25 metres deep	N/A
Deep cut (south-west of Wardell Road)	0.7H – 2H:1V Up to 15 metres deep	N/A
Service and access roads	2H:1V	4H:1V where fill height is less than 2.5 metres

At some cuttings, interchanges and bridge structures, a retaining wall may be used, rather than an earth batter due to soil instability or where there are space constraints. Should retaining walls be constructed as part of the project, the following design principles would be implemented:

- Retaining walls should be plain, monochromatic, recessive and constructed in one material type, without patterns or images on their surface
- Batter/retaining wall combinations should be used where possible
- Retaining walls should be screened by planting
- Gabion walls may be used where appropriate to context and setting.

The project would involve the excavation, processing, transport and stockpiling of large quantities of earthworks. Details of the earthworks required for the project and the potential sources of construction material within and near the project are provided in Chapter 6 (Description of the project – construction).

5.3.17 Roadside lighting, signage and fencing

Lighting

A lighting scheme would be developed in line with the Pacific Highway Design Guidelines (RTA, October 2009 Version R.2). The project would generally be unlit (including rest areas), except where lighting is required for safety reasons, such as at interchange roundabouts and merge and diverge traffic lanes. Lighting would also be provided on the major bridges.

Energy-efficient lighting would be favoured. Lighting design would be developed during detailed design and consider potential light spill into nearby properties.

Roadside signage

The upgraded highway would have traffic, locational, directional, warning and variable message signs. Roadside signage would be developed during detailed design and would consider ‘place marking’ and signage for tourist routes, attractions and nearby towns, particularly for those towns bypassed.

The design principles for signage include:

- Signage should be kept to a minimum wherever possible while taking traffic and road safety considerations into account
- Signposting, including directional signposting must be integrated with the urban and landscape design. Signposting, variable message signs and variable speed limit signs must be designed and located so that they:
  - Are not visually intrusive in the natural and coastal environment
  - Do not affect the short distance or panoramic views of the landscape , the visual relationship of communities to the project or the quality of community environments
  - Are compatible with, and integrated with the design of other structures such as bridges
- Signage should be kept below the skyline with a backdrop of landform or vegetation
- Signage should be avoided in highly scenic areas and where possible, should be located so that important views are not blocked. Further consideration of impacts should be carried out for all large scale signs, advertising signs, variable message signs and camera support structure areas
- With the exception of road name markers, name plates or navigational markers, signage should be kept off all bridges
- Signage structure and composition should be of a high quality design and finish
- Any safety devices, platforms, lighting or logos should be considered and assessed as part of the urban design and landscape strategy
- Consideration should be given to place marking and prominence of signs denoting tourist routes and nearby towns that are by-passed by the project.

Fences

Fencing would be required along the length of the project and could consist of:

- Stock fencing and property boundary fencing: This would be provided in consultation with property owners
- Fauna exclusion fencing. Fauna fencing locations have been developed as part of the Biodiversity Connectivity Strategy and would be further refined in consultation with relevant government agencies.

Permanent fencing would be installed prior to the commencement of major earthworks operations wherever possible, preferably in association with the site clearing and establishment activities.

Fauna fencing would be located within the limits of clearing for the construction and as close to the road formation as reasonably practicable. In some cases, the fencing would be installed on the embankment batters, passing over the inlet and outlet structures for the fauna underpasses and other major drainage facilities that could provide fauna passage. In these cases, the fauna fencing would be installed in conjunction with the earthworks and drainage construction activities.

Where considered appropriate, the fauna fencing could replace the road boundary fencing but would need to be reinforced sufficiently to act as a man proof or stock fence. Boundary markers would also need to be installed to identify the location of the road boundary in these areas.

Details on fencing would be finalised during detailed design.

5.3.18 Utility services

A number of utilities are located within or near the project. These include:

- Electricity: Essential Energy (low voltage and high voltage power lines)
- Telecommunications: Telstra cable and optic fibre cable
- Sewer and water mains: These are operated by Coffs Harbour City Council, Clarence Valley Council, Richmond Valley Council and Ballina Shire Council
- Water treatment works for Coffs Harbour City Council
- Water supply services and water supply infrastructure operated by Rous Water.

