



Devils Pulpit to Richmond River - Sections 7, 8 and 9

Prepared for



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Executive summary

This Draft Urban Design and Landscape Plan (UDLP) is produced to document the Urban design and Landscape design specific to Devils Pulpit to Richmond River Sections 7, 8 and 9 of the Woolgoolga to Ballina Pacific Highway upgrade) a combined total of 33 km of upgrade of the Pacific Highway. This document addresses the requirements of the Ministers's Conditions of Approval for the project (MCoA) D20.

Fulfilling The Ministers Conditions of approval ensures the project will achieve the environmental requirements and measures set by the projects Environmental Impact Statement (EIS) and Submissions/Preferred Infrastructure Report (SPIR). The design outcomes ensure the upgraded Pacific Highway will continue to service the needs of the travelling public and achieve transport efficiencies. The ecological sustainability and the needs of the coastal communities who live along the highway, will also be met.

Project background

The Pacific Highway upgrade is one of the largest road infrastructure projects in New South Wales. The Pacific Highway connects Sydney and Brisbane, and is a major contributor to Australia's economic activity. The Woolgoolga to Ballina upgrade for the Pacific Highway has been managed into 11 Sections with upgrade work to Woolgoolga to Halfway Creek (Section 1) and Halfway Creek to Glenugie (Sections 2 and 2A) already complete. The Australian and New South Wales Governments are committed to completing the Pacific Highway upgrade (Sections 3 to 11) by 2020.

Consultation

Consultation with communities, councils agencies and stakeholders is ongoing and will occur throughout the project in accordance with the Roads and Maritime Services Communications and Stakeholder Engagement Strategy.

Pacific Highway vision

Roads and Maritime Services vision for the highway as stated in the Pacific Highway Urban Design Framework is as follows:

'The upgrade should be a sweeping, green highway providing panoramic views to the Great Dividing Range and the forests, farmlands and coastline of the Pacific Ocean; sensitively designed to fit into the landscape and be unobtrusive; and characterised by simple and refined road infrastructure.'

Urban and landscape design objectives In fulfilling the Roads and Maritime Services vision and the Minister's Conditions, six objectives are developed to define the nature and parameters of this design response they are:

- Provide a flowing road alignment which is responsive and integrated with the landscape.
- Provide a well vegetated, natural road reserve.
- Provide an enjoyable, interesting highway.
- Value the communities and towns along the road.
- Provide consistency with variety in road elements.
- Provide a simplified and unobtrusive road design.

These objectives are employed to achieve a unified and consistent approach to the Woolgoolga to Ballina upgrade development as part of the wider Pacific Highway upgrade program.

Context analysis

The existing site (from Devils Pulpit to Richmond River) is analysed to understand the opportunities and constraints the site presented.

This analysis informed the design decisions made during the development of this UDLP, and included:

- Landscape character
- Land-use and communities
- Landform
- Hydrology
- Vegetation
- Flora
- Fauna
- Aboriginal and Non-Aboriginal heritage
- Soils
- Geology.

Reference documents

The design process also employed a number of reference documents and guidelines to support the development of design strategies and outcomes. These guidelines included:

- Upgrading the Pacific Highway—Design Guidelines, March 2015
- Pacific Highway urban design framework April 2005
- Bridge Aesthetics, Design guideline to improve the appearance of bridges in NSW, Roads and Maritime Services Centre for Urban Design July 2012
- Beyond the Pavement, Urban Design Policy, Procedures and Design Principles, Roads and Maritime Services Centre for Urban Design 2014.

This report includes a full bibliography of reference material.

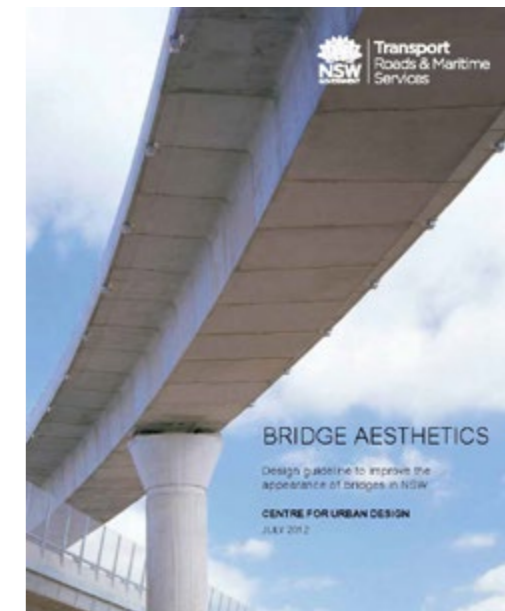
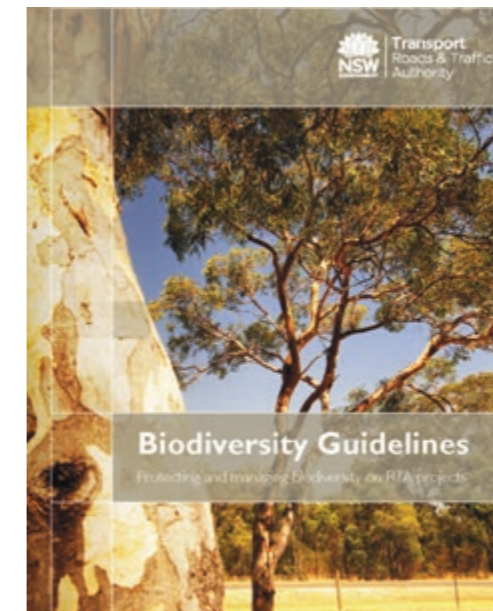
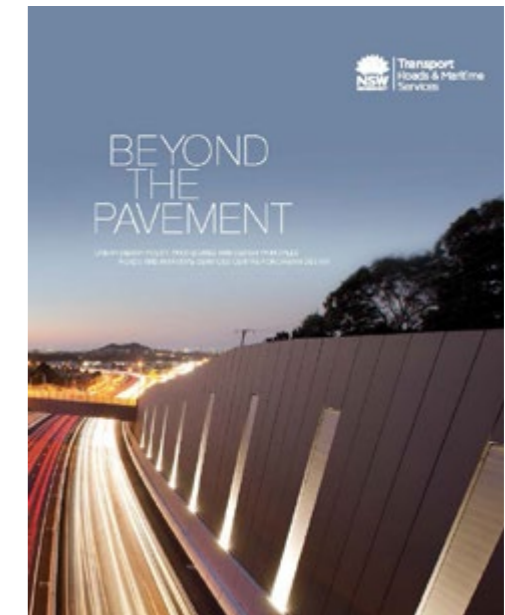


Fig.i Roads and Maritime Services design reference and guideline documents



Fig.iii Artist impression of Broadwater Interchange looking north subject to further design



Fig.iv Existing Wooyung Road overbridge with tapered median pier



Fig.v Artist impression of tapered median pier at the Broadwater overbridge subject to further design



Fig.vi Artist impression of New Italy car park subject to further design

The vision is achieved through the integrated design and sensitive delivery of the key infrastructure design elements of:

- Bridges
- Fauna crossings
- Drainage
- Fencing
- Interchange.

Specific design responses and the application of these responses to the infrastructure design elements collectively fulfil this vision are discussed below and in detail within the report.

Local conditions

The design is developed through rigorous analysis of local conditions and the development of design strategies will respond to the modified environment. Gently blending topographic changes through rounding batters and cuttings while reinstating nearby vegetation communities with locally seen planting and seeding.

Biodiversity

An exclusively New South Wales North Coast Bioregion species palette has been adopted for the design. The palette is composed with seed and plant stock which is commercially available and will be sourced wherever possible from local suppliers. Both the species and the designed ground conditions are composed to establish an attractive native corridor vegetation which is safe to maintain, appropriate for local fauna and is safe for motorists.

Local communities

Throughout the corridor local human, flora and fauna communities are considered through design responses which emphasise safe, legible, and regular connectivity of people, plants, places and populations. A feature is the upgrade to New Italy.

New Italy

Parking amenity and highway accessibility is provided. Parking for single vehicles, recreational vehicles, trailers and coaches is provided as shown in Fig Vi. Crossing points and native plantings to reinforce local vegetative character are integrated into the design.

Woodburn Interchange

The interchange nestles comfortably within the ridge line and feature extensive local plantings including Blackbean and Red Cedar feature plantings which directly reference the indigenous and European heritage of the region as described in Chapter five and eight of this report.

Broadwater Interchange

The Broadwater Interchange shown in Fig. iii will use local planting communities as a key design feature. In particular the coastal heath and subtropical palm rainforest of the Broadwater National Park to characterise the driver experience. This is described in Chapter eight of this report.

Sugar Cane conveyor bridge

Broadwater features a patterned sugar cane conveyor protection screen seen in Fig vii which provides a key way finding moment through its adoption of the patterning from the existing Broadwater entry signage.

Fauna connectivity structures

In conjunction with fauna fencing and habitat planting fauna connectivity structures are designed at regular intervals by a variety of techniques including creek realignments, overhead glider poles, fauna ledges, and a variety of culvert and bridge arrangements to encourage fauna east-west fauna movements an indicative arrangement is presented in Fig vii.

Integrated infrastructure

A consistent aesthetic of The Pacific Highway is the bridge architecture which responds to and extends the successful design language applied with the Yelgun Chinderah Pacific Highway upgrade.

The key elements which feature strongly are:

- Tapered median piers as seen in Fig iv and Fig v
- Throw screen design
- Medium performance barriers
- Spill through abutments.

Underbridges also feature the use of the regular performance barrier to provide for superior landscape views.

Summary

This design will satisfy the Ministers Conditions and achieves the Roads and Maritime Services Pacific Highway vision. The project will deliver a highway which sits comfortably within the natural and agricultural environments while selectively screening and featuring the local landscapes through which it passes.



Fig.vii Artist impression of the sugar cane conveyor bridge subject to further design



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Glossary

Terminology	Definition
Bioregion	Classification of Australia's landscape into 89 distinct bioregions based on climate, geology, landform and native vegetation and species information. The Woolgoolga to Ballina project site is within the New South Wales North Coast Bioregion (NNC) as defined by Interim Biogeographic Regionalisation of Australia mapping (IBRA).
Cover crop	Fast growing, but short lived non-native pasture grasses used to revegetate exposed batters to minimise erosion and weed infestation.
Compost blanket	Consists of high quality compost incorporating organic tackifiers, biological stimulants, wetting agents, soil ameliorants and seed mix which is applied to the batter surface with pneumatic blowers at a thickness of between 25–100 mm depending on type of vegetation to be established.
Drill/broadcast seeding	Seeding using a mechanical disc seeder towed by a tractor. Drill seeders have metal discs which create small furrows into which seed is placed. Broadcast seeding involves the mechanical spreading of seed on the soil surface using a trailer or truck mounted spinning type or agitator type seed spreader. Following seeding, the soil is harrowed to cover the seed with a thin layer of soil.
Direct return	Stripping and replacement of site soils containing a seed bank of native indigenous species.
Fauna crossing structure	Structures which allow animals to safely cross over human-made barriers such as highways.
Frangible	Planting which breaks under the impact of a motor vehicle (and hence helps to stop a vehicle). Generally trees and shrubs with a mature trunk diameter of less than 100 mm at 500 mm above ground are considered frangible.
Hydromulching	Various types of organic fibrous materials mixed with water and sprayed onto the soil surface in slurry form which sets to form a layer and provides temporary protection from wind and water erosion. The mix may include seed of a cover crop, legume, native ground cover, shrub or tree species.
Hydroseeding	Hydraulic application of seed, seed carrier and soil ameliorants added to a tank fitted with an agitator and pump. It is commonly followed by hydromulching or straw mulching to provide surface protection.
Indigenous species	Plant species native to the bioregion in which the project is located.
Landscape Management Plan	A defined combination of techniques and frequency of activities for the successful establishment, maintenance and ongoing management of all landscape areas developed by seeding, planting or bushland regeneration.
Landscape soil	Soil profile which is either modified from a natural soil or manufactured and installed using artificial components for the purpose of sustaining vegetation is chosen to achieve a particular landscape design outcome or revegetation.

Terminology	Definition
Local provenance seed	Seed collected from plants growing in the locality of the project site which may include the road corridor and adjoining areas within the New South Wales North Coast (NNC) Bioregion.
Native grasses	Grass species native to Australia.
Natural soils	Soils remaining insitu which have formed distinct horizons and typically sustaining specific plant communities.
Non-native	Plants which are not native to the bioregion in which the project site is located.
Noxious weeds	Plants declared noxious weeds which are classified into one of five control classes with specified action for each class by the Noxious Weed Act, 1993 and Weed Control Order 2014.
Pasture grass Mix	Mix of grasses and legumes, predominantly grasses with a portion of legumes to provide nitrogen; typically used on areas which are not to be managed.
Plant container	Containers for plant stock in various sizes and volumes. Pots are containers with rigid walls, which are identified by their diameter in millimetres. Bags are containers with flexible or woven walls, which are identified by their volume in litres.
Reconstruction	The practice of revegetating areas where the soil profile has been disturbed by construction activity; the process involves soil treatment, which may include return of bushland soil, followed by drill seeding, hydromulching or mass planting.
Regeneration	The practice of restoring disturbed or cleared bushland areas where the soil profile remains intact by reinstating and reinforcing the natural regeneration processes in areas within or adjoining bushland, primarily through weed control (weed cover should be less than 15 per cent after 12 months from start of the work).
Revegetation	Re-establishing vegetation on an area by direct seeding with native species using manual or mechanical means such as hydromulching, straw mulching, or tractor seeding. A cover crop of annual grass or legume species may be required to provide surface protection in some situations.
Tubestock	Rigid plant containers with a top edge length or diameter of 40–50 mm or 75 mm. Includes individual containers as well as trays, and may have proprietary names.
Revegetation	Re-establishing vegetation on an area by direct seeding with native species using manual or mechanical means such as hydromulching, straw mulching, or tractor seeding. A cover crop of annual grass or legume species may be required to provide surface protection in some situations.

Abbreviations

Terminology	Definition
EEC	Endangered Ecological Community
EIS	Environmental Impact Statement
EPBC	Environment Protection Biodiversity Conservation
ESD	Ecologically Sustainable Development
MCoA	Ministers Conditions of Approval
OPP	Oxleyan Pygmy Perch
PAD	Potential Aboriginal Archeological site
Roads and Maritime	Roads and Maritime Services
SAP	Sustainability Action Plan
SPIR	Submission/Preferred Infrastructure Report
UDLP	Urban Design Landscape Plan
W2B	Woolgoolga to Ballina

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Introduction

1

1.1 Background

The Pacific Highway upgrade is one of the largest road infrastructure projects in NSW. It connects Sydney and Brisbane, and is a major contributor to Australia's economic activity. The road is a vital piece of the nation's infrastructure and is a key link in the National Land Transport Network. The Australian and NSW governments have been jointly upgrading the Pacific Highway since 1996.

An upgraded Pacific Highway must continue to service the needs of the travelling public and achieve transport efficiencies, while also ensuring ecological sustainability and meeting the needs of the coastal communities that live along the highway. Upgrading new sections and carrying out safety improvements to the existing highway have brought major improvements to road conditions. These improvements support regional development and provide:

Upgrading new sections and carrying out safety improvements to the existing highway have brought major improvements to road conditions. These improvements support regional development and provide:

- Safe travel
- Reduced travel times with improved transport efficiency
- More consistent and reliable travel
- Improved amenity for local communities.

1.2 Overview of the Woolgoolga to Ballina Upgrade

The 155 kilometre upgrade between Woolgoolga to Ballina is the last highway link between Hexham and the Queensland border to be upgraded to four lanes. The project will duplicate the existing highway to two lanes in each direction from about six kilometres north of Woolgoolga (north of Coffs Harbour) to about six kilometres south of Ballina.

The project bypasses the towns of Grafton, South Grafton, Ulmarra, Woodburn, Broadwater and Wardell. The project will include building new lanes and realigning the road.

Key features of the upgrade include:

- Duplicating 155 kilometres of the Pacific Highway to a motorway standard (Class M) or arterial road (Class A), with two lanes in each direction and room to add a third lane if required in the future
- Split-level (grade-separated) interchanges at Range Road, Glenugie, Tyndale, Maclean, Yamba/Harwood, Woombah (Iluka Road), Woodburn, Broadwater and Wardell
- Bypasses of South Grafton, Ulmarra, Woodburn, Broadwater and Wardell
- More than 100 bridges including major crossings of the Clarence and Richmond rivers
- Bridges over and under the highway to maintain access to local roads that cross the highway
- Access roads to maintain connections to existing local roads and properties
- Structures designed to safely encourage animals over and under the upgraded highway where it crosses key animal habitat or wildlife corridors
- Rest areas conveniently located at intervals to assist with reducing driver fatigue
- Heavy vehicle checking stations near Halfway Creek and north of the Richmond River
- Connections from the project to the local road network and other sections of the Pacific Highway
- Emergency stopping facilities, and U-turn bays
- Relocation of utilities and provision of roadside furniture, fencing (including wildlife exclusion fencing) and lighting.

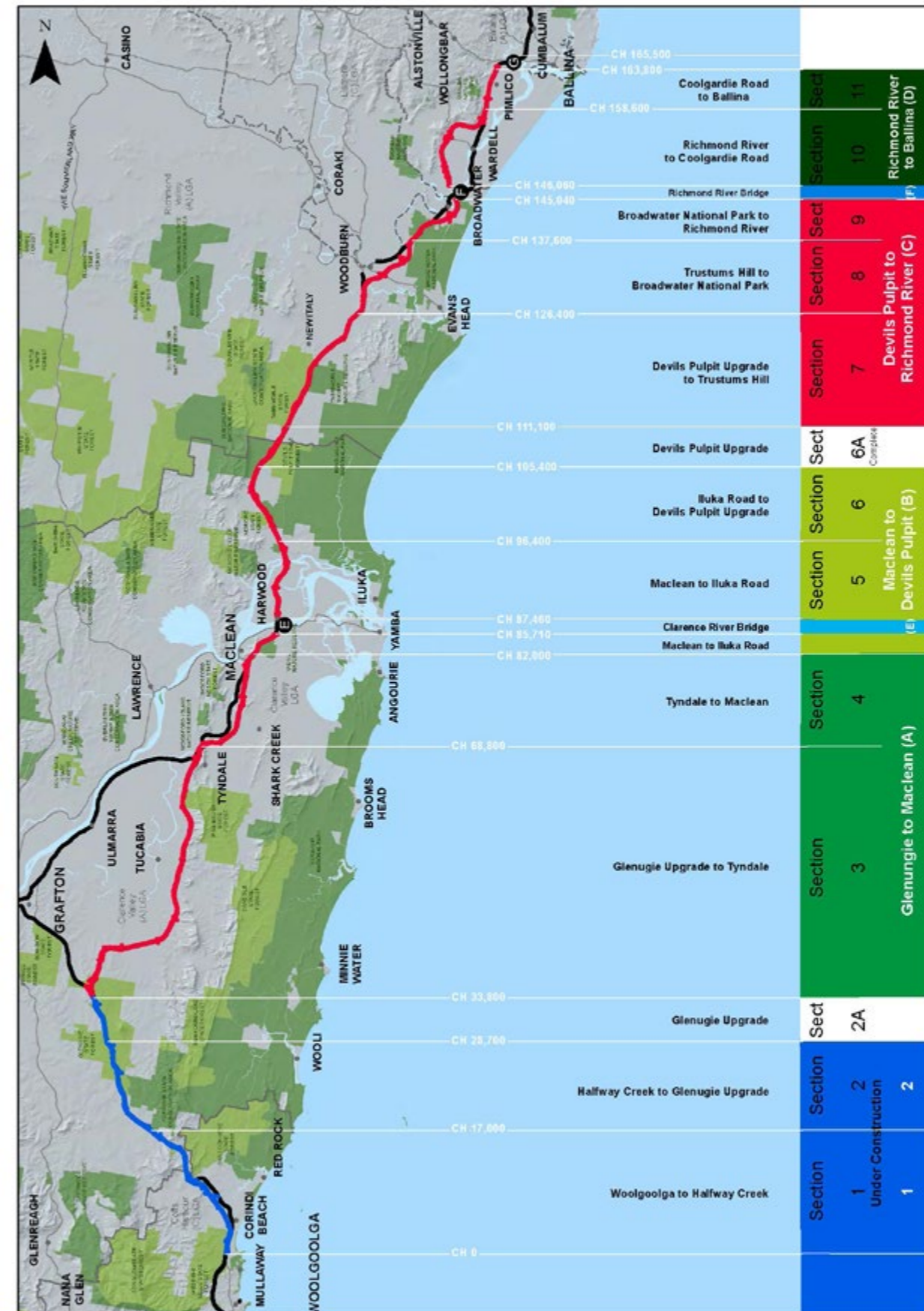


Fig.1.0 Pacific Highway dual carriageway status map (Source: Roads and Maritime Services)

1.3 Project type and staging

The Pacific Highway Office is responsible for the 657 kilometre Pacific Highway upgrade program between Hexham and the Queensland border and is leading the wave of major infrastructure projects in NSW with an equally strong focus on delivery and leaving a positive legacy. A clear benefit of the program office is that it provides a single point of contact for the general public and key stakeholders while also offering an integrated and collaborative office tasked with developing and delivering the upgrade program.

In order to realise Roads and Maritime's vision of 'driving a better highway upgrade' the program office has adopted a delivery partner model for the Woolgoolga to Ballina upgrade.

The delivery partner model is based on the approach used to oversee construction of the London Olympics and supports collaboration and innovation by bringing business, workers, consumers and suppliers together. It encourages the best ideas and solutions from the private sector while also drawing on the Roads and Maritime's knowledge to ensure better engineering and design, customer outcomes and public value including:

- Greater access to resources and optimising resources from within the public and private sector
- Greater flexibility in resource use to better respond to delays and disruptive events
- Better customer outcomes through a consistent and coordinated approach
- Economies of scale and better access to competitive suppliers and subcontractors
- Direct engagement of design, management and construction skills to fast track the upgrade.

The delivery partner Pacific Complete, comprising Laing O'Rourke and WSP. Parsons Brinkerhoff is working closely with the Pacific Highway office to oversee the project and handle multiple contracts for professional services and building of the \$4.36 billion upgrade.

The project was divided into 11 sections in the Environmental Impact Statement (EIS) for assessment purposes, excluding the completed Glenugie and Devils Pulpit upgrades.

Sections 1 and 2 of the upgrade, between Woolgoolga and Glenugie, are being built and Sections 3-11 are being managed during design development in the following portions (Fig. 1.0).

- Glenugie to Maclean (sections 3 and 4)
- Maclean to Devils Pulpit (sections 5 and 6)
- Devils Pulpit to Richmond River (sections 7, 8 and 9)
- Richmond River to Pimlico (sections 10 and 11).

Design and construction of the bridges crossing the Clarence and Richmond rivers is being managed separately.

1.4 Purpose of this plan

This plan has been developed to address the requirements of the Minister's Conditions of Approval (MCoA) D20 and present an integrated urban design for the Woolgoolga to Ballina project. This plan specifically addresses Devils Pulpit to Richmond River (sections 7, 8 and 9) and demonstrates commitment to the mitigation and management measures identified in the Woolgoolga to Ballina Environmental Impact Statement (EIS), the submissions/preferred infrastructure report (SPIR, and other approved environmental management documentation).

1.5 Urban and landscape design methodology

The urban and landscape design methodology has been revised at each design stage. As the project progresses through detailed design an integrated multidisciplinary design approach has been instilled to achieve urban design and landscape objectives which provide a holistic, yet varied and consistent design strategy. The design process is shown in Fig. 1.1.

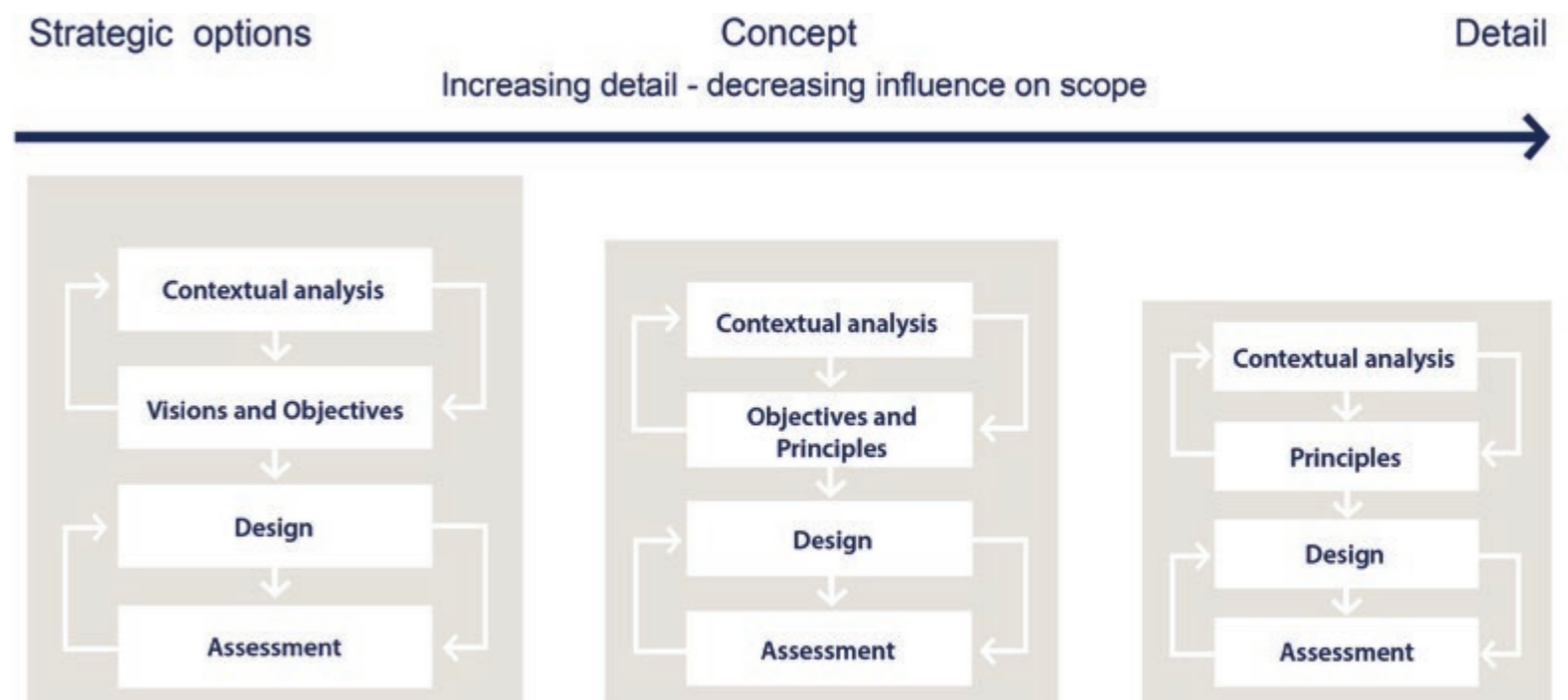


Fig.1.1 Design Process (Image source: Beyond the Pavement 2014)

1.6 Reference documents, standards and guidelines

Urban design for the project is guided by three key documents:

- The overarching best practice urban design principles as set out in Beyond the Pavement – Urban Design Policy Procedures and Design Principles by Roads and Maritime Services' Centre for Urban Design, 2014
- The urban design framework for the Pacific Highway upgrade – Pacific Highway Upgrade Urban Design Framework – Urban Design Vision, Objectives and Design Principles for the Upgrade of the Pacific Highway from Hexham to Tweed Heads, RMS, 2013
- The Urban Design report prepared as part of the EIS for the Woolgoolga to Ballina project – Pacific Highway Upgrade Woolgoolga to Ballina Urban Design Report Landscape Character and Visual Impact Assessment, Hassell, September 2012.

In addition, the UDLP has been prepared with reference to the following approval and policy guideline documents.

Approval documents:

- Project Approval Notice dated 14 August 2014. Modification 2 of the Project Approval is dated 7 October 2015
- The Woolgoolga to Ballina – Pacific Highway Upgrade – Environmental Impact Statement (EIS), Roads and Maritime Services 2012
- Woolgoolga to Ballina Urban Design Report Landscape Character & Visual Impact Assessment, Roads and Maritime Services 2012
- The Woolgoolga to Ballina – Pacific Highway Upgrade – EIS Working Paper – Biodiversity Assessment, Roads and Maritime Services 2012
- Upgrading the Pacific Highway – Design Guidelines, March 2015

Guidelines documents:

- Guideline for Batter Surface Stabilisation using vegetation, RMS, April 2015
- Environmental Impact Assessment Practice Note: Guidelines for Landscape Character and Visual Impact Assessment ("EIA No4 Guidelines"), RMS, March 2013
- Soils for Landscape and Garden Use, Australian Standards AS 4419
- Composts, Soil Conditioners and Mulches, Australian Standards AS 4454
- Construction Specifications including R178 Vegetation and R179 Planting, RMS Beyond the Pavement – Urban Design Policy, Procedures and Design Principles, RMS 2014
- Bridge Aesthetics, RMS, July 2012
- Landscape Guidelines, RMS, April 2008
- Shotcrete Design Guidelines, RMS, March 2016
- Noise Wall Design Guidelines, RMS, March 2016
- Biodiversity Guidelines – Protecting and Managing Biodiversity, RTA Sept 2011

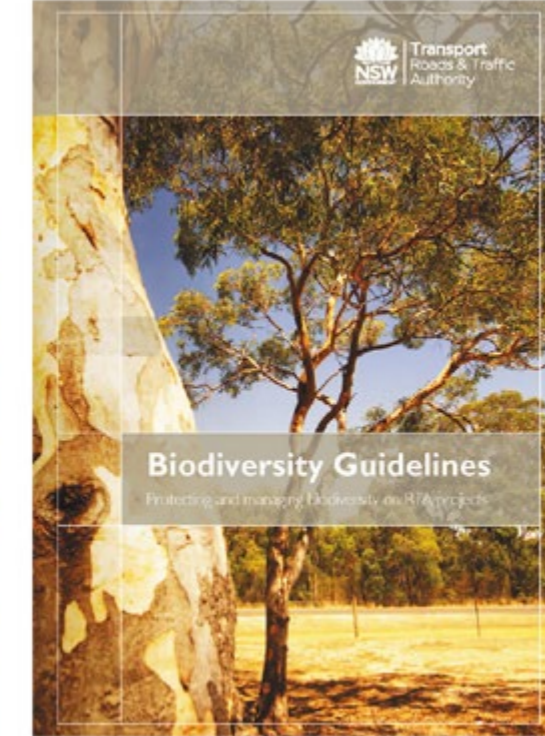
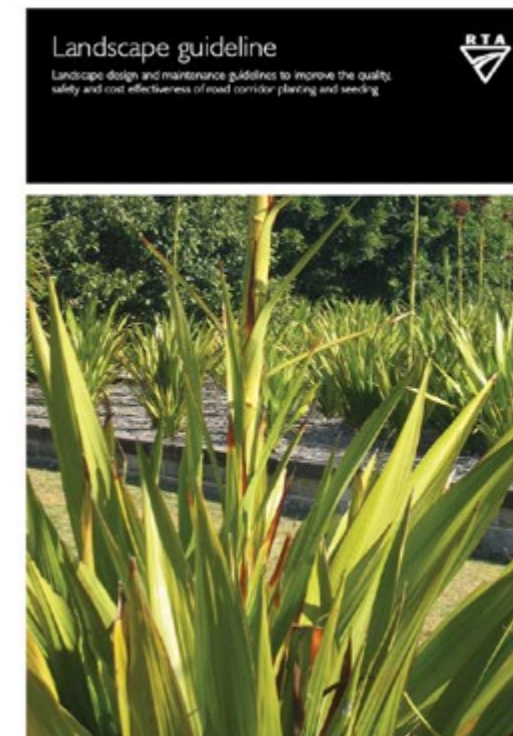
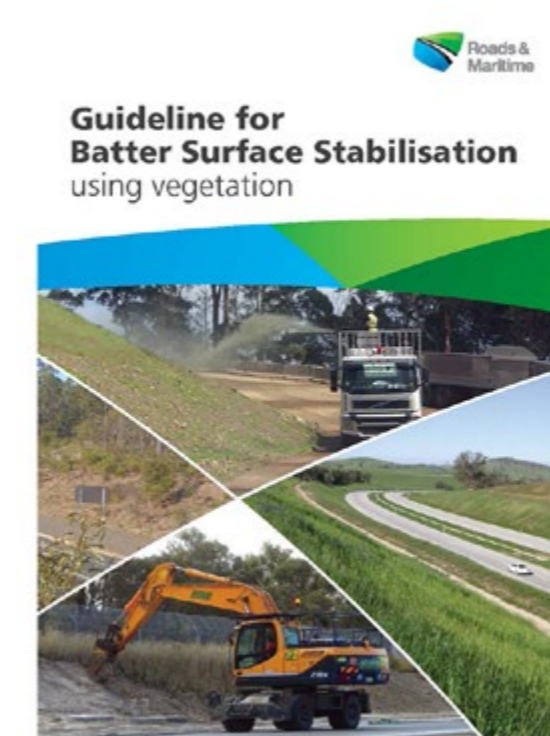
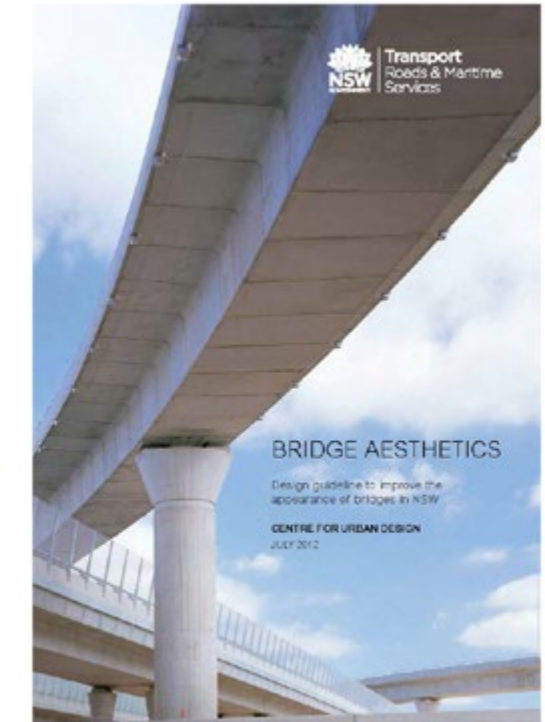


Fig. 1.2 Reference documents

1.6 Document structure

The structure and content of the urban design and landscape plan is presented in Table 1.0.

Table 1.0 Document structure

Title	Description
Executive summary	Provides a summary of the UDLP
Chapter 1 – Introduction	Provides a broad overview of the project and identifies the purpose and structure of the UDLP
Chapter 2 – Overview of the Pacific Highway upgrade	Provides a broad overview of the Pacific Highway upgrade
Chapter 3 – Consultation	Describes the consultation undertaken, and identifies the corresponding issues raised and where they are addressed in this UDLP
Chapter 4 – Pacific Highway urban design, landscape objectives and principles	Describes the project wide urban design and landscape objectives and principles
Chapter 5 – Contextual analysis	Describes specific contextual analysis and design principles
Chapter 6 – Design principles	Describes the Devils Pulpit to Richmond River (sections 7, 8 and 9) urban design and landscape objectives and principles
Chapter 7 – Urban design and landscape design	Urban design and landscape strategy plans presenting the integrated landscape and urban design solutions
Chapter 8 – Detailed response for the urban and landscape design	Detailed descriptions of all urban elements
Chapter 9 – Planting	Describes the soft landscape work
Chapter 10 – Topsoil	Describes the topsoil management
Chapter 11 – Drainage and water quality	Describes the drainage design and water quality management
Chapter 12 – Fauna crossings	Description of fauna connectivity measures
Chapter 13 – Conclusion	Summary of design outcomes
Chapter 14 – Bibliography	Catalogue of referenced documents and document appendices
Appendix A	Environmental management compliance tables
Appendix B	Planting and seeding schedules

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Overview of the Pacific Highway Upgrade

2

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2.1 Conditions of Approval D20 matrix cross references (MCoA)

The Woolgoolga to Ballina project has been approved as State Significant Infrastructure under Part 5.1 of the New South Wales Environmental Planning and Assessment Act 1979 (SSI-4963, approval dated 24 June 2014). The project is also approved under the Commonwealth Environment Protection and Biodiversity Act 1999 (012/6394 approval dated 14/08/14).

MCoA D20 relates to the preparation of an UDLP to be implemented before the start of permanent built work and/or landscaping. The specific requirements of MCoA D20 and where they are addressed in this plan are outlined in Table 2.0

Table 2.0 MCoA D20 Conditions

C0A No.	Condition Requirements	Document Reference
D20	The applicant shall prepare and implement an Urban Design and Landscaping Plan prior to the commencement of permanent built work and/or landscaping, unless otherwise agreed by the Secretary, to present an integrated landscape design for the SSI. The plan shall be prepared in accordance with the Roads and Maritime Services urban design and visual guidelines, the design principles outlined in the EIS, and the revegetation principles outlined in the EIS Working Paper – Biodiversity. The Plan shall be prepared by an appropriately qualified expert in consultation with the relevant council and community, to the satisfaction of the secretary.	This report
(a)	The plan shall include but not necessarily be limited to: Identification of design principles and standards based on: (i) Local environmental values (ii) Heritage values (iii) Urban design context (iv) Sustainable design and maintenance (v) Community amenity and privacy (vi) Relevant design standards and guidelines (vii) The urban design objectives outlined in Section 4.2 of the EIS Working Paper Urban Design Landscape Character and Visual Impact.	Chapter 6.4 Chapter 6.5 Chapter 6.2 Chapter 6.6 Chapter 6.7 Chapter 4 Chapter 1
(b)	The location of existing vegetation and proposed landscaping (including use of indigenous and endemic species where possible). Details of species to be replanted/revegetated shall be provided, including their appropriateness to the area and habitat for threatened species.	Chapter 7 Chapter 9 Appendix B
(c)	A description of locations along the corridor directly or indirectly impacted by the construction for the SSI (eg. Temporary ancillary facilities, access tracks, watercourse crossings, etc.) and details of the strategies to progressively rehabilitate regenerate and/or revegetate the locations with the objective of promoting biodiversity outcomes and visual integration.	Chapter 6.8
(d)	Take into account appropriate roadside plantings and landscaping in the vicinity of heritage items and ensure no additional heritage impacts.	Chapter 5.18
(e)	A description of disturbed areas (including borrow sites) and details of the strategies to progressively rehabilitate, regenerate and/or revegetate these areas, including clear objectives and time frames for rehabilitation work, procedures for monitoring success of regeneration or revegetation, and corrective actions should regeneration or revegetation not conform to the objectives adopted.	Chapter 6.8
(f)	Location and design treatments for any associated footpaths and cyclist elements, and other features such as seating, lighting (in accordance with AS4282–1997 Control of the Obtrusive Effect of Outdoor Lighting), fencing, materials and signs.	Chapter 8.13 Chapter 8.14
(g)	An assessment of the visual screening effects of existing vegetation and the proposed landscaping and built elements. Where properties have been identified as likely to experience high visual impact as a result of the SSI and high residual impacts are likely to remain, the Applicant shall, in consultation with affected landowners, identify opportunities for providing at property landscaping to further screen views of the SSI. Where agreed with the landowner, these measures shall be implemented during the construction of the SSI.	N/A all identified locations assessed as moderate impact Chapter 5.21
(h)	Graphics such as sections, perspective views and sketches for key elements of the SSI, including, but not limited to built elements of the SSI.	Chapters 7 and 8
(i)	Strategies for progressive landscaping and other environmental controls such as erosion and sedimentation controls, drainage and noise mitigation.	Chapters 9,10,11
(j)	Monitoring and maintenance procedures for the built elements, rehabilitated vegetation and landscaping (including weed control) including performance indicators, responsibilities, timing and duration and contingencies where rehabilitation of vegetation and landscaping measures fail.	Refer Landscape Management Plan
(k)	Evidence of consultation with the relevant council and community on the proposed urban design and landscape measures prior to its finalisation.	Chapter 3

2.2 Compliance with EIS and SPIR environmental mitigation measures and landscape strategies

In the EIS a range of environmental outcomes and management measures were identified to avoid or reduce the impact the project has on the environment. During the SPIR these measures were further refined, additional commitments were identified and conditions that had already been fulfilled were removed. Table 2.1 outlines compliance with relevant environmental mitigation measures related to landscape and urban design specific to Devils Pulpit to the Richmond River (sections 7, 8 and 9).

The EIS identified a range of strategies and management measures to minimise the visual impact and adverse changes to the landscape character by the project. This UDLP has been developed based on the landscape character and visual assessment and landscape strategy prepared as part of the EIS and revised in the SPIR.

Table 2.1 SPIR Mitigation measures

Mitigation measures	Document Reference
<p>UD3 - Landscaping and planting strategy</p> <p>The project will be carried out in accordance with the urban design and landscaping strategy, as identified in Section 11.4.1 of this EIS. Detailed landscape design for all project batters, and median planting areas will be developed in accordance with the Landscape Guidelines (RTA, 2008), the requirements of the Working Paper – Biodiversity (Section 5.2.2) and the landscape strategy to provide a robust, successful and effective planting design</p>	Chapter 9
<p>UD4 -Design of urban design features and road furniture . The built form of the project, including consideration of the height, bulk, scale, materials and finishes for:</p> <ul style="list-style-type: none"> • Bridges • Retaining walls • Cuttings and embankments • Road barriers • Signage • Fences • Clear zones • Topsoil management • Water quality control ponds • Fauna crossing • Place marking and cultural plantings. <p>The project will be designed in accordance with the design principles identified in Working Paper – Urban Design, Landscape Character and Visual Impact, and relevant Roads and Maritime guidelines.</p>	Chapter 8
<p>UD5 - Shadowing</p> <p>Further assessment will be undertaken of the impact of overshadowing on areas surrounding the project, particularly around Harwood Bridge, interchanges and overpasses near residential properties.</p>	N/A

Mitigation measures	Document Reference
<p>UD6 - Visual impacts from viewpoints</p> <p>Measures to mitigate visual impacts to viewpoints will be implemented, as identified in Table 11-42 and Working Paper – Urban Design, Landscape Character and Visual Impact. If any further viewpoints were identified during detailed design that have a moderate–high or high impact, screen planting also be considered.</p>	Chapter 5
<p>UD7 - Construction visual impacts</p> <p>Disturbed areas will be progressively revegetated throughout the construction period.</p>	Chapter 6,7,9
<p>UD8 -Visual impacts of ancillary facilities</p> <p>Where required, typical landscape treatments for ancillary facilities in forest areas will include:</p> <ul style="list-style-type: none"> • Providing screen planting • Considering reinstatement of disturbed forest in heavily forested • Considering the importance of the visual landscape at each location and allowing • Restoration of important forest vegetation to prominent ridge lines or other landscape elements where feasible and reasonable • Negotiating with private landowners, as applicable, to determine future treatments for other non-forested ancillary facility locations • Re-grading disturbed areas to achieve a sustainable and functional landform • Stabilising all surfaces in accordance with good engineering and environmental practice. 	Chapter 6
<p>UD9 - Visual impacts of ancillary facilities</p> <p>Typical landscape treatments for ancillary facilities in agricultural areas will include:</p> <ul style="list-style-type: none"> • Considering returning remnant agricultural land to agricultural uses • Providing screen planting • Reinstating riparian vegetation through ancillary facilities, where practicable, in the open landscape • Considering the visual landscape at each ancillary facility and considering restoration of important forest vegetation to prominent ridge lines or other landscape elements where feasible and reasonable • Re-grading disturbed areas to achieve a sustainable and functional landform • Stabilising all surfaces in accordance with good engineering and environmental practice. 	Chapter 6
<p>UD11 - Visual impact of borrow sites – The extent of excavation and the landscaping strategy at borrow sites will be reviewed considering material requirements on the project and the visual impact on the resultant cuttings.</p>	Chapter 6

2.3 Urban Design compliance with EIS

Chapter 11 of the EIS – Urban Design, Landscape Character and Visual Impact Assessment presented a summary of the landscape character and visual impact assessment carried out to assess the direct and indirect impact of the project. Overall, it was identified the project was expected to have a low to moderate impact on landscape character. Table 2.3 identifies EIS landscape strategies related to landscape and urban design specific to Devils Pulpit to the Richmond River (Sections 7, 8 and 9).

