

**TSRC
PART 2
A.0 - INTERPRETATION**

Interpretation of Part 2 of the Performance Specification

1. The parties acknowledge that this Part 2 of the Performance Specification:
 - (a) has been developed from a proposal submitted by Project Co to the State in response to the request for proposals by the State in relation to the Project;
 - (a) includes certain technical clarifications in the form of questions submitted by the State and answered by Project Co on or before the date of the Project Deed which are set out in, and only in, each of the tables described as "Clarification Questions" in this Part 2 of the Performance Specification (**Technical Clarifications**); and
 - (b) is included in the Performance Specification solely for the purposes of giving the State the benefit of any clarifications, commitments, promises, requirements, proposals, recommendations, options and philosophies proposed by Project Co in relation to the Project.
2. The inclusion of this Part 2 within the Performance Specification (including the inclusion of any Technical Clarifications within this Part 2 of the Performance Specification) is not intended to, and will not, impose any obligations whatsoever on the State or its Associates except as expressly set out in a State Project Documents other than this Part 2 of the Performance Specification.
3. This Part 2 of the Performance Specification must be interpreted in accordance with the interpretation provisions set out in the Project Deed (including clause 2.2(c)) and the Performance Specification (including Sections 1.1, 1.2 and 1.3 of Part 1 of the Performance Specification).
4. Without limiting the above, to the extent this Part 2 of the Performance Specification refers to any act, thing, requirement or characteristic in language which is or could be interpreted as:
 - (a) non-mandatory, ambiguous or not binding on Project Co (including by using words or phrases such as proposal, proposed, value add, should, could, may include, looks to, recommend, recommended, commitment, submitted, submission, expected, generally expected, in general, required, option, alternative, alternative program, alternative proposal, needs to be, strives to do, supports, approach, process or similar words or phrases), or does not specify who is responsible for such act, thing, requirement or characteristic, then such act, thing, requirement or characteristic will be deemed to be a mandatory obligation which forms part of, and which Project Co must comply with in carrying out, the Project Activities; and
 - (b) an aspirational standard or process (including by using words or phrases such as philosophy, objective, ethos, initiatives, outputs, aim or strives to do or similar words or phrases), or does not specify who is responsible for such aspirational standard or process, then Project Co will be bound to perform the Project Activities in a manner which complies in all respects with any such act, thing, requirement or characteristic, and meets or exceeds any such aspirational standard or process.
- 4.2 In this Part 2 of the Performance Specification, any reference to:
 - (a) "Nexus", "Nexus Infrastructure", "Proponent", "we", "our" or a similar expression is a reference to Project Co;
 - (b) "D&C JV", "Design JV", "CJV" or a similar expression is a reference to the D&C Subcontractor and/or its Subcontractors, as the context requires, including as replaced from time to time;
 - (c) "Acciona Infrastructure Australia", "Acciona", "Ferrovia Agroman Australia", "Ferrovia Agroman", "Ferrovia", "Aurecon", "Parsons Brinckerhoff", "BMD" or a

related or similarly-named Entity is a reference to the D&C Subcontractor and/or its Subcontractors, as the context requires, including as replaced from time to time;

- (d) "Transfield Services", "Transfield Australia", "Transfield" or a related or similarly-named Entity is a reference to the O&M Subcontractor and/or its Subcontractors, as the context requires, including as replaced from time to time;
- (e) an obligation, responsibility or liability of a Subcontractor, including the D&C Subcontractor or the O&M Subcontractor, is a reference, as between the State and Project Co, to an obligation, responsibility or liability of Project Co;
- (f) "TMR" is a reference to DTMR;
- (g) "IR" is a reference to the Independent Reviewer;
- (h) "PUP", "Utilities", "Utility Owner", "PUP authorities", "PUP providers" or a similar expression is a reference to Utility Infrastructure, a Utility Provider or a relevant Authority, as the context requires;
- (i) "Activities" or a similar expression is a reference to the Project Activities;
- (j) "Tender Design" or a similar expression is a reference to the design for the Works which has been developed and is required to be further developed by Project Co as part of the D&C Activities;
- (k) "Conforming Tender Program", "Conforming TSRC Project Program", "Project Program", "Construction Program" or a similar expression is a reference to the Bid D&C Program and/or the D&C Program, as the context requires;
- (l) "Conforming Proposal", "Conforming Offer" or a similar expression is a reference to the commitment of Project Co to perform its obligations, including to carry out the Project Activities, in accordance with the State Project Documents; and
- (m) "Reference Design" or "Reference Layout" is a reference to the initial design for the Works which was included in the request for proposals by the State in relation to the Project.

5. Project Co acknowledges and agrees that:

- (a) it is bound by, and must perform the Project Activities in compliance with, all clarifications, commitments, promises, requirements, proposals, recommendations, options and philosophies of Project Co evidenced by, contained in or otherwise contemplated by the Technical Clarifications;
- (b) nothing in any Technical Clarification imposes, or will be construed as imposing, any obligation whatsoever on the State or any of its Associates and, to the extent any Technical Clarification refers to an act or responsibility of the State or any of its Associates, the State or the relevant Associate is not responsible for such act or responsibility; and
- (c) all references in the Technical Standards to costs, additional costs, dollars (including "\$") or other monetary amounts have, on or before the date of the Project Deed, been reflected and included within, and are therefore subsumed and superseded by, the amounts which are or may become payable to Project Co pursuant to the State Project Documents (other than this Part 2 of the Performance Specification), such that Project Co will not have any entitlement to make any Claim for payment of any such amount in connection with carrying out, performing or otherwise complying with all clarifications, commitments, promises, requirements proposals, recommendations, options and philosophies evidenced by, contained in or otherwise contemplated by the Technical Clarifications.

**TSRC
PART 2
A.1 - DESIGN**

Table of Contents

Executive Summary Design	7
Global Capability, Local Application	7
Depth of Technical Resources	7
Design Outcomes	8
<i>Features of Nexus Infrastructure's Design</i>	8
1 A.1 1 Traffic (T1, T2, T3)	8
1.1.1 <i>Turn Pocket Storage and 95th Percentile Queue Lengths</i>	8
2 A.1 2 Road Geometry & Road Safety (R1, R2, R3)	9
2.1 R3 Application of Extended Design Domain	9
2.2 R3 Road Design Approach and Methodology	9
2.2.1 <i>Coordination of Vertical and Horizontal Alignment</i>	9
2.2.2 <i>Roadside Barriers</i>	10
2.2.3 <i>Emergency Stopping and U-turn Facilities</i>	11
2.2.4 <i>Arrester Beds</i>	15
2.2.5 <i>Vehicle Stopping Place</i>	15
2.2.6 <i>Public Transport</i>	15
2.2.7 <i>Fencing</i>	15
3 A.1 3 Pavement (P1, P2)	17
3.1 Executive Summary	17
3.2 Subgrade	17
3.2.1 <i>Assessment of CBRs</i>	17
3.2.2 <i>Design Assumptions</i>	17
3.3 Environmental Conditions	18
3.3.1 <i>Drainage</i>	18
3.4 Pavement Design	18
3.4.1 <i>Sustainability</i>	18
3.4.2 <i>Shoulders</i>	18
3.5 Risk Management	18
3.5.1 <i>Subgrade Properties</i>	18
3.5.2 <i>Water</i>	19
3.5.3 <i>Pavement Materials</i>	19
3.5.4 <i>Sensitivity of Pavement Material Properties</i>	19
<i>Specifications and Materials</i>	19
<i>Maintenance</i>	19
3.6 Conclusion	19
4 A.1 4 Geotechnical (G1, G2)	20

Executive Summary	20
4.1.1 <i>Earthworks.....</i>	20
4.1.2 <i>Bridge and structure foundations.....</i>	20
Design Inputs	21
4.2 Surface Movement Assessment.....	21
4.2.1 <i>Design Options</i>	21
4.2.2 <i>Recommendations.....</i>	23
4.3 Cutting and Subgrade Treatment	24
4.3.1 <i>Treatments.....</i>	24
4.3.2 <i>Drainage Blanket</i>	24
Foundation Assessment	25
4.4 Deep Foundations.....	25
4.4.1 <i>Design Methodology</i>	25
Instrumentation and Monitoring	25
4.5 Instrumentation	25
4.6 Monitoring Frequency.....	27
Operations and Maintenance Considerations.....	27
4.6.1 <i>Slope Risk Assessment</i>	28
4.6.2 <i>Ground Support</i>	28
4.6.3 <i>Soil Batters</i>	28
4.6.4 <i>Maintenance of Rock Fall Fence.....</i>	29
Geology and Geotech (G2).....	30
4.7 Key Design Features.....	30
4.7.1 <i>Embankments:.....</i>	30
4.7.2 <i>Cut Excavations:.....</i>	31
4.8 Embankment Design Recommendations.....	32
4.8.1 <i>Embankment Zoning Strategy.....</i>	32
4.8.2 <i>Batter Slopes and Benching.....</i>	33
4.8.3 <i>Erosion Protection.....</i>	35
4.9 Settlement Analysis.....	35
4.9.1 <i>Assessment Methodology.....</i>	35
4.9.2 <i>Main Alignment.....</i>	36
Bridge Abutments Design	36
4.10 Bridge Abutment Recommendations	36
Cut Slope Design	37
4.11 Cutting Design Recommendations	37
4.11.1 <i>Batter Slopes and Benching.....</i>	37

4.11.2	<i>Slope Face Protection and Face Support</i>	37
4.11.3	<i>Slope Reinforcement</i>	38
4.11.4	<i>Sub-surface Drainage</i>	39
4.11.5	<i>Rock Fall and Debris Flow Protection</i>	39
5	A.1 5 Hydrology and Drainage (D1)	40
5.1	Executive Summary	40
5.2	Cross Drainage	41
5.2.1	<i>Management of Debris</i>	41
5.3	Longitudinal Drainage	43
5.3.1	<i>Design Concept</i>	43
5.4	Scour Protection.....	46
5.4.1	<i>Cross Drainage Culvert Outlets</i>	46
5.4.2	<i>Cross Drainage Culvert Inlets</i>	47
5.5	Longitudinal Drainage Outlets	47
5.6	Open Drains.....	47
5.7	Creek Diversions.....	48
5.8	Water Quality	48
5.8.1	<i>General Approach</i>	48
5.8.2	<i>Urban catchment</i>	48
5.8.3	<i>Forest and woodland upper catchments of Sandy Creek and Gatton Creek</i>	48
5.8.4	<i>Agricultural catchment of the Western Downs plateau to the west of</i> <i>Toowoomba</i>	50
6	A.1 6 Noise (N1)	51
6.1	Executive Summary	51
6.2	Project Criteria	51
6.2.1	<i>Application to this Project</i>	51
6.3	Conclusion	51
7	A.1 7 Structures (Incl. Bridges, Major Culverts and Retaining Walls) (S1, S2, S3)	52
	Structures Design	52
7.1	Executive Summary	52
7.2	Relationship to Project Objectives.....	52
	Design Standards and Criteria	53
7.3	Design Standards.....	53
	Methodology	53
7.4	Substructure.....	53
7.4.1	<i>Design Principles</i>	53
7.5	Superstructure.....	53