Utilities would need to be relocated, adjusted or protected where they may be affected by the construction of the project. Further work would be carried out during detailed design to confirm the exact impacts on utilities, and any permanent relocations that would be required.

Potential impacts on utilities are discussed in Chapter 6 (Description of the project – construction).

5.3.19 Bus stops

As outlined below, the provision of bus stops would vary between the initial arterial upgrade and the ultimate motorway upgrade.

Motorway standard

The Pacific Highway currently has a number of important informal bus stops (such as at Tyndale).

However, due to safety concerns with pedestrians accessing a high-speed highway, bus stops would not be provided across the project when it operates as a motorway. However, opportunities would be provided on local roads and service roads to pick up school students and other passengers, and buses would be able to exit the highway at controlled access points such as interchanges.

A U-turn facility is provided in the current design at Mororo Road and also Tully Morgan Jacky Bulbin Road further north to allow safe pick-up of students travelling to and from Grafton. The interchange at Iluka Road has also been designed in consideration of the requirements of transport companies that service the area.

Future requirements would be considered further during detailed design, in consultation with the relevant bus companies operating at that time.

Arterial standard

Under an initial upgrade to arterial standard, pull-in bays for buses and U-turn facilities would be provided across the project. These would be provided along deceleration lanes at or near intersections.

Bus stops would be located where there is a likely demand for pick-ups and drop-offs. Bus stops are proposed at:

- Section 1: Between Range Road and Halfway Creek
- Section 2: Between Halfway Creek and the Glenugie upgrade
- Section 5: Between Maclean and Watts Lane
- Section 6: Between Iluka Road and the upgrade at Devils Pulpit.

5.3.20 Emergency facilities and U-turn bays

Combined emergency crossover and U-turn facilities are proposed within the concept design to allow U-turns by Roads and Maritime Services, police and emergency vehicles and for diversion of traffic to the opposing carriageway in the case of an emergency.

The project includes a shoulder 2.5 metres wide and a one-metre clearance to the gutter. This allows vehicles to pull over at any location in the event of a sudden breakdown or other incident, and provides space between the stationery vehicle and passing traffic.

Across bridges, the shoulder width would be three metres with no clearance to the gutter. This would be adequate for most vehicles to be able to stop clear of through traffic.

Motorway standard

Combined emergency U-turn bays, maintenance crossovers and stopping bays (in addition to the shoulder) would be provided about every 2.5 kilometres. These would enable emergency vehicles to conduct U-turns and contra-flow arrangements to be put in place.

However, the public would be prohibited from using the U-turn bays.

In sections that are separated from service roads, emergency services would have access to a locked gate for emergency access onto the controlled road corridor. These sections include:

- Section 3: Glenugie upgrade to Tyndale
- Section 8: Trustums Hill to Broadwater National Park
- Section 9: Broadwater National Park to Richmond River
- Section 10: Richmond River to Coolgardie Road.

Access would also be provided to water quality control ponds for the Rural Fire Services and the NSW Fire and Rescue crews in case of fire along the project.

Arterial standard

During the initial upgrade to arterial standard, U-turn bays would enable U-turns on the highway.

Some U-turn facilities would be located near intersections with local access roads that could provide the opportunity for local traffic to access the opposite carriageway. These would be in:

- Section 1: Woolgoolga to Halfway Creek
- Section 2: Halfway Creek to Glenugie upgrade
- Section 6: Iluka Road to Devils Pulpit
- Section 7: Devils Pulpit to Trustums Hill.

Across the floodplains, the location of wire rope safety barriers would determine the location of U-turns and crossovers.

Management of hazards and incidents

Risks to members of the public during operation of the project would relate to incidents involving the release of dangerous goods. The Pacific Highway is a designated dangerous goods route. Dangerous goods that might be transported in significant quantities include flammable and combustible petroleum products (petrol and diesel), liquefied petroleum gas and toxic gases (eg ammonia and chlorine), corrosive materials (acids and alkalis), other toxic materials (eg pesticides), and nitrogen-based fertilisers or bulk explosives. The EPA administers the *Dangerous Goods (Road and Rail Transport) Act 2008*, which adopts uniform national requirements for the transport of dangerous goods, including the requirements of the Australian Dangerous Goods Code.