Table 2.2 Urban and landscape design compliance with EIS

EIS compliance	Document reference	EIS compliance	Document reference
Retain the strong contrasting experience of driving through forest and open agricultural land as a feature of the Pacific Highway experience Acknowledge and highlight the small and medium sized coastal towns which mark progress along the coastal Pacific Highway journey Highlight numerous minor and major creek and river crossings across the Pacific Highway journey nearby the coastal floodplains Acknowledge and preserve the natural and cultural landscapes and landmarks identified along the full length of the Pacific Highway journey.	Chapter 7 Chapter 8	Viewpoint 42 – Evans Head Road, Woodburn Provide new screen planting buffer to existing homes in accordance with the concept design Provide new woodland/forest trees to extend existing tree patterns in the landscape in accordance with the concept design.	Chapter 5.7
Viewpoint mitigation measures		Viewpoint 43A and 43B – Evans Head Road, Broadwater Minimise loss of existing trees Provide new screen planting buffer to existing houses in accordance with the concept design Provide new native heath vegetation to reinstate existing heath land in accordance with the concept design Reinstate agricultural land where possible.	Chapter 5.7
Viewpoint 38 – Swan Bay – New Italy Road, New Italy Minimise loss of existing trees Plant local woodland/forest trees on cut/fill batters Reinstate local forest vegetation where applicable.	Chapter 5.7		
Viewpoint 39 – Pacific Highway, South Woodburn Minimise loss of existing trees Plant local woodland/forest trees on cut/fill batters Reinstate local forest vegetation where applicable.	Chapter 5.7		

2.4 Urban design and landscape compliance with the EIS working paper - Biodiversity

The Woolgoolga to Ballina project EIS Working Paper: Biodiversity (W2BPA 2012b) identified the potential biodiversity impacts of the project to be:

- Loss of vegetation, threatened species and wildlife habitat
- Wildlife mortality during construction
- Edge effects and weeds
- Habitat fragmentation, barrier effects and wildlife mortality during operation
- Impacts on aquatic habitats, changed hydrology and fish passage.

To ensure a consistent approach to the mitigation, management and offsetting of biodiversity for the project, an overarching management strategy was developed as part of the EIS, comprised of: a Mitigation Strategy, a Monitoring Strategy and an Offset Strategy. Table 2.3 identifies each of the vegetation and landscape design principles for connectivity measures as outlined in the EIS Biodiversity Connectivity Strategy, and where they are addressed in this report.

Table 2.3 Vegetation and landscape design connectivity measures

EIS Compliance	Document Reference
<p>Mitigation Strategy - Landscaping Plans</p> <p>In general, landscape plans would avoid dense plantings of grasses and graminoids in road verge areas in sections 2 and 3 to discourage use by Rufous Bettong and minimise potential road kill of this species. Additional planting of trees around glider crossings and widened medians would be conducted to act as a long terms replacement of these structures.</p>	<p>Chapter 7 Chapter 12</p>
<p>Mitigation Strategy - Avoiding loss of vegetation and habitat</p> <p>Avoiding and minimising vegetation removal wherever possible</p> <p>Selection of ancillary facilities within the context of the ancillary site. A prior site inspection will be conducted to survey and map hollow-bearing trees and check for large nests for species such as raptors, including Osprey and also Black-necked Stork at these sites.</p> <p>Construction compounds and stockpile sites will be sited in cleared or sparsely treed portions of the ancillary facility sites where feasible and reasonable, to avoid unnecessary clearing of vegetation and threatened flora species</p> <p>Sedimentation basins and water quality ponds would be placed in the optimal location for treating surface runoff. During detailed design, the location of water quality treatment measures would consider the competing environmental requirements of minimising vegetation removal, particularly where there is the potential for threatened plant species, threatened fauna habitat or in identified regional wildlife corridors</p>	<p>Chapter 6 Chapter 7 Chapter 8 Chapter 11</p>
<p>Construction Environmental Management Plans (CEMP's), to include Guide 3: Re-establishment of native vegetation including, revegetation actions around dedicated fauna crossing structures should consider the height and density of vegetation so as not to screen the structure from view, but also aim to provide some cover for fauna approaching and exiting the structure. It is important for landscaping at entrances not to intrude/shadow the window of the entrance. Landscaping should use locally indigenous species and should target key fauna food resources to encourage usage either side of the structure and thus provide the habitat linkage to the structure.</p>	<p>Chapter 7 Chapter 12 Appendix B</p>

2.5 Landscape and urban design compliance with threatened species management plans

Threatened species management plans outline specific mitigation measures and monitoring identified for target threatened species before work, during major work and operation of the project.

The Threatened Species Management Plans for the Woolgoolga to Ballina project, and their applicability to the section, are outlined in the following Table 2.4

This UDLP addresses the mitigation measures related to landscape and urban design stipulated in the threatened species management plans that are applicable to the area between Devils Pulpit and Richmond River (Sections 7, 8 and 9). Appendix B provides further details about compliance with specific urban design and landscape requirements that are included in these management plans.

Table 2.4 Threatened species management plans relevant to Sections 7, 8 and 9.

Threatened species management plans	Applicable to Sections 7, 8 and 9
Coastal emu management plan (RMS 2015)	NO
Koala management plan (RMS 2016)	YES
Rainforest communities and threatened rainforest plants management plan (RMS 2016)	YES
Threatened flora management plan (RMS 2015)	YES
Flora Translocation Strategy (RMS 2016)	YES
Threatened fish management plan (RMS 2015)	YES
Threatened frog management plan (RMS 2015)	YES
Threatened glider management plan (RMS 2015)	YES
Threatened invertebrate management plan (RMS 2015)	NO
Threatened mammal management plan (RMS 2015)	YES
Wallum management plan	YES

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Consultation

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3.1___ Consultation

Community and stakeholder consultation for the project has been carried out in line with the Woolgoolga to Ballina Communications and Stakeholder Engagement Strategy. The strategy identifies the key stakeholders and communities, and the methods by which they would be consulted. The strategy outlines the following communication and engagement objectives for the project:

- Provide clear, consistent and timely information about the project to local communities, road users and stakeholder groups
- Raise awareness of the project and develop relationships with communities and key stakeholders
- Provide a single point of contact for communities
- Anticipate and manage local issues
- Manage community feedback and complaints in a timely fashion
- Identify opportunities for local and regional communities and stakeholder groups to be involved in the project
- Inform government and other major stakeholders, including emergency services of project progress
- Monitor and evaluate feedback to measure success and review overarching communications and community involvement strategy and actions plans as required.

The key consultation activities for the project are:

- Project notifications
- Variable message signage (VMS)
- Community information sessions
- Staffed information displays
- Stakeholder briefings
- Face-to-face meetings
- Woolgoolga to Ballina information centre
- Community focus groups
- 1800 information line
- Email
- Collaborative map
- Community contact database and complaints handling procedure.

3.2___ Community consultation

Limited preliminary draft detailed design concepts for the UDLP were available for community review and comment during community information sessions held in April and May 2016. The draft UDLP will be placed on public exhibition for the community to provide input. Following the exhibition period all community comments will be collated and where appropriate the UDLP will be revised and finalised in response to community comments.

3.3___ Stakeholder consultation

Agency stakeholders identified in the Woolgoolga to Ballina Communications and Stakeholder Engagement Strategy were invited advised the draft UDLP would be available for review and comment. Stakeholders who will be provided the UDLP to review include:

- NSW Environment Protection Agency
- NSW Department of Primary Industries
 - Fisheries
- Richmond Valley Council.

Following agency review all stakeholder comments will be collated and where appropriate the UDLP will be revised and finalised in response to those comments.

The community and stakeholders have been consulted on the project alignment, the environment, the projects delivery model, project staging and noise attenuation

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Pacific Highway urban design, landscape vision, objectives and principles

4.1 Project wide vision

The Pacific Highway Urban Design Framework (RMS, 2013) has established a vision for the Pacific Highway which is:

“The upgrade should be a sweeping, green highway providing panoramic views to the Great Dividing Range and the forests, farmlands and coastline of the Pacific Ocean; sensitively designed to fit into the landscape and be unobtrusive; and characterised by simple and refined road infrastructure.”

4.2 Project wide objectives

In fulfilling this vision a number of key objectives have been developed by Roads and Maritime:

- Provide a flowing road alignment that is responsive and integrated with the landscape
- Provide a well vegetated, natural road reserve
- Provide an enjoyable, interesting highway
- Value the communities and towns along the road
- Provide consistency-with-variety in road elements
- Provide a simplified and unobtrusive road design.

4.3 Urban design and landscape principles

Four key landscape and urban design principals were outlined in the project EIS:

- Retain the strong contrasting experience of driving through forest and open agricultural land as a feature of the Pacific Highway experience
- Acknowledge and celebrate the small and medium sized coastal towns that mark progress along the coastal Pacific Highway journey
- Highlight and celebrate the numerous minor and major creek and river crossings that punctuate the Pacific Highway journey across the coastal floodplains
- Acknowledge and preserve the natural and cultural landscapes and landmarks identified along the full length of the Pacific Highway journey.

These are shown graphically in Fig. 4.0. To achieve these strategies, the project would incorporate urban design and landscape key objectives and design principles that are consistent with the key Roads and Maritime guiding documents – Beyond the Pavement (2014) and Pacific Highway Urban Design Framework (2013).

4.4 Urban design and landscape strategy

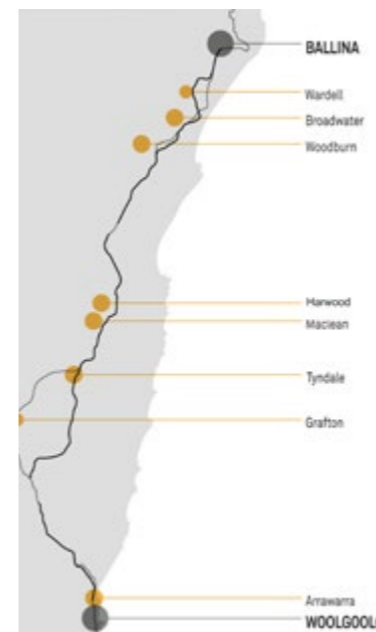
The project EIS Working paper Urban design report, landscape character and visual impact assessment (Hassell, 2012) outlined typical landscape and urban design strategies to be adopted for the length of the project.

The strategies were incorporated into the concept design and recommended mitigation strategies for the project at EIS stage and have been carried through the detailed design for the UDLP.

RETAIN CONTRASTING EXPERIENCE



ACKNOWLEDGE TOWNS



HIGHLIGHT WATERWAY CROSSINGS



PRESERVE NATURAL AND CULTURAL LANDSCAPES AND LANDMARKS



Fig.4.0 Project wide principles developed during the EIS

4.4.1__Project wide objectives

- The project wide landscape and urban design strategies outlined in the project EIS Working paper Urban design report, landscape character and visual impact assessment (Hassell, 2012) are as follows:
- Built environment, landscape character and land use
- Highlight major towns on-route with distinctive landscape treatments
- Highlight creek and river crossings.

Views

- Ensure open or filtered views to pastureland are retained
- Provide screen planting on batters to specifically mitigate the visual impact of the project to adjacent residences.

Ecology

- Reinstate disturbed areas of riparian vegetation where possible and comply with core riparian zone requirements
- Maximise riparian vegetation under creek crossings to encourage wildlife connectivity along creek lines
- Use local and endemic species on batters to complement existing vegetation patterns and reduce the visual impact of earthworks. This is particularly important for disturbed areas on prominent ridge lines
- Adhere also to ecological requirements outlined in specialist reporting.

Landscape treatment

- Install large size plant stock at interchanges and near townships to maximise impact and mitigation at project outset
- Lay back the top batter of cuttings and tie back into the existing landform. Revegetate the top of the profile to blend with the existing landscape
- Where competent rock is encountered, steepen batter grades (1V:0.25H) and expose rock faces
- Avoid use of shotcrete at all cutting locations. If shotcrete is to be used at cutting locations then any treatments and pigmentation must blend with the surrounding vegetation and rock setting
- Provide frangible planting within clear zones
- Where possible reinstate agricultural land uses
- Provide functional and safe rest areas with high landscape amenity. Provide planting in the medians to reduce headlight glare.

Built elements

- Minimising both the use and scale of noise walls and ensuring they are recessive in the landscape, or transparent, where they are required
- Minimise the road furniture that is required in the project and ensure that road furniture proposed is an integrated and cohesive set of elements
- All materials and finishes of the built infrastructure are to be of high quality for durability and appearance.

4.4.2__Devils Pulpit to Richmond River (Section 7, 8 and 9) specific landscape and urban design strategies

Refer to Chapter 6 of this report for the area between Devils Pulpit and Richmond River (Sections 7, 8 and 9) specific landscape and urban design strategies outlined in the project EIS Working paper: Urban design report, landscape character and visual impact assessment (Hassell, 2012).

4.5 Woolgoolga to Ballina project strategy plan

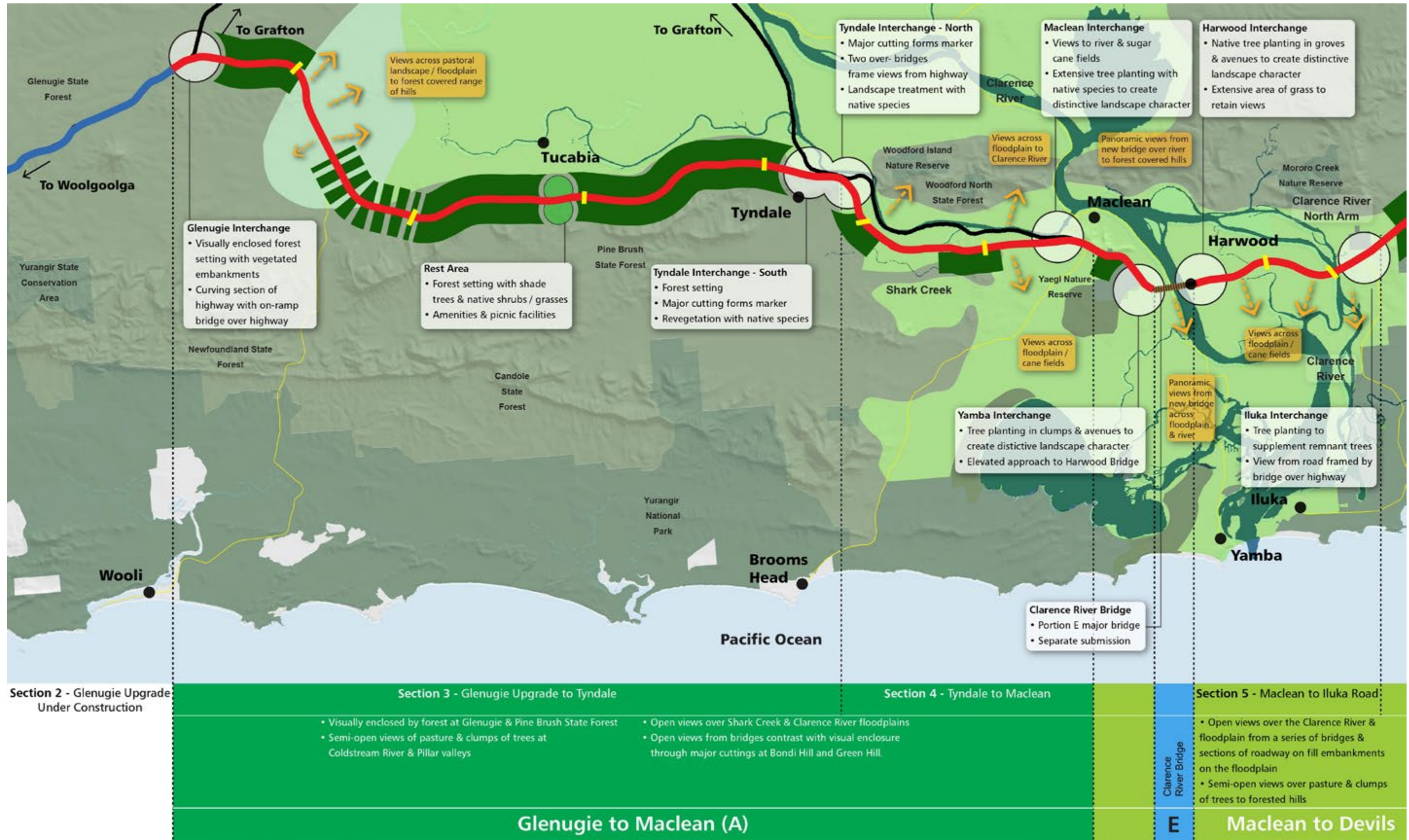
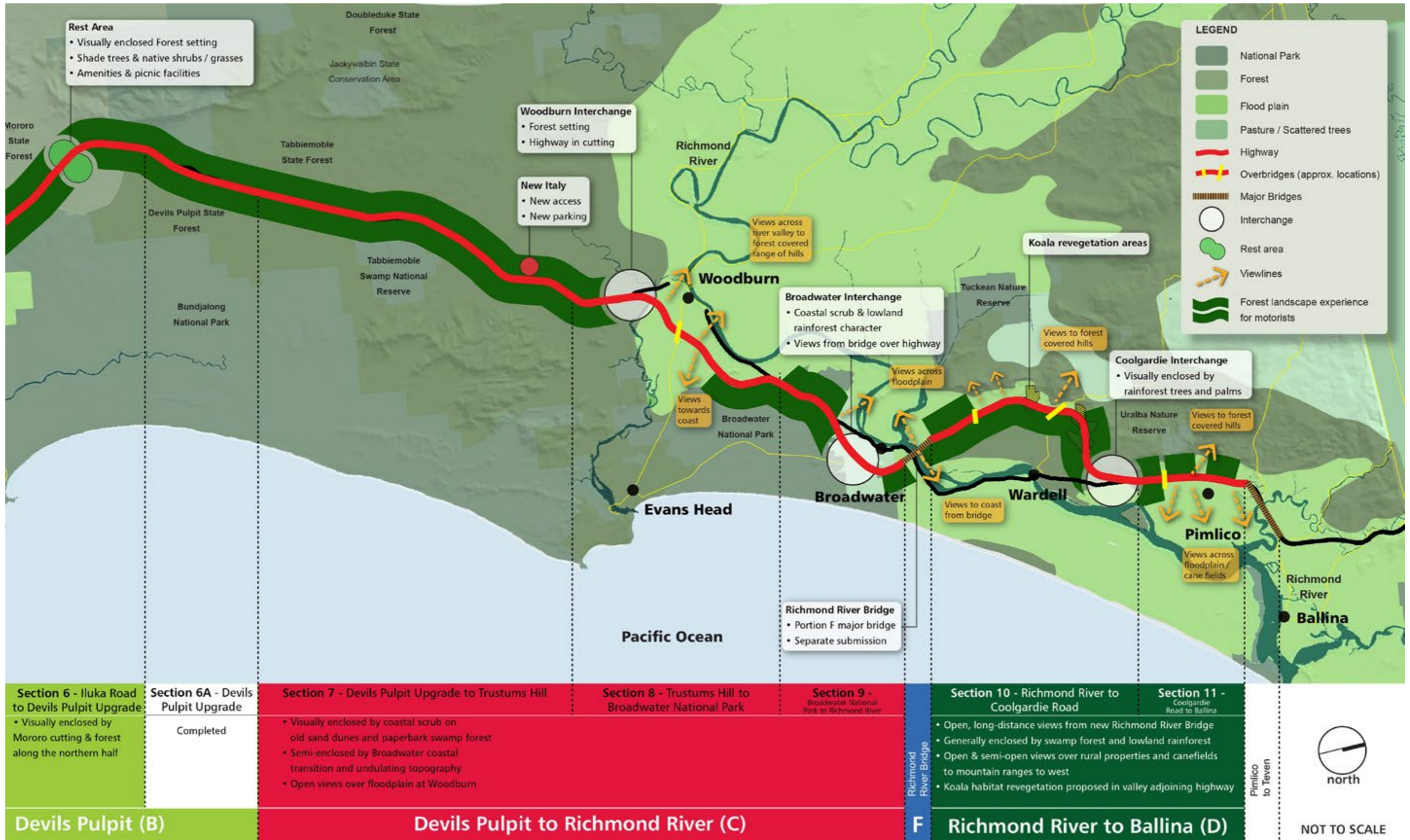


Fig. 4.1 Strategy diagram for the Woolgoolga to Ballina project



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Contextual analysis

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Landscape character is the aggregate of built, natural and cultural aspects which make up an area and provide its unique sense of place.

The landscape character of the Woolgoolga to Ballina corridor is defined largely by the interplay of tall eucalypt forests interspersed with the repeating patterns of crop and pasture land.

Visually activated by and interacting with townships, intermittent farms and homesteads, the contrasting near views within the corridor are punctuated with long views of distant ranges and the occasional glimpse of the rivers which meander across the coastal plains.



Fig.5.0 Aerial view over Richmond River. (Image source: Pacific Complete)

5.1 ___ Character zones

The existing landscape character of Devils Pulpit to Richmond River (Sections 7, 8 and 9) is largely determined by its vegetative characteristics seen in the landscape. It is a transitional landscape which transitions between closed forested areas and open cropping and grazing plains.

From the end of the Devils Pulpit upgrade the Section 7 corridor traverses along the existing Pacific Highway through the Tabbimoble and Double Duke State Forests and the Tabbimoble Swamp Nature Reserve and other forested areas.

In the north of Section 7 (Devils Pulpit to Trustrums Hill), the forested areas clear and the landscape is characterised by pasture land and open forest.

Transitioning through Trustrums Hill, the alignment continues through a tract of remnant native forest and forested residential blocks then on and into open floodplains of cultivated cropping and grazing land. Here, the road alignment diverts from its traditional Richmond River edge route closer to Bundjalung National Park through the agricultural floodplains and over the Evans River.

Continuing north of Evans River the landscape character varies from agricultural patterns with paperbark stands to swamp forests prior to aligning with and skirting the littoral scrub and coastal heath of the Broadwater National Park.

As Broadwater National Park transitions into Richmond River, the coastal heath to the east gives way to lowland subtropical palm rainforest and cane fields. The west features pasture then dry heath woodlands prior to paperbark and blackbutt forested ridges then cane fields prior to the Richmond River. This is illustrated in Fig. 5.0.



Fig.5.1 Existing Pacific Highway road alignment and character. (Image source:ACJV)



Fig.5.2 Existing Pacific Highway road edge. (Image source: ACJV)



Fig.5.3 Existing landscape node created using signage (Image source:ACJV)

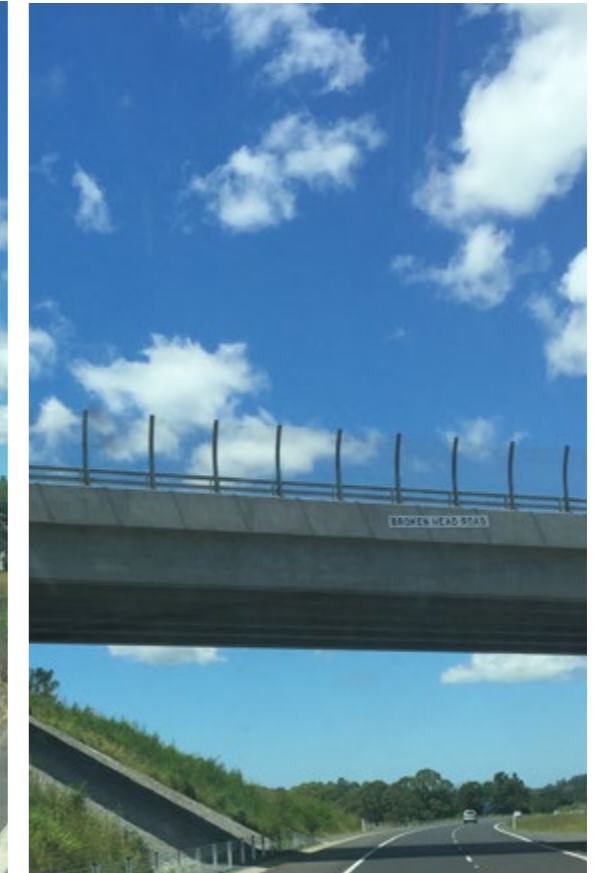


Fig.5.4 Existing landmark of a overpass bridge (Image source:ACJV)

Landscape character design response

The landscape character experienced as a journey along the road corridor is characterised by four elements:

- Road alignment
- Edge treatments
- Nodes
- Landmarks.

Combined, the design of these four elements will shape the landscape character to provide the road user with a sensitively designed road alignment. The existing landscape character is illustrated in Fig. 5.1

Road alignment

The road alignment will comfortably nestle into existing forested land and traverse lightly across agricultural lands and waterways connecting the townships along the highway. Fundamental to the way people read the journey, the road edge treatment will focus on the experience of movement through the transitional landscape characters by using landscape elements to visually engage the road user with the landscape surroundings.

Edge treatment

Landscape design to the edges will enrich the experience by contrasting the closed forested views with the open panoramic views of the agricultural plains, framing key landmark views and enhancing the viewing experience across floodplains. Fig. 5.2 shows an open landscape view.

Landscape nodes

Edge treatments on approach to interchanges will use cultural plantings and landscape statements in the form of nodes to alert drivers to local towns of Woodburn and Broadwater. Currently landscape nodes are created using signage as seen in Fig 5.3.

The landscape statements begin 1.5 kilometre from the highway off ramp and form a sequence of statements which terminate at the highway off ramps to form a sequence of distinctive landscape nodes.

These nodes will orient and inform the journey providing sensitive milestones and markers of journey moments and decisions.

Landscape landmarks

The introduced landmarks of the Woodburn and Broadwater interchanges, together with the Woodburn Evans Head Over Bridge, Sugar Cane Conveyor Protection Structure and the future Richmond River Bridge will provide key way finding opportunities which integrate and reinterpret layers of local landscape character. Landscape landmarks will be designed to compliment the existing landmarks typical to that shown in Fig. 5.4.

These landmarks form a suite of interactive experience as moments to pass beneath, opportunities to choose to depart the highway or both.

Devils Pulpit to the Richmond River (sections 7, 8 and 9) of the Woolgoolga to Ballina Pacific Highway Upgrade traverses through undulating Reserves, State Forests and National Parks which contrast with the low lying flat country predominance of agricultural cropping and grazing across the flood plains.



Fig.5.5 Aerial view over Broadwater Sugar Mill (Image source:ACJV)

5.2 Landuse and communities

Devils Pulpit to Richmond River (Section 7, 8 and 9) of the Woolgoolga to Ballina upgrade traverses through the Clarence and Richmond Valleys. It will pass by or near to agricultural land, rural residential areas and properties. It also passes through Broadwater National Park and traverses alongside the Tabbimoble Swamp Nature Reserve, Tabbimoble State Forest, Doubleduke State Forest and Broadwater National Parks.

There are three communities located next to or near Devils Pulpit to Richmond River (Sections 7, 8 and 9) works.

These are:

- New Italy, a settlement community with a museum and cultural centre which commemorates the settlement of previous generations
- Woodburn known as 'The travellers rest' is a junction town with connecting routes to Evans Head, Broadwater, Ballina, Coraki, Casino and Lismore
- Broadwater, identified as the sweet place to stop is a smaller community, which is supported by the sugar industry as shown in Fig. 5.5.

These communities provide well known rest stops along the journey from Sydney to Brisbane.

Landuse and communities design response

The Woolgoolga to Ballina Pacific Highway upgrade works provide the opportunity to reflect the local site context and cultural values of these communities and land uses at the interchange designs for Woodburn and Broadwater. For New Italy subtle design opportunities within the car parking and community access will be adopted which reinforce the cultural heritage of the existing New Italy facilities.

The design principles and urban design elements for these two interchange locations and a range of additional design opportunities are presented in Chapters 6 and 7.



Fig.5.6 Existing lowland topography (Image source:ACJV)



Fig.5.7 Existing floodplain (Image source:ACJV)

5.3___Landform and hydrology

Topography throughout Devils Pulpit to Richmond River (Sections 7,8 and 9) is variable but can be broadly categorised as either 'lowland' as shown in Fig 5.6. or 'elevated'. The sequence of lowland and elevated areas represent a shallow undulating landform which gently transitions between valleys and ridges.

Located in the Northern Rivers catchment area, the works will be developed on the floodplains of the Richmond River. The upgrade works will cross multiple waterways which range from natural water courses including creeks and gullies to engineered waterways including canals and canal drains. A selection of the waterways are classified as environmentally sensitive as they support migration and provide habitat to threatened aquatic species, this will be discussed further in Chapter 8.

Landform and hydrology design response

The gentle transitions between valleys and ridges are generally maintained through:

- Aligning the new road closely with the existing landform
- Using minimal fill embankments to improve flood immunity and views into the wider landscape
- Minimising the scale of the interchanges through alignment of ridgelines to overpass bridges
- Softening transitions into existing landscape with planting.

The floodplains are subject to frequent and extensive flooding caused by one or a combination of:

- Rainfall in the upper catchment
- Rainfall in the local catchment
- Large ocean tides.

Flood inundation in these areas can extend over a number of weeks. An existing floodplain is shown in Fig. 5.7.

The design of the underbridges at floodplains has considered the impact of flood water, fauna crossing potentials, local agricultural access and also the integration of the bridge design into the existing landscape.

Throughout the works, underbridge barriers have been designed to enhance the viewing experience across floodplains through the adoption of regular performance barriers.

In addition to spanning the waterways, culverts have been incorporated into the design to distribute water beneath the new road alignment. The design has considered the potential for scour at culvert outlet points and incorporated native planting to lessen the erosion potential.



LEGEND

- Angophora paludosa shrubby forest and woodland on sandstone or sands
- Blackbutt - bloodwood dry heathy open forest on sandstones of the Northern Coast
- Blackbutt - bloodwood grassy open forest
- Brush box - tallwood shrubby open forest of the northern ranges of the North Coast
- Coast cypress pine shrubby open forest of the North Coast bioregion (EEC)
- Coastal heath on sands of the North Coast
- Forest red gum grassy open forest of the coastal ranges of the North Coast.
- Grey gum - grey ironbark open forest of the Clarence lowlands of the North Coast
- Narrow-leaved red gum woodlands of the lowlands of the North Coast (EEC)
- Needlebark stringybark - red bloodwood heathy woodland on sandstones of the lower Clarence of the North Coast
- Paperbark swamp forest of the coastal lowlands of the North Coast (EEC)
- Red mahogany open forest of the coastal lowlands of the North Coast
- Scribbly gum - needlebark stringybark heathy open forest of coastal lowlands of the northern North Coast
- Spotted gum - grey ironbark - pink bloodwood open forest of the Clarence Valley lowlands of the North Coast
- Swamp box swamp forest of the coastal lowlands of the North Coast (EEC)
- Swamp mahogany swamp forest of the coastal lowlands of the north coast (EEC)
- Swamp oak swamp forest of the coastal lowlands of the North Coast (EEC)
- Swamp oak swamp forest of the coastal lowlands of the North Coast (EEC)

Fig.5.8 Existing vegetation map, Data Source Pacific Complete (EIS/SPiR 2012)

The Woolgoolga to Ballina Pacific Highway upgrade is located in the NSW North Coast bioregion. This bioregion is one of the most ecologically diverse bioregions in NSW. The variety of ecosystems within the bioregion includes sub-tropical and warm temperate rainforests, a wide variety of wet and dry sclerophyll eucalypt forests, heathland, paperbark swamps, freshwater and estuarine wetlands, and waterways.

5.4 Flora and fauna

Existing vegetation types for the whole Woolgoolga to Ballina project corridor were mapped for the EIS (SKM 2012a). These were groundtruthed and refined by Roads and Maritime in 2015. A total of 17 vegetation types are present across Devils Pulpit to Richmond River (Sections 7, 8 and 9). Of those, six are endangered ecological communities (EECs) listed under the NSW Threatened Species Conservation Act 1995 (TSC Act). No threatened ecological communities listed under the EPBC Act occur this area. The existing vegetation types and distribution are shown in Fig 5.9.

Existing vegetation types

The existing vegetation types are grouped into vegetation communities which vary due to variations in topography, soil type, rainfall and proximity to the coastal environment.

The vegetation community types seen in the area are:

- Dry sclerophyll open forests and woodlands
- Wet sclerophyll forests
- Swamp forests
- Floodplain forests
- Modified habitats
- Rainforests
- Freshwater wetlands
- Estuarine wetlands
- Heathlands.

These are presented graphically in Fig. 5.8.

Threatened flora

Investigative work undertaken during the EIS identified threatened flora species and communities next to or near the road alignment documented in Table 5.0.

Flora design response

The vegetation types identified have been incorporated into the planting design through the adoption of commercially available vegetation community specific species suitable for use in the modified conditions.

The use of these community founded species along the corridor is directly responsive to site specific existing vegetation community locations. This highly contextual revegetation strategy has ensured the upgrade work responds to and appropriately strengthen the existing vegetative character of the area.

Specific culturally considered plantings including red cedar, grass trees, *Livistona* and blackbean amongst others have been selected for use in specific locations within and on approach to the Broadwater and Woodburn Interchanges. At these locations the structural arrangement of the surrounding vegetative strata is deconstructed and reimagined to provide a more formal planting. Typical forest stratification is demonstrated in Fig 5.9. The formalised planting arrangement will act as visual signifiers alerting the driver to the interchanges.

The weeping paperbark habitat is located near New Italy is proposed for translocation. Three potential receiving sites have been identified within the Translocation Strategy.

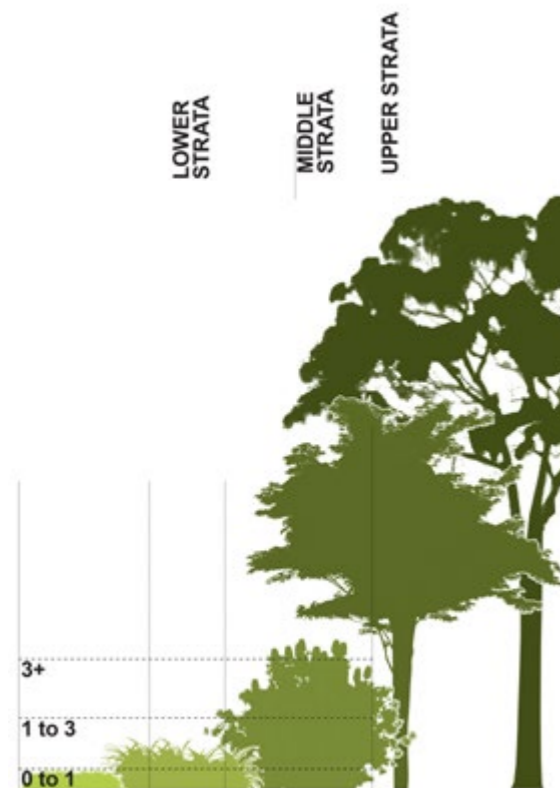


Fig.5.9 Forest strata diagram

Table 5.0 Threatened flora species

Common name	Scientific name	Section
Water nutgrass	<i>Cyperus aquatilis</i>	7
Maundia	<i>Maundia triglochinos</i>	7
Weeping paperbark	<i>Melaleuca irbyana</i>	7
Rough-shelled bush nut	<i>Macadamia tetraphylla</i>	8
Yellowflowered king of the fairies	<i>Oberonia complanata</i>	8
Siah's backbone	<i>Streblus pendulinus</i>	8



Fig.5.10 Existing koala habitat, Data Source Pacific Complete (EIS/SPIR 2012)

Table 5.1 Proposed fauna crossing structures

Structure type	Number
Bridges for Oxylean pigmy perch and/or fauna passage beneath and retained along river banks	10
Dedicated underpasses	7
Combined drainage/fauna passage culverts in wet areas (including one incidental)	7
Arboreal crossings targeting gliders	7
Widened median	1

LEGEND
 Koala habitat

The EIS identified a total of 350 fauna species (including fish and decapods) across the whole Woolgoolga to Ballina project corridor, comprising of 335 native species and 16 introduced fauna species.

Fauna species include 190 bird species, 66 mammal species, 31 frog species, 31 reptile species, 24 freshwater and estuarine fish species, six species of decapods (crabs, prawns and shrimp) and two terrestrial invertebrates.

Fauna populations present next to Devils Pulpit, Trustrums Hill, Broadwater National Park and Richmond River include:

- Glider species
- Brush-tailed Phascogale
- Long-nosed Potoroo
- Koala
- Microbats
- Green-thighed Frog
- Wallum Sedge Frog
- Oxylean Pygmy Perch.

Threatened fauna species

Targeted field studies undertaken during the EIS identified the presence of Oxylean Pygmy Perch (OPP) in the Devils Pulpit to Richmond River boundary which is listed as a threatened species.

In addition 27 species identified between Devils Pulpit to Richmond River are listed as vulnerable, of those species both the Green-thighed frog and the Wallum sedge frog were detected in habitat next to the works.

Fauna connectivity

The road alignment traverses land which is identified as key habitat and wildlife corridors. The key habitat areas comprise areas of predicted high conservation value for forest fauna, and include large areas of vegetated lands and important vegetation remnants. The habitat corridors facilitate important ecological processes such as:

- Migration
- Colonisation
- Interbreeding of animals between two or more larger areas of habitat.

Fauna connectivity strategy

A fauna connectivity strategy was developed to mitigate impact of the works on the connectivity of key threatened fauna populations and other terrestrial fauna species. This strategy is documented in the Devils Pulpit to Richmond River connectivity report. The connectivity goals are to:

- Reduce and minimise roadkill
- Avoid and minimise habitat loss and fragmentation
- Maintain and improve population viability and gene flow
- Maintain and improve connectivity
- Identify monitoring needs which build on existing knowledge to ensure the performance of the mitigation
- Maintain connectivity during construction for aquatic species.

Fauna design response

About 32 fauna connectivity structures have been designed as part of the Devils Pulpit to Richmond River (Section 7, 8 and 9) works. Connectivity structure types are shown in Table 5.1.

The design has been designed to meet the environmental objectives for the upgrade of 'protecting the long-term viability of local fauna populations' by:

- Providing fauna connectivity structures to facilitate population movement between existing habitats for all species. Existing habitat for Koala is mapped in Fig. 5.10
- Providing fauna protection fencing to protect from movement onto the highway and to direct fauna to key crossing locations
- Providing, strategic planting next to fauna connectivity structures to replicate the surrounding habitat and provide protective cover for at risk fauna while minimising concealment opportunities for predators.
- Providing strategic habitat planting for koalas in areas which will adjoin sections of the road corridor.



Fig.5.11 Rope bridge Source: Australian Research for Urban Ecology, Kylie Soanes



Fig.5.12 Fauna furniture next to underpass bridge Image by Faunacrossings.com.au

The traditional owners of the land in Richmond Valley are a part of the Bundjalung nation. The Bundjalung people are a large Aboriginal nation, a federation of a number of groups of clans which inhabit the region north of the Clarence River to the Logan River in South-East Queensland



Fig.5.13 Bundjalung nation clan map, Data Source Pacific Complete (EIS/SPIR 2012)

5.5 Heritage

Aboriginal heritage

Existing Aboriginal cultural heritage values between Devils Pulpit to Richmond River (section 7, 8 and 9) were identified during both the EIS and SPIR phases through consultation with the Bundjalung people and subsequent excavation of potential archaeological deposit (PAD).

The presence of PAD sites demonstrates the pattern of Aboriginal occupation in the area. Although, Aboriginal groups typically remained within their own territories (Fig 5.13) long distance travel was often undertaken to attend social and ceremonial events and to exchange goods between the north coast river systems.

This pattern of occupation is also passed along by songlines of the region. The songline tells of many Bundjalung who lived inland and would make a journey to the coast during winter months when mullet was plentiful. They would bring with them seeds from the blackbean tree (*Castanospermum australe*) for food and trading. Some of these would be dropped as they made their way along the banks of the Richmond River to the coast. Evidence of seed dispersal in this manner and subsequent tree growth is said to be responsible for many mature trees located along the banks of The Richmond River.

The investigations identified nine sites listed in the NSW Aboriginal Heritage Information Management System (AHIMS). Eleven sites were also identified to have PADs near the proposed site boundary.

The Aboriginal sites with most significance were:

- The scarred engraved tree near New Italy
- Cooks Hill.

A scarred/engraved tree is of high significance due to:

- Its function as an aboriginal women's ceremonial site
- One of the few remaining markers in the landscape which tells of Aboriginal occupation in the region
- The presence of engravings on the tree which is rare
- Cooks Hill is of significance as it is a known ceremonial ground (Bora ring).

Other significant sites of interest were identified and include:

- Gittoes Jali (also known as Lang Hill). This site extends along a sandstone ridge which overlooks the Richmond River and floodplain and is significant due to the presence of artefact scatters. Two conservation zones were identified within this area and will be protected from built works.
- Site 11, a number of artefact scatter sites. Where required, artefact scatter sites will have salvage excavation of cultural materials removed and catalogued.

Non-Aboriginal heritage

Settlement to the North Coast was driven by cedar getting, which subsequently transitioned to agriculture and then to sugar cane. These primary industries were supported by smaller ship building, commercial fishing, gold mining and brick making industries. Historically significant items were identified and assessed during the EIS and SPIR phases.

The EIS investigations into Non-Aboriginal historic sites near Devils Pulpit, Trustrums Hill, Broadwater National Park and Richmond River identified two sites of State and local significance shown in Table 5.3.

The historical significance of the New Italy Settlement is recognised by a listing on the State Heritage Register (no 1648). The settlement represents the first Italian farming community in Australia and one of the major migrant influences in the region. In 1881 217 Italian migrants arrived in Sydney where after serving for a year as labourers seven migrant families applied for and settled the township of New Italy. The township steadily grew with a school, post office, tavern and church established by 1887.

Aboriginal and Non-Aboriginal interaction
Like in all other parts of Australia, the arrival of Europeans brought disease and colonising acts of violence which had a devastating effect on the local Aboriginal people. Yet from the early days, some European people fostered individual friendships and a reliance on Aboriginal people. Initially interaction was reportedly amicable with Aboriginal people employed as cedar spotters and labourers; however, when cedar supplies diminished, widespread land clearance was conducted along river valleys and the interaction between the cedar getters and Aboriginal people reportedly became tense.

Design response

Impact to the historically significant sites located within or near the upgrade works have been avoided and mitigated where possible. The scarred engraved tree near New Italy is to have protective screening placed on the final boundary to block the site from the road. In addition, the significance of both the Aboriginal and Non-Aboriginal historic influences to the area have been conceptualised within appropriate locations as design generators for the urban and landscape design. This will be discussed further in Chapters 6 and 8 of this report.

Table 5.2 Non-Aboriginal items of historical significance

Item no.	Item name	Location	Description	Where listed
23	New Italy Settlement Landscape (incl. Historic New Italy Village Area)	Lot 2 DP616005, Part Lot 72 and Part Lot 73 DP755609	The item is New Italy Settlement area including the New Italy Museum, Park of Peace and the New Italy School site.	NSW State Heritage Register 1648
		Lot 59 DP755609, Lot 25 DP755610, Lot 2 DP616005, Lot 1 DP207390, Lot 97 DP755609, Lots 30 and 37 DP755609	The item comprises Bazzo's well, Cypress Road stone-lined well, memorial and stone lined well, Roder's stone-lined well and mango tree orchard, former St Peter's Church and wells, and former Pezzuli's wine shop The memorial (Monument to the Pioneers) was built in 1961 and is a concrete obelisk with the names of the original settlers inscribed on the sides. The stone-lined well is situated south-west of the memorial The Cypress Road stone-lined well is a circular well, located in the Double Duke State Forest on Cypress Road Roder's stone-lined well is round and lined with sandstone cobbles. A mango tree orchard is located to the north of the well.	Richmond Valley LEP 2012 sites IDs I145, I147, I148, I149, I150, A5, A7
26	Maloney property, Broadwater	Lot 5 DP 1142669	The item is a property which consists of a residence, buttery/creamery, dairy with an open bay with an adjoining large open bay shed and timber stockyards The dairy, buttery/creamery, sheds, residence and stockyards are included within the curtilage	Not listed (local significance)

Six different types of landscape soil are located between Devils Pulpit and Richmond River. All of which are considered to be moderate to highly erodible.