7.6	Operations and Maintenance Design Considerations	54
7.7	Environment.....	54
7.8	Future Widening	54
VMS and Static Sign Structure.....		54
Risk Management		55
7.9	Safety Risks to Users	55
Durability		56
7.10	Exterior Atmospheric Exposure	56
7.10.1	<i>Air Quality</i>	<i>56</i>
Design and Construction Methodologies to Achieve Durability.....		56
7.11	Design and Construction Issues	56
7.12	Improving Durability Outcomes	57
Inspection and Maintenance Requirements.....		58
7.13	Inspection and Maintenance Activities.....	58
7.14	Maintenance Triggers.....	58
Summary of Durability Requirements		59
7.15	Reinforced Concrete	59
7.16	Steelwork Protection in Exterior Environments	60
8	A.1 8a Tunnel (Geometry & Structure) (TU1, TU4).....	61
A.1 8b	Tunnel (M&E / F&LS) (TU2, TU3)	61
9	A.1 9 OMCS & ITS (O1, O2).....	62
10	A.1 10 Landscaping and Environmental Design (L1, L2)	63
Environmental		63
10.1	Purpose and Scope of Report	63
10.2	Relationship to Project Objectives	63
Design Standards and Criteria		63
10.3	Performance Criteria	63
10.4	Design Assumptions.....	64
Environmental Design, Management and Landscape Elements		64
10.5	Environmental Design Review.....	64
10.5.1	<i>Retention and Protection of Existing Vegetation.....</i>	<i>65</i>
10.5.2	<i>Temporary and Permanent Erosion and Sediment Controls.....</i>	<i>65</i>
10.5.3	<i>Aesthetic Treatments Proposed</i>	<i>65</i>
Environmental Approvals and Compliance		83
10.6	Environmental Management.....	83
10.6.1	<i>Environmental Management Plan (Construction)</i>	<i>83</i>
10.6.2	<i>Environmental Management Plan (Operation).....</i>	<i>84</i>

10.7	Offset Strategy	84
10.7.1	Offset Plans	85
10.7.2	Translocation Plan	85
	Value Add Options	86
	Agreed Exceptions	87

Executive Summary Design

Global Capability, Local Application

Nexus Infrastructure has strategically chosen the best partners from global and local markets based on competency and experience in large-scale road and tunnelling projects. Our collective capability encompasses the full spectrum of scope for the TSRC Project. We bring unrivalled experience, knowledge and lessons learned from the delivery of comparable national and international projects, a depth of technical and engineering expertise from some of the largest organisations in the world and the proven local capability of Australia's and Queensland's most experienced specialist regional road infrastructure designers and contractors.

Design and construction of the TSRC Project will be contracted by Nexus Infrastructure to our integrated Design and Construction (D&C) Joint Venture (JV) comprising Acciona Infrastructure Australia (Acciona) and Ferrovial Agroman Australia (Ferrovial Agroman).

Our dedicated Design JV comprises industry leaders Aurecon and Parsons Brinckerhoff who are arguably the most experienced road and tunnel designers in Australia having either collectively or individually been involved in virtually all road and tunnel projects in Australia in recent years. They have a combined portfolio of 24 PPPs in Australia.

Aurecon has operated an office in Toowoomba since 1996 and has had ongoing involvement in various phases of the TSRC development. This local presence provides Nexus Infrastructure with a detailed understanding of the Project, key stakeholders, the history behind the key Project drivers and changes that have occurred in the past 20 years.

Acciona and Ferrovial committed full time design resources within the Nexus Infrastructure bid office in Brisbane, and linked and integrated with design team resources in their respective Madrid home offices. At critical bid stages, technical discipline experts from the Acciona and Ferrovial Madrid offices travelled to the bid office to review and challenge the technical development of the design and inspect the TSRC corridor first-hand.

A significant point of difference for the Nexus Infrastructure consortium is the integrated end-to-end technical capability of each of our joint venture D&C Subcontractors. Each organisation has all-encompassing expertise as full service contractors in the design, delivery and operation of highway and tunnel infrastructure. This capability gives us a unique level of insight and understanding of the project requirements and ensures whole-of-life thinking through the design process and an innate ability to pursue the drivers of long term project success.

A significant point of difference is the integrated end-to-end technical capability of each of our joint venture D&C Subcontractors

Depth of Technical Resources

Our D&C JV members are global giants in road and tunnel infrastructure and tollroad services. We have drawn on their immense technical resource capability and global price benchmarking database to develop a very competitive offer, achieved through rigorous due diligence, analysis, challenging of assumptions and a pursuit of innovation.

Nexus Infrastructure has established a project specific technical Innovation and Review Group (IRG) comprising key representatives from the Centres of Excellence and international research and development divisions within our D&C JV members' parent organisations. Through Acciona and Ferrovial Agroman, we have access to an international pool of more than 1000 dedicated specialist transport engineers who have been instrumental in the review and development of our design.

The IRG has provided a critical link with our local Design JV and has facilitated the integration of global best practice with practical local knowledge and application.

The IRG was established to holistically review and challenge the Concept and developing Designs throughout the Design Development period, to achieve an innovative regional transport solution that maximises Design Life, considers future capacity requirements, facilitates operational efficiencies and ultimately drives value for the State.

The Group has been instrumental in driving our formal value for money workstreams, focusing on traffic volume, operational benchmarking, delivery program, pavement design and alternative alignments. Our technical knowledge and contribution to the interactive workshops has been acknowledged by the State. We have demonstrated an open and collaborative approach to working with the State's technical team and we have brought to the table a number of innovations and solutions for the Project, which have been conceived and developed by the IRG.

The Innovation and Review Group has provided a critical link with our local Design JV and has facilitated the integration of global best practice with practical local knowledge and application.

Design Outcomes

Nexus Infrastructure will meet the challenge presented by the State to deliver a world class Tollroad asset that becomes the centrepiece of economic development in the region. We acknowledge the State's Project Objectives and minimum requirements which have formed the basis of our design approach.

Features of Nexus Infrastructure's Design

- **Integrated Design Development process:** Our significant investment in Design Development, including the integration of specialist technical advisors, international resources and all key workstreams has delivered innovative alternative options and removed layers of Project delivery risk contingencies to drive down cost across all elements.
- **Geometry integrated with the landform to minimise grades:** Horizontal and vertical geometry of the Tollroad has been optimised within the corridor to minimise grades. This will result in improved travel times to and around Toowoomba, contributing to greater freight vehicle efficiency and improved safety for all road users.
- **Efficient cut and fill strategy:** The Design JV has undertaken sophisticated 3D geological modelling at critical cutting locations along the alignment to provide a more accurate assessment of the materials won from each cutting and to determine the stability of each cutting. This analysis has provided Nexus Infrastructure with more certainty over our ability to source materials on site, which has enabled us to develop an efficient cut and fill strategy that will reduce the requirement to import materials to the site and maximise reuse of material including poor quality soils and spoil.

1 A.1 1 Traffic (T1, T2, T3)

1.1.1 Turn Pocket Storage and 95th Percentile Queue Lengths

Turn pocket queuing has been assessed against the provided storage in the Tender Design to ensure that turn pocket queuing will not impact on through movement traffic flow.

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.1 - Traffic

Question ID	Report Reference	Performance Specification Reference	Question	Proponent Response
T116	A1.1	Volume 4 - Proposal returnable schedules T2, T3	Can the Proponent please confirm they have assessed all the Toowoomba Regional Council (TRC) controlled intersections for level of service (LoS C) in accordance with the Performance Specification, Exhibit A, Section 3b(viii).	The Toowoomba Regional Council (TRC) controlled intersections have been analysed based on various assumptions to generate traffic numbers as traffic data wasn't made available during the RFP phase for all the intersections. As reported in the traffic element report, A.1, section 5.3.1 the LoS at the Gowrie Junction Road and Ganzer Road intersection is predicted to be LoS D if it is un-signalised. To achieve a LoS C or better signals need to be provided. A sketch showing the new configuration of the intersection is attached as Appendix T116a along with the corresponding traffic reports (Appendix T116b). Nexus confirms that there is no impact on either D&C or Operations and Maintenance costs.
T162	A1.1	Volume 4 - Proposal returnable schedules T2, T3	Further to your response to T116, can Nexus amend its Gore Highway Interchange solution designs to be consistent with the T116 response and include the left turn for the southbound TSRC onto the Gore Highway eastbound?	We believe the reference in the question should be T117 and not T116. In order to provide consistency with Nexus response to clarification question T117, a southbound TSRC to Gore Highway eastbound has been added. Due to the site constraints a 70 degree stand-up is provided at the Gore Highway as shown in the sketch attached as Appendix T162. The D&C cost impact of this change is \$2,430,000.00. The O&M Cost associated with this item over the concession term is \$655,025 (real) and the Capex cost is \$1.048m (real). Response Updated on 16th June 2015 Nexus' RFP submission excluded the subject left turn movement (TSRC southbound to eastbound movement onto the Gore) whereas our response to Q&A T117 misstated that the only movement not provided was the westbound on Gore north to the Tollroad, thereby inadvertently creating some ambiguity. Responding to T162 above we provided the cost impact of the left turn movement. However, we have now undertaken a detailed assessment which has yielded revised quantities for the work required. We confirm now that the D&C cost impact of the left turn movement is \$1,900,000.00 and not \$2,430,000.00 as indicated above. Furthermore, Nexus can confirm that the revised O&M Cost over the concession term is \$163,750 (real) and the Capex cost is \$665,556 (real). Attachment Not included - Refer T166

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.1 - Traffic
Attachment for T116

1. For notes and legend refer to Series No. GA-NL-01.

128SP197950

12A345

INSET

CONTROL LINE MCOO

CONTROL LINE MC10

HOLMES ROAD

Toowoomba City

TOOWOOMBA SECOND RANGE CROSSING
GENERAL ARRANGEMENT LAYOUT
SHEET 33



**Queensland
Government**

Job No.	—
Contract No.	—
Drawing No.	B
Series Number	GA-33 of 57
MRR Detail (06/13)	

[illegible]

LOCKYER VALLEY RC AND TOOWOOMBA RC				
WARREGO HIGHWAY - GORE HIGHWAY				
CTL CHGE 599.306 - 42563.038 (MCOO)				
Reference Points				
Preceding RP	Dist. to start of job (km)	From start to end of job	From end to Following RP	Following RP
Through Chaining from				