Crashes involving vehicles transporting chemicals and/or other dangerous goods would generally affect only a small part of the project. Hazards could include toxic effects, fire and explosions. The project is generally located within a sparsely populated area. Most incidents would have limited potential to affect those not directly involved in a crash or incident. The project has been designed to meet relevant design guidelines for highways and would contribute to an overall improvement in driving conditions and hazard reduction.

The project would result in vehicles carrying hazardous materials bypassing townships including Grafton, South Grafton, Ulmarra, Woodburn, Broadwater and Wardell. This would benefit road users travelling through these townships as there would be fewer hazardous materials being transported on the roads through these townships.

RMS have a well developed framework for managing risk associated with highway incidents. RMS hold memoranda of understanding with the NSW Fire Brigade and the NSW Police Service regarding emergency response.

During the detailed design of the project, an incident management plan would be prepared with emergency services for both construction and operation. Plans would require sign-off from the emergency services and would involve identification of alternative access arrangements to manage different incidents. This may involve contra-flow and/or use of the existing highway and appropriate temporary signage. (For example a contra-flow system may be used in the event that highway carriageways become flooded.)

Speed enforcement bays are not currently included as part of the Draft, Pacific Highway Design Guidelines (RTA, October 2009 Version R.2). These facilities have the potential to manage safe and responsible driving. They could also provide visibility for the police services on the highway network and provide safer working conditions for enforcement officers. RMS is reviewing the potential for providing speed enforcement bays along the Pacific Highway.

Consultation with the Rural Fire Service and emergency services regarding access would continue during the detailed design phase.

5.3.21 Road pavement

Different pavement designs would be applied across the project. The new dual carriageways would generally consist of a heavy-duty pavement (in accordance with the RTA design guidelines) with a nominal design life of 40 years. Heavy-duty pavement could encompass either a plain concrete pavement in remote areas or continuously reinforced concrete with asphalt surfacing for noise attenuation in more populated areas.

In some areas, a flexible / granular pavement is nominated as an alternative to a rigid concrete pavement due to the potential for ongoing settlement due to soft soils or damage from flood inundation. This pavement would allow for periodic (or rapid) pavement restoration.

Pavement designs for intersections and local access roads may differ depending on traffic loads. Pavements typically used would include an asphalt or asphalt surfacing pavement. At intersection roundabouts, a steel fibre concrete pavement would be used to protect the surface from potential deformations from higher turning movements. These would have a design life of 20 years.

Where the existing Pacific Highway is to be included within the new dual carriageway or would become the service road, various treatments could be considered. Their design would depend on the future use of the existing road and the age of the existing pavement. Treatments could include resealing with fine aggregate, thin asphalt overlays, or more substantial pavement restoration.

A low-noise wearing surface pavement is proposed close to sensitive receivers, where required, as detailed in Chapter 15 (Noise and Vibration). This type of pavement is predicted to reduce noise generated from the pavement by 2 to 4dBA when compared to standard pavements. It is proposed that a low-noise wearing surface pavement is used only through areas of closely spaced residences.

The low-noise wearing surface pavement is proposed across the following sections of the project subject to detailed design:

- Section 1, Darlington Park: between STN 0.2 to 1.6 (1.4 km)
- Section 3, Tyndale: between STN 66.4 to 68.3 (1.9km)
- Section 4, Maclean: between STN 80.5 and 82.5 (2km)
- Section 5, Harwood between station 85.9 and 88.0 (2.1km)
- Section 8, Trustums Hill: (The Gap Rd) between STN 127.0 and 128.1 (1.1km)
- Section 10, Wardell Rd to Coolgardie interchange: between STN 155.4 and 157.8 (2.4km).

The final decision on the type of pavement selected would be made during detailed design of the project. The design type would depend on total life costs (which include construction and ongoing maintenance costs), environmental impacts, material sourcing and constructability.

Further information on noise management as it relates to the road pavement is in Chapter 15 (Noise and vibration).

5.3.22 Detailed design

This EIS seeks approval for the project elements described in this chapter. The EIS has been prepared based on a concept design. If approved, a further detailed design process would follow which may include variations to the concept design. This approach is consistent with the approach taken in other environmental assessments of major infrastructure projects.

The detailed design process will seek to further minimise impacts and optimise traffic efficiency. In doing do it is likely to necessitate changes to a number of project elements but will not affect the key project elements described.

References

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