Aeolian

Highly erodible and permeable soil

Erosional soils

Highly erodible when cleared

Alluvial

Highly acidic and erodible, occurs in areas subject to flood hazards

Transferral

Typically highly acidic and erodible due to seasonal waterlogging

Stagnant alluvial

Associated with stagnant alluvial plains erodible due to seasonal waterlogging

Estuarine

Generally associated with deltaic plains and extra tidal flats of the Clarence and Richmond Rivers. Slopes are in the order of 0–3 percent and soils are typically saline, subject to regular flooding and of low bearing strength. Soil types are also prone to water erosion.

LEGEND

- Aeolian soil
- Erosional Soil
- Alluvial Soil
- Transferral Soil
- Estuarine Soil



Fig 5.14 Landscape soils map, Data Source Pacific Complete (EIS/SPiR 2012)

5.6 Geology and soils

The most common soil landscapes that occur between Devils Pulpit and Richmond River (Section 7, 8 and 9) boundary are the erosional, transferral and alluvial types as seen in Fig 5.14.

Soils within these landscapes are generally highly erodible and have low bearing strength. Acid sulphate soils are prevalent across the site.

Ground investigations have assessed the presence of acid sulphate soils and construction methods have been adopted to limit the excavation of the acid sulphate materials.

The Topsoil Management Plan details testing requirements for topsoil to be re-used on site. Any new planting to areas in risk of exposure to sulphuric acid will be tolerant of acidic soils.

Geology

The upgrade works generally traverse the geological sequence of the Clarence-Moreton Basin, an extensive Mesozoic age sedimentary basin extending from Southern Queensland to the NSW North Coast and comprising sedimentary rocks about 2.5 to 4 kilometres thick.

Devils Pulpit to Trustums Hill Section 7 Soil landscape

Section 7 is mainly underlain by erosional landscapes (highly erodible). Isolated areas of stagnant alluvial landscapes are located in the southern (highly erodible) and central portions, and isolated areas of transferral landscapes located in the northern portion near New Italy and Trustums Hill (moderately erodible).

Trustums Hill to Broadwater National Park

Section 8 Soil landscape

Section 8 is generally underlain by erosional landscapes in the south, alluvial landscapes in the central portion and aeolian landscapes in the north. All of these landscapes are highly erodible.

Broadwater National Park to Richmond River

Section 9 Soil landscape

Section 9 is mainly underlain by aeolian landscapes. An isolated area of disturbed landscape is located in the southern portion. These landscapes are highly erodible. Swamp landscapes located at the far northern end of the section adjoining the Richmond River are prone to water erosion, including areas of soft soils.

Soil landscape design response

The Topsoil Management Plan in Sub-chapter 8.2 details the testing requirements for topsoil to be re-used on site.

Recommendations for soil management from the soil scientist have been used to inform the design of the landscaping revegetation scheme.

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5.7 Key views

Visual impacts identify the impact of the upgrade works from select viewpoints

The EIS Visual Assessment identified eight locations between Devils Pulpit and Richmond River where the upgrade works will be able to be viewed from.

During the EIS the assessment identified mitigation strategies which when implemented would reduce the visual impact the upgrade works had on the existing landscape character.

These mitigation strategies are identified in Table 5.3

Table 5.3 Visual impact mitigation measures

EIS KEY VIEWPOINT		MANAGEMENT MEASURES IDENTIFIED DURING EIS	EVIDENCE OF IMPLEMENTATION OF MANAGEMENT MEASURES
EIS Viewpoint 37- Corner Minyumai Rd and Pacific Highway Tabbimoble Swamp Nature Reserve	Magnitude: High Moderate Sensitivity: Low Impact: Moderate	Minimise loss of existing trees Plant local forest trees on cut/fill batters Reinstate local forest vegetation where applicable.	Management measures are adopted in planting design and clear zone minimisation.
EIS Viewpoint 38 - Swan Bay - New Italy Road, New Italy	Magnitude: Moderate Sensitivity: High Impact: Moderate	Minimise loss of existing trees Plant local woodland trees on cut/fill batters Reinstate local forest vegetation where applicable.	Management measures are adopted in planting design and clear zone minimisation together with revised parking and facility parking.
EIS Viewpoint 39 - Woodburn Interchange	Magnitude: High Sensitivity: Moderate Low Impact: Moderate High	Minimise loss of existing trees Plant local woodland forest trees on cut/fill batters Reinstate local forest vegetation where applicable.	Management measures are adopted in planting design including deliberate visual stratification of landscape and species selection. Bridge architectural treatments include painting in charcoal tone to present a recessive visual presentation.
EIS Viewpoint 40 - Woodburn Evans Head Road overpass	Magnitude: Moderate Sensitivity: Moderate Impact: Moderate	Minimise loss of existing trees Plant dense low grasses/ground covers on fill batters Reinstate agricultural land where possible.	Management measures are adopted in planting design to include swamp oak screen and batter planting where appropriate to screen views and pasture grasses to reinstate agricultural road edges.
EIS Viewpoint 41 - Woodburn Evans Head Road overpass	Magnitude: Moderate Sensitivity: Moderate Impact: Moderate	Provide new intermittent screen planting on batters to screen to and from houses Provide new woodland/forest trees to extend existing tree patterns in the landscape in line with the concept design.	Management measures are adopted in planting design to include swamp oak screen and batter planting where appropriate to screen views and pasture grasses to reinstate agricultural road edges.
EIS Viewpoint 42 - Woodburn Evans Head Road overpass	Magnitude: High Sensitivity: Moderate Impact: Moderate High	Provide new screen planting buffer to existing homes in line with the concept design Provide new woodland/forest trees to extend existing trees to extend existing tree patterns in the landscape in line with the concept design.	Management measures are adopted in planting design to include swamp oak screen and batter planting where appropriate to screen views and pasture grasses to reinstate agricultural road edges.
EIS Viewpoint 43a and 43b - Broadwater Interchange	Magnitude: High Sensitivity: Moderate Low Impact: Moderate High	Minimise loss of existing trees Provide new screen planting buffer to existing houses in line with the concept Provide new native heath vegetation to reinstate existing heathland Reinstate agricultural land where possible.	Management measures are adopted in the planting design featuring the coastal heath and subtropical palm rainforest to buffer unsuitable views while reinforcing visual character.
EIS Viewpoint 44 - Pacific Highway	Magnitude: High Sensitivity: Moderate Low Impact: Moderate High	Minimise loss of existing trees Provide new screen planting buffer to existing houses in line with the concept Reinstate agricultural land where possible.	Management measures are adopted in the planting design featuring the coastal heath and subtropical palm rainforest to buffer unsuitable views while reinforcing visual character.

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Design principles

6



Fig.6.0 Aerial view over Richmond River (Image source: Pacific Complete)

6.1 Site description

Section 7 begins north of the Devils Pulpit upgrade about 13 kilometres north of Mororo Road and stretches around 34 kilometres north to Richmond River Bridge and is located in the Richmond Valley Local Government area.

The existing Pacific Highway alignment is the major interstate and regional route connecting Sydney to Brisbane. In a more localised context the alignment connects New Italy to Broadwater with a scenic rest stop in between at Woodburn. All three locations are frequented regularly by both visitors and heavy vehicle traffic.

Featuring large areas of forested land with creek crossings, minor ridge lines and low lying floodplains the existing alignment weaves through the Devils Pulpit State Forest, Tabbimoble State Forest and with the new alignment through The Broadwater National Park.

The Pacific Highway upgrade is divided into three sections as shown in Fig. 6.1:

- Section 7 is about 14.8 kilometres long, located between, from the Devils Pulpit upgrade in the south to just south of the Gap Road, Trustums Hill
- Section 8 is around 11.15 kilometres long, located between Trustums Hill to Broadwater National Park
- Section 9 is around 7.5 kilometres long, located between Broadwater National Park to Richmond River (Fig. 6.0).



Fig.6.1 Site location map



Fig.6.2 Woodburn township (Image source: Pacific Complete)

6.2 Urban design context

The urban design context of the highway describes the relationship, arrangement, appearance and function of the highway with the environment and towns it passes through.

The urban design of the existing Pacific Highway and subsequent highway upgrades has created a relationship between built and natural elements which encourages the built elements to sensitively fit within the landform as well as the built, natural and community environments in which it is situated.

The key elements of the existing Pacific Highway which define the existing urban design context are:

- The existing Pacific Highway arterial road and local adjoining roads and its relationship to the topography
- The iconic Woodburn Riverfront relationship to the Highway alignment (Fig. 6.2)
- The cultural heritage architecture seen in near by townships of New Italy and Broadwater
- The bridge crossings and the common infrastructure detailing shown in Fig.6.3.



Fig 6.3 Existing bridge, (Image source: ACJV)

6.3 Urban and landscape design strategies

The Woolgoolga to Ballina urban design objectives described in Chapter four of this report together with two additional Pacific Highway urban design framework objectives (listed below) were adopted to inform the urban and landscape design strategies.

Specific urban and landscape design strategies were developed for this design. These detailed strategies are specifically tailored to the site context and conditions related to the design for Devils Pulpit to Richmond River. The strategies are described below with attendant graphic. The graphic is shown throughout this report to highlight areas where each strategy was applied.

In addition to the over arching urban design objectives, landscape and urban design strategies have been specifically developed for the Devils Pulpit to Richmond River upgrade



WOOLGOOLGA TO BALLINA URBAN AND LANDSCAPE DESIGN OBJECTIVES				PACIFIC HIGHWAY URBAN DESIGN FRAMEWORK OBJECTIVES	
<p>OBJECTIVE 1 Provide a flowing road alignment which is responsive and integrated with the landscape.</p>	<p>OBJECTIVE 2 Provide a well vegetated, natural road reserve.</p>	<p>OBJECTIVE 3 Provide an enjoyable, interesting highway.</p>	<p>OBJECTIVE 4 Value the communities and towns along the road.</p>	<p>OBJECTIVE 5 Provide consistency with variety in road elements.</p>	<p>OBJECTIVE 6 Provide a simplified and unobtrusive road design. The visual character of the landscape.</p>
URBAN AND LANDSCAPE DESIGN STRATEGIES					
<p>STRATEGY 1 Blend topographic change Shape topography and revegetate cuttings and embankments to blend with the landform and maintain the visual character of the landscape.</p>	<p>STRATEGY 2 Respect local vegetation Deliver a local landscape adopting a vegetation palette founded upon local landscape types. Plant species selected from local vegetation communities for local conditions to reinforce the natural landscape character and cultural landscape qualities of the site. Planting application to be seeding along the main alignment and planting at interchanges.</p>	<p>STRATEGY 3 Sequence views Sensitively compose planting to create a varied sequence and depth of views along the journey. Landscaping is used to sequence the drivers views from closed forested views to open views of cropping and pasture land.</p>	<p>STRATEGY 4 Emphasise moments Adopt semi-mature tree plantings and compose character landscapes as markers of communities, rest stops, and moments along the journey.</p>	<p>STRATEGY 5 Consistently connect Connect communities through infrastructure design, fauna and planting elements which are composed using a consistent design language which contextually responds to local character and cultural values remaining true to the overall Pacific Highway presentation approach.</p>	<p>STRATEGY 6 Safely and sensitively structure Structure the landscape to provide a hierarchical treatment which responds to frangibility, structures, maintenance and fauna fence clear zones. This will ensure safe movement for drivers, animals, and maintenance teams at installation and as the landscape matures.</p>

The Richmond Valley region comprises mountain bush and hilly scrubland, timber country and grazing land, floodplains with sugar cane and tea tree stands, wetland and swamp to coastal heath, rocky headlands and dunal systems.



Fig.6.4 Broadwater National Park

6.4 Local environmental values

A number of local environmental value elements exist along or in the vicinity of the alignment of the proposed highway. These elements include:

- Flora and fauna habitat needing to be protected or translocated
- State forests and national parks (View across Broadwater National Park shown in Figure 6.4)
- Environmental connectivity
- Areas of landscape which include threatened flora species
- Landscapes with potential acid sulphate soils
- Aboriginal sites and or conservation zones
- Aboriginal archeological PAD sites
- Non-Aboriginal historic sites.

The impact to these local environmental values was assessed and quantified through the environmental design for Devils Pulpit to Richmond River (Sections 7, 8 and 9). Where applicable mitigation measures detailed in the environmental design report have been instilled during the design process of the landscape and urban design works.



Fig.6.5 Red cedar canopy

6.5 Heritage values

Impact to the historically significant sites located within or near the works identified in Chapter 5 of this report have been avoided and mitigated where possible.

In addition, the significance of both the Aboriginal and Non-Aboriginal historic influences to the area have been conceptualised in the urban and landscape design. Cultural influences responding to the landscape and urban design strategy four have been included in the following ways:

- The Woodburn Interchange will feature a red cedar trees (Fig. 6.5) representative of the cedar cutting history
- The song lines of the patterns of navigation described in Chapter 5 are also represented in the feature tree planting seen at the Woodburn Interchange. This songline is represented by an informal scattering of the Black Bean tree (*Castanospermum australe*) within the interchange landscape.
- The Broadwater Interchange will include feature tree planting of *Livistonia* and *Xanthorrhoea* to acknowledge and reinforce the existing iconic vegetative character seen within the Broadwater region.

6.6 Sustainable design and maintenance

Sustainability Action Plan (SAP) was developed for the Devils Pulpit to Richmond River (Section 7, 8 and 9) works, to ensure the works are an Ecologically Sustainable Development (ESD) when tested using the infrastructure sustainability council of Australia (ISCA) rating tool. Details of the ISCA rating tool are presented in the Sustainability Action Plan Report.

The SAP:

- Identifies the key principles of sustainable development
- Describes the sustainability objectives and policy
- Outlines the embedment of sustainability into the design process
- Documents the monitoring and measuring process for the project lifecycle using the ISCA rating tool.

The ISCA has developed a rating tool which evaluates sustainability initiatives and potential environmental, social and economic impact of infrastructure projects and assets.

For urban design the tool focuses specifically on the analysis, planning and design of the infrastructure asset within its community and environment to achieve contextually appropriate infrastructure design.

This achieved by allowing the local context to influence the design to create infrastructure which fits its setting, while preserving and enhancing scenic, aesthetic, cultural, community, and environmental resources and values.

The SAP for the Sections 7, 8 and 9 is outlined in Table 6.0 with landscaping responses.

Table 6.0 SAP action plan

Themes	Categories	Objective	Target/Evidence	Section 7, 8 and 9 measures	Urban design responses
Using resources	Water	Minimise water use.	Report on three initiatives undertaken to minimise water use (within the sustainability register)	Design to consider opportunities to re-use water where possible.	Use of native plant species to minimise water use.
Ecology	Ecology	Maintain the integrity and quality of the ecological environment through appropriate planning during detailed design.	Reduce clearing extents where possible Connectivity Strategy.	Minimising vegetation clearing where possible Develop a Connectivity Strategy for Sections 7, 8 and 9 Adhere to approval conditions including vegetation clearing limits, dedicated fauna structures and fauna fencing requirements.	Use of appropriate plant species to maximise wildlife habitat connectivity at fauna crossing points Dedicated fauna structures and fauna fencing coordinated with landscape design.
People and place	Community health, wellbeing and safety	Work with the community to pursue, promote and develop sustainable outcomes.	Two community consultation events Public exhibition of UDLP.	Community consultation to be undertaken during development of the UDLP UDLP to be placed on public exhibition for community comment.	UDLP made available for consultation purposes.
	Heritage	Maintain the integrity and quality of the cultural environment through appropriate planning during detailed design.	Report on three initiatives undertaken to minimise impact on identified heritage items (within the sustainability register).	Minimising impact of design on identified heritage items.	Minimising impact of design on heritage items and inclusion of heritage context in cultural landscape plantings to interchanges.
	Urban and landscape design	Identify design principles and standards for sustainable design and maintenance.	UDLP.	Develop an UDLP which will include design principles and standards for sustainable design and maintenance.	This document Design strategies located in Chapter 6 Landscape maintenance plan documented in Appendix B of this report and to be in line with QA specifications R178/179.

Residents indicate the best thing about living in Richmond Valley centres around the location and proximity of the region, as well as the peaceful and quiet atmosphere
- Richmond Valley Towards 2025 Community Strategic Plan



Fig.6.6 Community location map

6.7 Community amenity and privacy

There are three communities located next to or near to the Devils Pulpit to Richmond River (Section 7, 8 and 9) works shown in Fig. 6.6. All of which are situated within the Richmond Valley Shire:

- New Italy, a settlement community with a museum and cultural centre which commemorates the settlement of previous generations
- Woodburn known as 'The travellers rest' is a junction town with connecting routes to Evans Head, Broadwater, Ballina, Coraki, Casino and Lismore
- Broadwater, identified as 'The sweet place to stop' is a smaller community, which is supported by the sugar industry.

The key community values relating to amenity for residents of the Richmond Valley Shire as described in The Richmond Valley Towards 2025 Community Strategic Plan are:

- A quiet, friendly and relaxed lifestyle
- Access to natural attributes
- Open space and recreation.

The design responds to these values by:

- Diverting the highway from Woodburn and Broadwater to remove unnecessary through traffic and encouraging a quiet, friendly and relaxed lifestyle
- Providing access to open space and recreation through interchange connections to Woodburn, Evans Head and Broadwater
- Allowing people to view the natural attributes through use of regular performance barriers on floodplain bridges and diverting through the Broadwater National Park.

6.8 Temporary works and ancillary facilities, access tracks, watercourse crossings

The Woolgoolga to Ballina project will require ancillary facilities to support the construction activities associated with the project. The Project Approval defines ancillary facility as:

- Temporary facility for construction, including for example an office and amenities compound, construction compound, batch plant (concrete or bitumen), material crushing and screening, materials storage compound, maintenance workshop, testing laboratory or material stockpile area.

In line with the Minister's Conditions of Approval (MCoA) D21, Pacific Complete has prepared an Ancillary Facilities Management Plan which outlines how ancillary facilities will be assessed and managed during construction of the project. The Management Plan provides details of the approval pathway, environmental impact assessment, and includes details of all ancillary facilities approved for the project. Ancillary facilities covered by the Management Plan include:

- Office compounds – including the main site compounds, site offices, sheds, workshops and storage; satellite compounds – small site offices
- Minor ancillary facilities – including lunch sheds, office sheds, and portable toilet facilities
- Bridge site compounds – site office to allow for easy access to major bridge sites
- Batch plants – for the production of concrete and asphalt
- Crushing plants and material processing sites – plant and equipment for the processing, crushing and screening of excavated material for use on-site
- Plant workshops – for the storage and maintenance of plant and equipment
- Stockpile sites – for the stockpile and storage of excavated material, mulch and spoil
- Material storage (laydown areas) – for the storage of materials delivered to site for construction.
- Display centres and visitor parking.

The ancillary facilities associated with the Woolgoolga to Ballina project include areas which are located within the existing or proposed highway corridor and are directly or indirectly impacted by the construction works, in addition to locations nearby or separate to the construction activities. As outlined in the MCoA definitions all ancillary facilities are temporary and can

only be used for the Woolgoolga to Ballina project. MCoA B76 of the Project Approval outlines the rehabilitation requirements of these sites:

The land on which ancillary facilities are located shall be rehabilitated to at least their pre-construction condition or better, unless otherwise agreed by the landowner

Borrow sites

The Woolgoolga to Ballina project will also require a number of borrow sites will be used to source material for construction of the project. MCoA D22 of the Project Approval requires the preparation of a Borrow Sites Management Plan for each of the borrow sites proposed for the project. The plan needs to identify details of the site, assessment of impact resulting from the borrow operations, and rehabilitation details of the borrow site. The rehabilitation details are to include future landform and use of the borrow site, landscaping and revegetation, and measures to be implemented to minimise or manage the ongoing environmental effects of the site.

General location and size

The temporary ancillary facilities utilised during the highway construction phase will vary in their size and configuration, depending on the nature of use and nearby construction activities. There is likely to be a combination of larger main construction compounds in addition to smaller satellite compounds located within each portion of the project. The specific locations of the ancillary facilities to be used for the project are not fully known at the time of preparation of the UDLP, and as a result are not detailed in the plan. Temporary ancillary and borrow sites are located on two different categories of land which include:

1. Land owned by Roads and Maritime for the purposes of the project.
2. Private properties leased for the construction period of the highway.

All ancillary facilities will be managed for the project in line with the approved Ancillary Facility Management Plan. It is anticipated each ancillary facility will be developed and rehabilitated in line with the principles.

Ancillary and borrow site rehabilitation principles

1. Establish landowner requirements and identify rehabilitation objectives.
2. Consideration of the location context and amenity requirements.
3. Integrate rehabilitation with nearby landform, topography.
4. Consider fauna connectivity and wildlife corridors and enhance where possible.
5. Apply landscape treatments consistent with the project UDLP to ensure an integrated outcome.

Commitment to site rehabilitation

The intention with all Temporary Construction sites is to rehabilitate them as soon as possible after they are no longer required for the highway construction operations.

1. **On Roads and Maritime owned sites used for temporary construction** which are to be sold, and are located within or near native vegetation communities, the area impacted within those properties will be revegetated with species compatible with the remnant vegetation. Where appropriate the revegetation will to enhance wildlife habitat values. The rehabilitation works are to include maintenance until the vegetation is well established.
2. **On Roads and Maritime owned sites used for the extraction of construction material** the rehabilitation works may include disposal of soil material classified as 'unsuitable' generated by the highway works, regrading to create landforms compatible with adjoining areas and establishment of a stable revegetation cover. Re-use of this material is subject to all relevant waste and planning approval requirements.
3. **On privately owned land** the rehabilitation works will be in line with an agreement to be reached with the property owner. The rehabilitation works are to meet all relevant environmental requirements.

Woolgoolga to Ballina Pacific Highway upgrade

Draft detailed design urban and landscape plan

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Urban design and landscape design

7

Precinct integration vision

The design strategy delivers a safer more efficient and enjoyable driver experience demonstrating superior fauna connectivity, stronger native vegetation communities, improved flood immunity and enhanced local town amenity.

7.1 Urban design and landscape design strategy

The urban and landscape design strategy is focused upon delivering the project objectives through practical design and construction measures which support and ground truth the overarching urban and landscape design principles identified in Chapter 6.

The urban and landscape design strategy is presented on the following 12 pages at 1 to 8000 scale.

This strategy embraces the design principles and through succinct dot point statements and icon graphics communicates the key design features relative to:

- Planting
- Seeding
- Existing vegetation communities
- Fauna connectivity
- Views
- Threatened species
- Urban design elements
- Community way finding.

DESIGN STRATEGY KEY



Strategy 1 – Blend topographic change

Shape topography and revegetate cuttings and embankments to blend with.



Strategy 2 – Respect local vegetation

Deliver a local landscape adopting a vegetation palette founded upon local landscape types. The landform will maintain the visual character of the landscape.

Plant species selected from local bioregions for local conditions to reinforce the natural landscape character and cultural landscape qualities of the site.

Planting application to be seeding along the main alignment and planting at interchanges.



Strategy 3 – Sequence views

Sensitively compose planting to create a varied sequence and depth of views along the journey. Views have selectively screened sensitive receptors while concentrating on the driver experience to create character variance from ridge to floodplain, forest to crop and pasture.



Strategy 4 – Emphasise moments

Adopt semi-mature tree plantings and compose character landscapes as markers of communities, rest stops, and moments along the journey.



Strategy 5 – Consistently connect

Connect communities through infrastructure design, fauna and planting elements which exhibit, and are composed using a consistent design language which contextually responds to local character and cultural values remaining true to the overall Pacific Highway presentation approach.



Strategy 6 – Safely and sensitively structure

Structure the landscape to provide a hierarchical treatment strata which responds to frangibility, structures, maintenance and fauna fence clear zones to ensure safe movement for drivers, animals, and maintenance teams at installation and as the landscape matures.



Section 7 – Devils Pulpit to Trustums Hill
Forested landscape outcome. Plant species will replicate those of the surrounding landscape and in doing so create an enclosed driver experience for both the north and southbound journey. Fauna crossings have been included to mitigate habitat fragmentation.

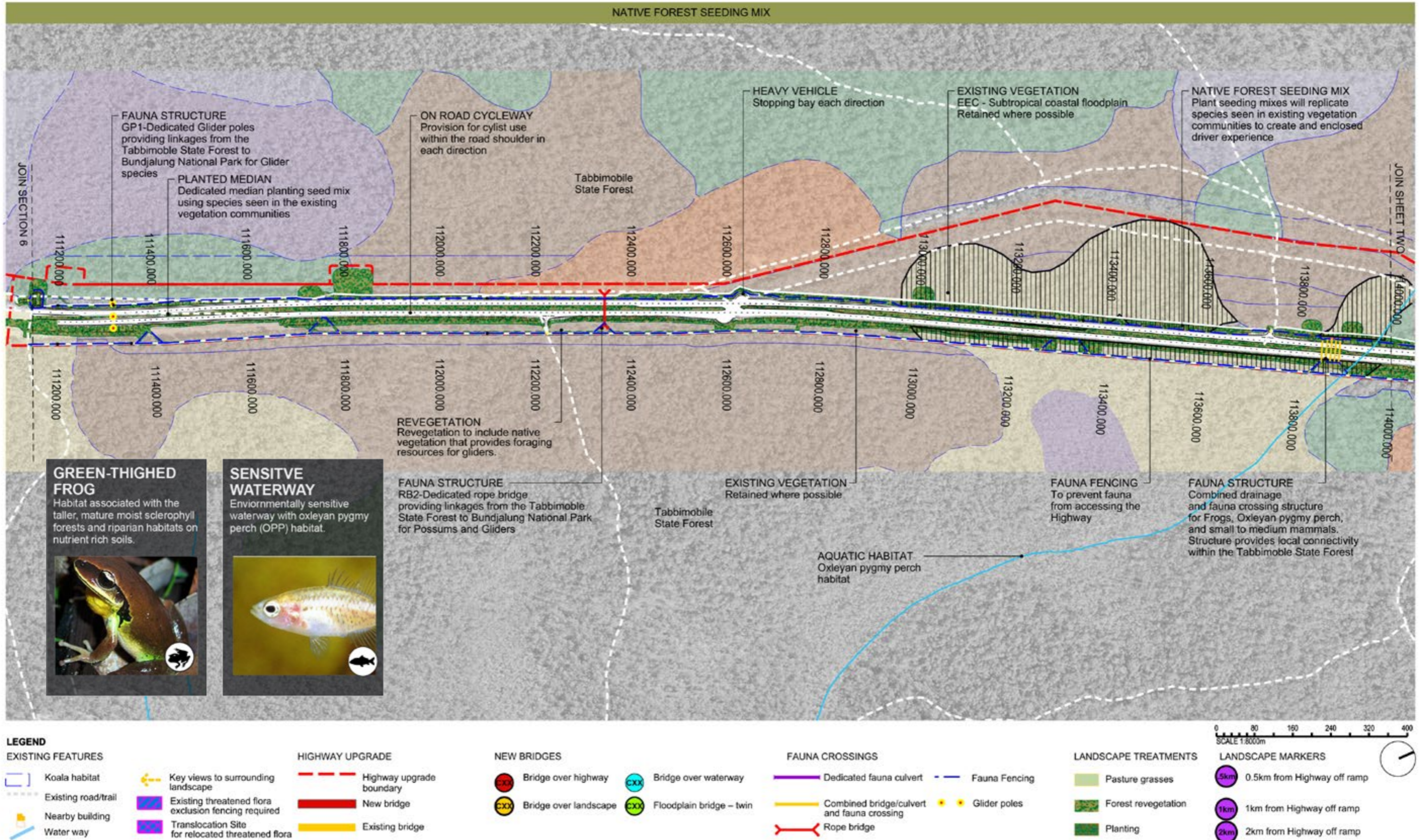


Fig 7.0 Urban and Landscape Design Strategy Plan – Devils Pulpit to Trustums Hill – Sheet 1

Design is subject to further development - all elements within composition are indicative only



Section 7 – Devils Pulpit to Trustums Hill

Forested landscape outcome. Plant species will replicate those of the surrounding landscape and in doing so create an enclosed driver experience for both the north and southbound journey. Fauna crossings have been included to mitigate habitat fragmentation.

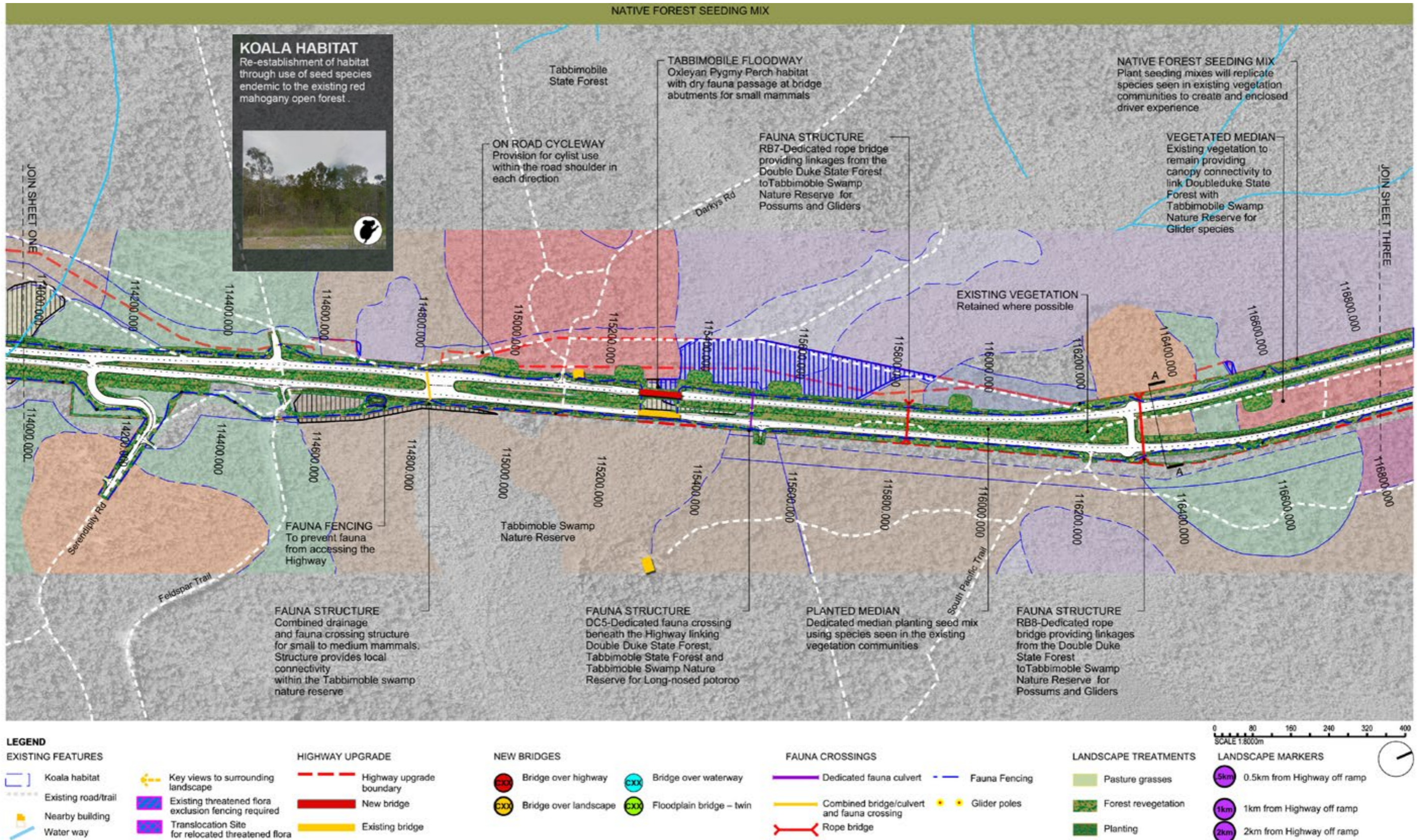


Fig 7.1 Urban and Landscape Design Strategy Plan – Devils Pulpit to Trustums Hill – Sheet 2

Design is subject to further development - all elements within composition are indicative only



Section 7 –Devils Pulpit to Trustums Hill
Forested landscape outcome. Plant species will replicate those of the surrounding landscape and in doing so create an enclosed driver experience for both the north and southbound journey. Dry fauna crossing at bridge underpass to mitigate fauna fragmentation.

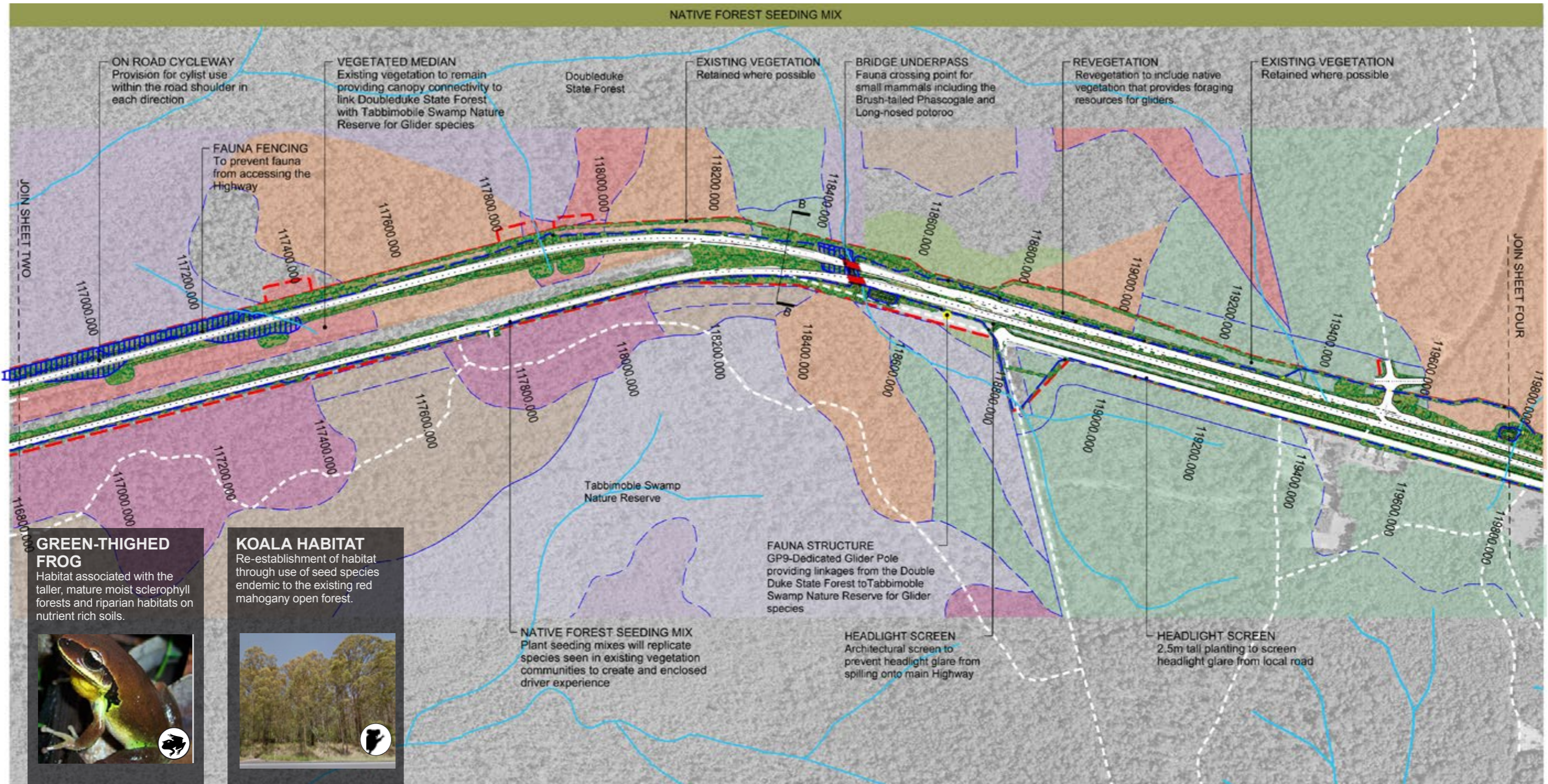
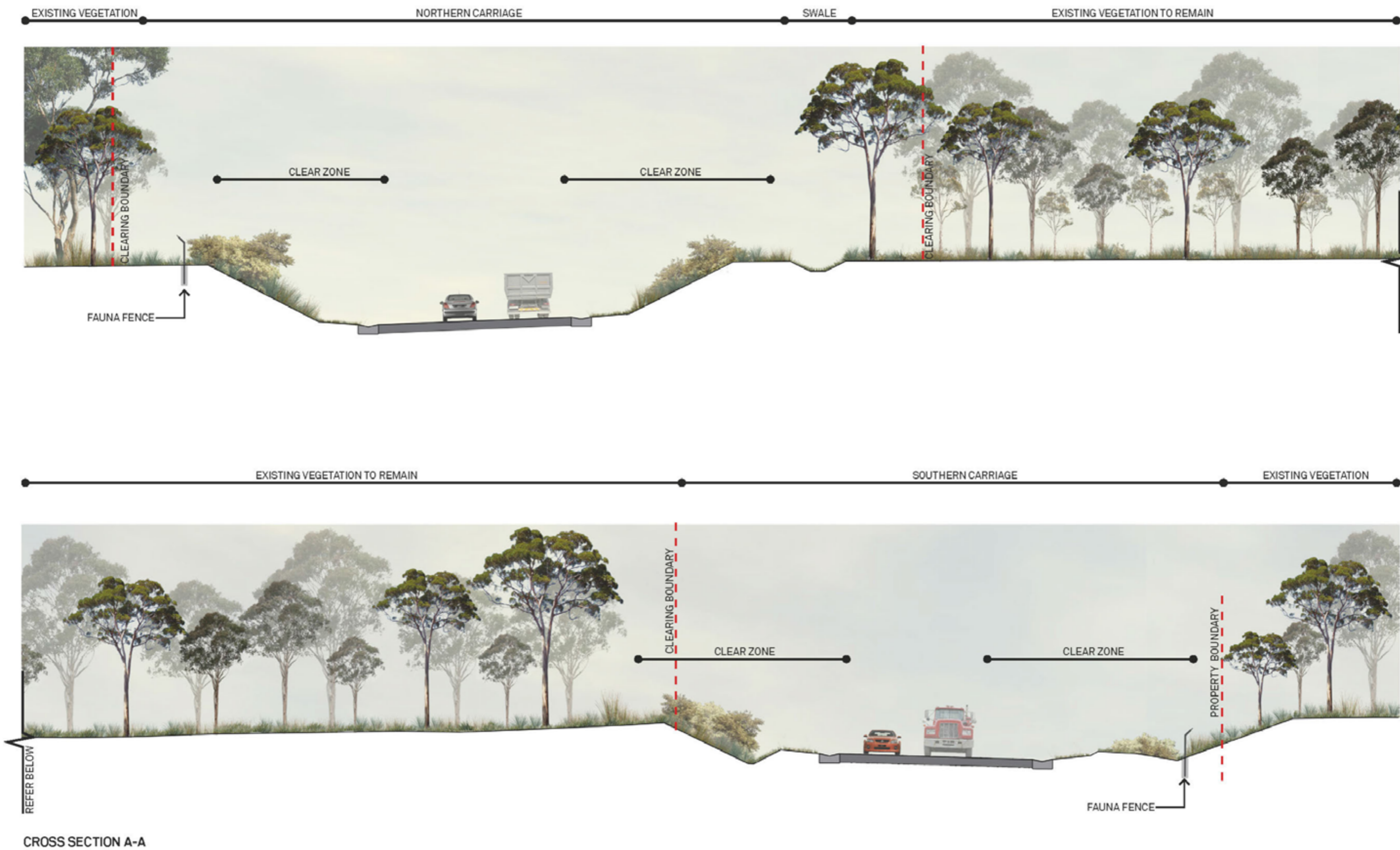


Fig 7.2 Urban and Landscape Design Strategy Plan – Devils Pulpit to Trustums Hill – Sheet 3

Design is subject to further development - all elements within composition are indicative only

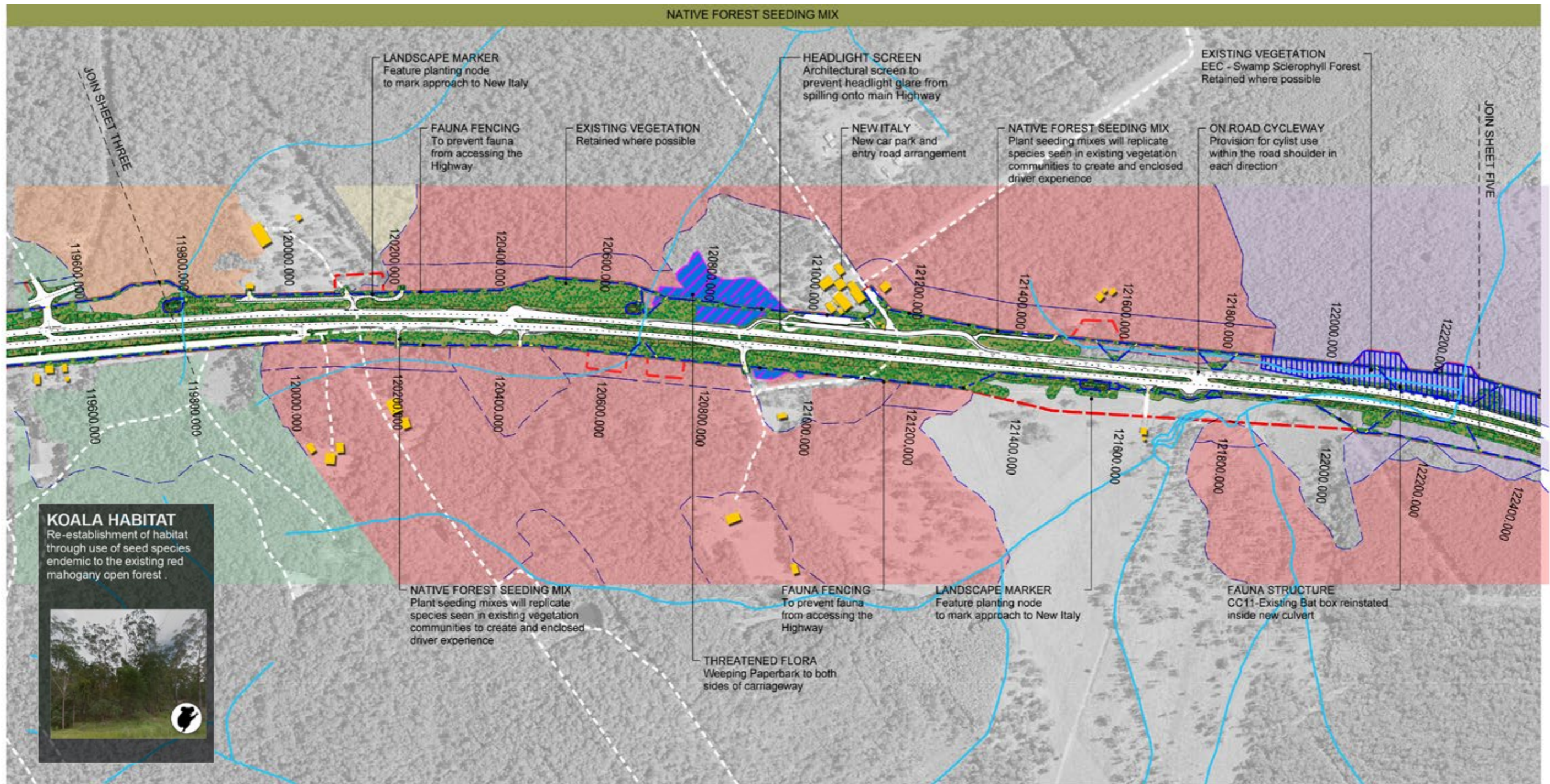


CROSS SECTION A-A

Fig 7.3 Urban and Landscape Design Cross Sections – Devils Pulpit to Trustrums Hill



Section 7 – Devils Pulpit to Trustums Hill
Forested landscape outcome. Plant species will replicate those of the surrounding landscape and in doing so create an enclosed driver experience for both the north and southbound journey. Reinstate existing bat box for fauna safety.