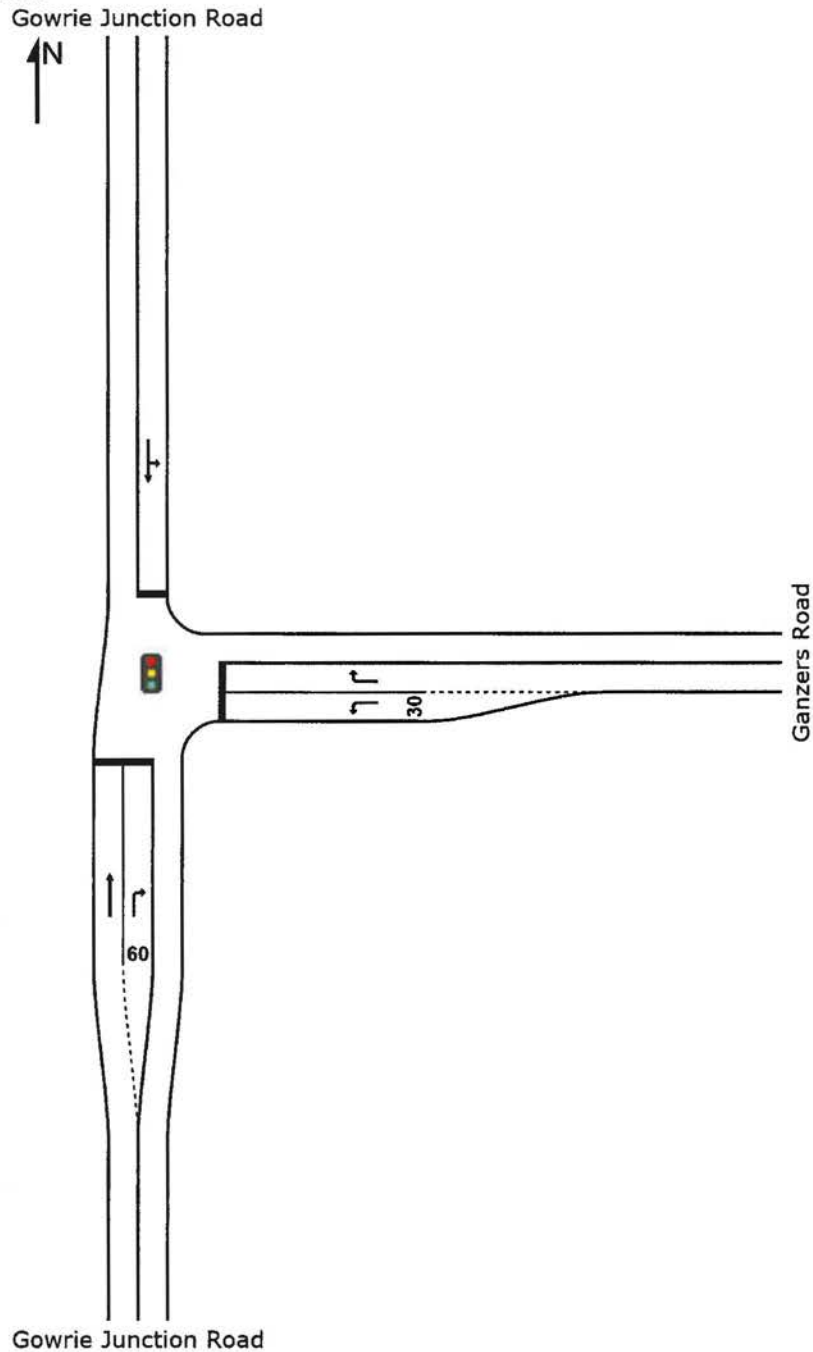
Drawn	ENGINEERING CERTIFICATION (RPEQ)				
J. McDonnell	ENG. AREA	NAME	SIGNATURE	NO.	DATE
Designed					
T. March					

SITE LAYOUT

 Site: Conforming Tender Design Gowrie Junction Road - Ganzers Road AM 2042

New Site

Signals - Fixed Time



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Project:
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_Business_Case\03_WrkPapers\Traffic\SIDRA\Non - tolled intersections\Gowrie Junction Road - Ganzers Road
11-02-2015.sip6
8000926, 6017362, PARSONS BRINCKERHOFF AUSTRALIA, NETWORK / Enterprise

MOVEMENT SUMMARY

 **Site: Conforming Tender Design Gowrie Junction Road - Ganzers Road AM 2042**

New Site

Signals - Fixed Time Cycle Time = 60 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMo v	Demand Flows	Deg. Satn	Average	Level of	95% Back of Queue		Prop.	Effective	Average	
		Total	HV	Delay	Service	Vehicles	Distance	Queued	Stop Rate	Speed	
		veh/h	%	sec		veh	m		per veh	km/h	
South: Gowrie Junction Road											
2	T1	535	0.0	0.392	4.0	LOS A	6.5	45.2	0.44	0.39	56.3
3	R2	40	0.0	0.215	34.2	LOS C	1.2	8.1	0.95	0.72	37.6
Approach		575	0.0	0.392	6.1	LOS A	6.5	45.2	0.48	0.42	54.4
East: Ganzers Road											
4	L2	45	0.0	0.081	22.0	LOS C	1.0	6.7	0.75	0.71	43.2
6	R2	60	0.0	0.323	34.6	LOS C	1.8	12.3	0.97	0.74	37.3
Approach		105	0.0	0.323	29.2	LOS C	1.8	12.3	0.87	0.73	39.6
North: Gowrie Junction Road											
7	L2	60	0.0	0.890	31.8	LOS C	30.5	213.4	0.97	1.09	40.9
8	T1	805	0.0	0.890	26.2	LOS C	30.5	213.4	0.97	1.09	41.7
Approach		865	0.0	0.890	26.6	LOS C	30.5	213.4	0.97	1.09	41.7
All Vehicles		1545	0.0	0.890	19.2	LOS B	30.5	213.4	0.78	0.82	45.5

Level of Service (LOS) Method: Delay (HCM 2000).

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akçelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

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Project:

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_Business Case\03_WrkPapers\Traffic\SIDRA\Non - tolled intersections\Gowrie Junction Road - Ganzers Road
11-02-2015.sip6

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LEVEL OF SERVICE

 **Site: Conforming Tender Design Gowrie Junction Road - Ganzers Road AM 2042**

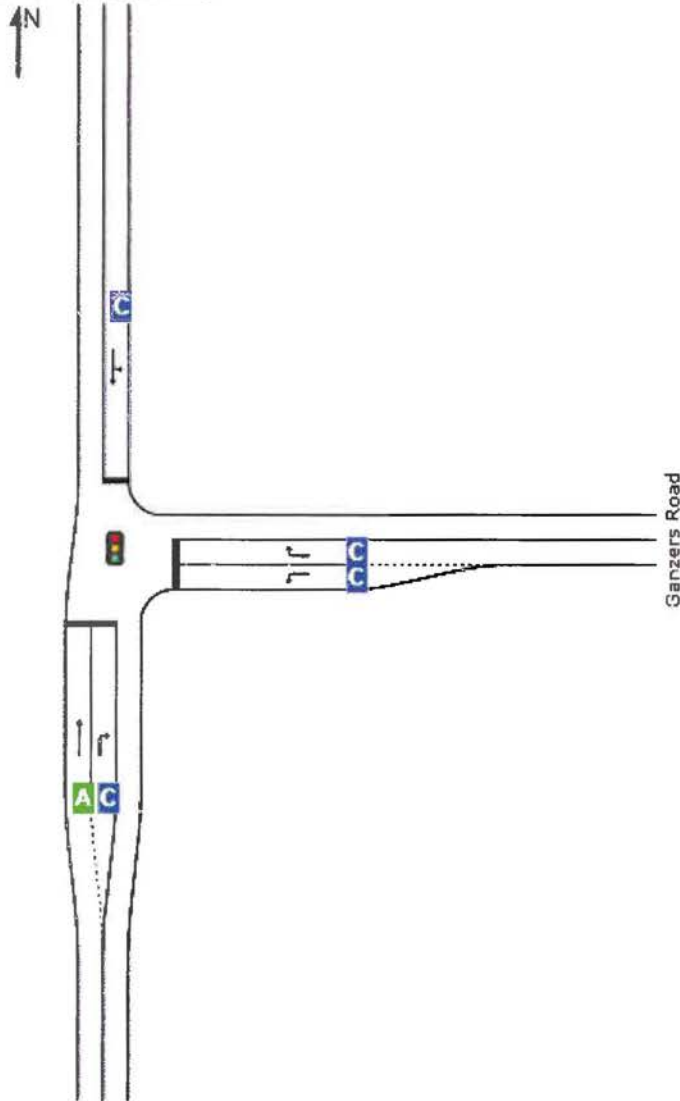
New Site

Signals - Fixed Time Cycle Time = 60 seconds (Practical Cycle Time)

All Movement Classes

	South	East	North	Intersection
LOS	A	C	C	B

Gowrie Junction Road



Gowrie Junction Road

Level of Service (LOS) Method: Delay (HCM 2000).

Lane LOS values are based on average delay per lane.

Intersection and Approach LOS values are based on average delay for all lanes.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

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Project:

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11-02-2015.sip6

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PHASING SUMMARY

 **Site: Conforming Tender Design Gowrie Junction Road - Ganzers Road AM 2042**

New Site

Signals - Fixed Time Cycle Time = 60 seconds (Practical Cycle Time)

Phase times determined by the program

Sequence: Opposed Turns

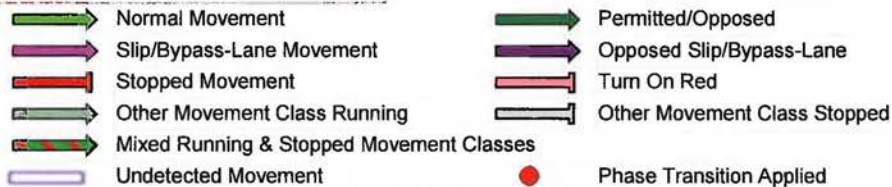
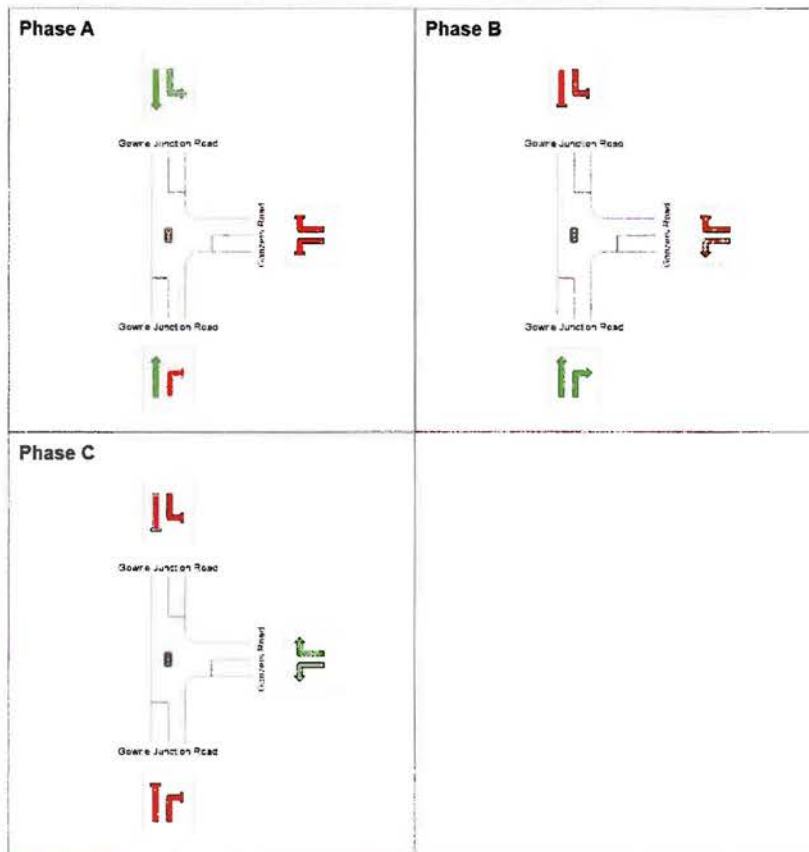
Movement Class: All Movement Classes

Input Sequence: A, B, C

Output Sequence: A, B, C

Phase Timing Results

Phase	A	B	C
Reference Phase	No	Yes	No
Phase Change Time (sec)	24	0	12
Green Time (sec)	30	6	6
Yellow Time (sec)	4	4	4
All-Red Time (sec)	2	2	2
Phase Time (sec)	36	12	12
Phase Split	60 %	20 %	20 %



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Project:

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_Business Case\03_WrkPapers\Traffic\SIDRA\Non - tolled intersections\Gowrie Junction Road - Ganzers Road
11-02-2015.sip6

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DEGREE OF SATURATION

Ratio of Demand Volume to Capacity (v/c ratio)

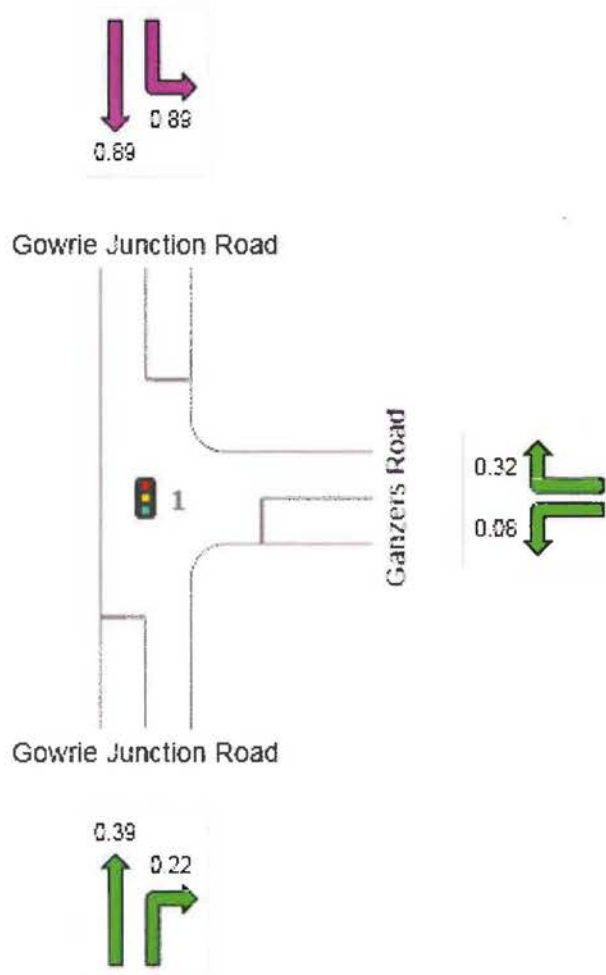
 **Site: Conforming Tender Design Gowrie Junction Road - Ganzers Road AM 2042**

New Site

Signals - Fixed Time Cycle Time = 60 seconds (Practical Cycle Time)

All Movement Classes

South	East	North	Intersection
0.39	0.32	0.89	0.89



Colour code based on Degree of Saturation

						
[< 0.6]	[0.6 - 0.7]	[0.7 - 0.8]	[0.8 - 0.9]	[0.9 - 1.0]	[> 1.0]	Continuous

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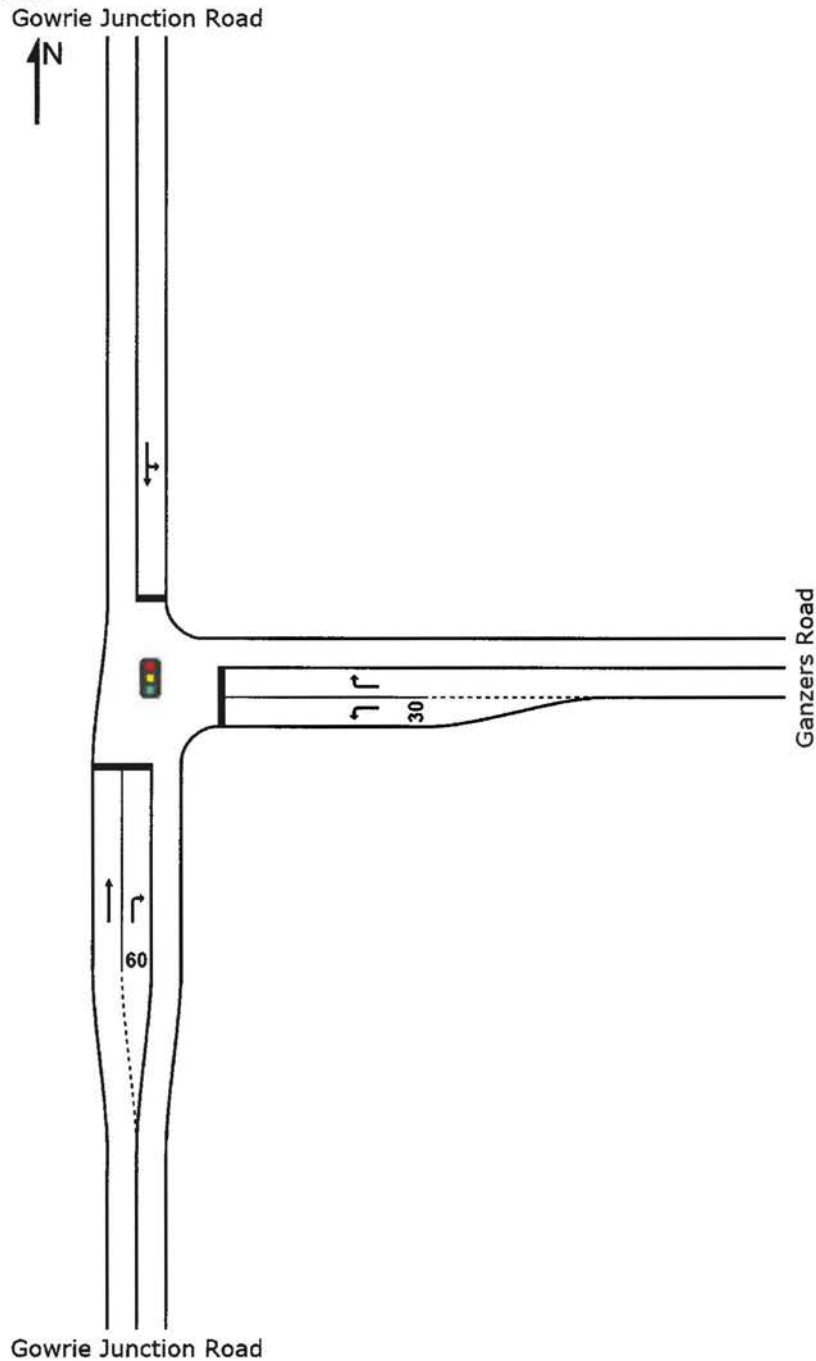
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SITE LAYOUT

 Site: Conforming Tender Design Gowrie Junction Road - Ganzers Road PM 2042

New Site

Signals - Fixed Time



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MOVEMENT SUMMARY

 **Site: Conforming Tender Design Gowrie Junction Road - Ganzers Road PM 2042**

New Site

Signals - Fixed Time Cycle Time = 50 seconds (Practical Cycle Time)

Movement Performance - Vehicles

Mov ID	ODMo v	Demand Flows Total veh/h	Flows HV %	Deg. Satn v/c	Average Delay sec	Level of Service	95% Back of Queue Vehicles veh	Distance m	Prop. Queued	Effective Stop Rate per veh	Average Speed km/h
South: Gowrie Junction Road											
2	T1	805	0.0	0.645	6.0	LOS A	12.2	85.2	0.66	0.60	54.6
3	R2	65	0.0	0.292	28.8	LOS C	1.6	10.9	0.95	0.74	39.8
Approach		870	0.0	0.645	7.7	LOS A	12.2	85.2	0.68	0.61	53.1
East: Ganzers Road											
4	L2	30	0.0	0.045	16.9	LOS B	0.5	3.4	0.68	0.68	46.0
6	R2	40	0.0	0.179	28.3	LOS C	0.9	6.6	0.93	0.72	39.8
Approach		70	0.0	0.179	23.4	LOS C	0.9	6.6	0.82	0.71	42.3
North: Gowrie Junction Road											
7	L2	90	0.0	0.807	24.3	LOS C	15.9	111.6	0.95	0.96	44.4
8	T1	535	0.0	0.807	18.8	LOS B	15.9	111.6	0.95	0.96	45.4
Approach		625	0.0	0.807	19.6	LOS B	15.9	111.6	0.95	0.96	45.2
All Vehicles		1565	0.0	0.807	13.2	LOS B	15.9	111.6	0.80	0.75	49.1

Level of Service (LOS) Method: Delay (HCM 2000).

Vehicle movement LOS values are based on average delay per movement

Intersection and Approach LOS values are based on average delay for all vehicle movements.

SIDRA Standard Delay Model is used. Control Delay includes Geometric Delay.

Gap-Acceptance Capacity: SIDRA Standard (Akcelik M3D).

HV (%) values are calculated for All Movement Classes of All Heavy Vehicle Model Designation.