Design is subject to further development - all elements within composition are indicative only

Fig 7.4 Urban and Landscape Design Strategy Plan – Devils Pulpit to Trustums Hill – Sheet 4



Section 7 – Devils Pulpit to Trustums Hill
Forested landscape outcome. Plant species will replicate those of the surrounding landscape and in doing so create an enclosed driver experience. A pocket of open pasture land provides a glimpse into the wider landscape contrasting against the typically forested edge. Fauna crossings have been included to mitigate habitat fragmentation.

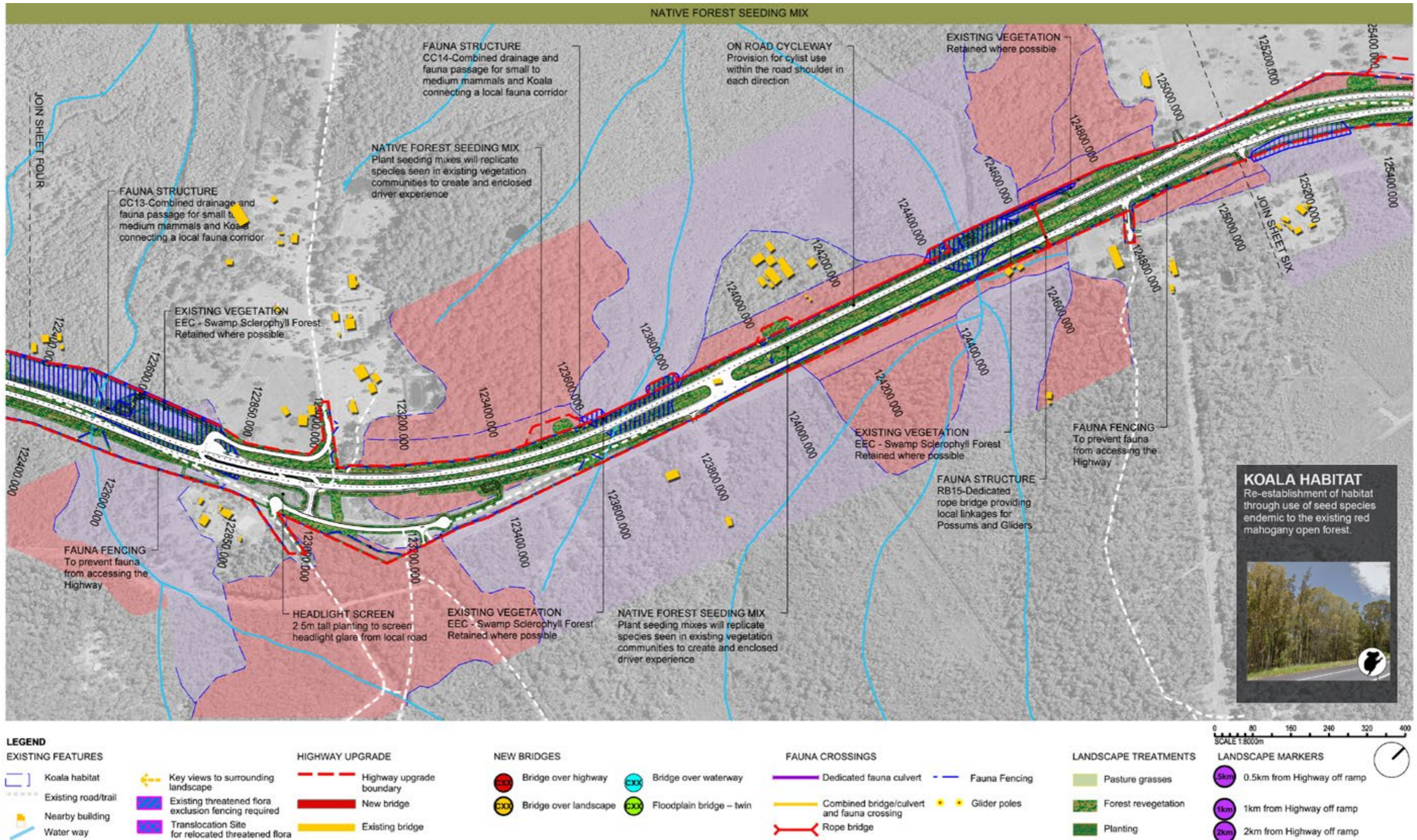
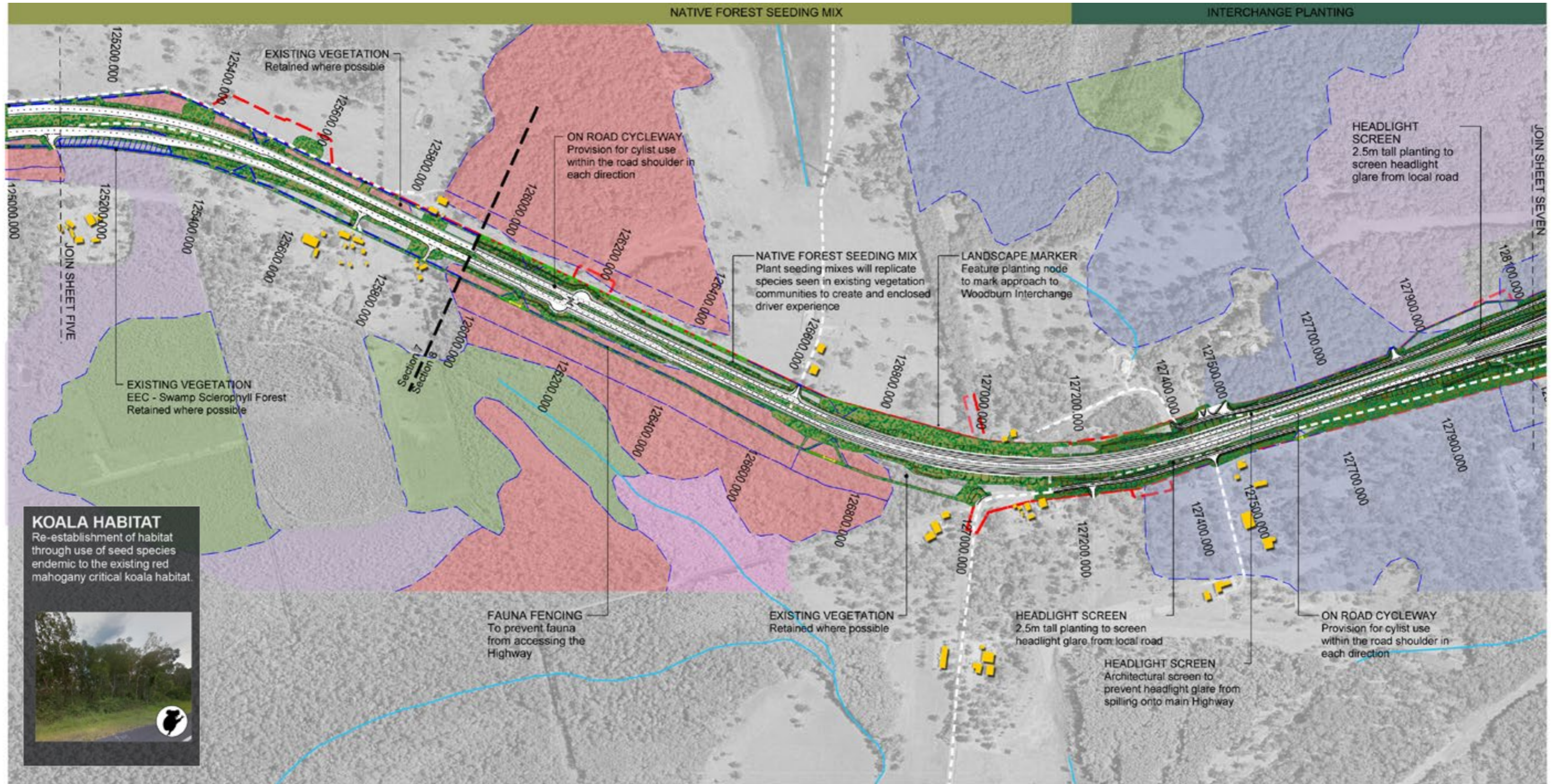


Fig 7.5 Urban and Landscape Design Cross Sections – Devils Pulpit to Trustums Hill – Sheet 5

Design is subject to further development - all elements within composition are indicative only



Section 7 and 8 – Trustrums Hill to Broadwater National Park
Forested landscape outcome. Plant species will replicate those of the surrounding landscape and in doing so create an enclosed driver experience. A pocket of open pasture land provides a glimpse into the wider landscape contrasting against the typically forested edge. Vegetated and architectural headlight screens for driver safety.



LEGEND - EXISTING VEGETATION COMMUNITY TYPE

Blackbutt - Bloodwood dry heathy open forest	Forest Red Gum - Grassy open forest	Spotted Gum - Grey Ironbark - Pink Bloodwood open forest	Coastal Heath on sands	Swamp Oak swamp forest	Littoral Rainforest
Blackbutt - Bloodwood Grassy open forest	Narrow-leaved Red Gum woodlands	Spotted Gum - Grey Box - Grey Ironbark open forest	Needlebark stringy bark - Red Bloodwood heathy woodlands	Paperbark swamp forest	Coastal Floodplain Sedgelands
Grey Gum - Grey Ironbark open forest	Scribbly Gum - Needlebark Stingingbark heathy open forest	Red Mahogany open forest	Wet Heathland and shrubland	Swamp Mahogany swamp forest	Coast Cypress Pine Open Forest

ENDANGERED ECOLOGICAL COMMUNITIES

Coastal Cypress Pine Forest	Swamp Oak Floodplain Forest on Coastal Floodplains
Subtropical Coastal Floodplain Forest	Swamp Sclerophyll Forest on Coastal Floodplains

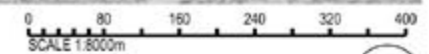


Fig 7.6 Urban and Landscape Design Strategy Plan – Trustrums Hill to Broadwater National Park – Sheet 6

Design is subject to further development - all elements within composition are indicative only



Section 8 – Trustrums Hill to Broadwater National Park
Transitional landscape outcome. Interchange landscape design draws upon local cultural references to inform plant species and formalised distribution. The landscape transitions from forested to pasture past the Tuckombil canal in keeping with the existing landscape character and promoting views into the wider landscape. Fauna crossings are provided through dedicated dry passage beneath bridge structures.

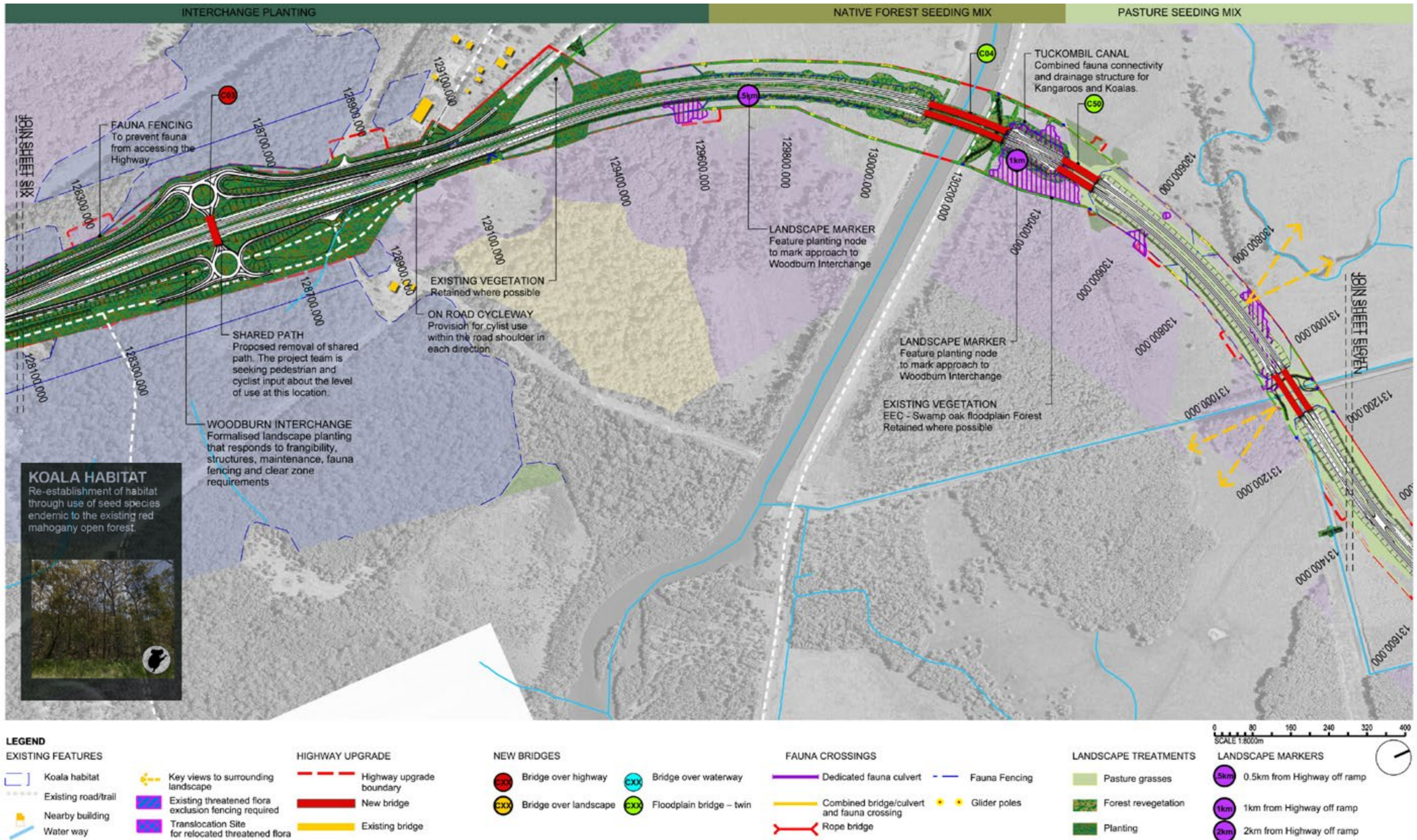


Fig 7.7 Urban and Landscape Design Strategy Plan – Trustrums Hill to Broadwater National Park – Sheet 7

Design is subject to further development - all elements within composition are indicative only

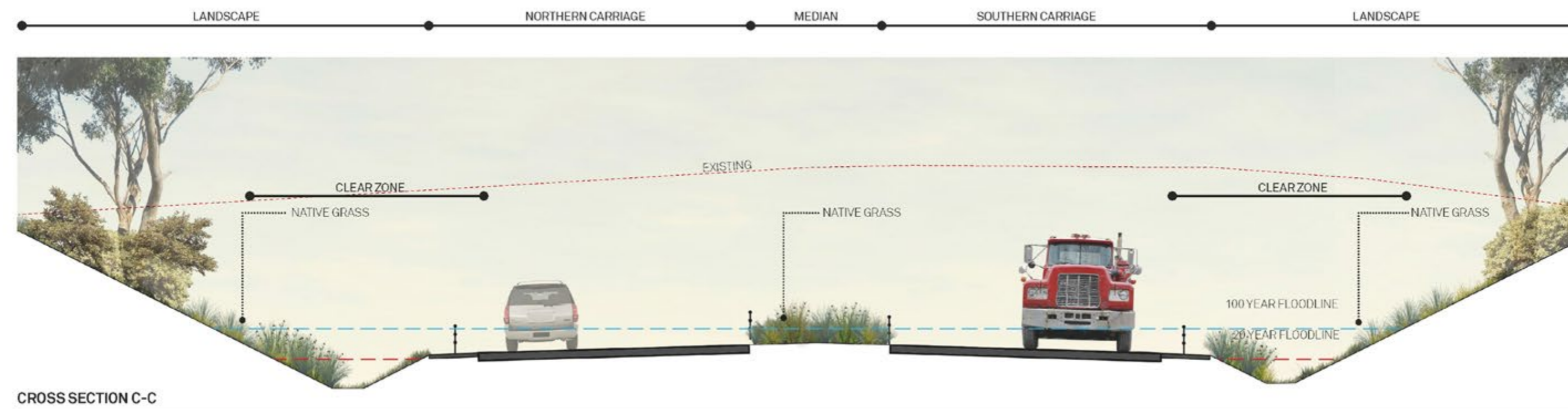
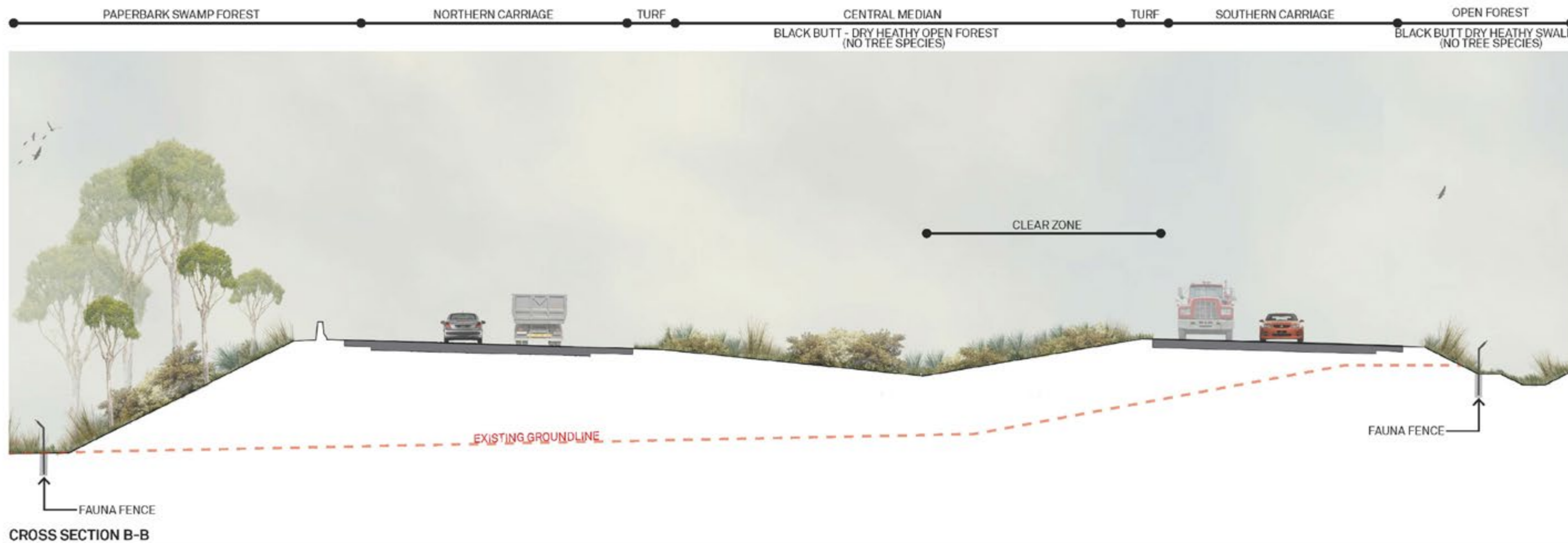


Fig 7.9 Urban and Landscape Design Cross Sections – Trustrums Hill to Broadwater National Park



Section 8 - Trustrums Hill to Broadwater National Park
Pasture landscape outcome. Predominately pasture land with pockets of native seeding mix to reinstate Broadwater National Park landscape. Fauna crossing is included beneath bridges to allow for fauna passage and mitigating fragmentation.

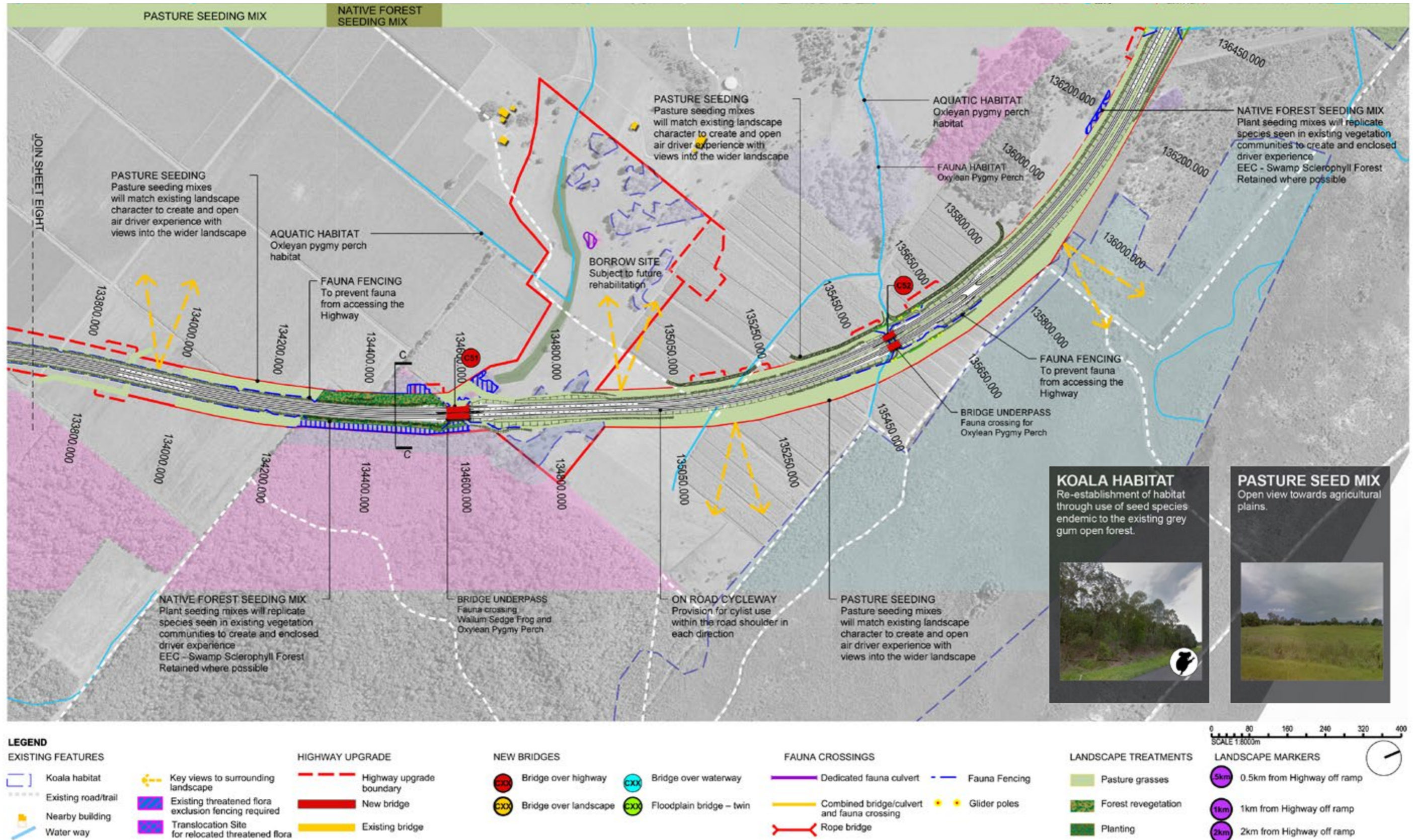


Fig 7.10 Urban and Landscape Design Strategy Plan – Trustrums Hill to Broadwater National Park – Sheet 9

Design is subject to further development - all elements within composition are indicative only

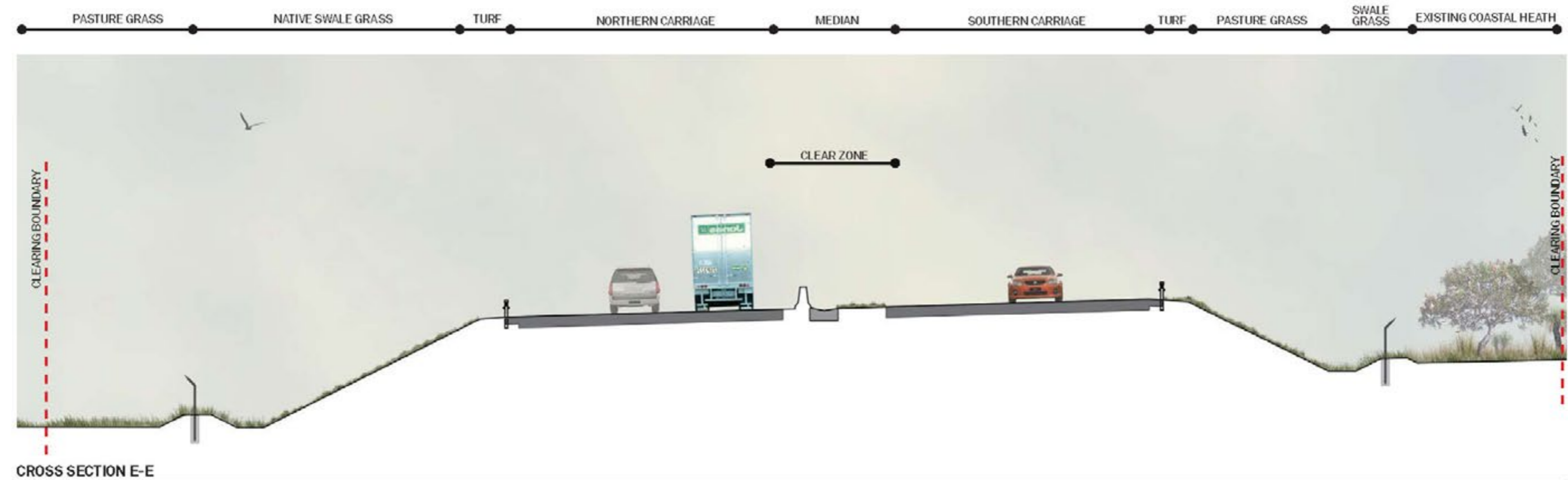
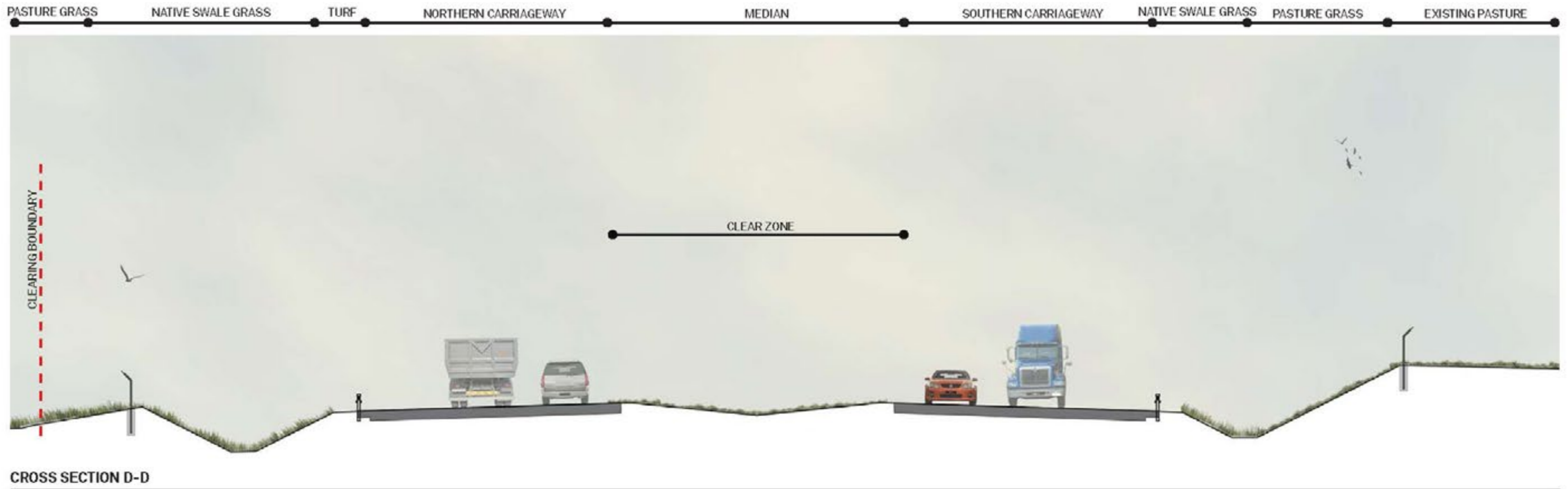
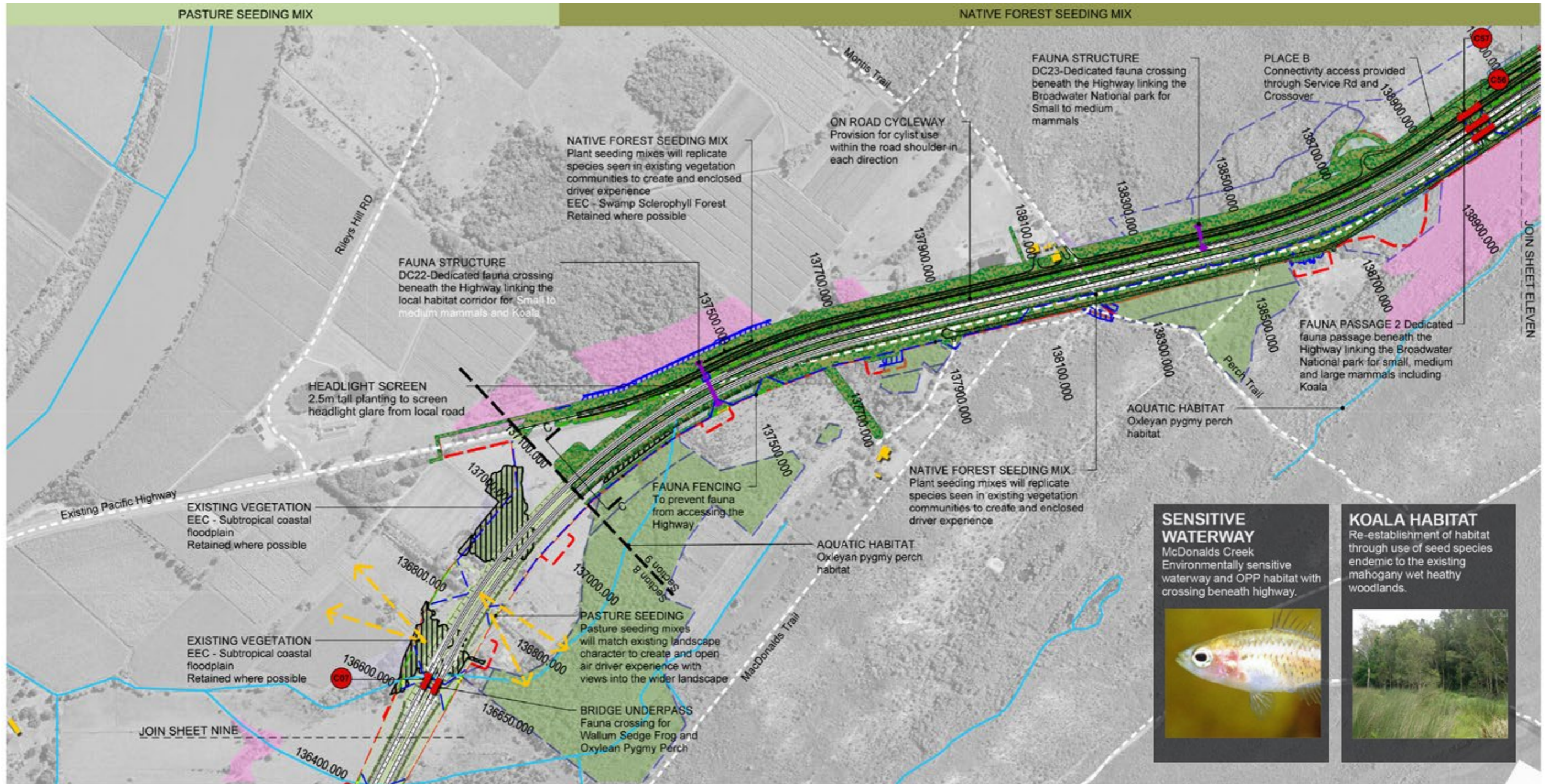


Fig 7.11 Urban and Landscape Design Cross Sections – Devils Pulpit to Trustrums Hill



Section 8-9 Trustrums Hill to Broadwater National Park
Forested landscape outcome. Plant species will replicate those of the surrounding landscape and in doing so create an enclosed driver experience for both the north and southbound journey. Fauna crossings have been included to mitigate habitat fragmentation.



LEGEND - EXISTING VEGETATION COMMUNITY TYPE

Blackbutt - Bloodwood dry heathy open forest	Forest Red Gum - Grassy open forest	Spotted Gum - Grey Ironbark - Pink Bloodwood open forest	Coastal Heath on sands	Swamp Oak swamp forest	Littoral Rainforest
Blackbutt - Bloodwood Grassy open forest	Narrow-leaved Red Gum woodlands	Spotted Gum - Grey Box - Grey Ironbark open forest	Needlebark stringy bark - Red Bloodwood heathy woodlands	Paperbark swamp forest	Coastal Floodplain Sedgeland
Grey Gum - Grey Ironbark open forest	Scribbly Gum - Needlebark Stingybark heathy open forest	Red Mahogany open forest	Wet Heathland and shrubland	Swamp Mahogany swamp forest	Coast Cypress Pine Open Forest

ENDANGERED ECOLOGICAL COMMUNITIES

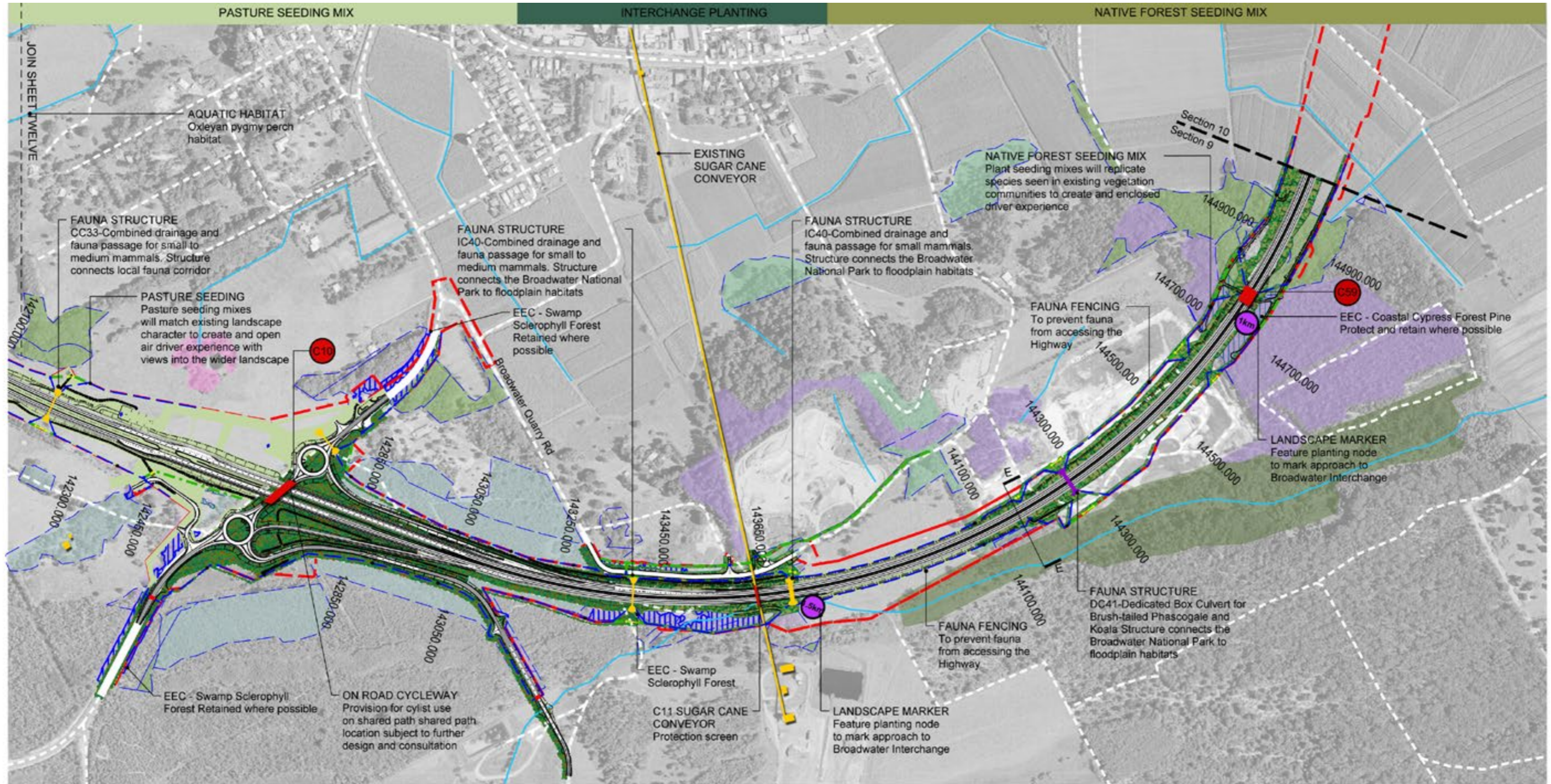
Coastal Cypress Pine Forest	Swamp Oak Floodplain Forest on Coastal Floodplains
Subtropical Coastal Floodplain Forest	Swamp Sclerophyll Forest on Coastal Floodplains

Fig 7.12 Urban and Landscape Design Strategy Plan – Trustrums Hill to Broadwater National Park – Sheet 10

Design is subject to further development - all elements within composition are indicative only



Section 9 Richmond River– Landscape markers alert drivers to highway off ramps at Broadwater Interchange. Plant species at the interchange reflect the existing distribution of coastal heath woodlands and paperbark swamp forests. The sugar cane conveyor will form a key way finding landmark in both directions. Fauna crossings have been included to mitigate habitat fragmentation.



LEGEND - EXISTING VEGETATION COMMUNITY TYPE

Blackbutt - Bloodwood dry heathy open forest	Forest Red Gum - Grassy open forest	Spotted Gum - Grey Ironbark - Pink Bloodwood open forest	Coastal Heath on sands	Swamp Oak swamp forest	Littoral Rainforest
Blackbutt - Bloodwood Grassy open forest	Narrow-leaved Red Gum woodlands	Spotted Gum - Grey Box - Grey Ironbark open forest	Needlebark stringy bark - Red Bloodwood heathy woodlands	Paperbark swamp forest	Coastal Floodplain Sedgeland
Grey Gum - Grey Ironbark open forest	Scribbly Gum - Needlebark Stingingbark heathy open forest	Red Mahogany open forest	Wet Heathland and shrubland	Swamp Mahogany swamp forest	Coast Cypress Pine Open Forest

ENDANGERED ECOLOGICAL COMMUNITIES

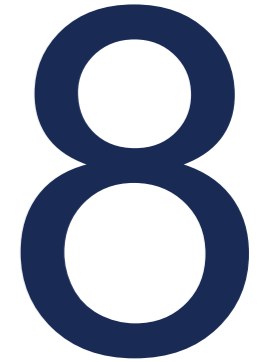
Coastal Cypress Pine Forest	Swamp Oak Floodplain Forest on Coastal Floodplains
Subtropical Coastal Floodplain Forest	Swamp Sclerophyll Forest on Coastal Floodplains

Fig 7.14 Urban and Landscape Design Strategy Plan – Broadwater National Park to Richmond River– Sheet 12

Design is subject to further development - all elements within composition are indicative only

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Detailed response for urban and landscape design



8.1 Structures

Structural elements documented in between Devils Pulpit to Richmond River include:

- Interchanges
- Bridges
- Overhead structures
- Stabilised cuttings and embankments.

8.1.1 Interchanges

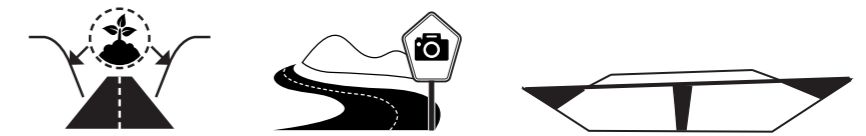
Two grade-separated interchanges will be constructed to provide access to the Woodburn and Broadwater townships from the highway as illustrated in Fig 8.0. Each interchange was designed to achieve a seamless physical link between the main carriageway and the local road network for vehicles and cyclists.

The interchanges have been designed to fit within the surrounding landform. The visible bridge elements within the interchanges have been designed to consider the height, bulk, scale, materials and finishes in order to create visually unobtrusive interchanges which recede into the natural and rural north coast environment.

The landscape and urban design of the interchanges is designed with a unique narrative which draws upon local history as design generators to integrate with the landscape and provide distinctive way-finding moments along the journey. Common to both interchanges is the use of landscape markers to alert the driver of the upcoming interchange entrance.



Fig.8.0 Interchange location map



For the Woodburn Interchange, significant opportunity existed to adopt the contextual qualities of Site, Setting and History as design generators to underpin, unify and ground the urban and landscape design within its natural landscape character.



Fig. 8.1 Artist impression of aerial view of the Woodburn Interchange looking north-west. Landscape shown at full maturity, subject to further design.

8.1.2__Woodburn Interchange design generators

Site

Located 3.4 kilometres south of Woodburn Township the new road alignment will divert the through traffic past Woodburn Township creating the opportunity to design an interchange approach and bridge crossing which adds to the driver experience.

Setting

The interchange is located in Trustums Hill, a transitional precinct between the heavily forested areas to the south and the open floodplain precincts to the north. The interchange will be formed by cutting into the existing landform.

History

Local history colloquially suggests Woodburn was first referred to as Rocky Mouth by early cedar getters but named after burning of the timber during clearing operations in the early 1900s after the cutting of highly prized red cedar in the 1800s.

Aboriginal occupation is also evident through identification of PAD sites and songlines of the region. A particular songline tells of many Bundjalung who lived inland and would make a journey to the coast during winter months when mullet was plentiful. They would bring with them seeds from the black bean tree (*Castanospermum australe*) for food and trading.

Woodburn Interchange design response

The height, bulk, scale, planting and materials used in the design of the approach and exit ramps was addressed to sensitively embed the interchange ramps within the natural setting. The flowing and responsive road alignment is shown in Fig. 8.1 and achieved through:

- The design of the approach ramps to gently follow the natural topography and grain of the landscape to the top of the existing ridgeline producing an alignment which is of appropriate height, bulk and scale
- Planting the road reserve, median and ramp tapers to provide a well vegetated road reserve which uses a formal planting design to replicate the existing forest strata distribution
- Reinstating the existing forest experience and biodiversity of the area through specific planting species
- Use of contextually significant tree species planted in roundabouts and as landscape markers
- Water sensitive urban design to treat water runoff and increase water quality through minimising clearing and incorporating swales into the earthwork design, using bunds and cut off drains to separate clean and dirty water and where possible retaining existing vegetated swales for re-use.

Proposed removal of shared path. The project team is seeking pedestrian and cyclist input about the level of use at this location

Landscape markers will be located at one kilometre, 1.5 kilometres and two kilometres from the off ramp entrance to alert drivers of the interchange. The landscape markers will feature tree plantings of red cedar to acknowledge and re-establish a visual cedar presence while concurrently paying homage to the red cedar cutting early settlement history.



Fig 8.2 Artist impression of landscape marker with red cedar feature planting on approach to the Woodburn Interchange. Landscape shown at full maturity, subject to further design.



Fig 8.3 Artist impression of the planting strategy at the Woodburn Interchange. Landscape shown at full maturity. Shared path on bridge is subject to further consultation and design development.