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**SIDRA
INTERSECTION 6**

PHASING SUMMARY

 **Site: Conforming Tender Design Gowrie Junction Road - Ganzers Road PM 2042**

New Site

Signals - Fixed Time Cycle Time = 50 seconds (Practical Cycle Time)

Phase times determined by the program

Sequence: Opposed Turns

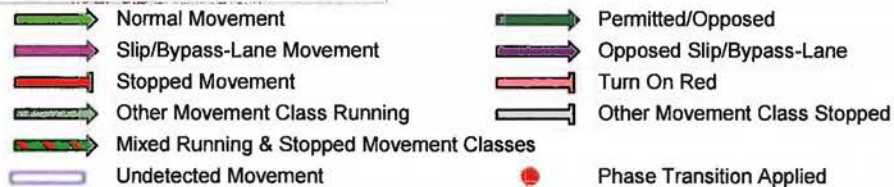
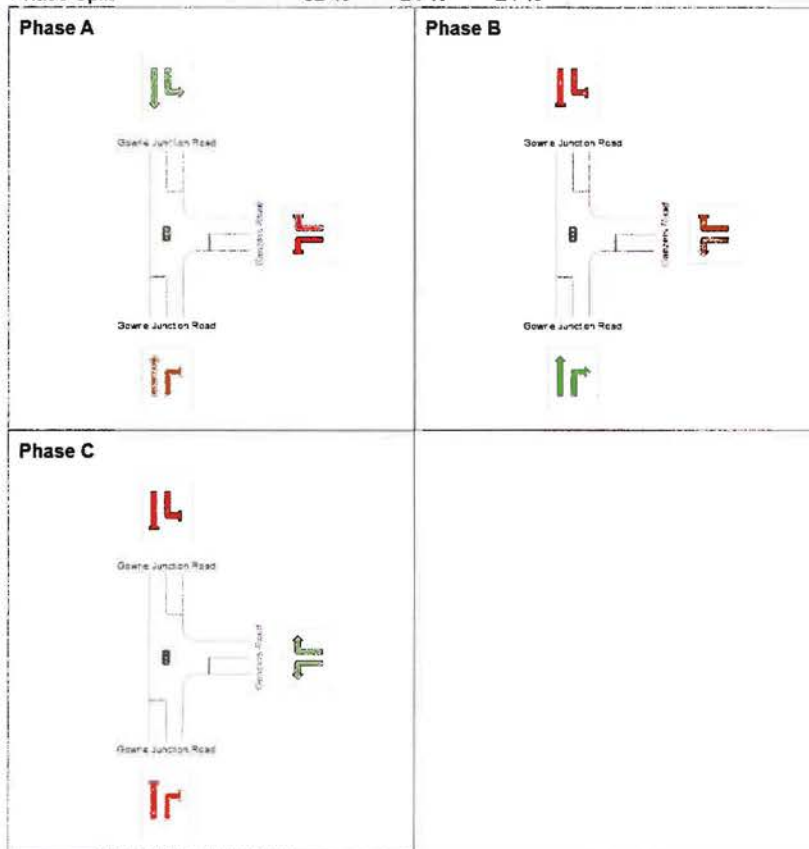
Movement Class: All Movement Classes

Input Sequence: A, B, C

Output Sequence: A, B, C

Phase Timing Results

Phase	A	B	C
Reference Phase	No	Yes	No
Phase Change Time (sec)	24	0	12
Green Time (sec)	20	6	6
Yellow Time (sec)	4	4	4
All-Red Time (sec)	2	2	2
Phase Time (sec)	26	12	12
Phase Split	52 %	24 %	24 %



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Project:

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_Business Case\03_WrkPapers\Traffic\SIDRA\Non - tolled intersections\Gowrie Junction Road - Ganzers Road
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2 A.1 2 Road Geometry & Road Safety (R1, R2, R3)

2.1 R3 Application of Extended Design Domain

An extended design domain is not proposed on any aspects of the TSRC Project.

A normal design domain in accordance with the anticipated road function is proposed for all aspects of the TSRC road design.

2.2 R3 Road Design Approach and Methodology

The TSRC Tender Design has been developed from the Reference Design provided by the State to optimise constructability, geometry, connectivity and safety.

The major opportunities identified by Nexus Infrastructure to improve the Reference Design include:

- Improved horizontal and vertical alignments to better coordinate with the landform and terrain
- Realignment to reduce aquaplaning potential
- Optimisation of the cross-section to improve safety
- Sight distance widening in constrained alignments to improve safety
- Overtaking provision
- Inclusion of safety features including emergency U-turn facilities, emergency stopping bays and vehicle stopping bays
- Interchange reconfiguration to separate movements and provide increased functionality
- Local access and interface with the local road network
- Emergency, fire trail and maintenance access.

Our approach to how we addressed each of these issues is outlined in the following sections.

2.2.1 Coordination of Vertical and Horizontal Alignment

The Tender Design has been refined within the corridor to achieve:

- A consistent, safe driving experience that matches the driver's expectations for the variations in the topography and roadside use
- Appropriate application of current design standards
- Improves coordination with the terrain, reducing the corridor's impacts
- Safe, value-driven construction.

The extent of realignment has been constrained by:

- Extremes in the topography, particularly on the eastern side of the New England Highway
- Corridor boundary constraints and the availability of adjacent property
- Environmental and cultural heritage impacts
- Geotechnical conditions
- Flooding impacts and impacts on watercourses
- Major services
- Connectivity to the adjacent road network and adjacent property development (including the Brisbane West Wellcamp Airport)
- Coordination with future road network upgrades.

This design optimisation has been achieved by:

- Matching the alignment to suit the adjacent land use and topography. Broadly, the Project can be defined by the following sections:
 - > Warrego Highway East to Murphys Creek Road: Rural, wide median-separated carriageway alignment consistent with the adjacent Warrego Highway
 - > Murphys Creek Road to the New England Highway Bridge: Rural and environmentally sensitive, constrained topography with extensive cut and fill
 - > New England Highway Bridge to Warrego Highway (West): Urbanised roadside use with higher visual amenity and impacts on adjacent property
 - > Warrego Highway West to Gore Highway: Rural, high speed, low volume road similar to the adjacent Gore Highway
- Realigning to reduce the extent of sidelong cuts and fills
- Reducing the number of short lengths of straights and 'broken back' curves
- Removing trapped sags in cuttings from the design wherever possible
- Including crests within horizontal curves to improve driver recognition of changes in alignment
- Placement of the alignment in defined fill or cut in 'black soil' environment to reduce sidelong expansive clay treatments
- Relocation of the alignment (horizontally and vertically) to reduce impacts on major services.

2.2.2 Roadside Barriers

Roadside barriers have been minimised for the length of the project by adoption of flat, traversable batter slopes with appropriate hazard free zones where possible.

However, due to the extreme sidelong terrain, the alignment of the road and associated roadside hazards (drainage structures, opposing traffic, bridge piers etc) lengths of barrier have been included in the design of the TSRC through carriageway and side roads.

TSRC Barriers

The selection of barriers (location and type) has been reviewed as part of the design with the following approach adopted:

- Batters have been flattened where appropriate to provide traversable roadside environment
- Barrier protection has been included in accordance with the RPDM to protect against roadside hazards including:
 - > High fill embankments
 - > Non-traversable cut and fill slopes (including 1 on 2 or steeper cutting slopes)
 - > Major drainage structures
 - > Bridge piers.

The most significant hazards within the clear zone adjacent to the TSRC carriageway are the high cut and fill batters, roadside structures and the opposing traffic streams.

The roadside batters are up to 50 m high with 1V:2H batter slopes and occur along significant lengths of the both carriageways.

Roadside structures include bridge piers, bridge crossings of waterways and large drainage structures

In dual carriageway sections with narrow median, opposing traffic streams are separated by median barrier as the TSRC has:

- A narrow median to minimise the overall impact of the works
- a horizontal alignment that varies along much of its length, with potential for vehicles to cross the narrow median

- significant portions of heavy vehicles
- high traffic volumes

Level of Protection

The TSRC will carry up to 28,000 vehicles per day (predicted 2042 traffic volume), of which approximately 30% are commercial vehicles.

In accordance with the DTMR Road Planning and Design Manual (RPDM) Section 8.2.5.2, Test Level 4 has been adopted as a minimum standard to reflect the relatively high proportion of commercial vehicles in the traffic stream.

Compliant Test Level 4 barriers include rigid concrete barrier, modified thrie beam or wire rope barrier.

As an outcome of the safety in design process, it was identified that rigid concrete barrier and modified thrie beam barrier have less driver exposure risk following an incident. These barrier systems perform satisfactorily without maintenance intervention outside the zone of impact.

The use of wire rope barrier systems was avoided due to the long lengths of compromised integrity of the wire rope barrier system following vehicle impacts. This aspect of wire rope barrier systems is of concern on the TSRC due to the potential for multiple incidents due to environmental factors (eg fog).

TSRC External Barrier

The following has been adopted for the installation of barriers on the TSRC:

- All TSRC barriers to be Test Level 4 compliant
- External (outside shoulder) barrier is to protect steep and/or rock cut batter faces and high fills
- All bridge piers and bridge approaches are to be protected by barrier

Median barrier

Concrete barrier has been adopted for the median with advantages of:

- Higher strength (TL-5 rated)
- Lower maintenance costs
- More consistent performance
- Performance is not impacted by pavement overlays
- Minor impacts do not degrade the performance of the barrier system.

Other Roadside Barriers

Other roadside barriers have been assessed using the TMR Road Planning and Design Manual (Chapter 8).

Generally, all locations that do not have traversable (1 on 3 or flatter) batters have been protected by w-beam barrier.

2.2.3 Emergency Stopping and U-turn Facilities

Emergency stopping and U-turn opportunities are required on the TSRC to provide access for emergency services and maintenance vehicles.

Opportunities to change carriageways on the TSRC alignment as part of the road network are:

- Mort Street interchange via the overpass structure
- Warrego Highway (west) interchange
- Cecil Plains Road interchange

Due to the limited opportunities to change carriageways east of Mort Street, dedicated emergency stopping and U-turn facilities have been included in the design.

Median Crossing Requirements

The specification also calls for the median breaks to allow for emergency vehicles to be able to cross where there is a continuous median barrier.

Emergency Vehicles

The specification calls for the median breaks to allow for emergency vehicles to be able to cross where there is a continuous median barrier.

The eastern section of the TSRC has continuous concrete median as appropriate wherever the grades are greater than 3% and the median is less than 15 metres.

In this area emergency vehicle cross overs should be provided at a maximum of 5km spacing.

General Public Vehicles

For other vehicles to be able to turn the median crossings should have a cross grade less than 3%. Austroads table 7.3 of Austroads Guide to Road Design - Part 4 allows for large vehicles to be able to turn if there is 27m of clear distance for a 19m semi-trailer to turn in, and up to 30 m for a B double. The vehicle speed of this manoeuvre is less than 5 km/hr.

The clear opening of the median is to allow for the swept path of the design vehicle (Type 1 Road train).

Maintenance Requirements

Maintenance vehicles will be able to use the General Public U-turn facilities and the local road network.

Maintenance vehicles will only be able to use narrow median breaks to access the other carriageways under full traffic management. Gated access to local roads will also be available.

Median Crossing Design Issues

Where the TSRC is a 4 lane median divided road east of the New England Highway with a wide median of approximately 15 m median there is an opportunity to provide a U-turn facility in accordance with Austroads.

Where the TSRC is a 4-lane median divided road east of the New England Highway with a narrow median of 1 m inner shoulders, there is insufficient width to allow for a vehicle to pull over into the inner shoulder to then access the median break for a U turn facility. The concrete median barrier at 1.1 m height will prevent the drivers being able to see vehicles coming in the opposite direction. Therefore the use of the median break to provide a u turn facility cannot be allowed unless the TSRC has been placed under traffic control and the traffic has been stopped.