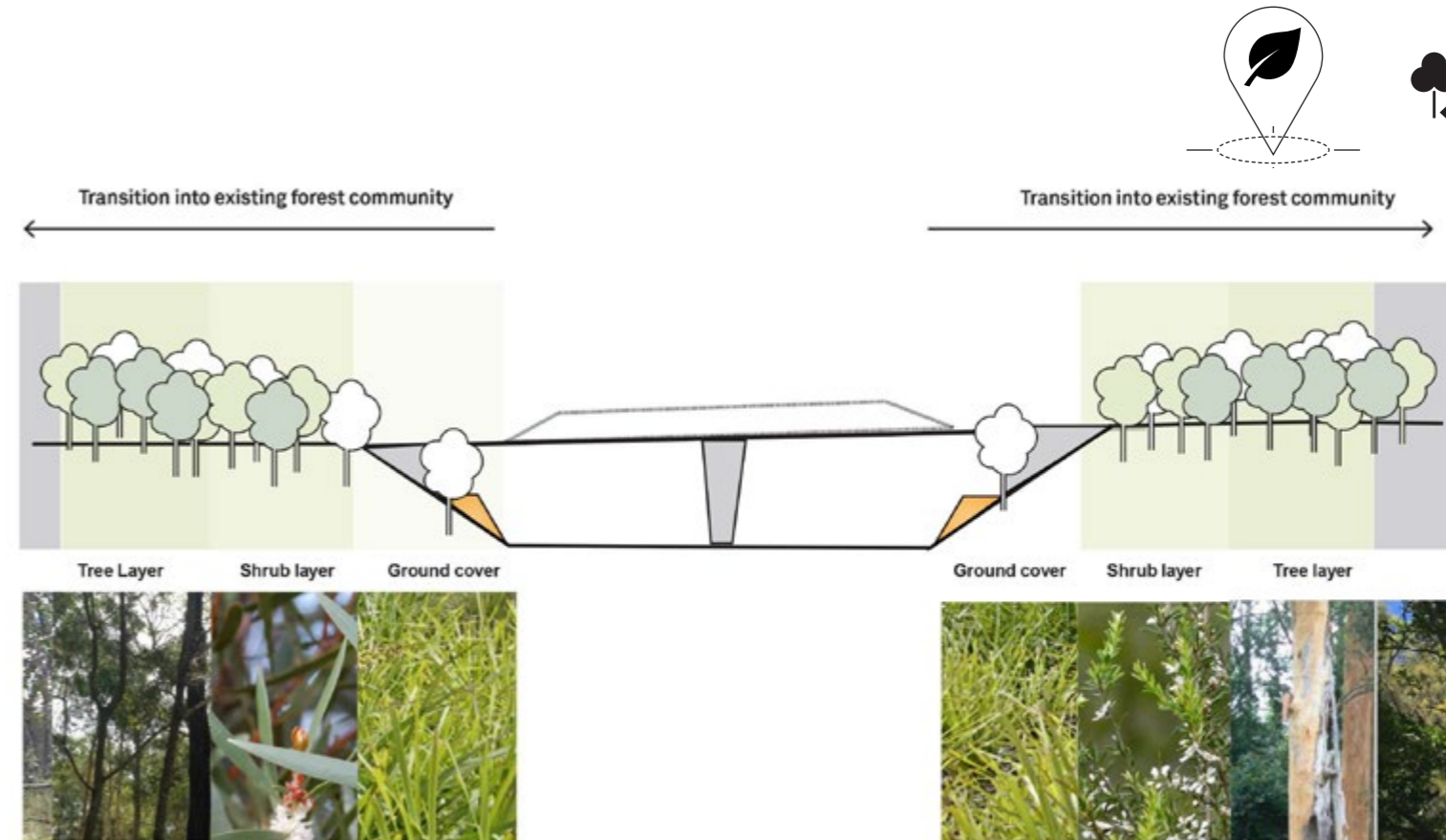


Fig.8.4 Woodburn Interchange landscape strategy.

Landscape strategy

The Woodburn Interchange landscaping strategy responds to:

- The existing forest structure surrounding the interchange
- The historic pattern of Aboriginal occupation.

The strategy will promote intuitive way finding alerting road users of the approaching off ramps.

Landscaping strategy responds to the vertical stratification of the existing grey gum ironbark open forest which dominates the local landscape. Planting species are separated into strata to formalise the planting approach and planted in three layers (ground cover, shrub and tree) to represent the three layers seen in the existing forest. This is shown in Fig. 8.4.

Ground cover layer

Lowest tier to include grasses and feature trees. Representative of the forest floor species the grassed embankments will open the view into the landscape. Species include Flax lily (*Dianella caerulea*), Matt rush (*Lomandra multiflora*) and Kangaroo grass (*Themeda australis*).

Shrub layer

Middle tier with shrubs and tree species informing the transition from new to old plating. Here, the planting species will include Finger Hakea (*Hakea dactyloides*) and Prickly Tea-tree (*Leptospermum juniperinum*).

An aerial view of the planting strategy is shown in Fig. 8.3.

Tree layer

Upper tier mix of trees, shrubs and ground covers will provide a direct visual connection to and reinforcement of the existing open forest. Tree species include gum (*Corymbia variegata*), Small-fruited Grey Gum (*Eucalyptus propinqua*), Grey Ironbark (*Eucalyptus siderophloia*) as well as informal clustered plantings of Black Bean (*Castanospermum australe*) and Kurrajong (*Brachychiton populneum*) trees which reference the historical pattern of Aboriginal occupation of the area. This is illustrated in Fig. 8.2.



For the Broadwater Interchange, significant opportunities existed to adopt the contextual qualities of Site and Setting as the underpinning design generators which unify and ground the urban and landscape design of the Broadwater Interchange within the natural and farmed environmental characters.



Fig 8.5 Artist impression of Broadwater Interchange aerial view looking north-west. Landscape shown at full maturity. The shared path is subject to further consultation and design.

8.1.3__Broadwater Interchange design generators

The interchange design utilises the natural beauty of the Broadwater National Park in collaboration with the active agricultural history of Broadwater as the signature design drivers for the Broadwater Interchange conceptual approach.

Site

Located 1.1 kilometres in a direct line south of the Broadwater Mill, 1.65 kilometres by local road from the centre of Broadwater and 12.2 kilometres by local road north of Evans Head. The new road alignment diverts through traffic past Broadwater to traverse closer to the coastal heath character of the Broadwater National Park.

Setting

The littoral scrub and lowland rainforest of the Broadwater National Park dominates the landscape character surrounding the Broadwater Interchange. The natural character frames the carriageway south of the Richmond River then forms the backdrop to the quarry sites and agricultural floodplains.

Broadwater Interchange design response

The height, bulk, scale, planting and materials used in the design of the approach and exit ramps was addressed to sensitively embed the interchange ramps within the natural setting. The flowing and responsive road alignment is shown in Fig. 8.5 and is achieved through:

- Creating a driver experience which is visually engaging from all approaches but particularly so on approach to the on and off ramps. Here, the natural and farmed vegetative pattern of the existing surrounding landscape will be used to define the approach experience to the interchange.
- Design of the approach ramps to gently follow the natural topography and grain of the landscape to the top of the existing ridgeline producing an alignment of appropriate height, bulk and scale
- Use of contextually significant tree species planted in roundabouts and as landscape markers
- Water sensitive urban design to treat water runoff and increase water quality through minimising clearing and incorporating swales into the earthworks design, using bunds and cut off drains to separate clean and dirty water and where possible retaining existing vegetated swales for re-use.



Fig 8.6 Artist impression of landscape marker to alert drivers to the Broadwater Interchange Landscape shown at full maturity, subject to future design.

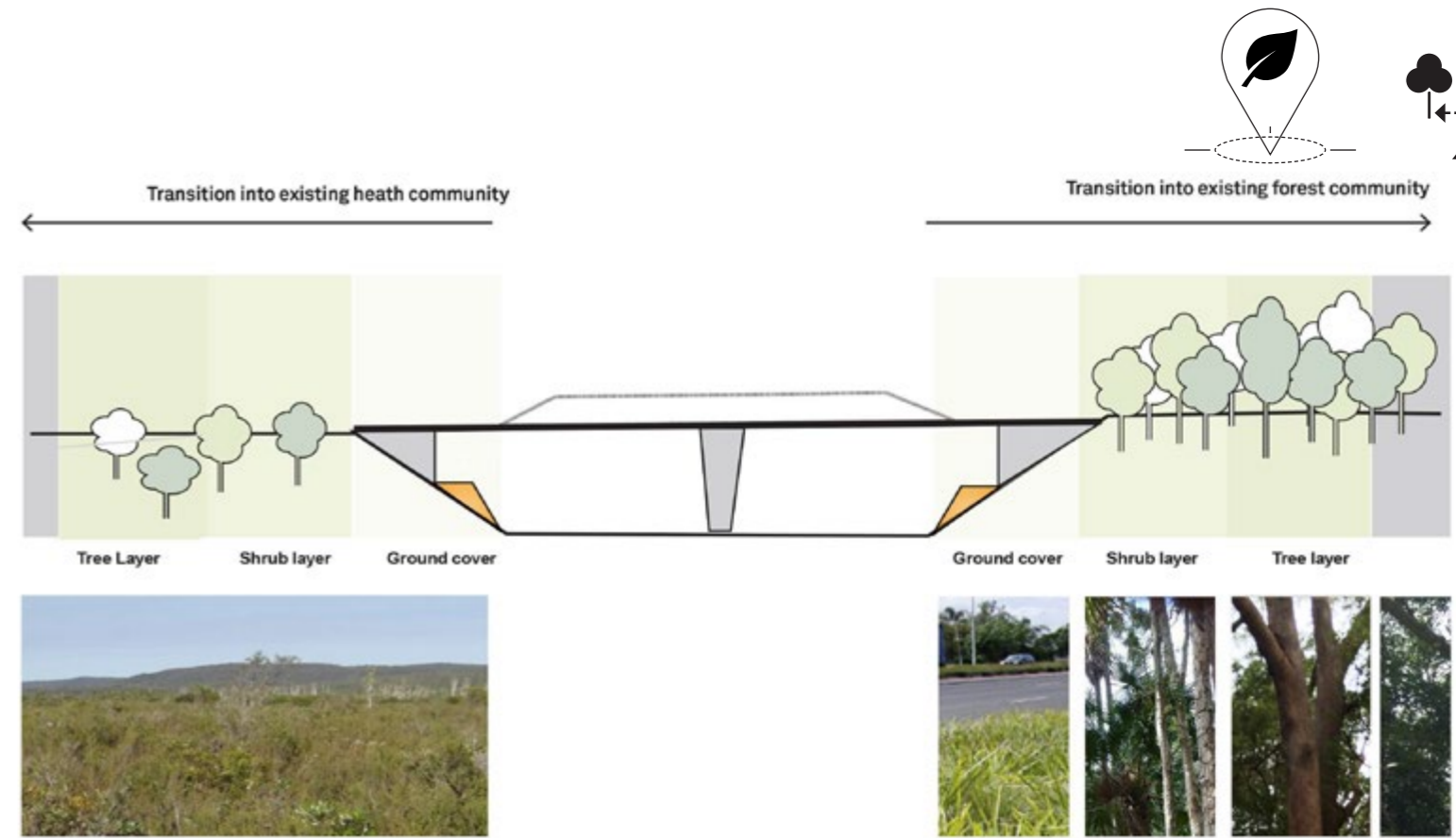


Fig. 8.7 Broadwater Interchange landscape strategy

Landscape strategy

The Broadwater Interchange landscaping strategy responds to:

- The subtropical palm rainforest on the northern eastern approach
- The horizontal heath landscape on the east
- Promotes intuitive way finding alerting road users of the approaching off ramps.

The landscaping strategy responds to the vertical stratification of the surrounding paperbark and blackbutt forest to the west and the coastal heathlands seen in the east shown graphically in Fig. 8.7.

To the west planting species are separated into strata to formalise the planting approach and planted in three layers (ground cover, shrub and tree) to represent the three layers seen in the existing forest.

Ground cover layer

Lowest tier to include grasses and ground covers. Representative of the forest floor species the grassed embankments will open the view into the landscape. Species include Climbing Guinea Flower (*Hibbertia scandens*), Flax Lily (*Dianella caerulea*), Wiry Panic (*Entolasia stricta*) and False Sarsapilla (*Hardenbergia violacea*).

Shrub layer

Middle tier with low planting and shrub species the middle tier will inform the transition from new to old. To the east this is largely low stunted shrubs and sporadic sedges. To the west this will be palm rainforest including ferns and grasses. Species include Sweet Wattle (*Acacia suaveolens*) Hairpin Banksia (*Banksia spinulosa*), Sandplain Bitter-pea (*Daviesia acicularis*).

Tree layer

Upper tier mix of trees, shrubs and ground covers providing a direct visual connection and physical reinforcement and edge refresh to the existing forest. Tree species include Coastal Banksia (*Banksia integrifolia*), Broad-leaved Paperbark (*Melaleuca quinquenervia*) and Black She-oak (*Allocasuarina littoralis*).

Feature trees

Feature tree plantings of *Livistona* and *Xanthorrhoea* will acknowledge and reinforce the existing iconic vegetative character on the northern approaches and departures including discreet moundings behind barriers at key locations as deliberate approach markers. This is illustrated in Fig. 8.6.

8.1.4__Bridges

Bridges are a major component of the proposed work to be undertaken, about 31 bridges will be built within Sections 7, 8 and 9 these include:

- Three overbridges crossing over the Pacific Highway shown in Fig. 8.8
- 13 pairs of twin bridges crossing canals, floodways, waterways and creeks
- One bridge duplication
- One conveyor bridge screen.

Of the 17 bridges, two form part of interchanges (Woodburn and Broadwater) and four are dedicated fauna underpasses.

The key design principles for bridges across the wider project have taken into account the bridge height, bulk, scale and materiality to ensure the bridges are well integrated into the surrounding landscape context.

Bridge design principles

Consistency

The design and arrangements of all elements should be considered as part of a family of elements which relate to each other and other sections of the highway upgrade to provide consistency with variety.

Simplicity and refinement

The design, form, materials and arrangement of all elements must be simple and refined and carefully integrated with adjoining elements.

Context

The design of all elements must be relevant to the existing context and road function.

Unobtrusive appearance

The bridges must be visually unobtrusive allowing the landscape and environmental attributes of the area to be fully appreciated by road users. Bridges must present smooth clean lines.

Integrated design

The design, form, materials and finishes of the bridges on the upgrade must be consistent and integrated with each other to ensure visual continuity.

Transparency

The bridge superstructure must be as transparent as possible to optimise views through the bridge to the landscape beyond. This includes minimising the depth of structure and refining the bridge abutments.



Fig 8.8 Overpass bridge location map



8.1.5__Overbridges

Three overbridges are included between Devils Pulpit to Richmond River (sections 7, 8 and 9) works:

- Bridge C03 Woodburn overbridge at the Woodburn Interchange
- Bridge C06 Woodburn Evans Head Road
- Bridge C10 Broadwater Evans Head Road at the Broadwater Interchange.

The overbridges have been designed as a family of bridges and are consistent with the urban design of the bridges in the adjoining sections of the Pacific Highway upgrade. Existing bridge elements are shown in Figures 8.9-8.12.

The individual bridge elements are designed to accord to the bridge aesthetics guidelines and specifically address consistencies in form (combination of proportion, symmetry, order, rhythm, simplicity) materials and finishes across the entire Woolgoolga to Ballina project.

Common elements of bridge abutments, parapets and girders, throw screens, piers and headstocks are described here.



Fig.8.9 Existing abutment

Abutment

The abutments are designed as spill through abutments with slopes of 1V:1.5H.

Precast abutment cheek walls conceal the bearings from view and allow for maintenance access via a recessed maintenance stair hidden from the flow of traffic. The angled facade provides a more open sleek look and visually anchors the span.

Stone faced, with local quarry stone the abutments anchor the bridge infrastructure into the landscape with a smooth junction to the ground plane below.



Fig.8.10 Existing bridge parapet and girder

Parapets and girders

Integrated with the medium performance traffic barrier the parapet has a continuous uninterrupted outer face with neat sharp edges and extends the full length of the bridge. The outer face is slanted to self clean and catch sunlight. With a top face angled toward the road to channel drainage the parapet extends beyond the soffit to mask the depth of the Super-T Girder. In doing so, it creates a shadowline which decreases the perceived depth of the girder and gives the bridge structure a slender appearance.



Fig.8.11 Existing throw screen

Throw screens

Mounted on top of the traffic barrier and extending 3.5 metres in height, the scale, proportion and curved form of the throw screen complements the slender bridge design. The transparent screen with tapered transition to the bridge barrier optimises the view through the bridge to the landscape beyond and is consistent with the overarching Pacific Highway bridge design aesthetic.



Fig.8.12 Proposed median pier

Piers and headstocks

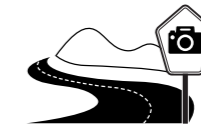
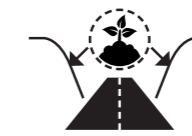
Median piers are to be "stiletto" form responding to the Yelgun to Chinderah bridge established aesthetic in order to reinforce a Pacific Highway north coast consistent design language.

The median stiletto pier is tapered on all sides with a 1:10 incline for the leading face and a 1:30 incline for face parallel to the main carriageway.

The headstock is shaped to continue the incline of the pier taper and form a neat transition to the bridge superstructure above.



Fig.8.13 Artist impression of bridge at Woodburn Interchange from Pacific Highway. Landscape shown at full maturity subject to further design.



8.1.6__Woodburn Interchange bridge crossing

The height, bulk, scale and materials used in the design of the interchange bridge crossing have been addressed to sensitively embed the overbridge within the natural setting. This ensured the bridge was simple, elegant and sensitively designed. The simple, refined and elegant bridge crossing is achieved through:

- Minimising the cut beneath the overbridge to reduce the perceived height of the bridge crossing
- Minimising the bulk and scale of the bridge elements to produce a slender structure. The slender horizontal alignment with smooth clean lines and minimised structural depth will create a visual slenderness which forms an unobtrusive counterpart to the natural ridgeline and planted embankments
- The use of transparent throw screens and spill through abutments to encourage views through the structure of the surrounding landscape.

The slenderness ratio measures proportion between the depth of the superstructure and bridge span and is used as a guide ensuring the proportion of a bridge and its elements is suited to its setting. For Woodburn Bridge, the slenderness ratio ranges from 9.5 to 10.2.

The bridge setting, overall scale and relationship of the bridge elements will result in an elegant bridge design which responds to the sequence of open and closed views along the highway.

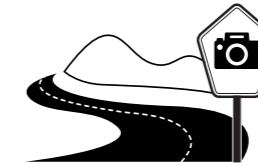
Artist impressions of the Woodburn Interchange bridge crossing are shown in Figures 8.13 and 8.14.



Fig.8.14 Artist impression of bridge at Woodburn Interchange. Landscape shown at full maturity, subject to further design.



Fig.8.15 Artist impression of approach to bridge at Broadwater Interchange towards Ballina. Landscape shown at full maturity, subject to further design.



8.1.7__Broadwater Interchange Bridge

The height, bulk, scale and materials used in the design of the interchange bridge crossing is being addressed to sensitively embed the overbridge within the natural setting. This ensured the bridge was simple, elegant and sensitively designed. The simple, refined and elegant bridge crossing is achieved through:

- Minimising the cut beneath the overbridge to reduce the perceived height of the bridge crossing
- Minimising the bulk and scale of the bridge elements to produce a slender structure. The slender horizontal alignment with smooth clean lines and minimised structural depth will create a visual slenderness which forms an unobtrusive counterpart to the natural ridgeline and planted embankments.
- The use of transparent throw screens and spill through abutments to encourage views through the structure of the surrounding landscape.

The slenderness ratio measures proportion between the depth of the superstructure and bridge span and is used as a guide ensuring the proportion of a bridge and its elements is suited to its setting. For Woodburn Bridge, the slenderness ratio ranges from 9.5 to 10.2. The bridges setting, overall scale and relationship of the bridge elements will result in an elegant bridge design which responds to the sequence of open and closed views along the highway.

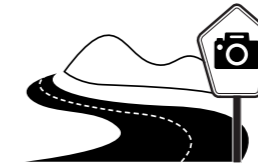
Artist impressions of the Broadwater Interchange Bridge are shown in Figures 8.15 and 8.16.



Fig.8.16 Artist impression of bridge at Broadwater Interchange. Landscape shown at full maturity, subject to further design.



Fig.8.17 Artist impression of approach to Bridge at Evans Head Road towards Ballina. Landscape shown at full maturity, subject to further design.



8.1.8__Bridge at Woodburn Evans Head Road

The bridge at Woodburn Evans Head Road crosses over the northbound and southbound carriageways of the Pacific Highway, it includes a dedicated cycle lane (subject to stakeholder consultation) to the southern side of the bridge.

The height, bulk, scale and materials used in the design of the bridge crossing are addressed to sensitively embed the overbridge within the natural setting. This ensured the bridge presents as simple, elegant and sensitively designed. The simple, refined and elegant bridge crossing is achieved through:

- Using the form, proportion and scale of bridge elements to create a slender and elegant bridge structure
- Using bridge elements to anchor the bridge into the landscape
- Use of symmetrical design to give the bridge order within the landscape
- Maximising views of the surrounding landscape when viewed from beneath or on the bridge deck.

The slenderness ratio measures proportion between the depth of the superstructure and bridge span and is used as a guide ensuring the proportion of a bridge and its elements is suited to its setting. For Woodburn Evans Head Road overbridge, the slenderness ratio ranges from 9.5 to 10.2. The bridge setting, overall scale and relationship of the bridge elements will result in an elegant bridge design which responds to the key bridge family of elements and views across the agricultural plains.

Landscape planting will frame the bridge approach and when mature will provide screening to properties nearby.

The shared path shown is subject to further consultation and design development.

Artist impressions of the Woodburn Evans Head road bridge are shown in Figures 8.17 and 8.18.



Fig.8.18 Artist impression of aerial view of the bridge at Woodburn Evans Head Road. Landscape shown at full maturity, subject to further design.

8.1.9__Underpass bridges

About 27 underpass bridges are included between Sections 7,8 and 9 and are shown on Fig 8.19.

- Bridge C01 over the Tabbimoble Floodway is a bridge duplication
- Twin bridges C04 over the Tukombil canal
- Twin bridges C05 over the Woodburn floodway
- Twin bridges C07 over Macdonalds Creek
- Twin bridges C50 over the Richmond floodway
- Twin bridges C51 over the Unnamed watercourse
- Twin bridges C52 over the Macdonalds Creek tributary
- Twin bridges C53 over the Montis Gully tributary 1
- Twin bridges C54 over the Montis Gully tributary 2
- Twin bridges C55 over fauna passage 1
- Twin bridges C56 over fauna passage 2
- Twin bridges C57 over fauna passage 2
- Twin bridges C59 over fauna passage 3
- Twin bridges C60 over Woodburn floodway
- Twin bridges C61 over Unnamed Watercourse 2.

Although often not visible to the road user, the design of low level creek crossings and local road underpass bridges addresses the key design principles for bridges and took into account the bridge height, bulk, scale and materiality to ensure the bridges are well integrated into the surrounding landscape context and sit comfortably within the Roads and Maritime, and Pacific Highway family of bridges so as to ensure a consistency of design language.

Bridge design principles

Consistency

The design and arrangements of all elements should be considered as part of a family of elements which relate to each other and other sections of the highway upgrade to provide consistency with variety.

Simplicity and refinement

The design, form, materials and arrangement of all elements must be simple and refined and carefully integrated with adjoining elements.

Context

The design of all elements must be relevant to the existing context and road function.

Unobtrusive appearance

The bridges must be visually unobtrusive allowing the landscape and environmental attributes of the area to be fully appreciated by road users. Bridges must present smooth clean lines. This is illustrated in Figures 8.20 to 8.23.

Integrated design

The design, form, materials and finishes of the bridges on the upgrade must be consistent and integrated with each other to ensure visual continuity.

Transparency

The bridge superstructure must be as transparent as possible to optimise views through the bridge to the landscape beyond. This includes minimising the depth of structure and refining the bridge abutments.



Fig.8.19 Location map of underpass bridges



Fig. 8.20 Abutment

Abutment

The abutments are designed as spill through abutments with slopes of 1V:1.5H the abutments consist of spill-through embankments with precast reinforced concrete abutment headstock beams. The spill-through embankments will require embankment protection. The embankment protection will consist of rock armour extending down the embankment at a slope of 1.5H: 1V, wrapping around the embankment and tying in with the road embankment slopes.



Fig. 8.21 Parapet

Parapets and girders

Integrated with the regular performance traffic barrier the parapet has a continuous uninterrupted outer face with neat sharp edges and extends the full length of the bridge. The outer face is slanted to self-clean and catch sunlight. With a top face angled toward the road to channel drainage the parapet extends beyond the soffit to mask the depth of the winged planks in doing so, it creates a shadow line which decreases the perceived depth of the girder/planks and gives the bridge structures a slender appearance.



Fig. 8.22 Barrier

Barriers

The bridge traffic barriers shall be regular performance level Roads and Maritime barrier, which comprises of a concrete parapet with cycling grab rail on the nearside shoulder.



Fig. 8.23 Piers and headstock

Piers and headstocks

Reinforced concrete column piers present a simplified structural foundation for the underpass bridges.

When crossing environmentally sensitive waterways, piers will be located outside the main channel to ensure flow is not altered or reduced. Construction would not alter or reduce flow.

The aesthetic value of a bridge is dependent on its design response to context – *Roads and Maritime bridge aesthetics guidelines*



Fig.8.24 Artist impression of aerial view of sugar cane conveyor bridge and its relationship to the Broadwater Interchange. Landscape shown at full maturity. Shared path is subject to further consultation and design development.



8.1.10_Sugar conveyor screen

The existing NSW sugar conveyor bridge structure forms part of the realigned Pacific Highway about 176 kilometres north of Coffs Harbour it is located near the Broadwater Interchange as seen in Fig.8.24

The protection screen provides a safety screen for the bridge.

Aside from the functional safety qualities the sugar cane conveyor screen will become an important way finding moment marking the arrival and departure point to Broadwater.

The patterned screen design subtly references the existing wider precinct wayfinding signage with the option to create a landmark moment as shown in Fig. 8.25.

View | Drivers view looking south on approach to Broadwater Interchange

Key features:

- Landscape planting at a common scale on the east and west
- Steel structure respects and responds to industrial materials and structural patterning
- Distinctive functional infrastructure is a way finding moment on approach to Broadwater and the Richmond River Bridge.

The sugar cane conveyor screen will reference the triangular pattern seen in the existing broadwater municipal signage and will provide a gateway marker to the Broadwater region.



Fig. 8.25 Artist impression of conveyor screen. Landscape shown at full maturity, subject to further design.

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8.1.11_Cutting and embankments

Cutting and embankments occur along the new road alignment as shown in Fig. 8.26. The height, bulk, scale and materiality of the finishes have been considered to reduce the impact of the cuttings and embankments against the character of the existing natural landscape.

Sections 7, 8 and 9 feature about 7.5 kilometres of cutting along the alignment with the most significant occurring at the Woodburn Interchange. At this location a stone faced abutment was used to stabilise the cutting as discussed in Sub-chapter 8.4.

Elsewhere, significant cuttings have been designed with soft feathered transitions and rounded edges which allow for revegetation beyond the top of the cutting. In doing so the revegetation of the cut batter will connect the new road alignment with the existing landscape. This reduces the contrast between old and new and allows the cuttings to blend with into the natural surroundings.

The new road upgrade for Sections 7,8 and 9 are largely formed upon stabilised fill embankments with around 23 kilometres being built in this way.

Similarly to cuttings, the junction between the embankment and existing landscape is neatly transitioned to reduce the visual impact the new upgrade will have at the intersection between old and new.

The planting design to both cut and fill slopes has considered batter slopes, topsoil requirements and bioregion specific species, frangibility clear zones and sightline requirements. The establishment of planting will provide a green sweeping highway and additional stability to both areas of cuttings and embankments.

Spoil mounds

A framework for managing surplus spoil is being produced to outline the decision making framework to manage excess spoil. This framework is documented in C-85-EN-04. The framework aims to:

- Optimise long term benefits for the environment and community
- Not impact on environmentally sensitive areas (eg heritage, threatened species);
- Address all regulatory and approval requirements
- Minimise environmental management issues associated with the sourcing, handling, transportation, stockpiling, disposal and re-use of material
- Be consistent with the urban design and landscape strategy
- Be accounted for in the clearing boundary and associated clearing calculations.

Spoil mounds are currently under review with the engineering and construction teams as excess fill quantities remain to be confirmed.

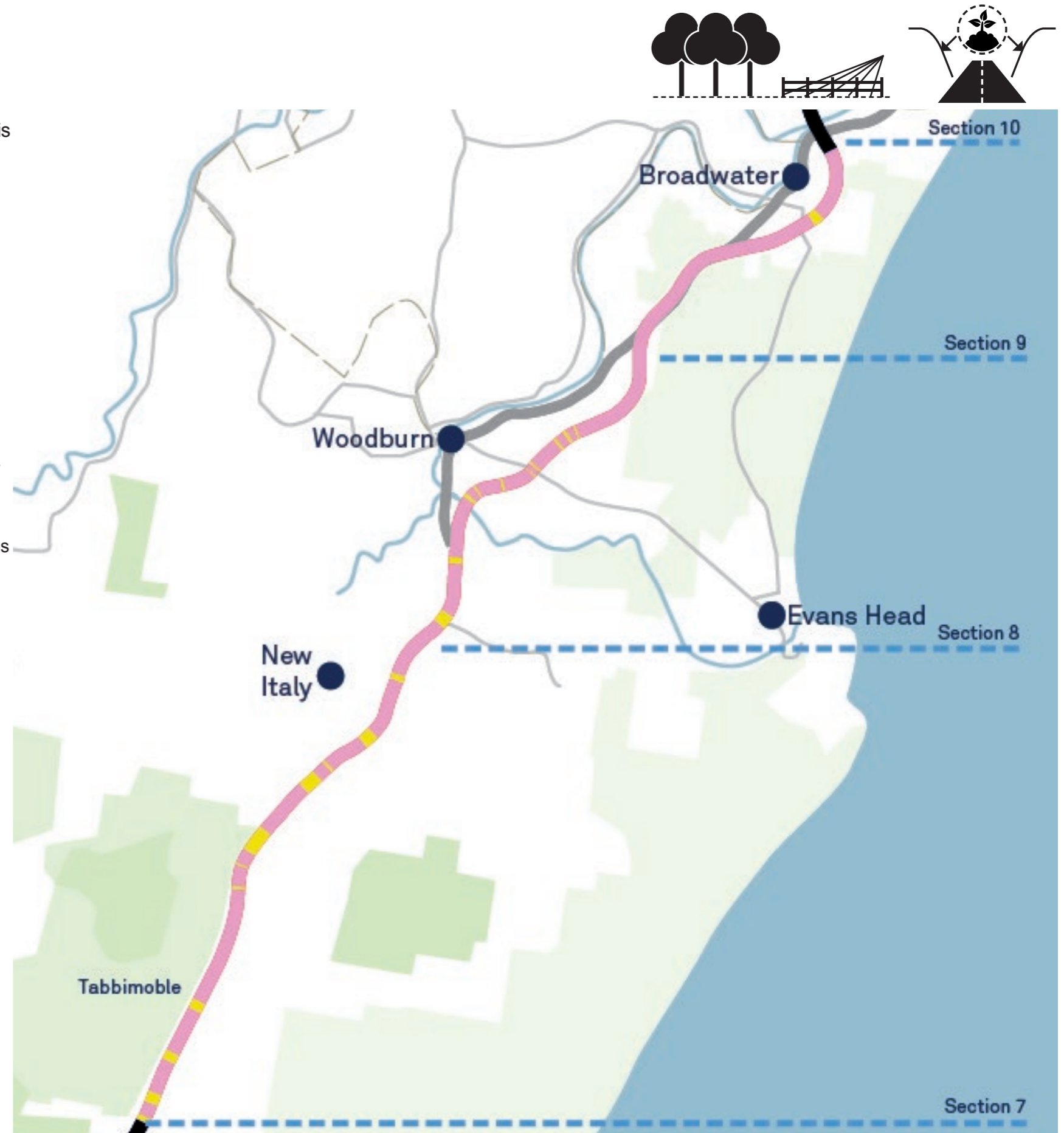


Fig.8.26 Cut and fill location map



The upgrade provides a dual carriageway and grade-separated interchanges to provide access to the Woodburn and Broadwater townships from the new highway alignment.



Fig.8.27 Artist impression of road verge treatment



Fig.8.28 Artist impression of planted median

8.2__Road corridor

The road corridor is designed to contribute to the quality of the environment and the road users travelling experience. It has used contextually appropriate road landscape treatments to improve the visual amenity of the road corridor.

Each element of the road corridor is designed to integrate all visible areas and components into the natural environment which it passes through. These areas and components include:

- Median and verge treatments
- Cyclist networks
- Bus stops
- Heavy vehicle stopping bays
- Furniture (to be discussed in Sub-chapter 8.3 of this report).

8.2.1__Median and verge treatments

Where space allows vegetated medians will be used to visually break up the expanse of hard paving and help continue the characteristics of the existing landscape across the road corridor. This will be achieved by matching plant species to those seen in the road verge. Frangible species are used when no road barrier exists to help slow vehicles which have left the road. The planting will also provide a screen for headlight glare when needed.

The verge is typically treated with a mown grass strip along the edge of the highway providing a neat green frame to the road edge which ensures trees and shrubs do not regenerate next to the highway. This is shown in Fig. 8.27.

Where appropriate existing vegetation to the existing widened median has been retained as shown in Fig. 8.28.

8.2.2__Cyclist networks

Provision for connection to the future NSW Coastline Cycleway is allowed for. This cycleway aims to:

- Safely connect the coastal settlements of the NSW coast
- Improve access for local people to schools, work and local facilities
- Improve cycle related tourism
- Create an internationally recognised cycle ride.

As the route is still under development provision is made for travel along the full length of the main carriageway within the 2.5m wide road shoulder. Dedicated shared paths have been included at overbridge crossings which will connect to the future cycling network. The shared path locations are subject to further design development and consultation with communities and agencies

8.2.3__Heavy vehicle stopping bays

13 stopping bays have been designed along the length of the main alignment at an average of 5 kilometres apart.

The planting design around these locations is designed to promote clear sightlines of the stopping bay signage and also clear sightlines for safe intersection with the main highway.

8.2.4__New Italy

The New Italy Museum is located just south of Woodburn inland which was part of the original New Italy Settlement described in Chapter 4.

The highway upgrade will result in:

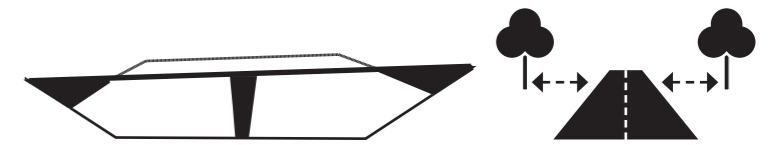
- Reconfiguration of the access to the carpark with improved traffic movements
- Reconfigured design of the car park itself
- A new car park exit with improved traffic merge
- Formalised coach parking bay

- Recreational articulated vehicle including caravans, boat trailer parking bays to the eastern edge
- Improved pedestrian pavement between the car park, museum entrance and the informal rest areas.

The changes to the highway alignment and car park facilities will not:

- Directly impact the New Italy settlement
- Significantly alter the New Italy settlement landscape.

The new landscaping to the New Italy car park and approach roads embraces the existing local vegetation aesthetic to reinstate and enhance as the planting matures. An artist impression of this arrangement is shown in Fig. 8.31.



The corridor furniture accords with Roads and Maritime standards and is designed to be as visually recessive as possible by integrating with the landscape treatments to blend into the background.



Fig.8.29 Typical fauna fence, fauna fence style under review



Fig.8.30 Security fencing and wire rope safety barrier

8.3__Furniture

The road corridor furniture is designed to contribute to the quality of the environment and the road users travelling experience.

Each element of the road corridor furniture is designed to integrate all visible components into the natural environment which the corridor will pass through.

These components include:

- Fences
- Headlight screens
- Lighting
- Safety barriers
- Lighting.

8.3.1__Fences

Fencing is provided to:

- Fence the road boundary (Fig. 8.29)
- Prevent livestock from entering the road corridor
- Prevent access into water basins
- Prevent fauna access into the road corridor, and promote fauna use of fauna structures.

Fencing selection and locations have been developed based on the main alignment road geometry and consultation with individual property owners. Where possible fauna fencing is combined with property fencing in order to reduce the environmental and maintenance impact resultant from additional clearing which would have been required. All fencing finishes are designed to be visually permeable with wide aperture infill mesh to be visually recessive and blend

harmoniously into the background landscape.

8.3.1.1 Boundary fence

When not combined with fauna fencing boundary fencing is standard post, wire and dropper stock proof fencing along the road reserve. Boundary fencing near glider crossing structures will not have barbed wire for the top two strands.

8.3.1.2 Security fence

Security fencing is included for both temporary and permanent drainage basins when the basins are accessible to the public. Visually recessive chain wire mesh (shown in Fig. 8.30) is to be used to blend the fence into the surrounding landscape.

8.3.1.3 Fauna Fence

A range of mitigation measures were identified during the EIS phase to minimise

the impact of habitat loss and fragmentation on threatened fauna species. These include installation of fauna fencing.

Fauna fencing is designed to facilitate the effective crossing of wildlife and funnelling of fauna to fauna crossing locations. With the main goal of reducing wildlife mortality. The alignment of fauna fencing will not create any trapping points.

The types of fauna fencing used in this work considered the species known in the area and the species specific fencing requirements. In particular general fauna fencing, koala fencing, amphibian fencing and a combined koala and amphibian fence have been located within the work.



Fig.8.31 Artist impression of New Italy car park. Landscaping shown at full maturity, subject to further design.

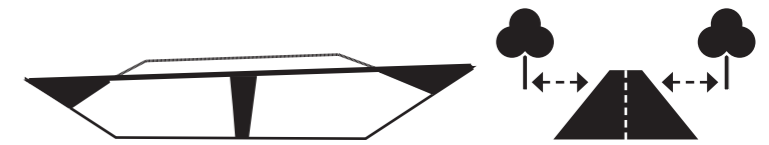


Fig.8.32 Highway lighting



Fig.8.33 Highway signage

8.3.2__Headlight screens

Headlight screens have been provided in areas where potential driver confusion may occur due to headlight spill to improve the safety for both local and through traffic.

2.5 metres in height the headlight screens will utilise planted trees and shrubs from advanced stock and selective landscape mounding to screen the headlight spill. Permanent vegetated headlight screens will be located between the main alignment and the Woodburn to Broadwater Service Road and next to the New Italy settlement.

A palette of small bushy trees, shrubs and ground covers was selected from the existing vegetation communities to use as headlight screen planting.

8.3.3__Lighting

Standard road lighting is provided on the upgrade at Woodburn and Broadwater interchanges. The light poles are galvanised 'Taperline' poles or similar to integrate with the existing light poles seen along the wider Pacific Highway (Fig. 8.32).

8.3.4__Clear zone and safety barriers

The clear zone is a measured offset from the edge of the carriageway which is free from non-frangible vegetation and road furniture. It is designed for emergency use by errant vehicles.

The offset differs for the main Pacific Highway alignment and the adjoining local access roads.

Safety barriers have been provided in locations where it was not possible to provide the required clear zone to the edge of the main alignment and local roads due to the presence of hazardous objects.

These objects include:

- Large non-frangible signage posts
- Non-frangible street lighting columns and infrastructure
- Bridge piers
- Water quality basins
- Non-traversable fill embankments
- Trees with a trunk greater than 100 millimetres in diameter
- Fauna furniture poles (rope bridge poles and glider poles)
- Headlight screens or noise walls/mounds.

Different safety barriers are used throughout Sections 7, 8 and 9 these include:

- W-Beam steel rail safety barriers (G4), semi-rigid safety barrier used on approaches to structures, road interchanges and roads with tight curves
- Concrete safety barriers (F) on overpass bridges
- Wire rope safety barrier, where there is a narrow median and to the top of embankments.

8.3.5__Signage

The signposting design forms an important role in the functioning of the highway and the legibility of the journey. The signposting is prepared to meet the following criteria:

- Appropriate for the climatic, lighting, travel speed and traffic conditions;
- Consistent with the State Road Network signposting
- Consistent between adjoining local roads, property accesses and tie-ins to the existing Pacific Highway and new roads.

Signage will be implemented for bypassed towns in consultation with relevant councils.

Signposting to be in accordance with the Woolgoolga to Ballina project signage policy developed to satisfy MCoA D17.

Typical warning signage is shown in Fig.8.33.

Woolgoolga to Ballina Pacific Highway upgrade

Draft detailed design urban and landscape plan


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Planting


9


Landscape principles

 **Respect local vegetation**
Deliver a local landscape adopting a vegetation palette founded upon local landscape types and species selected from local bioregions for local conditions to reinforce local agricultural and natural character.

 **Blend topographic change**
Shape topography and revegetate cuttings and embankments to blend with the landform and maintain the visual character of the landscape.

 **Consistently connect**
Reinstate and enhance fauna and vegetation community connectivity along and across the corridor through linking remnant verge, underpass, culvert and overhead crossings through contextual planting.

 **Sequence views**
Sensitively compose planting to create a varied sequence and depth of views along the journey to selectively screen sensitive receptors while featuring the driver experience of character variance from ridge to floodplain, forest to crop and pasture.

 **Emphasise moments**
Adopt semi-mature tree plantings and compose character landscapes as markers of communities, rest stops, and moments along the journey.


 **Safely and sensitively structure**
Structure the landscape to respond to frangibility, structures, fauna and clear zones to ensure diver and fauna safety.



Fig.9.0 Existing vegetation

9.1 Existing vegetation and proposed landscaping

The contextual analysis in Chapter 5 described the ecological diversity of the Sections 7, 8 and 9 based upon the NSW North Coast (NNC) bioregion it exists within.

This bioregion was classified based upon its unique climatic, geomorphic, landform, lithology, and flora and fauna attributes.

Existing vegetation communities within the NNC bioregion were identified through flora and fauna assessments during the EIS and detailed design phases a typical area is shown in Fig. 9.0.

Twelve vegetation communities have been identified within the Devils Pulpit to Richmond River (Section 7, 8 and 9) boundary.

The proposed landscaping strategy has used these identified vegetation communities to respond to the Woolgoolga to Ballina landscape principles of:

- Respect local vegetation
- Blend topographic change
- Reconnect communities
- Sequence views
- Emphasise moments
- Safely and sensitively structure and
- The environmental objectives of 'Maintaining and preserving the biodiversity values' and protecting the extinction of threatened species'.

The landscaping design intent delivers an environmentally integrated, well vegetated highway corridor with lush and distinctive interchanges which showcase the diversity and character of the local region through which the highway traverses.

Specifically the landscaping vegetation design has:

- Identified existing vegetation communities to inform species selection for new work to maintain and preserve the biodiversity values
- Used historically cultural plant species as feature landscape markers at interchange approaches to acknowledge and preserve the cultural landscape
- Protected existing threatened species with exclusion fencing during construction where possible and translocating suitable species where possible
- Used existing vegetation classes and floristic distribution to inform new planting arrangements at interchanges as shown in the detailed design response in Sub-chapter 8.2
- Emphasised the existing sequence of open and closed views.

9.2 Vegetation communities

Exploring and applying the principle to respect local vegetation, existing vegetation habitats and ensuing vegetation communities have been identified and analysed to inform the landscape planting strategy.

Specifically but not exclusively to Devils Pulpit to Richmond River (Sections 7,8 and 9) the EIS identifies a variety of vegetation formations for the Woolgoolga to Ballina upgrade. Eight different vegetation formations have been identified and succinctly defined to the right, with attendant imagery (Figures 9.1-9.8).

Within these vegetation formations, specific vegetation classes have been identified which informed the planting, seeding and reconstruction treatments.

These formations and resultant communities are listed in Table 9.0.

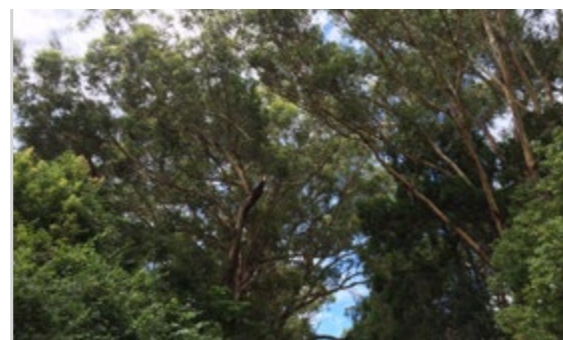


Fig.9.1 Forest canopy (Image source:ACJV)

Dry sclerophyll open forests and woodlands

Sclerophyll forests are a typically Australian vegetation type having plants (typically eucalypts, wattles and banksias) with hard, short and often spiky leaves, which is a condition closely associated with low soil fertility.