Narrow Median Crossing Detail

The concrete median barrier will need to be continuous around any curve so that their crash rating is maintained therefore no median crossings will be placed on a curve, or within 4 seconds of travel of a curve (122 m), even if sight distance is not an issue.

Given that the inner shoulders are only 1 metre wide providing a clear opening of at least 4 metres will create a hazard to the oncoming traffic. Crash cushions will need to be placed at each end of the concrete barriers to reduce the consequence of any crashes that may occur.

Designed Median Breaks

Possible Locations

The ability to place median breaks on the eastern section of the TSRC (east of the New England Highway) is constrained by the vertical geometry. An initial assessment identified locations where the grades are less than 3%, facilitating a potential median crossing location.

Table 1: Grades Less Than 3% (East of tunnel)

Start Chainage	End Chainage
600	3 700
4 100	4 690
5 540	6 070
6 580	7 170
7 860	8 600
12 450	13 040
13 770	14 210

While these areas are less than 3%, other geometric issues may prevent them from being acceptable turn around areas.

Additional Locations

Chainage 2 300 (Public Vehicle U-Turn)

Chainage 2 300 is situated in an area of wide median and relatively flat grades at the beginning of the project. This area can provide a U-turn area that meets Austroads requirements.

The design vehicle can make a U-turn from the left lane based on nominal widening of the outer edges. This means that the design vehicle would only be able to do the U-turn under stopped conditions on the TSRC.

However, a large truck such as a B double would be able to turn from the right lane.

The advantage of a U-turn facility here is that maintenance and emergency vehicles can safely make turns at this location.

Chainage 4 500 (Maintenance access via public road)

Chainage 4 500 is situated in an area of narrow median adjacent to the Murphy's Creek Road overbridge. Murphy's Creek Road is a declared Main Road and under TMR management. This location ties into the old Murphy's Creek Road alignment. However a subsequent review of the old road shows that it has been removed at the southern end and examination shows that the connection would be very difficult to reinstate given the realigned roads levels and location.

The connection to the north from the Brisbane bound lanes of the TSRC has been made, suitable for maintenance vehicles only.

Chainage 8 700 (Maintenance access via public road)

Chainage 8 700 is situated in an area of steep grade and narrow median. The existing Gittens Road will be passing under the TSRC in this location. Given the realignment of the National Trail and the required access roads in the area, it was deemed an appropriate location to provide maintenance and/or emergency vehicle access at this point. The access would be to leave the TSRC and to use the Gittens underpass to re-enter the TSRC on the other side. This would mean that safe and convenient U-turn facility is provided.

Chainage 12 800 (Emergency vehicle cross over)

Chainage 12 800 is situated in an area of relatively flat grade and narrow median. This section occurs between the two steep climbs in the eastern section of the TSRC. Providing a pull over area in this location would be necessary to allow for distressed vehicles to be able to stop before continuing the second climb up towards the New England Highway. Consequently on the down grade side it provides an area for vehicles to stop after traversing the first steep down grade, before they have to traverse the second steep down grade.

Putting layby areas in this location provides sufficient width that if it was deemed absolutely necessary a U-turn facility to suit the design vehicle could be installed, however it would only be able to operate under TSRC stopped conditions and is not recommended due to the topography.

Summary

Table 2: Emergency Crossings and Maintenance Accesses

Chainage	Design Vehicle U-Turn	Emergency Vehicle Crossing	Incident Response Vehicle	Fire Trail Access	Maintenance Access	Comment
2300	✓	✓	✓		✓	
4500					✓	Eastbound only
8700					✓	
10450				✓	✓	Grade separated fire access to McNamaras Road via underpass
11500				✓	✓	
12800				✓	✓	At emergency arrestor bed
13580				✓	✓	Grade separated fire access via underpass
14520				✓	✓	
15100				✓	✓	

Chainage	Design Vehicle U-Turn	Emergency Vehicle Crossing	Incident Response Vehicle	Fire Trail Access	Maintenance Access	Comment
19000	✓	✓	✓		✓	Mort Street

2.2.4 Arrester Beds

Annexure 01: Performance Specification – Design does not directly refer to the need for arrester beds to be installed in the Project. However, the drawings provided for two vehicle arrester beds at approximate chainages 9,700 and 13,100.

2.2.5 Vehicle Stopping Place

A dedicated vehicle stopping place site has been located on the TSRC at Chainage 20600 for both eastbound and westbound traffic.

This site was selected as it:

- Allows load and brake inspection prior to the downgrade east of Mort Street
- Provides a recovery zone for westbound vehicles following the upgrade east of Mort Street
- Is on a crest, facilitating acceleration for vehicles after use of the stopping bay
- Provides 30 second travel time (800 m) between the Mort Street ramps and the stopping bay, reducing the impacts of the interchange and stopping bay on traffic flows
- Is on a four-lane section of the alignment, allowing overtaking of accelerating vehicles and minimising disruption to through traffic.

The vehicle stopping bay has been designed as a heavy vehicle stopping bay in accordance with Chapter 20 of the TMR Road Planning and Design Manual.

2.2.6 Public Transport

There are limited public transport facilities currently in the Project corridor, with the only public bus route crossing the corridor at New England Highway.

As the TSRC is a major freight route, provision for public transport infrastructure was not included due to the safety impacts.

No public transport infrastructure was impacted by the changes to the local road network, therefore it is not proposed to include new or replacement public transport infrastructure into the Project.

2.2.7 Fencing

Fencing has been provided within the project to provide boundary separation of the road corridor and the adjacent properties. Additional fencing has been provided to discourage unauthorised fauna, vehicle and pedestrian access to the TSRC through carriageway and the sedimentation basins.

Boundary Fencing

Part of the Boundary fencing for the Project has been undertaken by the State in conjunction with the property acquisition and consultation activities. The outstanding part of the Boundary Fencing will be either undertaken by Nexus (as part of the Accommodation Works Schedule) or directly by the State.

Fauna Fencing

Fauna fencing has been included at key fauna passage routes to reduce the potential for fauna strike on the road corridor, improving driver safety and reducing environmental impact.

This fencing has been located to:

- Coincide with identified fauna corridors
- Direct fauna to crossing points under the alignment
- Supplement the concrete roadside barrier in directing fauna away from the road corridor.

The fencing is to be in accordance with TMR Standard Drawing 1603 and is shown on the design drawings.

Separation Fencing

To provide separation between the TSRC and longitudinal property accesses and local road network, an 1,800 mm high chain wire fence has been included between the TSRC and the local road network in accordance with TMR Standard Drawing 1602.

Gates have been included in this fence to facilitate maintenance and emergency access to the TSRC and are shown on the drawings in the Roads and Safety Element of the A.1 – Design Drawings Folder.

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.2 – Road Geometry & Road Safety

Question ID	Report Reference	Question	Proponent Response
T72	A1.2	From your Proposal it is not evident that your Proposed design for Six Mile Creek Road has complied with the road width required in accordance with the Performance Specification, Exhibit A, Table 3.1. In particular, the road width must achieve the following: 'Access must be suitable for use by a semi-trailer with adequate width to pass a car'. Please confirm your compliance with these requirements, and what impact, if any, this has to your Proposal including program, cost or other related items.	Performance Specification, Exhibit A, Table 3.1 requires that Six Mile Creek Road be reinstated as an Unsealed Rural Road - Access, and it must be suitable for use by a semi-trailer with adequate width to pass a car. Nexus has nominated a pavement width of 5.5m for Six Mile Creek Road. Nexus has assumed the design width for a car is 2.0m while a semi-trailer is 2.5m, which in our opinion provides sufficient room for a semi-trailer and a car to pass, albeit at a slow speed. Can the State please confirm whether the State or Council require a wider cross section for Six Mile Creek Road.
T73	A1.2	From your Proposal it is not evident that the design of Morleys Road has complied with the road width required in accordance with the Performance Specification, Exhibit A, Table 3.1. In particular, the road width must achieve the following: 'Access must be suitable for use by a semi-trailer with adequate width to pass a car'. Please confirm your compliance with these requirements, and what impact, if any, this has to your Proposal including program, cost or other related items.	Performance Specification, Exhibit A, Table 3.1 requires that Morleys Road be reinstated as a Bush Management accessibility track (to a similar standard as the tracks it connects with), and it must be suitable for use by a single unit truck with adequate width to pass a car. Nexus has nominated a pavement width of 5.5m for Morleys Road. Nexus has assumed the design width for a car of 2.0m and 2.5m for a truck, which in our opinion provides sufficient room for a truck and a car to pass, albeit at a slow speed. Further, the Report prepared by LVRC "Lockyer Valley Regional Council /TSRC Interaction Report for the LVRC Road Network" Appendix B Item No. 7 & 8 for Morleys Road states that the existing road width is 3.8m and as such the design complies with "matching the existing" requirement. Can the State please confirm whether the State or Council requires a wider cross section for Morleys Road.
T81	A1.2	From your Proposal it is not evident that the Sight Distance to the exit nose is achieved on the TSRC westbound exit to Boundary Street in your PAM design in accordance with AustRoads Table 7.1. Please confirm your compliance with these requirements including sufficient information to describe how this compliance will be achieved, and what impact, if any, this has to your Proposal including program, cost or other related items.	AUSTROADS Part 4c: Interchange, Table 7.1 requires that 215m of sight is provided to the exit nose for a design speed of 110kph. We confirm that 215m sight is provided to the westbound exit nose for the Pre Agreed Modification at Boundary Street. Please see Appendix T81
T82	A1.2	The State is seeking further information regarding your Alternative Option and request that you provide the horizontal and vertical SSD checks and graphs for your Alternative option alignment. This information should be sufficiently detailed for the State to consider the compliance of your Alternative Option.	Please find attached the horizontal and vertical SSD checks and graphs for Nexus' Alternative Option alignment in Appendix T82a, T82b, T82c and T82d.
T94	A1.2	The State requests that the Proponent provides a general layout and long section that describes a system interchange between the Warrego Highway east and the Toowoomba Second Range Crossing. The system interchange must: - comply with the DTMR Road Planning and Design Manual - comply with Austroads Guide to Road Design Part 4C: Interchanges and as specified below; - be configured as a two lane exit consistent with Figure 2 a (i) or Figure 4C-6 of the TMR Supplement to Part 4C and consistent with Figure 11.3 of Austroads including an auxiliary lane that is not less than 300m long; - westbound route from the existing Warrego Highway to the Toowoomba Second Range Crossing being the through route (i.e. vehicles travelling westbound in either existing lane from the Warrego Highway to the Toowoomba Second Range Crossing must be able to effect that manoeuvre without needing to change lanes); - be configured as a major branch connection generally* consistent with Figure 11.8: of Austroads with the eastbound route from the Toowoomba Second Range Crossing to the Warrego Highway being the through route (i.e. vehicles travelling eastbound in either lane of the Toowoomba Second Range Crossing to the existing two lane section of the Warrego Highway must be able to effect that manoeuvre without needing to change lanes). *Notwithstanding Austroads Part 11 the lower traffic volume from the Toowoomba Second Range Crossing may be in the right hand carriageway to facilitate the through route requirements; - not provide for any other traffic movements; - not include any single lane carriageways (i.e. all carriageways must be two lanes west of the point where they merge or diverge; and must be two lanes plus auxiliary lanes as appropriate [in terms of configuration and length] on the mainline east of that point); - include lighting at all merges and diverges; and - avoid any impact up to the ARI 2000 years flood level along Gatton Creek (Lockyer Valley Regional Council has concerns about even larger floods, bank stability and vegetation retention along Gatton Creek). Please advise what impact, if any, this has to your Proposal including program, cost or other related items. Please response by close of business on 20 April 2015.	Please refer to the following documents: - Option T94 Report - Warrego Highway (East) interchange.pdf - Option T94 Report - Attachment A - Sight Distance Checks.pdf - Option T94 Combined Drawings.pdf Nexus infrastructure advises that the modification has no impact in the program. The impact in D&C cost is: \$4,800,000.00 There is no impact in O&M cost.
T97	A1.2	It is not evident that run out area for entry ramps has either been provided or considered in the design of the Mort Street Interchange in accordance with the requirement of RPDM Chapter 15, Figure 15.6. Please confirm your compliance with these requirements, and what impact, if any, this has to your Proposal including program, cost or other related items.	Nexus confirms that the run out area for the entry ramps was not identified in our proposed design although we do acknowledge the requirement. We assess that the run out area to the West bound entry ramp requires a minor increase in the pavement area. At the East bound entry ramp, the run out area requirement would involve realigning the ramp to reduce its overall length resulting in a corresponding minor downward adjustment in the pavement area. The structure over the existing railway would require some tapered shoulder widening (0.62-0.00m) with a minor change to the area of structure (ca. 9 sqm). Nexus confirms it will comply with these requirements with no impact on its Proposal, including program or submitted price.
T99	A1.2	Please confirm in relation to Hermitage Road / Service Road access to existing industries that the design vehicle for the turnaround facility allows for a B-Double as a minimum.	Nexus Infrastructure confirms the Hermitage Road turnaround facility allows for a B-Double as a minimum. The facility has been designed to suit a B-Triple vehicle movement.