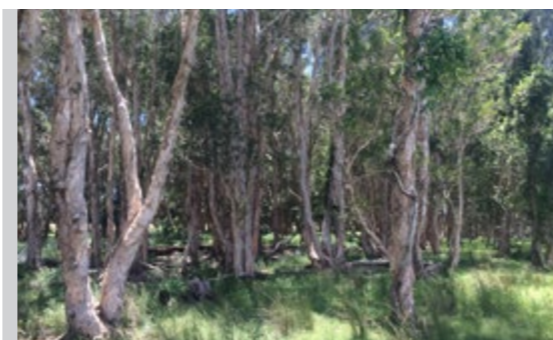


Fig.9.3 Swamp Forest (Image source:ACJV)

Swamp forests

Low dense mixed forest of eucalypts and paperbarks with minimal shrub cover and dense ground cover. The boggy ground is heavily clothed in leaf litter, interspersed with patches of sedges and ferns, temporary pools of water and bare ground.

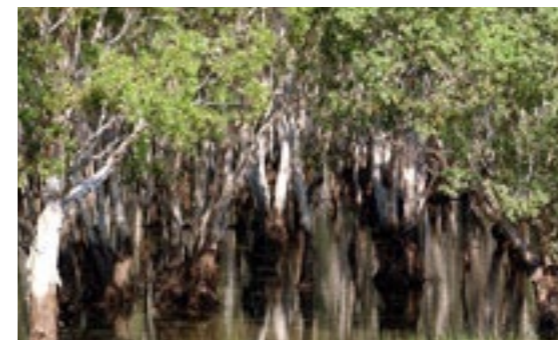


Fig.9.5 Floodplain forest (Image source:ACJV)

Floodplain forests

The composition of subtropical coastal floodplain forest is primarily determined by the frequency and duration of waterlogging and the texture, nutrient and moisture content of the soil. Composition also varies with latitude.



Fig.9.7 Wetland (Image source:ACJV)

Estuarine wetlands

Estuarine wetlands are found in bays and other partly enclosed waters which are tidal and sometimes have freshwater inflows.



Fig.9.2 Wet forest (Image source:ACJV)

Wet sclerophyll forests

The wet sclerophyll forests of New South Wales occur on moderately fertile soils in high rainfall areas, and are characterised by a tall, open, sclerophyllous tree canopy dominated by eucalypts. They include blue gums, mahoganies, peppermints and green-leaved ashes and a luxuriant understorey of soft-leaved, shrubs, fern and herbs.

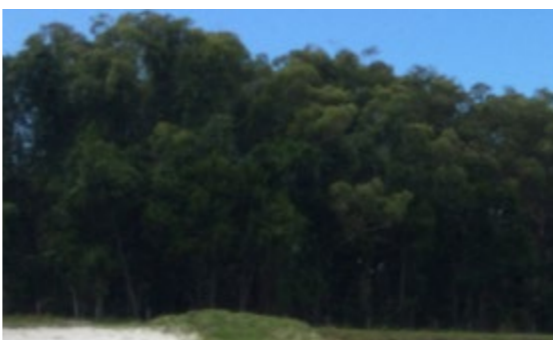


Fig.9.4 Rainforest (Image source:ACJV)

Rainforests

Characterised by a closed and continuous tree canopy composed of relatively soft, horizontally-held leaves, each class of rainforest varies in structure, species composition, climate, soils and biogeography.



Fig.9.6 Wetland (Image source:ACJV)

Freshwater wetlands

Freshwater wetlands are ecosystems which are affected by permanent or temporary inundation. They are dominated by shrubs, sedges and herbs.

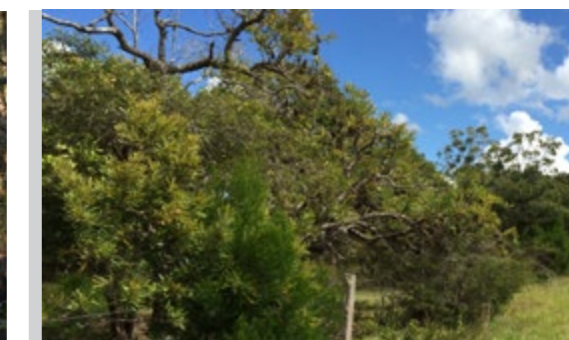


Fig.9.8 Heath forest (Image source:ACJV)

Heathlands

Despite having a restricted distribution, heathlands are associated with some of Australia's most distinctive and inspirational coastal and mountain scenery. Shrubs and heaths dominate the vegetation, while grasses and trees are conspicuously scarce.

Table 9.0 Existing vegetation community types

Vegetation community type	Description
Angophora paludosa Shrubby forest and woodland on sandstone or sands	Open forests and woodlands. In the Central Clarence region where it forms dry sclerophyll woodlands and forests on poor sandy soils.
Blackbutt Bloodwood dry heathy open forest on sandstones	Named for the Eucalyptus pilularis and Corymbia gummifera, this community features a range of species across the upper, middle and ground strata including Eucalyptus, Corymbia, Allocasuarina, Banksia, Acacia, Leptospermum, Lomandra, Themeda and Hibbertia.
Blackbutt Bloodwood grassy open forest	Tall to very tall open forest. On coastal lowlands and foothills of the central and southern North Coast.
Brush box Tallowood shrubby open forest of the Northern ranges of the North Coast	Tall to extremely tall moist forest usually with a well-developed midstorey of rainforest species.
Coast cypress pine Shrubby open forest on coastal sands (EEC)	Named for the Callitris columellaris this community features a range of species across the upper and middle strata including Banksia, Corymbia, Angophora, Allocasuarina and Acacia.
Coastal heath on sands of the North Coast	This ecosystem is an aggregation of many different plant communities. It is concentrated along the coast (eg Broadwater, Yuraygir, Crowdy Bay and Booti Booti National Parks). Usually near the coast on coastal sands.
Forest red gum Grassy open forest of the coastal ranges	Named for the Eucalyptus tereticornis this community features a range of species across the upper and ground strata including Eucalyptus, Corymbia, Angophora, Breynia, Dianella, Lomandra, Themeda, Imperata and Hardenbergia.
Grey gum Grey ironbark open forest of the Clarence lowland	Named for the Eucalyptus propinqua this community features a range of species across the upper, middle and ground strata including Eucalyptus, Corymbia, Allocasuarina, Syncarpia, Dianella, Lomandra and Imperta.
Narrow-leaved red gum woodlands of the lowland (EEC)	Named for the Eucalyptus seeana this community features a range of species across the upper, middle and ground strata including Eucalyptus, Lophostemon, Casuarina, Angophora, Melaleuca, Schonoenus, Themeda and Gahnia.
Needlebark stringybark – Red bloodwood heathy woodland on sandstones of the lower Clarence of the North Coast	Mid-high to tall open forest or woodland usually with a dense dry heath understorey. Mainly on sandstones in the Glenreagh area of the lower Clarence Valley.
Paperbark swamp forest of the coastal lowlands (EEC)	Named for the predominance of Melaleuca species within this community, it also features a range of species across the upper, middle and ground strata including Eucalypts, Callistemon, Casuarina, Leptospermum, Melastoma, and Gahnia.
Red mahogany open forest of the coastal lowlands	Named for the Eucalyptus resinifera subsp. Resinifera this community features a range of species across the upper, middle and ground strata including Eucalyptus, Corymbia, Acacia, Banksia, Lomandra and Themeda.
Scribbly gum Needlebark stringybark heathy open forest of coastal lowlands	Named for the Eucalyptus signata, this community also features a range of species across the upper, middle and ground strata including Eucalyptus, Corymbia, Angophora, Syncarpia, Banksia, Leptospermum, Lomandra, Dianellam and Xanthorrhoea.
Spotted gum Grey ironbark pink bloodwood open forest of the Clarence Valley lowlands	Named for the Corymbia henryi and Eucalyptus sideroploia, this community features a range of species across the upper, middle and ground strata including Eucalyptus, Corymbia, Allocasuarina, Banksia, Acacia, Leptospermum, Lomandra, Themeda and Hibbertia.
Swamp boX swamp forest of the coastal lowlands (EEC)	Named for the Casuarina glauca, this community also features a range of species across the upper, middle and ground strata including Eucalyptus, Angophora, Allocasuarina, Jacksonia, Cymbopogon and Themeda.
Swamp mahogany swamp forest on coastal lowland	Named for the Lophostemon suaveolens, this community also features a range of species across the upper, middle and ground strata including Eucalyptus, Corymbia, Melaleuca, Glochidion, Melicope, Baekia, Cordyline, Blechnum, Hypolepsis and Xanthorrhoea.
Swamp oak swamp forest on coastal lowlands of the North Coast (EEC)	Low to very tall woodland and forest. Widespread on poorly drained sites in coastal areas.

The seeding and planting palettes proposed for Sections 7, 8 and 9 are informed by the bioregions identified in Table 8.1. The seed mixes have been composed to optimally respond to the modified corridor conditions. The seed mixes are identified in Appendix B.

9.3 ___ Batter stabilisation planting

In keeping with the philosophy of 'context sensitive design', and the Principles of Blending Topographic Change the treatment of the road cross and long sections respond to local landforms wherever and whenever possible.

The road alignment is deliberately arranged so it:

- Sits comfortably within the landscape context
- Balances the functional and pragmatic requirements of applicable design standards, flood immunity, and cut and fill balance.

Batter stabilisation planting is applied to revegetate exposed cut and fill batters to help minimise erosion and weed infestation.

The stabilisation technique chosen across the Section 7, 8 and 9 work was developed in line with the Roads and Maritime Services Guideline for batter surface stabilisation using vegetation and considers:

- The batter type (fill or cut)
- The level of erosion protection required
- The planting application
- The visual amenity and ecological outcome
- Existing technical specifications and procedures.

Figures 9.9 and 9.10 illustrate hydroseeding application techniques to be used to revegetate the landscape.

Fill batter

Fill batters throughout the design are typically profiled to a gradient of 2H:1V with varying shallower profile departures to accommodate feathering into the natural topography.

Subject to specific location and local context, fill batters will have upstream surface flows diverted away from the batters using gutters and catch drains. This reduces the erosion protection required as it only needs to withstand raindrop splash impact and self generated overland flow.

The fill batters will be topsoiled and revegetated with tree, shrub and ground cover species suited to the existing vegetation community and consistent with frangibility clear zone and sight line requirements.

A maximum fill batter slope of 2H:1V is adopted to ensure flexibility of revegetation technique. With a preference for vegetative based stabilisation (hydromulch, hydroseeding, bush regeneration) which is free from matting and netting.

Responding to the Principles of Blending Topographic Change and Respecting Local Vegetation the profiling and treatment of the fill batters in this manner will provide for improved visual integration of the road formation with the existing landscape through:

- Improved driver views in pasture and cropping zones
- Reduced work footprint and thus vegetative clearing.

Cut batter

Cut batters throughout the design are typically profiled to a gradient of 2H:1V with the exception of overbridge cuttings wherein a 1.5H:1V profile is adopted.

Where competent rock is encountered it has been preserved as the batter finish. In instances wherein otherwise competent rock exhibits fissures these have been stabilised by filling with appropriate quarry rock.

All top hinges for cut batters have been rounded to retain existing vegetation, sides of cuttings have been feathered back into the existing landscape and topographic condition through progressive contour tying in.

Subject to specific location, local context and in the absence of competent rock, cut batters will have upstream surface flows diverted away from the batters using catch drains.

The batters will be horizontally tined, topsoiled and revegetated with tree, shrub and ground cover species suited to the existing bioregion and consistent with frangibility clear zone and sight line requirements.

A maximum cut batter slope of 2H:1V for vegetated batters is adopted to ensure flexibility of revegetation technique. With a preference for vegetative based stabilisation (hydromulch, hydroseeding, bush regeneration) which is free from matting and netting.

Responding to the Principles of Blending Topographic Change and Respecting Local Vegetation the profiling and treatment of the cut batters in this manner will provide for improved visual integration of the road formation with the existing landscape through:

- Improved driver views in pasture and cropping zones
- Reduced footprint and thus vegetative clearing.



Fig.9.9 Water cart application of a tackifier.(Photo: Vital Chemical Pty Ltd)



Fig.9.10 Standard Hydromulch being applied to a batter on the Hunter Expressway.

Due to the size of the areas involved, the majority of the vegetated landscape on the Highway is revegetated using native seeding.



Fig.9.11 Native seed hydromulch growth (Image source: Aussie erosion)

9.4 Seed application and establishment

Areas to be revegetated along the main highway will be seeding using either:

- Hydroseeding
- Hydromulching
- Bushland reconstruction.

Hydroseeding is the hydraulic application of seed, seed carrier and soil ameliorants added to a tank fitted with an agitator and pump. It is commonly followed by hydromulching or straw mulching to provide surface protection.

For Sections 7, 8 and 9 pasture grasses reinstating grazing and agricultural flat lands and formation batters shallower than 3H:1V will be hydroseeded together with medians to provide surface stabilisation with appropriate grass species as identified in Appendix B.

Hydromulching has a similar application method to hydroseeding but contains

various types of organic fibrous materials mixed with water and the seed mix. This is sprayed onto the soil surface in slurry form which sets to form a layer providing temporary protection from wind and water erosion.

For Sections 7, 8 and 9 endemic seed mixes composed of North Coast bioregion species will be mixed with cover crop seed species and hydromulched to reinstate forest, heath and lowland areas onto cut and fill batters, medians and verges of 3H:1V or steeper. Fig. 9.11 shows native seed hydromulch growth in a semi-mature state.

Both hydroseeding and hydromulch applications provide a micro-climate for successful germination of both the cover crop and native species. Cover crop seed will be integrated within both hydroseed and hydromulch applications.

Cover crops are fast growing, but short lived non-native pasture grasses used to revegetate exposed batters to minimise

erosion and weed infestation. The cover crop species are intended to provide the temporary batter stabilisation before the permanent species germinate and establish.

Cover crops have been composed with Roads and Maritime R178 approved species at the designated application rates relative to season of installation.

Care was taken in formulating the final cover crop mix percentages within native seed mixes to ensure secondary and tertiary permanent species seed germination and plant growth is not hindered by overly dense cover crops.

Bushland reconstruction is a revegetation strategy successfully enacted on the Pacific Highway Glenugie upgrade.

Since its installation in 2010 this process was used on a number of Roads and Maritime projects and due to the location and forest community similarities it is considered to be directly applicable for use

in reinstating disturbed forest communities within Sections 7, 8 and 9.

At the Woodburn Interchange and within the Bundjalung and Broadwater National Parks the nearby verge edges are largely weed free heath and grey gum forest communities which offer a potential seedbank abundant with inherently appropriate species.

Clearing footprints within these areas are anticipated to generate a significant volume of tub ground shredded mulch rich with seed which will be incorporated into the site select stripped and reapplied topsoil.

Re-establishing the bushland with a full suite of site sourced and composed endemic components will provide for the optimum indigenous vegetation reconstruction.

Bushland reconstruction relies upon a clean site process which strips and stockpiles topsoil and grinds and composts

mulch only from the bushland zone and only for reconstruction within the zone to safeguard enduring vegetation community integrity through weed free construction hygiene.

Establishment of time means the short-term period and process required for vegetative materials to germinate and become self-sustaining.

During this phase, some activities may be required to achieve establishment, such as watering, weed management, fertilising, application of other landscape materials. Batters using vegetative techniques for stabilisation are not considered complete until establishment is achieved.

To reduce water consumption, preserve local biodiversity and landscape distinctiveness, the use of indigenous species of local provenance are preferred on the road corridor in rural areas. Local native seed collection is an important operation in revegetation along Roads and Maritime Services road projects.

9.5 Seed collection

Locally provenant seed collection from the work clearing footprint and immediate local regional is the optimal method by which seed supply shall be supplied. In developing the seed mixes consideration is being given to the commercial availability of seed suited to the vegetation communities present.

9.6 Monitoring maintenance and ecological establishment.

Roads and Maritime requirements for maintenance are contained in specification QA-R174.

The specification covers standards and methods for all the normal tasks required for landscape/horticultural maintenance.

The scope of this work is identified in the Landscape Management Plan shown in Appendix B.

The maintenance work begins at the time of occupation of the site and together with measures designed to protect the biodiversity of the corridor will be carried out over the duration of the construction work and maintenance period covered by the contract.

Particular attention will be given to the monitoring of planted areas within the first 18 months after planting. This is the most sensitive time for newly installed planted hydroseeded and hydromulched material.

Additionally, the inspections will monitor the germination of Acacia species. If this is too dense, selected plants will be removed by hand or using an appropriate non-residual herbicide.

Fig. 9.12 illustrates the successful native plant growth on a similar project in a semi-mature state.

The objectives for monitoring landscape rehabilitation areas and ecological establishment are detailed in the Landscape Management Plan. They include:

- Plant species must be representative of each of the structural strata (tree, shrub and herb layer) of the target vegetation community
- At least 50 per cent of the vascular plant species should be representative of the target vegetation community
- Sufficient cover of native herbs established at a density which is sufficient to ensure continuous plant coverage by completion of the landscaping maintenance period
- Weed species comprise no greater than five percent of all plant species per restored area with exception of 15 per cent in riparian vegetation communities
- Weed cover is less than five per cent per restored area.



Fig.9.12 Native planting growth (Source: Diversity native seeds)

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Topsoil 10



Fig.10.0 Existing soil map

10.1__Topsoil

Topsoil treatments include:

- Ripping the subsoil or sub base (depth varies)
- Application of the site topsoil/composted mulch mix (depth varies)
- Application of seed mixes by hydroseeding or hydromulching or planting
- Application of rice straw mulch to a minimum 25 millimetres thickness over seeding (where hydroseeded)
- Application of 75 millimetres thick site-won or hardwood woodchip mulch (or rice or sugar cane straw mulch in riparian areas) where planting occurs.

Three main topsoil treatments are used, which include:

Topsoil treatment 1: For bushland topsoil containing seed bank placed over cut/fill slopes

- Prepare batter slopes by ripping or roughening the surface to a depth of 100 millimetres using the tynes on a swivelling head excavator bucket, or by some other means to form a loosened or roughened surface suitable for the application of topsoil
- During ripping, mix in any materials required by the soil testing into the upper 100 millimetres layer to the rates specified within the soil testing recommendations or geotechnical advisor. This may include the mixing of gypsum or any other suitable agent to prevent erosion of subsoil, if dispersivity is identified as an issue for the materials on the cut batter faces to be vegetated. Provide 'cleatmarks', 'dimples' or horizontal scores to cut and fill batters prior to topsoil application
- Apply A1 horizon site-won topsoil mixed with composted site mulch (as directed by the soil test results), to a minimum depth of 100 millimetres, but not more than 200 millimetres. (topsoil and mulch should have been previously ameliorated and any additional materials required by soil testing mixed at the stockpile
- Alternatively, apply A1 horizon topsoil to a minimum depth of 100 millimetres, but not more than 150 millimetres. Mix with windrowed composted site mulch by pushing up and down the prepared slope in order to achieve a reasonable mixing of the two and to achieved a minimum depth of 100 millimetres but not more than 200 millimetres
- Spread out the topsoil/composted mulch mix to an even surface but do not otherwise smooth or compact the surface
- Apply appropriate hydromulch seed mix (if no soil borne seed has germinated)
- For slopes steeper than 2H:1V and up to 1.5H:1V (eg transitions from bridge abutments to 2H:1V slopes) and for basins, vegetated swales and channels install organic fibre mesh as per the specification over final topsoil preparation and prior to seeding.

Topsoil treatment 2: For planting and seeding areas

- Rip the subsoil to a depth of 300 millimetres. Do not smooth or compact the roughened subsoil surface prior to the application of topsoil
- Apply A1 horizon topsoil to a minimum depth of 150 millimetres
- Spread the topsoil but do not otherwise smooth or compact the surface except where pasture/native grass is to be applied
- Level and trim the surface flush with adjacent surfaces and roll to lightly compact
- Apply appropriate hydromulch seed mix or plant
- For tubestock: prepare 200x200x200 millimetres deep hole
- For advanced tree: prepare 600x600x450 millimetres deep hole
- For super advanced trees: prepare 600x600x600 millimetres deep hole
- Apply fertiliser at the rates as shown on the landscape drawings
- Install advanced trees/tubestock and backfill with topsoil to finish flush with ground level
- Apply mulch to a depth of 75 millimetres.

Topsoil treatment 3: For pasture grasses and native grass seeding on medians, verges and cut/fill slopes

- Cultivate all areas to a depth of 150 millimetres. Do not smooth or compact the roughened subsoil surface prior to the application of topsoil
- Apply site-won topsoil to a minimum depth of 50-100 millimetres. Do not use composted site mulch.
- Spread the topsoil, level and trim the surface flush with adjacent surfaces to provide an even finish and roll to lightly compact
- Apply appropriate grass seed mix via hydroseeding or hydromulching with fertiliser as shown on the landscape drawings and Specification.

10.2___Topsoil management

Devils Pulpit to Richmond River (sections 7, 8 and 9 works) traverse a vast extent of forested areas (approximately 32 kilometres). The topsoils stripped from the formation will contain a seed bank species diversity that cannot be replicated by seeding due to limitations on availability.

The best landscape outcome is to be achieved by re-applying site topsoil containing this intact soil-borne seed bank back to the locations from which it was stripped within a time frame which ensures that most of the seed remains viable.

Natural regeneration ensures that foreign genotypes are not introduced to the existing vegetation communities and also that the species mix is maximised. Other benefits include reduced fertiliser requirements (excess fertiliser can run off and cause algal blooms and fish death in waterways). It also introduces indigenous species which are impractical to establish by other means, either because their seed is difficult to collect in quantity or to apply (Terrestrial Orchids, ferns and native lilies) or because they are opportunistic colonisers that will persist or colonise rapidly where conditions are favourable (Bracken Ferns, Blady Grass and Geebung species). These types of plants can be expected to re-colonise disturbed areas of the corridor rapidly with the application of correct topsoil management procedures.

There are five key aspects to the management of existing topsoil:

- Topsoil stripping to maintain the integrity of the topsoil from the existing vegetation communities
- Direct return of topsoil (where feasible) Topsoil management zones and stockpile management procedures
- Topsoil testing
- Topsoil and composted mulch amelioration.

Where the topsoil is to be stripped from intact bushland areas, it is to be separated by vegetation community type and referred to as Bushland Topsoils. Topsoil stripped from pasture areas and referred to as Landscape Topsoil, is to be stripped and stockpiled separately and quarantined from Bushland topsoils in order to prevent the spread of weeds.

Direct return is the procedure whereby site topsoil is returned to the batter location from which it was stripped either immediately or soon after formation. It is dependent on the construction staging and the full commitment of construction staff to the re-vegetation process. Direct return will be implemented where construction staging allows.

Topsoil stockpile management and storage procedures are designed to ensure the survival of soil seedbank, microflora and microorganisms in the stockpile for the duration of the stockpile period and until it is returned to re-vegetation areas.

The stockpiles will be sized to maintain the viability of native seed with 2H:1V batter slopes. Large, clearly legible signs will be placed and maintained on each stockpile, nominating vegetation community type, soil horizon, collection area (eg by station) and date of stockpiling. No soils should be stockpiled for greater than 18 months where possible.

Topsoils will be tested in situ prior to stripping in accordance with Roads and Maritime specification R44 and within the stockpiles in accordance with Roads and Maritime Woolgoolga to Ballina project specific specification R178. Amelioration is to be carried out in accordance with the test result recommendations, prior to installation.

Topsoil management zones are derived from the vegetation community boundaries shown on the landscape plans to ensure that the topsoil with stored seed from each vegetation community is returned to a location with the same vegetation community. In some instances the exact extent of a zone is rationalised in order to assist the stripping and reapplication. For instance a zone may be extended to the end of a batter if the distance to the end of a batter does not warrant a change in soil type.

For the purposes of stockpile management for this project, soils have been classified into two types.

Bushland topsoil

This includes topsoil stripped within mapped vegetation communities that have been cleared. Striped bushland topsoil is to be stockpiled and managed to retain their environmental integrity and preserve the soil seed bank. Topsoil from different vegetation communities is to be stockpiled separately where feasible. Bushland topsoil is for reuse where native seeding and planting is specified on the landscape drawings and within vegetation community boundaries. Refer to Fig. 22 which illustrates the procedure for handling Bushland topsoils.

Landscape topsoil

This includes topsoil stripped from existing pasture grass areas or where mapped in the Weed Management Plan as having a High Weed Density Abundance. Landscape topsoil may contain weed seeds and must be quarantined from Bushland Topsoils. Landscape topsoil is for re-use where pasture grasses are shown on the landscape drawings. Refer to Fig. 23 which illustrates the procedure for handling Landscape topsoils.

10.3___Mulch treatment

All planted areas are to have a surface layer of hardwood mulch sourced from site applied to a nominal minimum depth of 75mm. Mulch is to be stockpiled for 6 months prior to use in order to reduce the impacts of nitrogen draw-down on soils and its effect on plantings.

Composted mulches

Composted mulches, derived from site-won mulch that has been windrowed for a minimum of six months in a manner to accelerate composting, will be mixed with site topsoil as shown on the landscape drawings. At a minimum, site topsoil mixed with composted site mulch is to be spread on batter slopes receiving runoff in order to increase its organic (carbon) content and to aid in erosion resistance on batters. The component of composted site mulches mixed with topsoils will be considered during the detailed design phase and will form part of the soil testing procedures with advice from the soil scientist conducting the testing. The general ratio of 75 per cent topsoil to 25 per cent composted site mulch will be applied but may be varied as advised by the soil scientist.

Composted site mulch is required to be ameliorated to raise the pH, improve the composting processing to reduce the nitrogen drawdown effect of the mulch, and to counter any major nutrient deficiencies that would inhibit germination. The soil scientist will provide advice as to soil and compost additives to render the mix suitable for growth of the proposed plant species.

Around riparian zones Straw Mulch (rice or sugar cane) will be used in lieu of site won mulch to prevent tannins from leaching into waterways. uncompacted on batter slopes receiving run-off to improve erosion resistance and to enhance organic composition.

Composted site mulch will be mixed with site topsoil on the prepared slopes using a windowed berm technique or at the site

topsoil stockpile subject to final site topsoil volumes and construction works stripping, stockpiling and landscape construction programming.

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10.4 Landscape outcomes

The landscape work to be carried out as part of the Woolgoolga to Ballina upgrade will take time to develop as the new vegetation is established and grows. Consequently the visual character of the landscape work will also change over time.

These changes are illustrated by the set of images presented below (Figures 10.1-10.8).

The photographs have been taken at a number of different locations along other sections of the Pacific Highway upgrade.

They illustrate the visual character of the landscape work at various stages of development which include:

- During completion of the landscape work
- Soon after completion
- Subsequent years after the vegetation has had time to grow.



Fig.10.1 Cleared median awaiting seeding



Fig.10.3 Median with established planting five years after planting



Fig. 10.5 Landscape batter before seeding



Fig. 10.7 Landscape batter with established planting five months after seeding



Fig.10.2 Cut batter before roadwork and planting



Fig.10.4 Cut batter with new planting growth 15 months after seeding

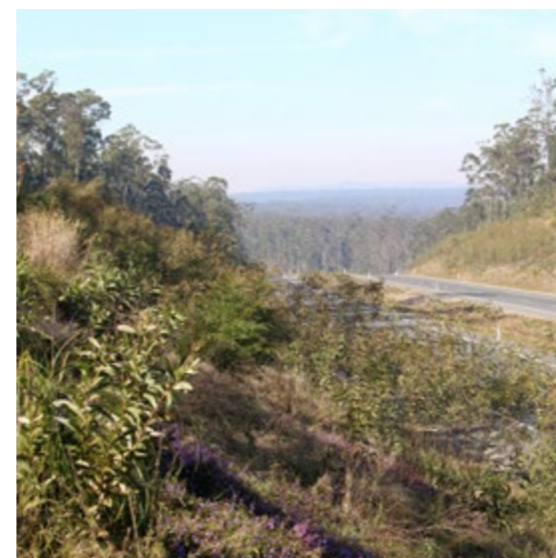


Fig.10.6 Cut batter with established planting



Fig.10.8 Cut batter with mature planting one year after establishment

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Drainage and water quality

11

11.1 Drainage and water quality

Water quality control systems

Drainage and water quality control systems designed include:

- Grass lined channels
- Central medians
- Free draining scuppers
- Batter vegetation
- Operational basins.

These water quality control systems are designed to:

- Minimise the extent of clearing by incorporating swales into the earthworks design in preference of permanent basins.
- Manage stormwater flows onto, through and from the site by separating dirty and clean water channels. In some locations where the available road alignment width does not allow a cutoff drain to be provided as well as a water quality treatment swale, the bund nearby to the water quality swale has been used to separate the dirty and clean flows.
- Retain existing vegetated swales for re-use (where possible), particularly in areas where the existing alignment is being retained
- Ensure water runoff will not be conveyed directly into OPP streams
- Consideration is given to the competing environmental requirements of minimising impact to native vegetation, fauna habitat and wildlife corridors.

In order to capture and convey the runoff from the road surfaces, drainage channels have been provided. Longitudinal drainage channel elements including limited cutoff drains (toe of batter) and central median drains to convey road runoff to water quality basins.

The grassed channels treat stormwater by allowing interception, settling filtration and infiltration of pollutants, primarily solids based.

Removal of pollutants such as sediments, nutrients and hydrocarbons occurs as these particles attach to the suspended solids and drop out of suspension.

Where bridges are not crossing sensitive waterways free draining scuppers from bridge decks will allow for water to percolate into the ground plane below.

Batter vegetation treats the batter surface water runoff as it flows down the vegetated fill batters. Shallow vegetated swales will be located along the toe of each batter bordered by highway fill on one side and bounded by a vegetated, earth-covered biofiltration media on the other, to direct the sheet flow to water quality basins where required.

Water quality basin

Permanent water quality basins have been proposed next to the road carriageway. These basins treat runoff from the highway before it percolates through into the natural ground below. Permanent basins are to be shaped with an organic edge where possible. When constrained by available space selective tree planting was used at basin edges to soften the rectilinear visual presentation through cast shadows and vertical disruption. Fencing of basins when required used visually recessive chain wire fence. An artist impression of a permanent water quality basin with mature growth is shown in Fig. 11.0..

Culverts

Culverts have been installed where the works cross existing watercourses and low points in the landscape. The culverts will facilitate the passing of clean non-highway water flow under the highway, service roads, access ramps, local roads and access tracks ensuring the watercourse is not disturbed. Scour protection will be provided at both the inlet and outlet of culverts to prevent erosion at the transition between the culvert and the natural channel.

Creek rehabilitation

Appropriate plant species will be incorporated into the rehabilitation of disturbed aquatic habitats and drains as a result of the built works. Typical species are included in Table 11.0. The rehabilitation works will be monitored and remedial measures implemented where required until vegetation has stabilised. The bed and banks will be reinstated to a condition similar to or better than the original condition ensuring that there are no adverse impacts on the aquatic values.

Table 11.0 Planting species for riparian environments

Dry grass species - botanical name	Common name
<i>Gahnnia sieberiana</i>	Rough saw sedge
<i>Lomandra filiformis</i>	Wattle matt rush
<i>Lomandra longifolia</i>	Spiny headed matt rush
<i>Lomandra multiflora</i>	Many flowered matt rush
Margin grass species - botanical name	
<i>Dianella caerulea</i>	Blue flax lily
<i>Ficinia nodosa</i>	Knobby club rush
<i>Gahnnia sieberiana</i>	Rough saw sedge
<i>Juncus usitatus</i>	Common rush
Wet grass species - botanical name	
<i>Baumea arthropphylla</i>	Swamp twig rush
<i>Carex spp</i>	Sedge
<i>Ficinia nodosa</i>	Knobby club rush
<i>Fimbristylis spp</i>	Fimbry



Fig.11.0 Artist impression of detention basin at Broadwater to Evans Head Road with organic shaping to typically engineered edge subject to further design

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Fauna crossings **12**

12.1__Fauna connectivity

To mitigate the fauna fragmentation we will provide fauna crossings at key animal movement corridors shown in Fig. 12.3.

These fauna crossings aim to reduce fragmentation of habitats and improve and maintain species diversity.

12.2__Fauna crossing structures

Connectivity structures for this design are listed in Table 12.1. Landscape planting to fauna connectivity structures will replicate the surrounding habitat and where possible to provide foraging resources for fauna. Remnant vegetation will be maintained near structures.

Fauna underpasses

An underpass is a structure which allows wildlife to cross the road beneath the road surface. It includes bridge underpasses, dedicated and combined box culverts, combined with koala and small mammal structures and fish passages.

Fauna structures include horizontal logs placed as high off the ground as possible for koalas and small mammals to avoid predators. The logs are also supported by vertical logs to allow for koalas and small mammals to climb down if required. Fauna furniture has been designed to extend beyond the underpass into the surrounding habitat.

Strategic planting of koala habitat next to the structures will further enhance the connectivity. This is shown in Figures 12.0 and 12.1.

Rope bridges

Have been introduced where there is a significant break in tree canopy. Support poles are located behind fauna proof fencing and are integrated into the landscape with new tree and existing tree planting as shown in Fig. 12.2.

Widened medians

Can act as a measure to mitigate the loss of continuous habitat and increase the chance of safely crossing roads by providing stepping-stone connectivity.

Fauna exclusion fencing

Designed to direct fauna to fauna crossing locations and prevents fauna from accessing the road. All fences have been designed to prevent fauna from digging underneath or passing through points where fencing crosses drainage lines. Arboreal mammal fences is designed to prevent animals from climbing over.

Temporary barrier fencing will also be installed during construction to protect Koalas during the construction process.

12.3__Fish crossings

All of the water courses understood to be Oxleyan pygmy perch habitat have been design with fish structures to encourage movement throughout the waterways. Piers to bridges crossing environmentally sensitive habitat are located outside the main channel.

12.4__Frog ponds

Constructed or augmented breeding ponds will be used as a compensatory mechanism to reduce impacts for the Wallum sedge frog and Green-thighed frog.

Ponds which are known to provide habitat for sedge frogs, but are limited in their extent of emergent sedges growing in freestanding water, will be augmented by the planting of suitable sedge species.

The ponds will be vegetated via assisted planting techniques with low naturally occurring ground covers (ie *Carex spp.*, *Fimbristylis spp.*)



Fig.12.0 Artist impression of fauna culvert with fauna furniture, Landscape shown at full maturity, subject to further design

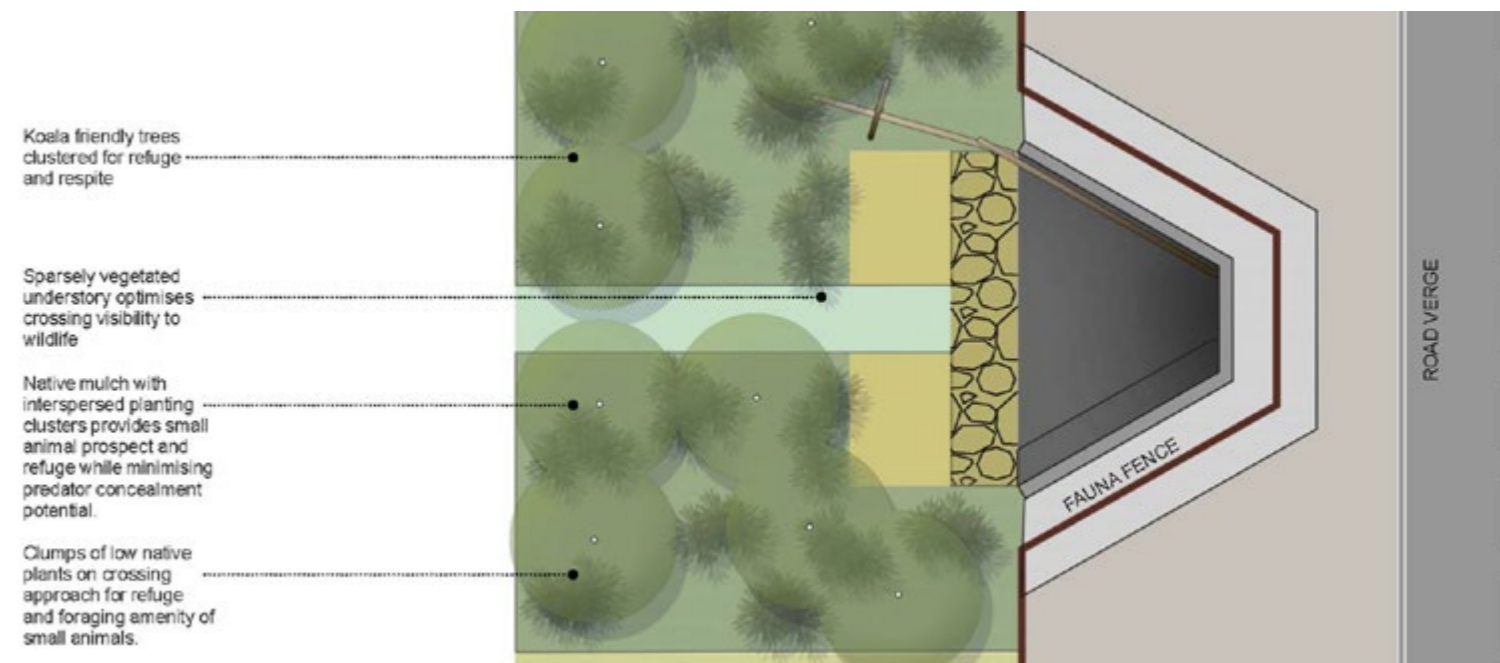


Fig.12.1 Typical fauna structure arrangement with additional planting for foraging

Table 12.1 Fauna connectivity furniture






Furniture type	Fauna type	Key
Bridge underpasses	Small mammals	
Dedicated and combined box or pipe culvert	Koala, small mammals, reptiles and amphibians	
Fish passage	Fish	
Rope bridges	Brush-tailed phascogale, possums and gliders	
Glider poles	Gliders	



Fig. 12.2 Rope bridge (Image source: Michael Clarkson)



Fig. 12.3 Fauna structure locations

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Conclusion 13



13.1 Conclusion

This conclusion provides a succinct description of the UDLP design document. It identifies key design outcomes proposed to achieve the Pacific Highway vision and deliver a safe environmentally responsible landscape that satisfies the Ministers' Conditions of Approval. This conclusion reprises and condenses content from the Executive Summary and main report while adopting a more descriptive focus on specific design outcomes.

This Draft Urban Design and Landscape Plan (UDLP) documents the Urban design and Landscape design specific to Devils Pulpit to Richmond River (Sections 7, 8 and 9 of the Woolgoolga to Ballina Pacific Highway upgrade) a combined total of 33 km of upgrade of the Pacific Highway. It has been principally composed and authored to address the requirements of the Ministers' Conditions of Approval for the project (MCoA) D20 and in so doing inform the landscape design documentation for construction.

The design as described in this document achieves the environmental requirements and measures set by the project Environmental Impact Statement (EIS) and Submissions/Preferred Infrastructure Report (SPIR) and fulfils the stated requirements of the Ministers' Conditions of Approval for the project (MCoA).

The overall corridor design outcomes inclusive of the living landscape will ensure the upgraded Pacific Highway will continue to service the needs of the travelling public, achieve transport efficiencies, sit comfortably within the local environment and contribute positively to the neighbouring human and animal communities.

As one of the largest road infrastructure projects in New South Wales, the Pacific Highway connects Sydney and Brisbane, and is a major contributor to Australia's economic activity. The Woolgoolga to Ballina upgrade for the Pacific Highway has been managed into 11 Sections with both the Australian and New South Wales Governments committed to completing the Pacific Highway upgrade (Sections 3 to 11) by 2020. Due to the significance of the upgrade, consultation with communities, councils agencies and stakeholders is substantial, ongoing and will continue to occur through to the finalisation of this UDLP in late 2016.

This document has been deliberately structured with the design described in a logical linear format progressing from broad scale planning through to small scale design. The structure starts with a summary of the wider corridor planning and then moves sequentially through approval processes through to contextual analysis and then onto design principles and strategies. These principles and strategies are then articulated graphically within the strategy plans prior to the document completing with detailed design intentions discussed by infrastructure element.

In embracing the Pacific Highway vision, the design for Devils Pulpit to Richmond River (Sections 7, 8 and 9) blends with landform and integrates refined elegant infrastructure. The environmental focus will achieve a varied visual journey featuring open and closed views of pasture, cane fields, National Park, State Forest and a wide variety of native vegetation communities from the New South Wales north coast bioregion. Closely

supporting this focus the corridor design through vertical and horizontal road alignments and integrated civil, drainage and landscape earthworks ensures that the roadway that is flanked and frequently divided by local native vegetation sensitively sits within the natural landscape and will rapidly become unobtrusive as the landscape matures.

Working with both the natural environment through vegetation, and the civil environment through landform, the built environment of bridges, barriers and signage has been developed as a refined cohesive suite of complementary elements. This suite of elements sits comfortably within the Pacific Highway infrastructure design "family" and in particular has adopted the "stiletto" piers, spill through stone abutments and throw screen detailing that characterises a number of visually appealing, well integrated sections of the Pacific Highway within the New South Wales North Coast region

Specifically in conclusion, the key design features of each critical design UDLP Report Chapter are described below:

Chapter 4 - Objectives and Design Principles

- The landscape design offers a range of visual experiences integrated with the flowing road alignment. Principally the experience contrasts a range of native forests with a variety of productive agricultural landscapes
- The corridor is well vegetated with appropriate species mixtures that will thrive and rapidly re-establish contextually relevant and visually significant landscapes
- The roadway sits simply and unobtrusively within the landscape integrating the corridor within the natural environment while delivering contextually considered interchanges that provide wayfinding cues for local communities and towns.

Chapter 5 - Contextual Analysis

- The landscape design is firmly ground within the local context with specific design responses adopting planting and seeding mixtures that are informed by detailed analysis of the existing topographic, vegetative, hydrological and geological conditions
- The infrastructure design components have been composed and site specifically considered to respond to well received recently constructed bridge, throw screen and abutment in nearby sections of the Pacific Highway
- The overall design composition and detailed design outcomes respond to local fauna, flora and human communities to realise environmentally and culturally connected communities. New Italy, Woodburn and Broadwater have been sensitively referenced in and responded to within the design while a range of fauna and flora communities will have their connectivity and physical extents increased and enhanced through the landscape design.

Chapter 6 and 7 - Principles and Strategy Plans

The urban and landscape design strategy delivers the project objectives through practical design and construction measures.

- Planting of interchange with appropriate local vegetation arranged to provide wayfinding cues
- Seeding of appropriate local vegetation and pasture grasses between interchanges to stabilise the road formation and reinstate corridor consistent landscapes
- Achieve a safe roadway environment for people and fauna through tree setbacks, fauna fencing, fauna underpasses, rope bridges and consistent targeted habitat plantings.

Chapter 8 - Detailed Response

A consistent family of bridges and barrier components has been delivered that adopts a suite of design elements featured across all portions and that have been previously adopted along the Pacific Highway in Northern New South Wales.

Floodplain bridges feature a regular performance barrier to improve the view to the adjoining landscapes through a single rail only.

The sugar cane screen at Broadwater has been subtly featured as a wayfinding device providing advanced notice of the Broadwater interchange off ramp.

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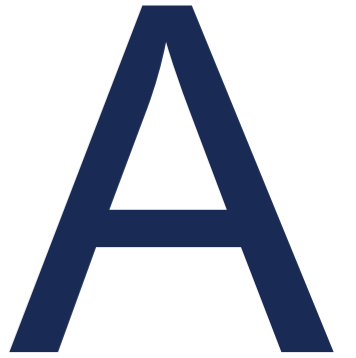
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Environmental management compliance tables



A.1 Compliance with threatened species management plans

Where specific mitigation measures have been identified for target threatened species they have been outlined in the threatened species management plans. These plans aim at providing mitigation and monitoring measures for implementation during pre-construction, construction and operation. As part of the Conditions of Approval for the project, the Ballina Koala Plan and Koala Management Plan must be approved before building can start in the area known as section 10, which starts at Broadwater and finishes at Coolgardie, south of Ballina. This UDLP addresses the following measures stipulated in the following threatened species management plans:

- Threatened frog management plan
- Rainforest communities and threatened rainforest plants management plan
- Threatened flora management plan
- Threatened glider management plan
- Threatened mammal management plan
- Threatened fish management plan
- Threatened invertebrate management plan

Table A.1 Threatened species management plan requirements

ID	Management plan requirements	Yes/No	Document Reference
Flora_MP 027	To reduce the impacts to threatened orchid species restrict the availability of information identifying where orchids occur within the project area, and in close proximity to the project area. Limit site access to areas where orchids naturally occur and may be being managed in situ.	Yes	Chapter 5.09
Flora_MP 034	The landscape design would provide specific details for the re establishment of native vegetation within areas disturbed by construction, such as batters and bare areas to provide protection for in situ threatened species. Methods for topsoiling, seeding, planting and weed control would be in accordance with the Biodiversity Guidelines: Protecting and managing biodiversity on RTA Projects (RTA 2011).	Yes	Chapter 9
Flora_MP 060	The detailed design presents further opportunities to avoid and minimise impacts to threatened species/populations, including: a) Avoiding or minimising vegetation removal wherever possible b) Where possible, final planning for construction compounds, ancillary infrastructure, access tracks and stockpile areas will be placed within cleared or disturbed areas, and away from threatened plants to avoid unnecessary clearing and indirect impacts c) When locating water quality treatment measures, consideration will be given to the competing environmental requirements of minimising impact to native vegetation, particularly where there could be threatened plant species, and also wildlife corridors and potential fauna habitat.	Yes	Chapter 6.6 and 9.3 Chapter 6.8 Chapter 11.1
Koala_MP 001	Impact to koala habitat outside the construction zone. Identification of exclusion zones and limits of clearing.	No	Refer CEMP
Koala_MP 002	Potential impacts to koalas within the project during clearing works. Pre-clearing and clearing procedures.	Yes	Chapter 12
Koala_MP 004	Potential impact to koala habitat when siting ancillary facilities.	Yes	Chapter 6.8
Koala_MP 005	Disruption to koala movements and gene flow. Fauna crossing structures – underpasses, including refuge poles and furniture.	Yes	Chapter 5.4 Chapter 12
Koala_MP 006	Fauna exclusion fencing. The design and construction of fauna exclusion fencing, drainage or fauna underpass structures in widened medians minimise vegetation clearing.	Yes	Chapter 8.3.1 Chapter 7 Chapter 12
Koala_MP 008	Temporary and permanent fencing detail location of temporary and permanent fencing, encourage use of crossing points and direct koalas from the road corridor.	Yes	Chapter 6.8
Koala_MP 010	Ancillary and access roads Ancillary facilities and access roads to be planned and sited within cleared or disturbed areas within the project boundary and in accordance with NSW CoA B73, B74 and B75. This will occur across all ancillary sites for each stage of the project and will be documented in the CEMP.	Yes	Chapter 6.8
Koala_MP 017	Revegetation In situations where no fencing is present, and revegetation is required, roadside plantings to avoid koala food trees to prevent koalas being attracted to road edges.	Yes	Chapter 7
Koala_MP 025	Connectivity structures The locations of these fauna connectivity structures are indicated by the chainages in Table 5-1 of the Management Plan.	Yes	Chapter 7 Chapter 12

Table A.1 Threatened species management plan requirements

ID	Management plan requirements	Yes/No	Document Reference
Koala_MP 026	<p>Fauna furniture</p> <p>Fauna furniture installed at the targeted koala underpasses will be finalised in the detailed design and adhere to the connectivity guidelines in the EIS which include:</p> <p>Horizontal logs placed as high off the ground as possible for koalas to avoid predators with a minimum space of 600 mm between the top of the horizontal log and the structure's roof</p> <p>Horizontal logs supported by vertical logs at regular intervals (approximately every 2-3 metres) along the underpass for koalas to ascend or descend the koala furniture as required</p> <p>Logs greater than 200 mm in diameter</p> <p>Koala furniture extends beyond the underpass into koala habitat</p> <p>Where fauna furniture is placed inside a culvert, it is to be constructed on the left or right side of the culvert (not in the middle), minimise incidence of flooding.</p>	Yes	Chapter 7 Chapter 12
Koala_MP 027	<p>Planting of koala habitat.</p> <p>Strategic planting of koala habitat adjacent to targeted connectivity structures will also be undertaken post-construction, or beforehand if practicable, to improve and maintain connectivity.</p>	Yes	Chapter 7 Chapter 12
Koala_MP 053	<p>Fauna fencing</p> <p>Response: The type and location of fauna fencing is scheduled in the Environmental Report W2B-ACJ-C-EN-RPT-00001 and shown graphically on the Strategy plans</p>	Yes	Chapter 7
Koala_MP 055	Design to be aware of Table 4.1 Location of Proposed Fauna Fencing in Sections 3-11 of the Environmental Report W2B-ACJ-C-EN-RPT-00001.	Yes	Chapter 6.6 Chapter 7 Chapter 8.3.1
Koala_MP 056	Design to be aware of Table 7.1 Fauna Connectivity Structures Targeted for the koala as detailed in the Connectivity Strategy seen in W2B-ACJ-C-EN-RPT-00003.	Yes	Chapter 7 Chapter 12
Koala_MP 057	Design to be aware of Table 5.1 Fauna Connectivity Structures as detailed in the Connectivity Strategy seen in W2B-ACJ-C-EN-RPT-00003.	Yes	Chapter 7 Chapter 12

Table A.1 Threatened species management plan requirements

ID	Management plan requirements	Yes/No	Document Reference
Glider_MP 001	Exclusion zones will be established prior to the commencement of clearing and construction to ensure that any activities do not unnecessarily remove protected vegetation within the project, proposed widened median areas, and roadside vegetation that would be retained in and/or near threatened glider habitat areas and crossing structures.	No	CEMP
Glider_MP 002	Targeted glider surveys undertaken during detailed design and crossing structure locations refined.	Yes	Chapter 7 Chapter 12
Glider_MP 003	Tree habitat survey to quantify number of hollows to be removed for input into the Nest Box Management Plans.	No	EN03
Glider_MP 004	Road and construction related infrastructure to be planned and sited within cleared/disturbed areas or minimised, where possible. Particularly away from water sources and known glider habitat and movement areas. Development of UDLP to outline areas for revegetation. Revegetation to include native vegetation that provides foraging resources for gliders.	Yes	Chapter 7 Chapter 12 Appendix B
Glider_MP 005	Temporary and permanent exclusion zone identification informed by the targeted glider surveys. To occur during pre-construction and marked on detailed design plans (to be implemented prior to commencement of clearing).	No	CEMP
Glider_MP 006	In all cases defining the limits of clearing to give priority to maintaining as much threatened glider habitat as possible. Methods in reducing clearing requirements will include; consideration of construction methods, alterations to batter slope, utilisation of existing cleared areas, location of stockpiles and lay-down areas and location of ancillary facilities to avoid where practicable fauna habitat. For example, ancillary facility sites (eg temporary sites for construction related activities) will be sites in cleared land or sites with low ecological value to avoid unnecessary clearing of habitat. The limits of clearing will also consider retaining remnant vegetation along road verges and in widened median strips to enhance the proposed crossing structures. Strategic revegetation will be undertaken adjacent to crossing structures in disturbed areas to guide threatened gliders to crossing structures or away from the road.	Yes	Chapter 6.6 Chapter 6.8 Chapter 7 Chapter 12
Glider_MP 010	Installation of connectivity structures at pre-defined locations (based on targeted survey findings). Monitor installation of connectivity structures during construction. All crossing structures installed at the correct locations and as per specifications prior to operation.	Yes	Chapter 7 Chapter 12
Glider_MP 011	Implementation of the UDLP that considers threatened glider population, habitat and revegetation of habitat areas, including strategic revegetation around crossing structures and in disturbed areas.	Yes	Chapter 7 Chapter 12
Glider_MP 017	The final exact location of glide poles and proximity to retained trees can only be established at the time of construction due to a number of variables that may occur. Where practicable, glide poles and retained trees proximate to the project and vegetated medians will be established no greater than 50 m apart to allow safe glide spaces for threatened gliders. The final location of glide poles will be determined in consultation with the EPA.	Yes	Chapter 7 Chapter 12
Glider_MP 024	It is also important that boundary fencing does not include barb wire (top two strands) in the areas of known glider habitat.	Yes	Chapter 8
Glider_MP 048	Strategic tree planting to direct glider movement to crossing structures or locations where unassisted crossing is possible. Consideration of further glide poles and rope bridges, particularly where mortality hotspots are noted and proximate mitigation measures are not being utilised.	Yes	Chapter 7 Chapter 12
Glider_MP 050	Poles suspending the ladder would be made from treated timber to minimise the risk of rope bridges falling onto the road. Rope would be inspected periodically for signs of decay or weakening, and replaced where necessary.	No	PC standard details and PC LMP
Glider_MP 051	Design to be aware of Table 6.2 Arboreal crossings structures Sections 3-11 and associated text. Response: Fauna connectivity structures designed and developed in Environmental report EN03 and documented in this report.	Yes	Chapter 7 Chapter 12

Table A.1 Threatened species management plan requirements

ID	Management plan requirements	Yes/No	Document Reference
Mammal_MP 001	Targeted mammal surveys undertaken during detailed design and crossing structure locations refined. Identification of BACI monitoring sites (impact and control) from targeted survey findings. Baseline surveys at monitoring sites completed. To be completed during detailed design prior to construction.	Yes	Chapter 7 Chapter 12
Mammal_MP 002	Results of targeted surveys to inform final locations of fauna exclusion fencing and connectivity structures where appropriate. Completed during detailed design and signed off prior to construction commencing.	Yes	Chapter 7 Chapter 12
Mammal_MP 005	Survey data will also be used to inform the identification of fauna habitat revegetation areas as outlined in the UDLP and refinements to the location of fauna exclusion fencing, fauna crossing structures, permanent monitoring sites and ancillary facility locations	Yes	Chapter 6.8 Chapter 7 Chapter 9 Chapter 12
Mammal_MP 008	The exact fencing location will be refined as part of detailed design and take into consideration the results of baseline surveys and monitoring. Details will be captured in a Fauna Connectivity Strategy (Sections 3-11) which will be provided to DoE and DP&E for approval prior to construction commencing in these areas.	Yes	Chapter 7 Chapter 12
Mammal_MP 012	Installation of connectivity structures at pre-defined locations (supported by targeted survey findings). All crossing structures completed prior to operation.	Yes	Chapter 7 Chapter 12
Mammal_MP 016	Exclusion zones will be established prior to the commencement of clearing and construction to ensure that any activities do not unnecessarily remove protected vegetation within the project, proposed widened median areas, and roadside vegetation that would be retained in and/or near threatened glider habitat areas and crossing structures.	Yes	Chapter 6.8 CEMP
Mammal_MP 037	Fauna exclusion fencing for threatened mammals the subject of this TMMP includes: Construction of fencing on both sides of the carriageway and generally extending at least 200 metres either side of a designated crossing structure Fencing either side of the crossing structure will have a 'return area' at their ends to guide animals back into habitat rather than across the carriageway Perpendicular fencing in widened medians to direct fauna across the median and to ensure that fauna do not colonise habitat within the median, or turn back onto the road Mesh size selected to prevent the target species from climbing through, with four different types of fencing being implemented, as outlined for Sections 1 and 2 in Table 51 of the Final Fauna Connectivity Strategy Fence design to prevent fauna from digging underneath, or passing through points where fencing crosses drainage lines; and The consideration of appropriate additional fauna exclusion fencing should hot spots (areas where incidental observations or road kills of threatened mammals are noted during the construction) are noted.	Yes	Chapter 7 Chapter 8 Chapter 12

Table A.1 Threatened species management plan requirements

ID	Management plan requirements	Yes/No	Document Reference
Mammal_MP 039	Both dedicated and combined fauna connectivity structures which have been designed specifically for threatened mammals are summarised in Table 6.3 and Table 6.4 in Section 6.3.7 of the Management Plan. This table does not include all structures targeted for the koala or threatened gliders which are outlined in the Koala Management Plan and Threatened Glider Management Plan.	Yes	Chapter 7 Chapter 12
Mammal_MP 040	Fauna furniture will be placed within dedicated underpasses or crossing structures, including interconnecting logs to provide a dry passage for threatened mammals whilst also providing refuge from predators. With regard to combined structures fauna furniture will be installed at these locations where it will not impact on flooding/hydrological issues. The details of which combined structures will have fauna furniture will be detailed in the Connectivity Strategy required under CoA D2. Refuge poles outside and within the culvert will also be installed to provide refuge from predators for the brush-tailed phascogale.	Yes	Chapter 7 Chapter 12
Mammal_MP 041	A detailed design and furniture association for each crossing type for Section 1 and 2 of the project is outlined within Section 5.3 of the Fauna Connectivity Strategy. Further refinement of detailed design and furniture association for Sections 3 to 11 will be defined and updated within ongoing revisions of the Fauna Connectivity Strategy.	Yes	Chapter 7 Chapter 12
Mammal_MP 087	Arboreal mammal fences would need to be designed to prevent animals from climbing over, with the addition of a barrier in Sections 1 to 3 and 6 to 8 of the project for the brush-tailed phascogale.	Yes	Chapter 7 Chapter 12
Mammal_MP 088	Fauna furniture will be placed within dedicated underpasses or crossing structures, including interconnecting logs to provide a dry passage for threatened mammals whilst also providing refuge from predators. Refuge poles outside and within the culvert will also be installed to provide refuge from predators for the brush-tailed phascogale.	Yes	Chapter 7 Chapter 12
Mammal_MP 089	Fauna fencing will be installed on the outside edge of the on-load and off-load ramps where interchanges are located within the locations nominated in Table 6.1 and Table 6.2 of the Plan.	Yes	Chapter 7 Chapter 12
Mammal_MP 090	A number of factors will be addressed in the detailed design phase for each section to minimise the impacts of the project. The factors to be considered which will be particularly relevant for the minimisation of impacts to threatened mammals include: Avoiding and minimising vegetation/habitat removal wherever possible Consideration of water quality and altered hydrology Refinement of connectivity mitigation measures including the design and location of underpasses, overpasses, rope crossings and fauna exclusion fencing.	Yes	Chapter 6.8 Chapter 11 Chapter 12
Mammal_MP 091	As a minimum, the design of targeted threatened mammal crossing structures and permanent exclusion fencing will be based on the design principles outlined in the EIS and the process for managing threatened mammal connectivity described in the Woolgoolga to Ballina Upgrade Working paper: Biodiversity Assessment (Roads and Maritime 2012).	Yes	Chapter 7
Rainforest_MP 056	Inspection, monitoring and maintenance is specified within the Roads and Maritime specifications including R178 and R179. Specific detail regarding revegetation including areas to be revegetated, species to be used and the maintenance program will be described in the UDLP for the project. A second translocation plan will be prepared for Section 3-11 by Roads and Maritime Services to further address the requirements of MCoA D7.	Yes	Chapter 7 & Appendix B LMP to be provided by PC
Rainforest_MP 074	Specific detail regarding revegetation including areas for revegetation, species to be used and maintenance will be described in the UDLP for the project.	Yes	Chapter 7, 9 and Appendix B
Wallum 005	Consideration should be given to temporary construction and operational frog exclusion fencing in W2B Section 9 in the vicinity of Site 12 (~ch. 139500) to reduce impacts associated with road induced mortality during the operation phase of the project.	Yes	Check wallum frog text from EN03
Wallum 007	The location of water quality/sediment basins used during construction is reviewed to determine potential management actions or conflicts with any Environmental Protection Licence (EPL) issued for the project. The aim of this is to ensure that any water being released off site does not adversely impact on the habitat requirements of wallum frog fauna including the sedge frog. Typically this species occurs in pH waters ranging from 2.8–5.5 and the ongoing release of higher pH waters will result in other pond dwelling species (<i>Crinia signifera</i> , <i>limnodynastes peroni</i> , <i>litoria fallax</i> , <i>litoria tyleri</i> , <i>litoria peronii</i>) invading wallum habitats.	No	CEMP
Frog_MP 002	Identify exclusion zones, frog fencing and compensatory pond locations. Install exclusion zones, temporary frog fencing prior to clearing. Install compensatory ponds after clearing is complete. Protection of threatened frog habitat by accurately identifying exclusion zones, and installing temporary frog fencing and compensatory ponds.	Yes	Chapter 7 and 12

Table A.1 Threatened species management plan requirements

ID	Management plan requirements	Yes/No	Document Reference
Frog_MP 004	<p>Temporary fencing will be erected prior to construction commencing and will be replaced with operational frog fencing in proximity to known breeding habitat areas once the project is nearing the completion of construction and before it is opens to traffic. The design and extents of frog fencing will differ between each species but the fencing strategy for all aspects of the project will be designed to be adaptive and require a reduced maintenance schedule. The general location of temporary exclusion fencing used during construction will be defined based on the breeding habitat areas mapped in Figure 3-1, Figure 3-2 and Figure 3-3, and as described in Table 5-1. The locations of operational frog fencing, including general fauna fencing with design considerations for frogs, is detailed in Table 5-2.</p> <p>Fencing locations are finalised for Sections 1 and 2 as detailed design has been completed. However for Sections 3 to 11 these are only proposed locations and will be confirmed during detailed design and will form part of the Fauna Connectivity Strategy.</p>	Yes	Chpater 7 and 12

Table A.1 Threatened species management plan requirements

ID	Management plan requirements	Yes/No	Document Reference
Frog_MP 006	Constructed or augmented breeding ponds would be used as a compensatory mechanism to reduce impacts for the wallum sedge frog and green-thighed frog. The locations of these ponds will be carefully selected during pre-clearance surveys to ensure that their placement causes no unnecessary damage to existing habitat (ie outside the clearance footprint) while ensuring their success as mitigative instruments. Ponds that are known to provide habitat for sedge frogs, but are limited in their extent of emergent sedges growing in freestanding water, may be augmented by the planting of suitable sedge species.	Yes	CEMP
Frog_MP 007	The location of compensatory or augmented ponds for the green-thighed frog and wallum sedge frog in Sections 3 to 11 will be finalised during the detailed design of these areas of the project. These will be constructed where breeding habitat will be directly impacted by the project or changed hydrological patterns have the potential to affect the suitability of breeding habitat areas adjacent to the corridor.	Yes	Chapter 7 Chapter 12
Frog_MP 008	Constructed or augmented breeding ponds would be used as a compensatory mechanism to reduce impacts to the wallum sedge frog and green-thighed frog. The following locations have been identified as sites for green-thighed frog ponds for Section 1 and 2: Section 1: Redbank Creek area between ch. 5500 to ch. 6700 and Dirty Range at a suitable location preferably adjacent to a fill section between ch. 11500 to ch. 12900. Section 2: Halfway Creek (ch. 19000-19500) providing ponds on both sides of the project corridor; Bald Knob Tick Gate Road area (ch. 25000) providing ponds on the eastern side of the project corridor; and Franklins Road (ch.28000) providing ponds on the eastern side of the project corridor if this area is impacted by means of ground disturbance or changed hydrological regimes. At each of these locations, the positioning of ponds will ideally be within retained areas of vegetation which support deep leaf litter and occur within low lying areas more likely to support their preferred habitat (ie swamp forest, moist forest associations). A critical component in the design of these ponds is to ensure the water body periodically dries out. The location of compensatory or augmented ponds for the green-thighed frog and wallum sedge frog in Sections 3-11 will be finalised during the detailed design of these areas of the project.	Yes	Chapter 7 Chapter 12
Frog_MP 009	Shallow excavated ponds will have the following attributes: Each pond will cover an area of at least 12 sqm Maximum depth of 400 mm Batters no steeper than 1:4 Construct 3-5 with each one staggered out from a drainage line thus ensuring they will be flooded at differing rainfall events Vegetated via assisted planting techniques with low naturally occurring ground covers obtained from the site (ie Carex spp., Fimbristylis spp.) Another key message in the design of the breeding ponds is to not over design the pond and replicate features from other known nearby breeding locations and thus provide the best opportunity for a successful breeding event.	Yes	Chapter 7 Chapter 11 Chapter 12
Frog_MP 014	Temporary frog exclusion fencing will have the following design considerations: Installed for up to 200 m either side of known threatened frog habitat including streams and breeding sites. Where the terrestrial habitat borders a stream that contains cleared land this could be reduced to 100 m Fence height will extend to at least 900 mm above the ground (or > 500 mm if just for the green-thighed frog or the wallum sedge frog) and buried to a depth of between 50 and 100 mm A return of wing of 3 to 5 m to minimise breaches Constructed using UV resistant shade cloth which is permeable to water. Geotextile materials may also form an adequate substitute. Posts/pegs placed on the works side of the exclusion fence to prevent frogs using these structures to climb the fence Include relevant signage to identify the area and inform construction personnel. The clearing footprint required to install the temporary frog fence (maximum of 5 m width) would be inspected by an ecologist within 24 hours prior to clearing for installation of fence (all seasons). Summer, Autumn, Spring – Temporary fence installed at least 7 days. Once installed, the frog fence will be inspected and signed off by a suitably qualified herpetologist/ecologist (hold point). The temporary frog fence will be maintained to ensure it remains effective or until the operational frog fencing is completed.	Yes	Chapter 7 Chapter 8 Chapter 12
Frog_MP 015	As detailed design has not been completed for the areas where wallum sedge frog habitat has been identified, connectivity structures for this species are yet to be confirmed. Proposed connectivity structures that may be used by the Wallum Sedge Frog are an underpass at ch.139500.	Yes	Chapter 7 and 12
Frog_MP 016	Targeted frog surveys and pre-construction baseline monitoring surveys have informed the location and design requirements of constructed and augmented ponds for Sections 1 and 2 and will inform locations for Sections 3 to 11 during detailed design. Ponds will be constructed during the relevant construction stages of each upgrade and typically these occur around the end of the bulk earthworks treatments in Year 2-3 of the construction program. Compensatory ponds will not be constructed in areas that will impact on existing frog habitats.	Yes	Chapter 7 CEMP

Table A.1 Threatened species management plan requirements

ID	Management plan requirements	Yes/No	Document Reference
Frog_MP 020	<p>The proposed changes apply to all temporary frog fences, such that the project ecologist be given flexibility in determining the length and location outside of that identified in the TFMP. When considering the placement and length of the temporary frog fence in the identified areas (as per Table 5.1 in the TFMP) the project ecologist will consider:</p> <ol style="list-style-type: none"> 1. The extent of mapped frog habitat in the TFMP 2. Fence lengths specified in Table 5.1 of the TFMP 3. Design considerations in the TFMP 4. Site specific adjustments to the Limit of Clearing (LoC) 5. Site topography and habitat suitability 6. Site constraints (ie driveways) 7. Constructability (ie construction of fence in steep rocky terrain in dry open forest outside frog habitat). <p>The project ecologist shall document and provide justification relating to all proposed changes for the review and comment of the EPA. Following endorsement from the EPA, the proposed changes would be provided to the ER for approval. The proposed changes to temporary frog fencing for Section 1 W2HC are available as attachment in Addendum 2. The EPA has endorsed the proposed changes relating to temporary frog fencing for Section 1, with the relevant correspondence available in Attachment C. Once approved by the ER, RMS proposes to incorporate the updates into the next revision of the Plan to be submitted to DP&E for approval as part of the Section 3-11 update.</p>	No	CEMP
Frog_MP 024	<p>Operational frog fencing will be installed in proximity to known frog breeding habitat areas and where there is a high chance of operational frog fencing will be installed in proximity to known frog breeding habitat areas and where there is a high chance of threatened frogs accessing the carriageway.</p> <p>The extent of operational fencing for green-thighed frog will extend at least 100 m beyond the edge/s of identified habitat.</p> <p>The use of operational frog fencing at other locations will be informed by the unexpected finds procedure and after considering the overall importance of the location to the local green-thighed frog population.</p>	Yes	Chapter 8 Chapter 12
Frog_MP 025	<p>Operational frog fencing will be installed in proximity to known frog breeding habitat areas and where there is a high chance of threatened frogs accessing the carriageway operational frog fencing for the wallum sedge frog is focused on an area of Section 9 where both sides of the carriageway require fencing (900 mm high and a minimum of 100 m beyond the edge of identified habitat). Section 10 has been nominated for operational fencing only on the eastern side of the carriageway due to the close proximity of sedge frog populations in this area.</p>	Yes	Chapter 7 and 12
Frog_MP 029	<p>Water quality monitoring, particularly following rainfall events, would identify if the hydrology and water quality has been adversely impacted by the project. Standard project water quality objectives criteria that are applicable project wide, and are relevant to areas of green-thighed frog and giant barred frog habitat, are as follows:</p> <p>Total suspended solids: <50mg/L pH: 6.5 – 8.5 Oil and grease: no visible trace.</p>	No	CEMP

Table A.1 Threatened species management plan requirements

ID	Management plan requirements	Yes/No	Document Reference
Frog_MP 030	Water quality requirements within Wallum Sedge Frog breeding habitat vary slightly from those of other species and therefore runoff from construction sites within mapped areas of Wallum Sedge Frog breeding habitat would be treated using a sedimentation basin. During construction, direct discharge to waterways of water from sediment basins that does not meet the water quality requirements for Wallum Sedge Frog habitat would not be permitted, but rather this water would be used for beneficial purposes (i.e., sprayed into adjacent open grass areas or used for construction purposes such as dust suppression). Discharge by diffuse method of land irrigation would be allowed only if a minimum of 50 m from a waterway, within the project boundary, and subject to negotiations with the landholder. If diffuse discharge is not feasible then water would be pumped to a proposed storage facility. Water quality objectives criteria that are applicable to areas of Wallum Sedge Frog habitat and the associated augmented ponds are as follows: <ul style="list-style-type: none"> • Total suspended solids: <50mg/L • pH: <5.5 • Oil and grease: no visible trace. 	No	CEMP
Frog_MP 032	Habitat revegetation / landscaping design - Revegetation works would be incorporated into the landscape plans and would be undertaken following construction in any areas disturbed within the road corridor that are adjacent to identified important threatened frog habitats or beyond if the habitat is located within properties owned by Roads and Maritime. This may include ponds, ephemeral areas, creek riparian areas, culvert and bridge locations to restore connectivity, and wetlands within the road corridor to minimise edge effects. This may also include sediment and water treatment ponds and immediate surrounds where these occur adjacent to identified important threatened frog habitats. It would also include any compensatory ponds constructed that were revegetated. Consideration of the threatened frog species located adjacent to revegetation areas is required to ensure suitable plant species are used to revegetate the areas suited to the particular threatened frog species. Ongoing maintenance of habitat revegetated areas adjacent to threatened frog habitats will be undertaken	Yes	Chapter 7 Chapter 8 Chapter 9 Chapter 12
Frog_MP 054	Consideration should be given to temporary construction and operational frog exclusion fencing W2B Section 9 in the vicinity of Site 12 (~ch 139500) to reduce impacts associated with road mortality during the operation phase of the project.	No	CEMP
Fish_MP 007	Management of riparian and aquatic habitats Development of construction methodologies to reduce disturbance to riparian and instream habitats where feasible, bridge supports will not be constructed in the main channel and on stream banks. Management of instream woody debris Rehabilitation of riparian and aquatic habitats near construction zones.	No	CEMP
Fish_MP 009	Permanent waterway crossings would be designed to ensure no physical, hydraulic and behavioural barriers to aquatic fauna movements, in accordance with SPIR condition MCoA B22, ensuring that: <ul style="list-style-type: none"> - Creek crossing structures designed to maximise light penetration - Natural stream flow and velocity be maintained as closely as possible - Surface level of causeway be the same or lower than the natural level of the stream bed to reduce interference with flow - Habitat within a culvert be as natural as possible (example allow rock and bed material to infill culvert base). To achieve this, the culverts will be designed to encourage the deposition of sediment, creating similar bed substrate to adjacent creek and the planting of specific plant species - Fauna and fish passage standards are maintained, as detailed in the Connectivity Strategy, including minimum design widths, including for natural banks, while also providing for scour protection and cut and fill batters - Bridges will be designed and sized to ensure peak flood velocities are not increased by more than one metre per second than the existing flood event, where Oxleyan Pygmy Perch have been confirmed. 	Yes	Chapter 11 Chapter 12
Fish_MP 010	Bridge structures would be designed to minimise impacts to flow regimes and fish passage in light of the following principles, in accordance with MCoA B23: <ul style="list-style-type: none"> - Bridges are to be single span bridges with piers to be located outside the main channel - Bridge structures to be designed to prevent an increase of backup of water during times of flood, which may enable Eastern Gambusia to access waterbodies where they are currently not found (e.g., Broadwater National Park) - Construction would not alter or reduce flow where there are existing or potential Oxleyan Pygmy Perch populations (primarily within Sections 7, 8 and 9). 	Yes	Chapter 8 Chapter 11 Chapter 12
Fish_MP 014	Design to prevent and/or minimise in-stream barriers, including appropriate design of bridges and culverts to ensure no physical, hydraulic and behavioural barriers to aquatic fauna movements. Avoid the need for scour protection on the flow of waterways. For small waterways with known Oxleyan Pygmy Perch commit to keeping piers out of the main channel.	Yes	Chapter 8 Chapter 11 Chapter 12

Table A.1 Threatened species management plan requirements

ID	Management plan requirements	Yes/No	Document Reference
Fish_MP 015	As per MCoA B40, all crossings of Class 1 watercourses in known Oxleyan Pygmy Perch habitat shall be designed and constructed with a bridge or arch structure and, where feasible and reasonable, no supporting structures shall be installed within affected waterways.	Yes	Chapter 8 Chapter 11 Chapter 12
Fish_MP 016	Where an Oxleyan Pygmy Perch habitat waterway is realigned or its stream profile is changed, or an in-stream structure is installed in the waterway (both permanent and temporary construction structures), the final design of that waterway will not result in water velocities exceeding 0.4 metres per second under normal flow conditions as per MCoA 41.	Yes	w2b-ACJV-DL-c
Fish_MP 017	As per MCoA B42, design and rehabilitation considerations ensure that afflux of waterways with known Oxleyan Pygmy Perch habitat will be more than the relevant flood management objective in the documents referred to in condition A2 for flood events up to the 1 in 100 year event.	Yes	w2b-ACJV-DL-c
Fish_MP 018	Where there are known populations of Oxleyan Pygmy Perch construction would not alter or reduce flow. Waterway crossings in areas of Oxleyan Pygmy Perch habitat will be designed such that water velocities through structures do not inhibit Oxleyan Pygmy Perch passage under normal flow conditions. This will be achieved by maintaining the existing substrate and vegetative habitat as controls hydraulic diversity and maintaining the pre-disturbance cross-sectional area of the waterway	Yes	w2b-ACJV-DL-c
Fish_MP 019	Operational spill basins be installed at key locations and other key drainage lines that lead directly into Oxleyan Pygmy Perch habitat. As such, all road surface runoff that have drainage lines leading directly into Oxleyan Pygmy Perch habitat will be directed into operational spill basins. To minimise the impact of runoff during the operation, runoff from the project will be directed to detention basins before being discharged to drains and then local waterways. Basins will also be located adjacent to wetlands and watercourses to protect waterways from unexpected spills. Implementation of erosion and sediment control and pollution control measures to avoid impacts to aquatic ecosystems and water quality, in accordance with MCoA B34, and as detailed in Section 6.3.9	Yes	Chapter 7 w2b-ACJV-DL-c

Table A.1 Threatened species management plan requirements

ID	Management plan requirements	Yes/No	Document Reference
Fish_MP 021	No water resulting from construction will be released directly into Oxleyan Pygmy Perch habitat. The release of water would only occur under the following conditions: <ul style="list-style-type: none"> - Release of stored water into areas where Oxleyan Pygmy Perch are known or have potential to occur would only be undertaken as a last resort - Released water would be a pH level that matches the mean pre-construction pH determined during baseline monitoring of the waterway, to within 1 pH unit - Chemical treatments used prior to the release of water from sediment basins would not persist in the environment or negatively impact upon the environment after release - Potential pre-release water treatments and/or their derivatives would be included as parameters in baseline water quality monitoring 	Yes	CEMP
Fish_MP 022	Management of riparian and aquatic habitats. Development of construction methodologies to reduce disturbance to instream habitats. Rehabilitation of aquatic habitats near construction zones.	Yes	CEMP
Fish_MP 023	Management of riparian and aquatic habitats. Development of construction methodologies to reduce disturbance to riparian and instream habitats. Rehabilitation of riparian and aquatic habitats near construction zones. This would include: <ul style="list-style-type: none"> -native riparian vegetation (using suitable native species from the local area) within the road reserve will be planted and managed over time to consolidate the banks and provide more natural erosion control. -where revegetation would not be possible (e.g. immediately under bridge due to permanent shading) rocks and other items may be used to protect disturbed banks and reduce flow. -any disturbed river banks would be restored to their natural gradient or have a lower gradient so as not to increase hydraulic shear during high flows prior to the spawning season. -any woody debris or rocks that are removed from the river channel during construction are to be returned to the river after construction has been completed 	Yes	CEMP
Fish_MP 024	During detailed design, locations for temporary watercourse crossings, the type of crossing, the duration each crossing will be established for the management and mitigation measures specified for each crossing location. Temporary watercourse crossings may include bridges, arches, multi-celled culverts, box culverts and pipe culverts. Where temporary access tracks occur over drainage lines with no flow, fords may be installed. The type of temporary watercourse crossing used will be determined in consultation DPI (Fisheries).	Yes	CEMP
Fish_MP 025	Temporary bridge or arch structures in known Oxleyan Pygmy Perch habitat shall be used if the crossing is intended to be in place for more than three months (MCoA B8). Temporary culvert crossings will be constructed using pipe or box culvert cells to carry flows. Where the watercourse is a known Oxleyan Pygmy Perch habitat, temporary crossings will be installed so as to not directly impact the watercourse bed, or impact water flow or fish passage <ul style="list-style-type: none"> ● Where temporary crossings in known Oxleyan Pygmy Perch habitat are proposed to use culverts, the Applicant shall, in consultation with DPI (Fisheries): <ul style="list-style-type: none"> ○ Determine the size of the culvert or pipes to facilitate fish passage; and ○ Identify the minimum size of clean rock to be used to ensure that rock material will not wash into the waterway in periods of high flows (MCoA B9) ● Where short duration crossing are proposed using culverts or pipes, these will be of adequate size to minimise flow velocity while maintaining light penetration to facilitate fish passage. The requirements will be determined in consultation with DPI (Fisheries) ● Installation and subsequent decommissioning of temporary waterway crossings would be undertaken outside of the peak Oxleyan Pygmy Perch spawning season as defined in the MCoA (October to April) in known Oxleyan Pygmy Perch habitat (MCoA B9) ● All temporary water crossings and culverts will be constructed in accordance with Guidelines for Controlled Activities Watercourse Crossings (DPI 2008) and, Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings (Fairful and Witheridge 2003) and with consultation of OEH, DPI (Fisheries), DoE and Roads and Maritime such that there are no barriers or impedances to instream fish movement (MCoA B38) ● All temporary works (e.g. crossings, flow diversion barriers) would be removed as soon as practicable and in a way that does not promote future channel erosion ● Where necessary waterways may need to be temporarily diverted to allow structures to be placed in order to minimise impacts to water quality ● The preferred temporary structure for crossing waterways would be consistent with Witheridge (2002) where the use of bridges is the preferred structure for Class 1 (major fish habitat waterways) (MCoA B40) 	Yes	CEMP

A.2 Environmental impact statement and submissions/preferred infrastructure report environmental mitigation measures

The EIS for the project identified a range of environmental outcomes and management measures that are required to avoid or reduce the impact the project has on the environment. The measures identified during the EIS were further reviewed and revised during the development of the SPIR. As a result additional commitments were identified and conditions that had already been fulfilled were removed. The relevant SPIR environmental mitigation measures related to landscape and urban design are listed in Table 1.2.

Table A.2 Environmental impact statement and submissions/preferred infrastructure report mitigation measures

ID	Mitigation measures	Yes/No	Document Reference
HF8	Revegetation of waterway diversions and surrounding areas will be undertaken in accordance with the following principles: Diversions will be stabilised prior to the diversion receiving flows, in conjunction with the establishment of other scour and erosion control measures. Diversions will establish appropriate vegetation communities along the channel bed and banks, using endemic native species.	Yes	Chapter 11
SSW7	Exposed areas will be progressively rehabilitated. Methods will include permanent revegetation, or temporary protection with spray mulching or cover crops.	Yes	Chapter 9
SSW10	Topsoil, earthworks and other excess spoil material will be stockpiled and managed in accordance with Roads and Maritime Stockpile Management Guidelines (Roads and Maritime, 2011a) and the "Management of Surplus Material" in Section 3.9 of the Submissions / Preferred Infrastructure Report.	Yes	Chapter 10
SSW11	Where reasonable and feasible, stockpiles will: Not require removal of areas of native vegetation. Be located outside of known areas of weed infestation. Be located such that waterways and drainage lines are not directly or indirectly impacted.	Yes	Chapter 6 CEMP
B3	Fauna connectivity All fauna connectivity structures will be developed in accordance with the design principles outlined in the Connectivity Strategy in Appendix A of the Working paper – Biodiversity and the Supplementary Biodiversity Assessment in Appendix J of the Submissions / Preferred Infrastructure Report.	Yes	Chapter 12
B8	Fauna exclusion fencing The design and construction of fauna exclusion fencing, drainage or fauna underpass structures in widened medians minimise vegetation clearing.	Yes	Chapter 7 Chapter 12
B12	Re-establishment of native vegetation A landscape management plan will be developed to provide specific details for the re-establishment of native vegetation on batters, cut faces, surrounding sediment basins and other areas disturbed during construction. This includes details for the appropriate removal and restoration of temporary creek crossings. The landscape management plan will be developed in line with Roads and Maritime Biodiversity Guidelines (RTA, 2011a), the design principles identified in the Connectivity Strategy and the design principles in Working paper – Urban design, landscape character and visual impact.	Yes	Chapter 7, 9, and Appendix B
B13	Re-establishment of native vegetation Disturbance and clearing of vegetation will be minimised, particularly: Avoiding and minimising vegetation removal wherever possible through the detailed design process. Placing water quality basins in the optimal location for treating surface runoff. During detailed design, the location of water quality treatment measures will consider minimising vegetation removal, particularly where there is the potential for threatened plant species, threatened fauna habitat or in identified regional wildlife corridors. Unnamed waterway at station 134.7 Tributary of Macdonalds Creek at station 135.5 Montis Gully tributary at station 141.8 Eversons Creek station 143.6	Yes	Chapter 7 Chapter 9 Chapter 11

Table A.2 Environmental impact statement and submissions/preferred infrastructure report mitigation measures

ID	Mitigation measures	Yes/No	Document Reference		
B17	Each permanent waterway crossing is to be designed to ensure no physical, hydraulic and behavioural barriers to aquatic fauna movements. Impacts be minimised by ensuring that: The natural stream flow and velocity are maintained as closely as possible Surface level of any causeway is the same or lower than the natural stream bed to reduce interference with flow Habitat within a culvert is as natural as possible (eg allow rock and bed materials to infill the culvert base) There is the maximum light penetration. Fauna and fish passage standards are maintained, as detailed in the Connectivity Strategy, including minimum design widths, including for natural banks, while also providing for scour protection and cut and fill batters Bridges will be designed and sized to ensure peak flood velocities are not increased by more than one metre per second than the existing flood event, where Oxleyan Pygmy Perch have been confirmed.	Yes	Chapter 8 Chapter 12		
B26	Re-use of woody debris and bushrock Woody debris and bushrock will be re-used on site for habitat improvement where possible and will be detailed in the landscape management plan in accordance with the Roads and Maritime Biodiversity Guidelines (RTA, 2011a).	Yes	PC - LMP		
B35	Riparian and aquatic habitat management The bed and banks are to be reinstated to a condition similar to or better than the original condition ensuring that there are no adverse impacts on the aquatic values (different measures may be required for each crossing) and where feasible and reasonable, avoid impacts on geomorphic processes.	Yes	Chapter 7 Chapter 12		
B39	Riparian and aquatic habitat management Where feasible and reasonable within the road corridor, existing pools will be retained upstream and downstream of crossings within known habitat of the Oxleyan Pygmy Perch to provide resting and refuge habitat near crossing structures.	Yes	CEMP		
B40	Riparian and aquatic habitat management Appropriate plant species will be incorporated into the rehabilitation of disturbed aquatic habitats and drains as a result of construction.	Yes	Chapter 11		
B61	Riparian and aquatic habitat management Detailed design will investigate measures to reduce impacts to Maundia triglochinos: Near Redbank Creek (population 14) & Near North of New Italy (population 12).	Yes	Landscape Documentation packages		
UD3	Landscaping and planting strategy The project will be carried out in accordance with the urban design and landscaping strategy, as identified in Section 11.4.1 of this EIS. Detailed landscape design for all project batters, and median planting areas will be developed in accordance with the Landscape Guidelines (RTA, 2008), the requirements of the Working Paper – Biodiversity (Section 5.2.2) and the landscape strategy to provide a robust, successful and effective planting design	Yes	Chapter 7 Chapter 8 Chapter 9		
UD4	Design of urban design features and road furniture . The built form of the project, including consideration of the height, bulk, scale, materials and finishes for:	Yes			
	<table border="0"> <tr> <td>Bridges. Retaining walls. Cuttings and embankments. Road barriers. Signage.</td> <td>Fences. Clear zones. Topsoil management. Water quality control ponds. Fauna crossing. Place marking and cultural plantings.</td> </tr> </table>	Bridges. Retaining walls. Cuttings and embankments. Road barriers. Signage.	Fences. Clear zones. Topsoil management. Water quality control ponds. Fauna crossing. Place marking and cultural plantings.		Chapter 7 Chapter 8 Chapter 9 Chapter 10 Chapter 11 Chapter 12
	Bridges. Retaining walls. Cuttings and embankments. Road barriers. Signage.	Fences. Clear zones. Topsoil management. Water quality control ponds. Fauna crossing. Place marking and cultural plantings.			
The project will be designed in accordance with the design principles identified in Working Paper – Urban Design, Landscape Character and Visual Impact, and relevant Roads and Maritime guidelines.					