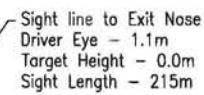
Question ID	Report Reference	Question	Proponent Response
T137	A1.2	Can the Proponent please confirm that the Toll road signage complies with the TRUM draft guideline, Toll road signs: November 2012 (amendment 18) and have also made allowance for Sign TC1810.	We confirm that we comply with the TRUM draft guideline, Toll road signs: November 2012 (amendment 18) and have also made allowance for Sign TC1810.
T140	A1.2	Project Specification, Section 3 3 PROJECT FUNCTIONAL REQUIREMENTS includes: (b) The purpose of the Project is to: (vi) provide for the public, including pedestrians and cyclists to cross the Tollroad only at safe locations; The DTMR Cycling Infrastructure Policy requires projects to provide for cycling in transport infrastructure. In addition to crossing facilities at Murphys Creek Road and local authority controlled roads, to comply with the policy facilities, including grade separation where appropriate, to provide for the safe passage of pedestrians and cyclists to cross the Tollroad are required at the following locations: • Mort Street (including through all intersections within the Project Site); • New England Highway (for the alternative "no tunnel" offer) • Warrego Highway (west); • Cecil Plains to Toowoomba Road; • Gore Highway. Please either identify the location of this information within your Proposal or provide the additional information/clarification in response to this question.	Nexus confirms it had provided in its submission for pedestrian facilities at Murphy's Creek Road as nominated. We address the additional requirements as follows: Cyclists can be accommodated through the listed intersection / road corridors on the 2.0m shoulders provided. At Mort St, the Mort St Interchange Overpass (BR11) needs to be widened to allow for a pedestrian footpath on one side. At New England Highway, no additional works are needed as each of the twin traffic bridges over the Tollroad is designed to have a footpath. At Warrego Highway (west), Cecil Plains to Toowoomba Road and Gore Highway intersections, provision is made to cross at the signals. Note, in order to achieve this, the intersection will need to be approximately 2.0m wider to accommodate pedestrian storage in the median. The impact on D&C cost for our base case at-grade intersections for our Conforming Proposal and Alternative Proposal to provide for pedestrians and cyclists is \$1,606,000. For the Grade Separated Value Add Options – To accommodate pedestrians, the overpass bridges at each of the interchanges (Warrego West, Cecil Plains Road, Gore Highway) will need to be increased in length to allow for footpaths underneath. At the Warrego and Cecil Plains pedestrians can cross at the signalised intersections. The impact on D&C cost for our Grade Separated Interchange options to provide for pedestrians and cyclists is \$1,646,000. (The costs have been included in the financial model, as requested by the State, submitted as part of our response to FC64 answer) The costs associated with the provisioning of pedestrian overpass structures associated with our roundabout intersection solutions are addressed in our response to T113. Appendix T140 provides the relevant overpass bridge drawings.
T141a	A1.2	Can the Proponent please confirm that the truck stop facilities off the Warrego Highway will remain operational 24/7 throughout the construction ?	We confirm that the truck stop facilities off the Warrego Highway will remain operational 24/7 throughout the construction.
T165	A1.2	Further to your response #202, can Nexus provide updated General Arrangement plans that adequately illustrate the Cecil Plains Road and Warrego Highway (west) interchanges to reflect the additional turning lanes for binding into the Part 2s.	Please find attached Appendix T165 which includes the updated General Arrangement drawings for the grade-separated interchanges at Cecil Plains Road and Warrego Highway (west) interchanges.
T166	A1.2	Further to your response on 18 June (Question ID 1853), the State require Nexus to comply with the Approvals and Project Documents and as such Nexus need to make all changes necessary to stay within the EPBC boundary near Murphys Creek Road (council side road) and the Gore Highway Interchange (left turn lane).	Please find attached Appendix T166 which provides amended general arrangement details at the Murphys Creek Road side road and the Gore Highway left turn lane, which demonstrate these road elements are now designed to be fully contained within the EPBC boundary. Nexus confirms that all proposed works on the project are within the EPBC boundary at all locations except at the tie-in at the eastern end, where the Warrego Highway east interchange falls within the road reserve beyond the EPBC area as confirmed in our response to Question ID 1853 on 18 June.
T174	A1.2	Further to your response on 17 June (Question ID 6089) in relation to the truck unloading facility, the State proposes an alternative location (refer T174.pdf) that replaces the current requirements for two truck unloading facilities as documented in the Performance Specification with a new set of requirements as listed below: Replace the two existing load breakdown areas with a load breakdown facility that must be located on the north western side of the Warrego Highway interchange. The load breakdown area must include: A) entry and egress via the existing Nass Road intersection to Lot 1 on SP 187181 that facilitates the safe usage of the load breakdown area; B) a paved load breakdown area that uses to the maximum extent practicable the residual land (west of the proposed interchange ramp) on Lot 1 on SP187181; C) pavement as per TMR drawing 611867 (Nugent Pinch Upgrade); D) toilet facilities (50 m2); and E) signage, including signage limiting its use to heavy vehicles and direction signage including advance direction signage. Please advise the impact, if any to your Proposal including program, cost or other related items to provide the above requirements. The State is anticipating a reduction in cost due to the reduction in requirements including the need for only 1 truck unloading facility.	Appendix T174 outlines the proposed location for the truck unloading facility within the area identified by the State. Nexus confirms the cost to build this facility is \$1,424,000. We also confirm there won't be any impact in program or other related items.
T178	A1.2	Further to your response to T165, it is not evident that Nexus has provided an at-grade, all movements intersection at both Nass Road and Wirth Road junctions with Warrego Highway (west) in accordance with the NP2C four laning project (refer T178.pdf). Can Nexus confirm these requirements are met and annotate their drawing accordingly.	The proposed solution at Warrego Highway (west) does not propose to upgrade this intersection however the new works will tie-into the existing road alignment (i.e. will tie-into the works constructed as part of the Nugents Pinch upgrade).

Question ID	Report Reference	Question	Proponent Response
T180	A1.2	Can Nexus please confirm that the Weighbridge and Toll House that is shown in your Proposal for the Toowoomba Waste Management Centre is a replacement of "like for like" with the existing infrastructure.	Nexus confirms that the Weighbridge and Toll House for the Toowoomba Waste Management Centre is a replacement of "like for like" with the existing infrastructure.

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.2 – Road Geometry & Road Safety
Attachment for T81

31/3/2015 @ 11:21am

DETAILS & DIMENSIONS ARE SUBJECT TO REVIEW OR
FURTHER DEVELOPMENT DURING DETAILED DESIGN



APPROACH SIGHT
DISTANCE SECTION
Horizontal Scale - 1:500
Vertical Scale - 1:100

[illegible]

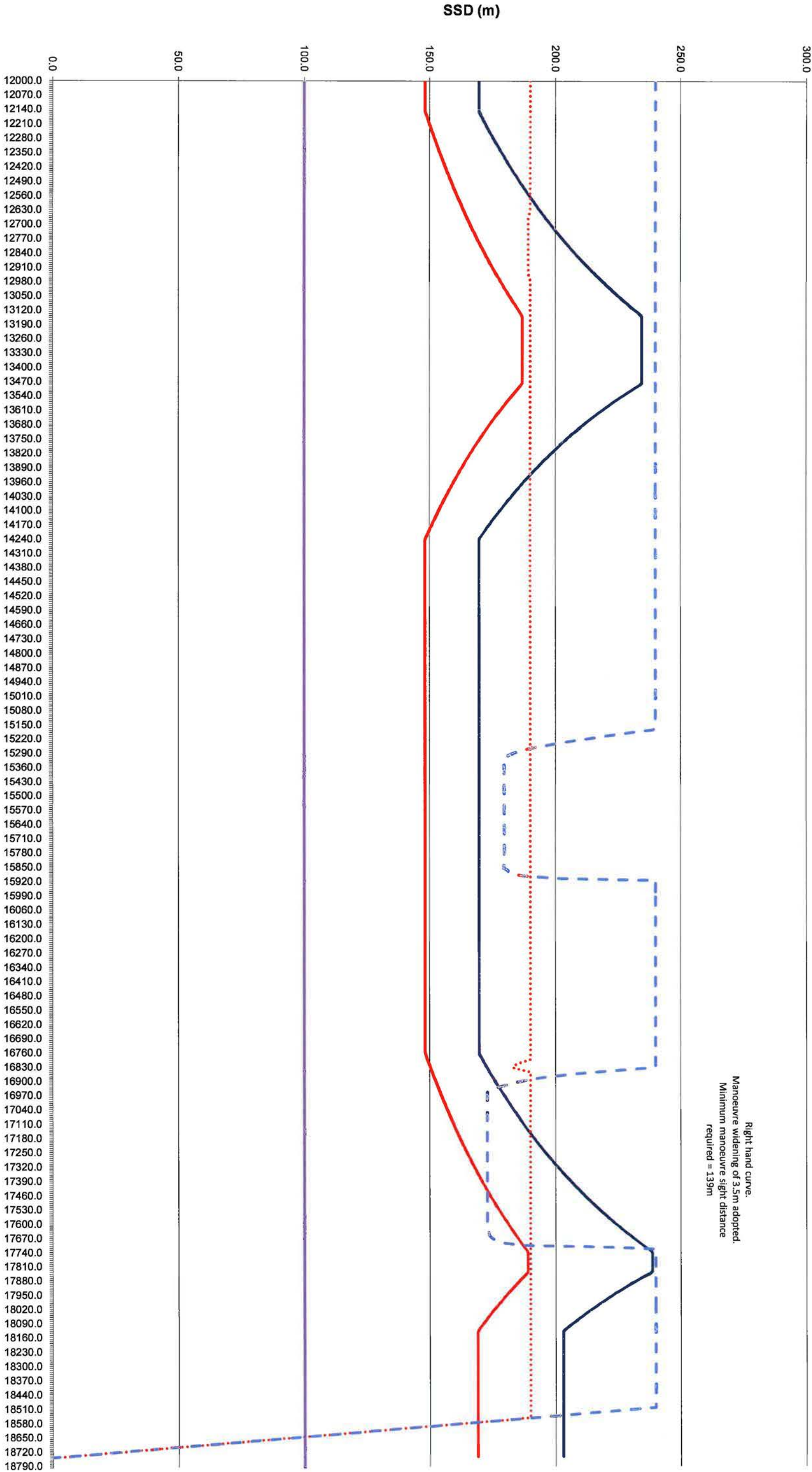
TSRC
PART 2 - CLARIFICATION QUESTION
A.1.2 – Road Geometry & Road Safety
Attachment for T82