Table A.2 Environmental impact statement and submissions/preferred infrastructure report mitigation measures

ID	Mitigation measures	Yes/No	Document Reference
UD6	Visual impacts from viewpoints Measures to mitigate visual impacts to viewpoints will be implemented, as identified in Table 11-42 and Working Paper – Urban Design, Landscape Character and Visual Impact. If any further viewpoints were identified during detailed design that have a moderate–high or high impact, screen planting also be considered.	Yes	Chapter 5
UD7	Construction visual impacts Disturbed areas will be progressively revegetated throughout the construction period.	Yes	Chapter 6 Chapter 7 Chapter 9
UD8	Visual impacts of ancillary facilities . Where required, typical landscape treatments for ancillary facilities in forest areas will include: Providing screen planting. Considering reinstatement of disturbed forest in heavily forested. Considering the importance of the visual landscape at each location and allowing restoration of important forest vegetation to prominent ridge lines or other landscape elements where feasible and reasonable.	Yes	Chapter 6
UD9	Visual impacts of ancillary facilities Typical landscape treatments for ancillary facilities in agricultural areas will include: Considering returning remnant agricultural land to agricultural uses. Providing screen planting. Reinstating riparian vegetation through ancillary facilities, where practicable, in the open landscape	Yes	Chapter 6
UD10	Visual impact of borrow sites – The extent of excavation and the landscaping strategy at borrow sites will be reviewed considering material requirements on the project and the visual impact on the resultant cuttings.	Yes	Chapter 6
UD13	Monitoring of landscaping and rehabilitation Landscape and rehabilitation works will be monitored and remedial measures implemented where required until vegetation has stabilised.	Yes	PC - LMP
UD14	Earth mounds The mounding profile of any earth mound will blend suitably into the existing landscape setting. Any mounding to be landscaped will be compacted in 1.5 metre layers with 1:3 maximum batter slopes where reasonable in consideration of constraints within the project corridor. Where feasible and reasonable, permanent mounds will be treated with ameliorants and overlaid with topsoil to minimum 150 millimetres to ensure suitable planting conditions are achieved.	Yes	Chapter 8
AH2	For areas avoided by construction, exclusion zones will be put in place. These will be fenced with high visibility construction webbing or other similar fencing and have a ‘Do Not Enter’ sign. Exclusion zones will be marked on construction plans and be maintained until construction is completed. A representative of the Local Aboriginal Land Council will be present during establishment of the fencing.	Yes	CEMP
AH12	An Aboriginal heritage interpretation strategy will be prepared as part of the Aboriginal heritage management plan. Measures will include opportunities for promoting salvage and investigation, the recovery of information, permanent installations and ways of marking the presence of Aboriginal people in the landscape, including, signage, interpretation products such as written materials, and through place naming a care agreement be necessary.	Yes	Chapter 5
AH20	Impacts on IR2W4 Salvage excavation will be undertaken within the portion of the site to be impacted by the project footprint as detailed in the Working paper Aboriginal Cultural Heritage (Iluka Road to Woodburn) and in consultation with RAPs.	Yes	Chapter 5

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Table A.2 Environmental impact statement and submissions/preferred infrastructure report mitigation measures

ID	Mitigation measures	Yes/No	Document Reference
AH41	Direct impact on culturally significant places –Place B: To maintain connectivity, access will be provided across the project area, from the end of Richmond Road, Pine Tree Road, or Fischer Street to Broadwater National Park during construction and operation, in consultation with the traditional owners. Pedestrian access within the project boundary will be provided, where feasible and reasonable from the eastern side of the project to the western side of Broadwater National Park. A connection from the existing Pacific Highway to Broadwater National Park along Eversons Lane be considered, in consultation with traditional owners and relevant land owners.	Yes	Chapter 7 + TE01
HH30	Impacts on New Italy Memorial and Stone-lined well– Appropriate directional signage to the New Italy Museum Complex will be installed at both the Operation 7 interchange at Woodburn and interchange at Iluka Road to divert visitors onto the service road in order to access the museum complex. Signage will comply with relevant Pacific Highway signage policy.	Yes	Chapter 8
HH51	Detailed design will consider the extent to which clearing High Conservation Value Old Growth Forest within the project boundary may be minimised.	Yes	Chapter 7
SE4	By-passed towns Signage will be implemented for bypassed towns in accordance with Roads and Maritime signage guidelines and in consultation with relevant councils. Signage on the project will identify bypassed townships (Grafton, Ulmarra, Tyndale, Maclean, New Italy, Woodburn, Broadwater and Wardell) as places for ‘stopovers’ for fuel, supplies and short term accommodation, to support demand for goods and services within these townships.	Yes	Chapter 8

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Planting and seeding schedules



PLANTING MIXES

Code	Species Name	Common Name	Bioregion
PDD	Planting - Drainage Basin Dry Grass		
Trees			
	<i>Allocasuarina littoralis</i>	Black She-Oak *	NNC SEQ
Grasses			
	<i>Gahnia sieberiana</i>	Rough Saw Edge	NNC SEQ
	<i>Lomandra filiformis</i>	Wattle Matt Rush	NNC SEQ
	<i>Lomandra longifolia</i>	Spiny headed Matt Rush	NNC SEQ
	<i>Lomandra multiflora</i>	Many Flowered Matt Rush	NNC SEQ
	* Note ensure <i>Allocasuarina</i> is planted away from basin spillways and outside roadway clear zones		
PDM	Planting - Drainage Basin Margin Grass		
Grasses			
	<i>Dianella caerulea</i>	Blue Flax Lilly	NNC SEQ
	<i>Ficinia nodosa</i>	Knobby Club Rush	NNC SEQ
	<i>Gahnia sieberiana</i>	Rough Saw Edge	NNC SEQ
	<i>Juncus usitatus</i>	Common Rush	NNC SEQ
	<i>Lomandra filiformis</i>	Wattle Matt Rush	NNC SEQ
PDW	Planting - Drainage Basin Wet Grass		
Grasses			
	<i>Baumea arthropylia</i>	Swamp Twig Rush	
	<i>Ficinia nodosa</i>	Knobby Club Rush	
	<i>Gahnia sieberiana</i>	Rough Saw Edge	
	<i>Juncus usitatus</i>	Common Rush	
PFMH	Planting - Frangible Media Headlight Screen		
Shrubs			
	<i>Callistemon "Captain Cook Dwarf"</i>	Dwarf Callistemon	
	<i>Dodonaea triquetra</i>	Common Hop Bush	
	<i>Hakea dactyloides</i>	Broad Leaved Hakea	
	<i>Pultenaea villosa</i>	Hairy Bush Pea	
Grasses			
	<i>Dianella caerulea</i>	Blue Flax Lilly	
	<i>Lomandra longifolia</i>	Spiny headed Matt Rush	
Code	Species Name	Common Name	PCTID
PCPT	Planting - Coastal Cypress Pine Shrubby Open Forest		
Trees			776
	<i>Callitris columellaris</i>	Cypress Pine	
	<i>Angophora costata</i>	Sydney Red Gum	
	<i>Angophora paludosa</i>	Small-leaved Apple	
	<i>Banksia serrata</i>	Oldman	
	<i>Banksia integrifolia subsp. integrifolia</i>	Coastal Banksia	
	<i>Corymbia intermedia</i>	Pink Bloodwood	
Shrubs			
	<i>Acacia suaveolens</i>	Sweet Wattle	
	<i>Acacia ulicifolia</i>	Prickly Moses	
	<i>Banksia aemula</i>	Wallum Banksia	
	<i>Banksia serrata</i>	Old-man Banksia	
	<i>Dodonaea triquetra</i>	Common Hop Bush	
Groundcovers			
	<i>Hardenbergia violacea</i>	False Sarsaparilla	
	<i>Hibbertia scandens</i>	climbing guinea flower	

Code	Species Name	Common Name	PCTID
PBFT	Blackbutt- Bloodwood Dry Heathy Open Forest		
Trees			683
	<i>Allocasuarina littoralis</i>	Black She-Oak	
	<i>Corymbia gummifera</i>	Red Bloodwood	
	<i>Eucalyptus pilularis</i>	Blackbutt	
	<i>Eucalyptus resinifera subsp. Hemilampra</i>	Red Mahogany	
Shrubs			
	<i>Acacia ulicifolia</i>	Prickly Moses	
	<i>Banksia oblongifolia</i>	Fem leaved Banksia	
	<i>Banksia spinulosa var collina</i>	Hairpin Banksia	
	<i>Leptospermum juniperinum</i>	Prickly Tea-tree	
	<i>Pultenaea villosa</i>	Hairy Bush Pea	
Grasses			
	<i>Dianella caerulea</i>	Flax Lilly	
	<i>Entolasia stricta</i>	Wiry Panic	
	<i>Lomandra longifolia</i>	Spiny headed Matt Rush	
	<i>Themeda australis</i>	Kangaroo Grass	
Groundcovers			
	<i>Glycine clandestina</i>	Twining glycine	
	<i>Hardenbergia violacea</i>	False Sarsaparilla	
	<i>Hibbertia scandens</i>	climbing guinea flower	
Code	Species Name	Common Name	
PSGT	Spotted Gum - Grey Ironbark Pink Bloodwood Open Forest		
Trees			
	<i>Allocasuarina torulosa</i>	Forest Oak	
	<i>Corymbia henryi</i>	Large-leaved Spotted Gum	
	<i>Corymbia intermedia</i>	Pink Bloodwood	
	<i>Corymbia variegata</i>		
	<i>Eucalyptus propinqua</i>	Small-fruited Grey Gum	
	<i>Eucalyptus siderophloia</i>	Grey Ironbark	
Grasses			
	<i>Dianella caerulea</i>	Flax Lilly	
	<i>Entolasia stricta</i>	Wiry Panic	
	<i>Lomandra longifolia</i>	Spiny headed Matt Rush	
	<i>Themeda australis</i>	Kangaroo Grass	
Groundcovers			
	<i>Hardenbergia violacea</i>	False Sarsaparilla	
	<i>Hibbertia scandens</i>	climbing guinea flower	
Code	Species Name	Common Name	
PCHT	Coastal Heath on Sand Tree		
Trees			
	<i>Allocasuarina littoralis</i>	Black She-Oak	
	<i>Banksia integrifolia subsp. integrifolia</i>	Coastal Banksia	
	<i>Melaleuca quinqueveneria</i>	Broad-leaved Paperbark	
Shrubs			
	<i>Acacia suaveolens</i>	Sweet Wattle	
	<i>Banksia spinulosa var collina</i>	Hairpin Banksia	
	<i>Daviesia acicularis</i>	Sandplain bitter-pea	
	<i>Hakea dactyloides</i>	Finger Hakea	
Grasses			
	<i>Lomandra multiflora</i>	Many Flowered Matt Rush	
	<i>Themeda australis</i>	Kangaroo Grass	
Groundcovers			
	<i>Hardenbergia violacea</i>	Purple Coral Pea	
	<i>Hibbertia obtusifolia</i>	Hoary Guinea Flower	
Code	Species Name	Common Name	
PGGT	Grey Gum Ironbark Open Forest		
Trees			
	<i>Allocasuarina torulosa</i>	Forest Oak	
	<i>Alphitonia excelsa</i>	Red Ash	
	<i>Corymbia intermedia</i>	Pink Bloodwood	

SEEDING MIXES

COASTAL LOWLANDS

SSMT Seeding - Swamp Mahogany Forest Tree

Trees			
<i>Casuarina glauca</i>	Swamp Oak	NSW NC	
<i>Corymbia intermedia</i>	Pink Bloodwood	NSW NC	
<i>Eucalyptus resinifera</i>	Red Mahogany	NSW NC	
<i>Eucalyptus robusta</i>	Swamp Mahogany	NSW NC	
<i>Eucalyptus tereticornis</i>	Forest Red Gum	NSW NC	
<i>Glochidion ferdinandi</i>	Cheese Tree	NSW NC	
<i>Lophostemon suaveolens</i>	Swamp Mahogany, Swamp Turpentine	NSW NC	
<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark	NSW NC	
Shrubs			
<i>Acacia fimbriata</i>	Fringed Wattle	NSW NC	
<i>Acacia maidenii</i>	Maiden's Wattle	NSW NC	
<i>Baeckea virgata</i>	Baekea	NSW NC	
<i>Banksia spinulosa var collina</i>	Hairpin Banksia	NSW NC	
<i>Bossiaea rhombifolia</i>	Bossiaea	NSW NC	
<i>Callistemon rigidus</i>	Wallum Bottlebrush	NSW NC	
<i>Hakea dactyloides</i>	Finger Hakea	NSW NC	
<i>Hakea sericea</i>	Silky Hakea	NSW NC	
<i>Leptospermum juniperinum</i>	Prickly Tea-tree	NSW NC	
<i>Melaleuca nodosa</i>	Prickly leaved Paperbark	NSW NC	
Groundcovers			
<i>Hardenbergia violacea</i>	Purple Coral Pea	NSW NC	
<i>Imperata cylindrica</i>	Blady Grass	NSW NC	
<i>Juncus usitatus</i>	Common Rush	NSW NC	
<i>Lomandra longifolia</i>	Spiny headed Matt Rush	NSW NC	
<i>Myoporum montanum</i>	Creeping Boobialla	NSW NC	

SSOT Seeding - Swamp Oak Swamp Forest Tree

Trees			
<i>Casuarina glauca</i>	Swamp Oak	NSW NC	
<i>Corymbia intermedia</i>	Pink Bloodwood	NSW NC	
<i>Eucalyptus resinifera</i>	Red Mahogany	NSW NC	
<i>Eucalyptus robusta</i>	Swamp Mahogany	NSW NC	
<i>Eucalyptus tereticornis</i>	Forest Red Gum	NSW NC	
<i>Glochidion ferdinandi</i>	Cheese Tree	NSW NC	
<i>Lophostemon suaveolens</i>	Swamp Mahogany, Swamp Turpentine	NSW NC	
<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark	NSW NC	
Shrubs			
<i>Acacia fimbriata</i>	Fringed Wattle	NSW NC	
<i>Acacia maidenii</i>	Maiden's Wattle	NSW NC	
<i>Baeckea virgata</i>	Baekea	NSW NC	
<i>Banksia spinulosa var collina</i>	Hairpin Banksia	NSW NC	
<i>Bossiaea rhombifolia</i>	Bossiaea	NSW NC	
<i>Callistemon rigidus</i>	Wallum Bottlebrush	NSW NC	
<i>Hakea dactyloides</i>	Finger Hakea	NSW NC	
<i>Hakea sericea</i>	Silky Hakea	NSW NC	
<i>Leptospermum juniperinum</i>	Prickly Tea-tree	NSW NC	
<i>Melaleuca nodosa</i>	Prickly leaved Paperbark	NSW NC	
Groundcovers			
<i>Hardenbergia violacea</i>	Purple Coral Pea	NSW NC	
<i>Imperata cylindrica</i>	Blady Grass	NSW NC	
<i>Juncus usitatus</i>	Common Rush	NSW NC	
<i>Lomandra longifolia</i>	Spiny headed Matt Rush	NSW NC	
<i>Myoporum montanum</i>	Creeping Boobialla	NSW NC	

SSM Seeding - Swamp Mahogany Forest

Shrubs		
<i>Acacia fimbriata</i>	Fringed Wattle	NSW NC
<i>Acacia maidenii</i>	Maiden's Wattle	NSW NC
<i>Baeckea virgata</i>	Baekea	NSW NC
<i>Banksia spinulosa var collina</i>	Hairpin Banksia	NSW NC
<i>Bossiaea rhombifolia</i>	Bossiaea	NSW NC
<i>Callistemon rigidus</i>	Wallum Bottlebrush	NSW NC
<i>Hakea dactyloides</i>	Finger Hakea	NSW NC
<i>Hakea sericea</i>	Silky Hakea	NSW NC
<i>Leptospermum juniperinum</i>	Prickly Tea-tree	NSW NC
<i>Melaleuca nodosa</i>	Prickly leaved Paperbark	NSW NC
Groundcovers		
<i>Gahnia sieberiana</i>	Tall Saw Sedge	NSW NC
<i>Hardenbergia violacea</i>	Purple Coral Pea	NSW NC
<i>Imperata cylindrica</i>	Blady Grass	NSW NC
<i>Juncus usitatus</i>	Common Rush	NSW NC
<i>Lomandra longifolia</i>	Spiny headed Matt Rush	NSW NC
<i>Myoporum montanum</i>	Creeping Boobialla	NSW NC

SSO Seeding - Swamp Oak Swamp Forest

Shrubs		
<i>Acacia fimbriata</i>	Fringed Wattle	NSW NC
<i>Acacia maidenii</i>	Maiden's Wattle	NSW NC
<i>Baeckea virgata</i>	Baekea	NSW NC
<i>Banksia spinulosa var collina</i>	Hairpin Banksia	NSW NC
<i>Bossiaea rhombifolia</i>	Bossiaea	NSW NC
<i>Callistemon rigidus</i>	Wallum Bottlebrush	NSW NC
<i>Hakea dactyloides</i>	Finger Hakea	NSW NC
<i>Hakea sericea</i>	Silky Hakea	NSW NC
<i>Leptospermum juniperinum</i>	Prickly Tea-tree	NSW NC
<i>Melaleuca nodosa</i>	Prickly leaved Paperbark	NSW NC
Groundcovers		
<i>Gahnia sieberiana</i>	Tall Saw Sedge	NSW NC
<i>Hardenbergia violacea</i>	Purple Coral Pea	NSW NC
<i>Imperata cylindrica</i>	Blady Grass	NSW NC
<i>Juncus usitatus</i>	Common Rush	NSW NC
<i>Lomandra longifolia</i>	Spiny headed Matt Rush	NSW NC
<i>Myoporum montanum</i>	Creeping Boobialla	NSW NC

SEEDING MIXES

COASTAL LOWLANDS			
Code	Species Name	Common Name	Bioregion
SSGT	Scribbly Gum - Needlebark Stringybark Heathy Open forest		
Trees			
	<i>Eucalyptus signata</i>	Scribbly Gum	NSW NC
	<i>Corymbia gummifera</i>	Red Bloodwood	NSW NC
	<i>Corymbia intermedia</i>	Pink Bloodwood	NSW NC
	<i>Syncarpia glomulifera</i>	Turpentine	NSW NC
	<i>Eucalyptus umbra</i>	Broadleaved White Mahogany	NSW NC
	<i>Angophora woodsiana</i>	Smudgy Apple	NSW NC
	<i>Eucalyptus baileyana</i>	Bailey's Stringybark	NSW NC
Shrubs			
	<i>Banksia oblongifolia</i>	Fern leaved Banksia	NSW NC
	<i>Banksia spinulosa var collina</i>	Hairpin Banksia	NSW NC
	<i>Gomphobium virgatum</i>	Wallum wedge pea	NSW NC
	<i>Jacksonia scoparia</i>	Dogwood	NSW NC
	<i>Lambertia formosa</i>	Mountain Devil	NSW NC
	<i>Leptospermum juniperinum</i>	Prickly Tea-tree	NSW NC
	<i>Leptospermum trinervium</i>	Slender tea tree	NSW NC
Groundcovers			
	<i>Aristida vagans</i>	Threeween Speargrass	NSW NC
	<i>Dianella caerulea</i>	Flax Lily	NSW NC
	<i>Entolasia stricta</i>	Wiry Panic	NSW NC
	<i>Imperata cylindrica</i>	Blady Grass	NSW NC
	<i>Lepidosperma laterale</i>	Variable Swordsedge	NSW NC
	<i>Lomandra longifolia</i>	Spiny headed Matt Rush	NSW NC
	<i>Imperata cylindrica var. major</i>	Blady Grass	NSW NC
SCHT	Seeding - Coastal Heath on Sand Tree		
Trees			
	<i>Allocasuarina littoralis</i>	Black She-Oak	NSW NC
	<i>Banksia integrifolia subsp. Integrifolia</i>	Coastal Banksia	NSW NC
	<i>Melealeuca quinquenervia</i>	Broad-leaved Paperbark	NSW NC
Shrubs			
	<i>Acacia suaveolens</i>	Sweet Wattle	NSW NC
	<i>Acacia ulicifolia</i>	Prickly Moses	NSW NC
	<i>Banksia spinulosa var collina</i>	Hairpin Banksia	NSW NC
	<i>Daviesia acicularis</i>	Sandplain bitter-pea	NSW NC
	<i>Hakea dactyloides</i>	Finger Hakea	NSW NC
	<i>Kunzea parvifolia</i>	Violet Kunzea	NSW NC
Groundcovers			
	<i>Capillipedium spicigerum</i>	scented-top grass	NSW NC
	<i>Hardenbergia violacea</i>	Purple Coral Pea	NSW NC
	<i>Hibbertia obtusifolia</i>	Hoary Guinea Flower	NSW NC
	<i>Lomandra multiflora</i>	Many Flowered Matt Rush	NSW NC
	<i>Themeda australis</i>	Kangaroo Grass	NNC SEQ
SSGT	Scribbly Gum - Needlebark Stringybark Heathy Open forest		
Shrubs			
	<i>Banksia oblongifolia</i>	Fern leaved Banksia	NSW NC
	<i>Banksia spinulosa var collina</i>	Hairpin Banksia	NSW NC
	<i>Gomphobium virgatum</i>	Wallum wedge pea	NSW NC
	<i>Jacksonia scoparia</i>	Dogwood	NSW NC
	<i>Lambertia formosa</i>	Mountain Devil	NSW NC
	<i>Leptospermum juniperinum</i>	Prickly Tea-tree	NSW NC
	<i>Leptospermum trinervium</i>	Slender tea tree	NSW NC
Groundcovers			
	<i>Aristida vagans</i>	Threeween Speargrass	NSW NC
	<i>Dianella caerulea</i>	Flax Lily	NSW NC
	<i>Entolasia stricta</i>	Wiry Panic	NSW NC
	<i>Imperata cylindrica</i>	Blady Grass	NSW NC
	<i>Lepidosperma laterale</i>	Variable Swordsedge	NSW NC
	<i>Lomandra longifolia</i>	Spiny headed Matt Rush	NSW NC
	<i>Imperata cylindrica var. major</i>	Blady Grass	NSW NC
SCH	Seeding - Coastal Heath on Sand		
Shrubs			
	<i>Acacia suaveolens</i>	Sweet Wattle	NSW NC
	<i>Acacia ulicifolia</i>	Prickly Moses	NSW NC
	<i>Banksia spinulosa var collina</i>	Hairpin Banksia	NSW NC
	<i>Daviesia acicularis</i>	Sandplain bitter-pea	NSW NC
	<i>Hakea dactyloides</i>	Finger Hakea	NSW NC
	<i>Kunzea parvifolia</i>	Violet Kunzea	NSW NC
Groundcovers			
	<i>Hardenbergia violacea</i>	Purple Coral Pea	NSW NC
	<i>Hibbertia obtusifolia</i>	Hoary Guinea Flower	NSW NC
	<i>Lomandra multiflora</i>	Many Flowered Matt Rush	NSW NC
	<i>Capillipedium spicigerum</i>	scented-top grass	NSW NC
	<i>Themeda australis</i>	Kangaroo Grass	NNC SEQ

SEEDING MIXES

COASTAL LOWLANDS

Code	Species Name	Common Name	Bioregion
SSGT	Scribbly Gum - Needlebark Stringybark Heathy Open forest		
Trees			
	<i>Eucalyptus signata</i>	Scribbly Gum	NSW NC
	<i>Corymbia gummifera</i>	Red Bloodwood	NSW NC
	<i>Corymbia intermedia</i>	Pink Bloodwood	NSW NC
	<i>Syncarpia glomulifera</i>	Turpentine	NSW NC
	<i>Eucalyptus umbra</i>	Broadleaved White Mahogany	NSW NC
	<i>Angophora woodsiana</i>	Smudgy Apple	NSW NC
	<i>Eucalyptus baileyana</i>	Bailey's Stringybark	NSW NC
Shrubs			
	<i>Banksia oblongifolia</i>	Fern leaved Banksia	NSW NC
	<i>Banksia spinulosa var collina</i>	Hairpin Banksia	NSW NC
	<i>Gomphobium virgatum</i>	Wallum wedge pea	NSW NC
	<i>Jacksonia scoparia</i>	Dogwood	NSW NC
	<i>Lambertia formosa</i>	Mountain Devil	NSW NC
	<i>Leptospermum juniperinum</i>	Prickly Tea-tree	NSW NC
	<i>Leptospermum trinervium</i>	Slender tea tree	NSW NC
Groundcovers			
	<i>Aristida vagans</i>	Threeawn Speargrass	NSW NC
	<i>Dianella caerulea</i>	Flax Lily	NSW NC
	<i>Entolasia stricta</i>	Wiry Panic	NSW NC
	<i>Imperata cylindrica</i>	Blady Grass	NSW NC
	<i>Lepidosperma laterale</i>	Variable Swordsedge	NSW NC
	<i>Lomandra longifolia</i>	Spiny headed Matt Rush	NSW NC
	<i>Imperata cylindrica var. major</i>	Blady Grass	NSW NC

Code	Species Name	Common Name	Bioregion
SSGT	Scribbly Gum - Needlebark Stringybark Heathy Open forest		
Shrubs			
	<i>Banksia oblongifolia</i>	Fern leaved Banksia	NSW NC
	<i>Banksia spinulosa var collina</i>	Hairpin Banksia	NSW NC
	<i>Gomphobium virgatum</i>	Wallum wedge pea	NSW NC
	<i>Jacksonia scoparia</i>	Dogwood	NSW NC
	<i>Lambertia formosa</i>	Mountain Devil	NSW NC
	<i>Leptospermum juniperinum</i>	Prickly Tea-tree	NSW NC
	<i>Leptospermum trinervium</i>	Slender tea tree	NSW NC
Groundcovers			
	<i>Aristida vagans</i>	Threeawn Speargrass	NSW NC
	<i>Dianella caerulea</i>	Flax Lily	NSW NC
	<i>Entolasia stricta</i>	Wiry Panic	NSW NC
	<i>Imperata cylindrica</i>	Blady Grass	NSW NC
	<i>Lepidosperma laterale</i>	Variable Swordsedge	NSW NC
	<i>Lomandra longifolia</i>	Spiny headed Matt Rush	NSW NC
	<i>Imperata cylindrica var. major</i>	Blady Grass	NSW NC

Code	Species Name	Common Name	Bioregion
SCHT	Seeding - Coastal Heath on Sand Tree		
Trees			
	<i>Allocasuarina floricola</i>	Black She-Oak	NSW NC
	<i>Banksia integrifolia subsp. integrifolia</i>	Coastal Banksia	NSW NC
	<i>Melaleuca quinquenervia</i>	Broad-leaved Paperbark	NSW NC
Shrubs			
	<i>Acacia suaveolens</i>	Sweet Wattle	NSW NC
	<i>Acacia ulicifolia</i>	Prickly Moses	NSW NC
	<i>Banksia spinulosa var collina</i>	Hairpin Banksia	NSW NC
	<i>Daviesia acicularis</i>	Sandplain bitter-pea	NSW NC
	<i>Hakea dactyloides</i>	Finger Hakea	NSW NC
	<i>Kunzea parvifolia</i>	Violet Kunzea	NSW NC
Groundcovers			
	<i>Capillipedium spicigerum</i>	scented-top grass	NSW NC
	<i>Hardenbergia violacea</i>	Purple Coral Pea	NSW NC
	<i>Hibbertia obtusifolia</i>	Hoary Guinea Flower	NSW NC
	<i>Lomandra multiflora</i>	Many Flowered Matt Rush	NSW NC
	<i>Themeda australis</i>	Kangaroo Grass	NNC SEQ

Code	Species Name	Common Name	Bioregion
SCH	Seeding - Coastal Heath on Sand		
Shrubs			
	<i>Acacia suaveolens</i>	Sweet Wattle	NSW NC
	<i>Acacia ulicifolia</i>	Prickly Moses	NSW NC
	<i>Banksia spinulosa var collina</i>	Hairpin Banksia	NSW NC
	<i>Daviesia acicularis</i>	Sandplain bitter-pea	NSW NC
	<i>Hakea dactyloides</i>	Finger Hakea	NSW NC
	<i>Kunzea parvifolia</i>	Violet Kunzea	NSW NC
Groundcovers			
	<i>Hardenbergia violacea</i>	Purple Coral Pea	NSW NC
	<i>Hibbertia obtusifolia</i>	Hoary Guinea Flower	NSW NC
	<i>Lomandra multiflora</i>	Many Flowered Matt Rush	NSW NC
	<i>Capillipedium spicigerum</i>	scented-top grass	NSW NC
	<i>Themeda australis</i>	Kangaroo Grass	NNC SEQ

SEED MIXES

COASTAL RANGE				COASTAL RANGE			
Code	Species Name	Common Name	Bioregion	Code	Species Name	Common Name	Bioregion
SRFT	Seeding - Forest Red Gum Grassy Open Forest Tree			SRF	Seeding - Forest Red Gum Grassy Open Forest		
Trees				Shrubs			
	<i>Angophora subvelutina</i>	Broad-leaved Apple	NSW NC		<i>Breynia oblongifolia</i>	Coffee Bush	NSW NC
	<i>Corymbia intermedia</i>	Pink Bloodwood	NSW NC		<i>Hakea dactyloides</i>	Finger Hakea	NSW NC
	<i>Eucalyptus siderophloia</i>	Grey Ironbark	NSW NC		<i>Hakea sericea</i>	Silky Hakea	NSW NC
	<i>Eucalyptus tereticornis</i>	Forest Red Gum	NSW NC		<i>Leptospermum juniperinum</i>	Prickly Tea-tree	NSW NC
Shrubs				Groundcovers			
	<i>Breynia oblongifolia</i>	Coffee Bush	NSW NC		<i>Desmodium brachypodium</i>	Large tick-trefoil	NSW NC
	<i>Hakea dactyloides</i>	Finger Hakea	NSW NC		<i>Dianella caerulea</i>	Blue Flax-lily	NSW NC
	<i>Leptospermum juniperinum</i>	Prickly Tea-tree	NSW NC		<i>Dichondra repens</i>	Kidney weed	NSW NC
Groundcovers					<i>Hardenbergia violacea</i>	False Sarsaparilla	NSW NC
	<i>Desmodium brachypodium</i>	Large tick-trefoil	NSW NC		<i>Imperata cylindrica var. major</i>	Blady Grass	NSW NC
	<i>Dianella caerulea</i>	Blue Flax-lily	NSW NC		<i>Lomandra longifolia</i>	Spiny headed Mat-rush	NSW NC
	<i>Dichondra repens</i>	Kidney weed	NSW NC		<i>Pratia purpurascens</i>	Whiteroot	NSW NC
	<i>Hardenbergia violacea</i>	False Sarsaparilla	NSW NC		<i>Themeda australis</i>	Kangaroo Grass	NSW NC
	<i>Imperata cylindrica var. major</i>	Blady Grass	NSW NC				
	<i>Lomandra longifolia</i>	Spiny headed Mat-rush	NSW NC				
	<i>Pratia purpurascens</i>	Whiteroot	NSW NC				
	<i>Themeda australis</i>	Kangaroo Grass	NSW NC				
CLARENCE LOWLAND				CLARENCE LOWLAND			
Code	Species Name	Common Name	Bioregion	Code	Species Name	Common Name	Bioregion
SGGT	Seeding - Grey Gum Ironbark Open Forest			SRFT	Seeding - Forest Red Gum Grassy Open Forest		
Trees				Shrubs			
	<i>Alibcasuarina torulosa</i>	Forest Oak	NSW NC		<i>Breynia oblongifolia</i>	Coffee Bush	NSW NC
	<i>Alphitonia excelsa</i>	Red Ash	NSW NC		<i>Hakea dactyloides</i>	Finger Hakea	NSW NC
	<i>Corymbia intermedia</i>	Pink Bloodwood	NSW NC		<i>Hakea sericea</i>	Silky Hakea	NSW NC
	<i>Corymbia variegata</i>	Gum	NSW NC		<i>Leptospermum juniperinum</i>	Prickly Tea-tree	NSW NC
	<i>Eucalyptus propinqua</i>	Small-fruited Grey Gum	NSW NC	Groundcovers			
	<i>Eucalyptus siderophloia</i>	Grey Ironbark	NSW NC		<i>Entolasia stricta</i>	Wiry Panic	NSW NC
	<i>Syncarpia glomulifera</i>	Turpentine	NSW NC		<i>Dianella caerulea</i>	Blue Flax-lily	NSW NC
Shrubs					<i>Glycine clandestina</i>	Twining glycine	NSW NC
	<i>Breynia oblongifolia</i>	Coffee Bush	NSW NC		<i>Dichondra repens</i>	Kidney weed	NSW NC
	<i>Hakea dactyloides</i>	Finger Hakea	NSW NC		<i>Imperata cylindrica var. major</i>	Blady Grass	NSW NC
	<i>Leptospermum juniperinum</i>	Prickly Tea-tree	NSW NC		<i>Lomandra longifolia</i>	Spiny headed Mat-rush	NSW NC
Groundcovers					<i>Pratia purpurascens</i>	Whiteroot	NSW NC
	<i>Entolasia stricta</i>	Wiry Panic	NSW NC				
	<i>Dianella caerulea</i>	Blue Flax-lily	NSW NC				
	<i>Glycine clandestina</i>	Twining glycine	NSW NC				
	<i>Dichondra repens</i>	Kidney weed	NSW NC				
	<i>Imperata cylindrica var. major</i>	Blady Grass	NSW NC				
	<i>Lomandra longifolia</i>	Spiny headed Mat-rush	NSW NC				
	<i>Pratia purpurascens</i>	Whiteroot	NSW NC				
SRWT	Seeding - Narrow Leaved Red Gum Woodlands			SRWT	Seeding - Narrow Leaved Red Gum Woodlands		
Trees				Shrubs			
	<i>Angophora subvelutina</i>	Broad-leaved Apple	NSW NC		<i>Hakea dactyloides</i>	Finger Hakea	NSW NC
	<i>Casuarina glauca</i>	Swamp Oak	NSW NC		<i>Hakea sericea</i>	Silky Hakea	NSW NC
	<i>Eucalyptus amplifolia subsp. sessiliflora</i>	Cabbage Gum	NSW NC		<i>Melaleuca nodosa</i>	Prickly leaved Paperbark	NSW NC
	<i>Eucalyptus secana</i>	Narrow-leaved Red Gum	NSW NC		<i>Melaleuca stypheloides</i>	Prickly-leaved Tea Tree	NSW NC
	<i>Eucalyptus siderophloia</i>	Grey Ironbark	NSW NC	Groundcovers			
	<i>Lophosieton suaveolens</i>	Swamp Mahogany, Swamp Turpentine	NSW NC		<i>Entolasia stricta</i>	Wiry Panic	NSW NC
	<i>Melaleuca quinquevenia</i>	Broad-leaved Paperbark	NSW NC		<i>Imperata cylindrica var. major</i>	Blady Grass	NSW NC
Shrubs					<i>Lomandra longifolia</i>	Spiny headed Mat-rush	NSW NC
	<i>Hakea dactyloides</i>	Finger Hakea	NSW NC		<i>Panicum effusum</i>	Hairy Panic	NSW NC
	<i>Hakea sericea</i>	Silky Hakea	NSW NC		<i>Themeda australis</i>	Kangaroo Grass	NSW NC
	<i>Melaleuca nodosa</i>	Prickly leaved Paperbark	NSW NC				
	<i>Melaleuca stypheloides</i>	Prickly-leaved Tea Tree	NSW NC				
Groundcovers							
	<i>Entolasia stricta</i>	Wiry Panic	NSW NC				
	<i>Imperata cylindrica var. major</i>	Blady Grass	NSW NC				
	<i>Lomandra longifolia</i>	Spiny headed Mat-rush	NSW NC				
	<i>Panicum effusum</i>	Hairy Panic	NSW NC				
	<i>Themeda australis</i>	Kangaroo Grass	NSW NC				

SEEDS MIXES

CLARENCE LOWLAND

Code	Species Name	Common Name	Bioregion
SSGT	Spotted Gum - Grey Ironbark Pink Bloodwood Open Forest		
Trees			
	<i>Allocasuarina torulosa</i>	Forest Oak	NSW NC
	<i>Corymbia henryi</i>	Large-leaved Spotted Gum	NSW NC
	<i>Corymbia intermedia</i>	Pink Bloodwood	NSW NC
	<i>Corymbia variegata</i>		NSW NC
	<i>Eucalyptus propinqua</i>	Small-fruited Grey Gum	NSW NC
	<i>Eucalyptus siderophloia</i>	Grey Ironbark	NSW NC
Groundcovers			
	<i>Aristida vagans</i>	Threecorn Speargrass	NSW NC
	<i>Cymbopogon refractus</i>	Barbed Wire Grass	NSW NC
	<i>Desmodium brachypodium</i>	Large tick-trefoil	NSW NC
	<i>Dianella caerulea</i>	Flax Lily	NSW NC
	<i>Glycine clandestina</i>	Twining glycine	NSW NC
	<i>Hardenbergia violacea</i>	False Sarsaparilla	NSW NC
	<i>Imperata cylindrica</i>	Blady Grass	NSW NC
	<i>Lomandra longifolia</i>	Spiny headed Matt Rush	NSW NC
	<i>Pratia purpurascens</i>	Whiteroot	NSW NC
	<i>Themeda australis</i>	Kangaroo Grass	NSW NC

Code	Species Name	Common Name	Bioregion
SSG	Spotted Gum - Grey Ironbark Pink Bloodwood Open Forest		
Groundcovers			
	<i>Aristida vagans</i>	Threecorn Speargrass	NSW NC
	<i>Cymbopogon refractus</i>	Barbed Wire Grass	NSW NC
	<i>Desmodium brachypodium</i>	Large tick-trefoil	NSW NC
	<i>Dianella caerulea</i>	Flax Lily	NSW NC
	<i>Glycine clandestina</i>	Twining glycine	NSW NC
	<i>Hardenbergia violacea</i>	False Sarsaparilla	NSW NC
	<i>Imperata cylindrica</i>	Blady Grass	NSW NC
	<i>Lomandra longifolia</i>	Spiny headed Matt Rush	NSW NC
	<i>Pratia purpurascens</i>	Whiteroot	NSW NC
	<i>Themeda australis</i>	Kangaroo Grass	NSW NC

SANDSTONE

Code	Species Name	Common Name	Bioregion
SBFT	Blackbutt- Bloodwood Dry Heathy Open Forest		
Trees			
	<i>Allocasuarina littoralis</i>	Black SheOak	NSW NC
	<i>Corymbia gummifera</i>	Red Bloodwood	NSW NC
	<i>Eucalyptus ptilularis</i>	Blackbutt	NSW NC
	<i>Eucalyptus resinifera subsp. Hemilampra</i>	Red Mahogany	NSW NC
Shrubs			
	<i>Acacia fimbriata</i>	Fringed Wattle	NSW NC
	<i>Acacia ulicifolia</i>	Prickly Moses	NSW NC
	<i>Banksia oblongifolia</i>	Fern leaved Banksia	NSW NC
	<i>Banksia spinulosa var collina</i>	Hairpin Banksia	NSW NC
	<i>Gomphobium virgatum</i>	Wallum wedge pea	NSW NC
	<i>Leptospermum juniperinum</i>	Prickly Tea-tree	NSW NC
	<i>Pultenaea villosa</i>	Hairy Bush Pea	NSW NC
Groundcovers			
	<i>Dianella caerulea</i>	Flax Lily	NSW NC
	<i>Entolasia stricta</i>	Wirry Panic	NSW NC
	<i>Glycine clandestina</i>	Twining glycine	NSW NC
	<i>Hardenbergia violacea</i>	False Sarsaparilla	NSW NC
	<i>Hibbertia scandens</i>	Climbing Guinea Flower	NSW NC
	<i>Lepidosperma laterale</i>	Variable Swordsedge	NSW NC
	<i>Lomandra longifolia</i>	Spiny headed Matt Rush	NSW NC
	<i>Panicum effusum</i>	Hairy Panic	NSW NC
	<i>Themeda australis</i>	Kangaroo Grass	NSW NC

Code	Species Name	Common Name	Bioregion
SBF	Blackbutt- Bloodwood Dry Heathy Open Forest		
Shrubs			
	<i>Acacia fimbriata</i>	Fringed Wattle	NSW NC
	<i>Acacia ulicifolia</i>	Prickly Moses	NSW NC
	<i>Banksia oblongifolia</i>	Fern leaved Banksia	NSW NC
	<i>Banksia spinulosa var collina</i>	Hairpin Banksia	NSW NC
	<i>Gomphobium virgatum</i>	Wallum wedge pea	NSW NC
	<i>Leptospermum juniperinum</i>	Prickly Tea-tree	NSW NC
	<i>Pultenaea villosa</i>	Hairy Bush Pea	NSW NC
Groundcovers			
	<i>Dianella caerulea</i>	Flax Lily	NSW NC
	<i>Entolasia stricta</i>	Wirry Panic	NSW NC
	<i>Glycine clandestina</i>	Twining glycine	NSW NC
	<i>Hardenbergia violacea</i>	False Sarsaparilla	NSW NC
	<i>Hibbertia scandens</i>	Purple Coral Pea	NSW NC
	<i>Lepidosperma laterale</i>	Variable Swordsedge	NSW NC
	<i>Lomandra longifolia</i>	Spiny headed Matt Rush	NSW NC
	<i>Panicum effusum</i>	Hairy Panic	NSW NC
	<i>Themeda australis</i>	Kangaroo Grass	NSW NC

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SEED MIXES

COASTAL SANDS

Code	Species Name	Common Name	Bioregion
SCPT	Seeding - Coastal Cypress Pine Shrubby Open Forest Tree		
Trees			
	<i>Allocasuarina fitzroyi</i>	Black She-Oak	NSW NC
	<i>Angophora costata</i>	Sydney Red Gum	NSW NC
	<i>Angophora parkinsonii</i>	Small-leaved Apple	NSW NC
	<i>Banksia aemula</i>	Wallum Banksia	NSW NC
	<i>Banksia integrifolia subsp. integrifolia</i>	Coastal Banksia	NSW NC
	<i>Banksia serrata</i>	Oldman	NSW NC
	<i>Callitris columellaris</i>	Cypress Pine	NSW NC
	<i>Corymbia intermedia</i>	Pink Bloodwood	NSW NC
Shrubs			
	<i>Acacia suaveolens</i>	Sweet Wattle	NSW NC
	<i>Acacia fimbriata</i>	Fringed Wattle	NSW NC
	<i>Acacia ulicifolia</i>	Prickly Moses	NSW NC
	<i>Bursaria spinulosa</i>	Blackthorn	NSW NC
	<i>Dodonea triquetra</i>	Common Hop Bush	NSW NC
	<i>Hakea dactyloides</i>	Finger Hakea	NSW NC
	<i>Indigofera australis</i>	Indigo	NSW NC
	<i>Ozothamnus diosmifolius</i>	Rice Flower	NSW NC
Groundcovers			
	<i>Hardenbergia violacea</i>	Purple Coral Pea	NSW NC
	<i>Hibbertia obtusifolia</i>	Hoary Guinea Flower	NSW NC

Code	Species Name	Common Name	Bioregion
SCP	Seeding - Coastal Cypress Pine Shrubby Open Forest		
Shrubs			
	<i>Acacia fimbriata</i>	Fringed Wattle	NSW NC
	<i>Acacia suaveolens</i>	Sweet Wattle	NSW NC
	<i>Acacia ulicifolia</i>	Prickly Moses	NSW NC
	<i>Bursaria spinulosa</i>	Blackthorn	NSW NC
	<i>Dodonea triquetra</i>	Common Hop Bush	NSW NC
	<i>Hakea dactyloides</i>	Finger Hakea	NSW NC
	<i>Indigofera australis</i>	Indigo	NSW NC
	<i>Ozothamnus diosmifolius</i>	Rice Flower	NSW NC
	<i>Pultenaea villosa</i>	Hairy Bush Pea	NSW NC
Groundcovers			
	<i>Hardenbergia violacea</i>	Purple Coral Pea	NSW NC
	<i>Hibbertia obtusifolia</i>	Hoary Guinea Flower	NSW NC
	<i>Themeda australis</i>	Kangaroo Grass	NSW NC

GRASSES

Code	Species Name	Common Name	Bioregion
SNG	Seeding - Native Grass		
Grasses			
	<i>Aristida vagans</i>	Threecawn Spear Grass	NNC SEQ
	<i>Cymbopogon refractus</i>	Barbed Wire Grass	NNC SEQ
	<i>Imperata cylindrica</i>	Blady Grass	NNC SEQ
	<i>Microlaena stipoides var Griffin</i>	Weeping Grass	NNC SEQ
	<i>Themeda australis</i>	Kangaroo Grass	NNC SEQ
	<i>Themeda triandra var Tengera</i>	Harsh Ground Fern	NNC SEQ
SSG	Seeding - Swale Grass		
Grasses			
	<i>Carex appressa</i>	Tall Sedge	NNC SEQ
	<i>Cymbopogon refractus</i>	Barbed Wire Grass	NNC SEQ
	<i>Ficinia nodosa</i>	Knobby Club Rush	NNC SEQ
	<i>Gahnia aspera</i>	Tall Saw Sedge	NNC SEQ
	<i>Gahnia sieberiana</i>	Rough Saw Edge	NNC SEQ
	<i>Imperata cylindrica</i>	Blady Grass	NNC SEQ
	<i>Juncus usitatus</i>	Common Rush	NNC SEQ
	<i>Microlaena stipoides var Griffin</i>	Weeping Grass	NNC SEQ

Code	Species Name	Common Name	Bioregion
SPG	Seeding - Pasture Grass		
Grasses			
	<i>Coolabah Oats</i>	Coolabah Oats	
	<i>Cymbopogon refractus</i>	Barbed Wire Grass	NNC SEQ
	<i>Cynodon dactylon</i>	Green Couch	NNC SEQ
	<i>Eclipse rye</i>	Eclipse Rye	
	<i>Secate cereate "sterile"</i>	Sterile Rye Corn	
	<i>Trifolium pratense</i>	Red Clover	

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