Stopping Sight Distance
Control Line MC00 L1

Design Speed 100 km/h
Reaction time 2.0 sec
Car Coefficient 0.36
Truck Coefficient 0.28

Required SSD for Car with grade correction Required SSD for Truck with grade correction Achieved SSD Car 0.2 Object Achieved SSD Truck 0.2 Object Design Speed for Cars (km/h)

Right hand curve.
Manoeuvre widening of 3.5m adopted.
Minimum manoeuvre sight distance
required = 139m



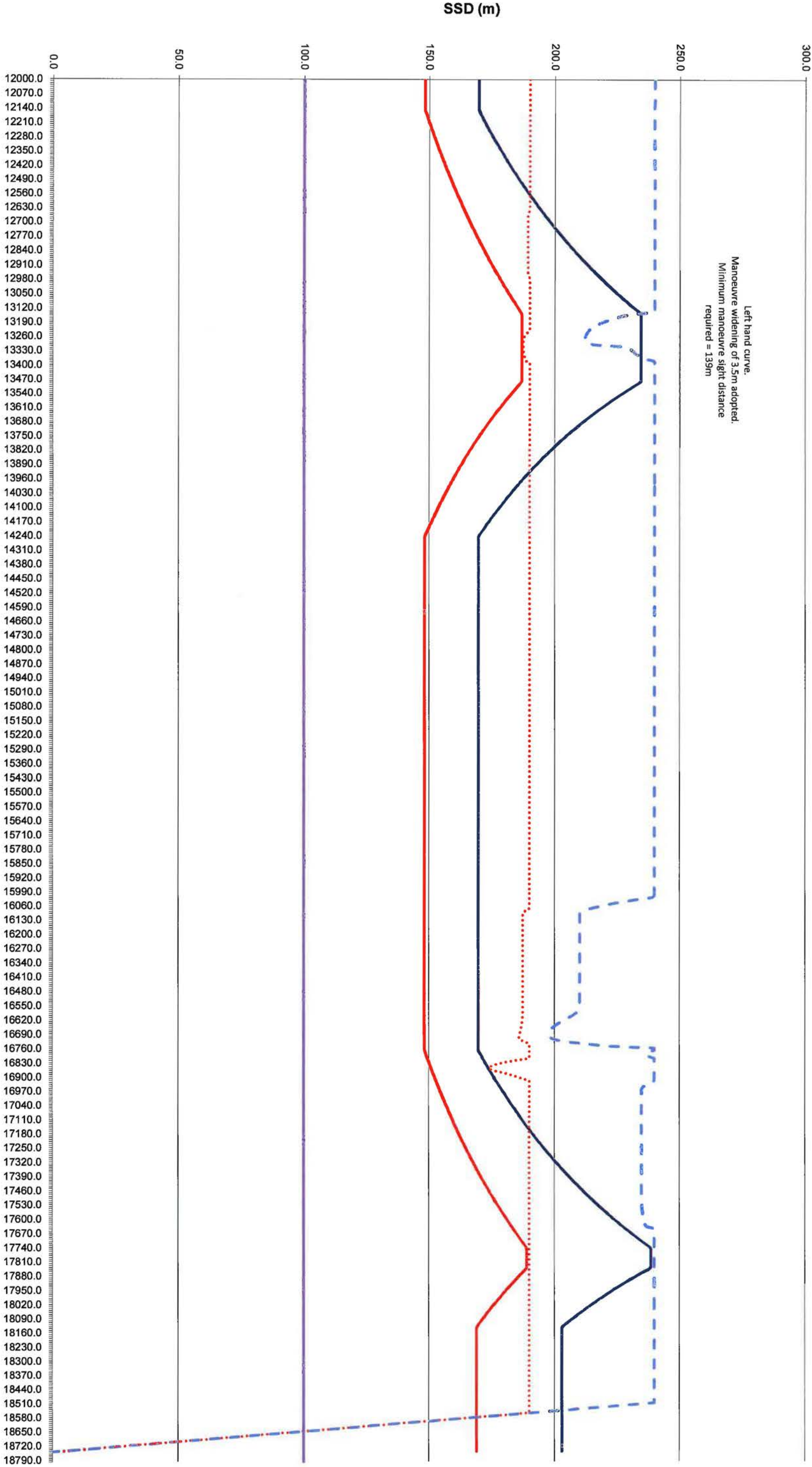
Control Line Chainage (m)

Stopping Sight Distance
Control Line MC00 L2

Design Speed 100 km/h
Reaction time 2.0 sec
Car Coefficient 0.36
Truck Coefficient 0.28

Required SSD for Car with grade correction Required SSD for Truck with grade correction Achieved SSD Car 0.2 Object Achieved SSD Truck 0.2 Object Design Speed for Cars (km/hr)

Left hand curve.
Manoeuvre widening of 3.5m adopted.
Minimum manoeuvre sight distance
required = 139m



Control Line Chainage (m)

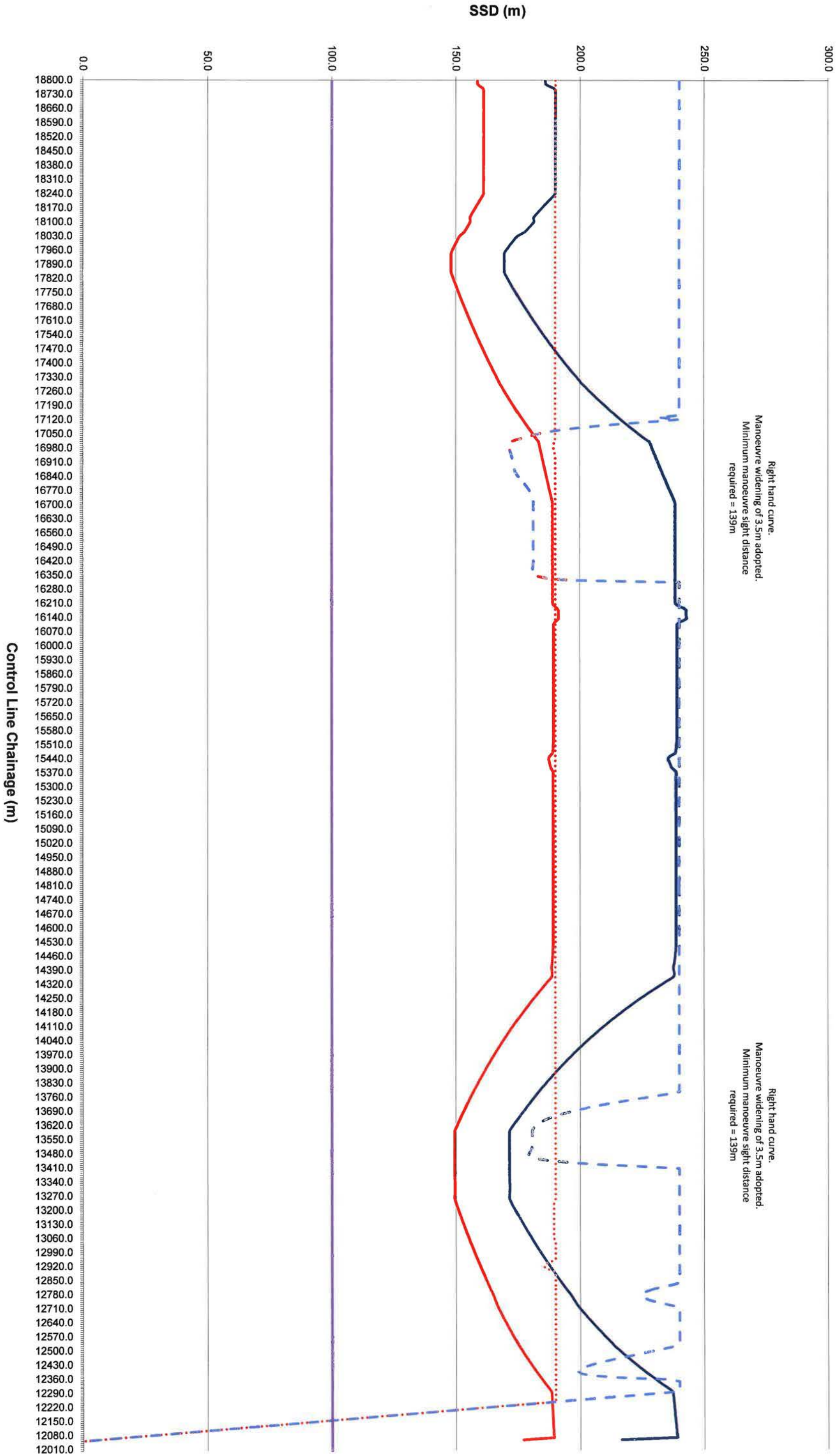
Stopping Sight Distance
Control Line MC10 L1

Design Speed 100 km/h
Reaction time 2.0 sec
Car Coefficient 0.36
Truck Coefficient 0.28

Required SSD for Car with grade correction Required SSD for Truck with grade correction Achieved SSD Car 0.2 Object Achieved SSD Truck 0.2 Object Design Speed for Cars (km/hr)

Right hand curve.
Manoeuvre widening of 3.5m adopted.
Minimum manoeuvre sight distance
required = 139m

Right hand curve.
Manoeuvre widening of 3.5m adopted.
Minimum manoeuvre sight distance
required = 139m



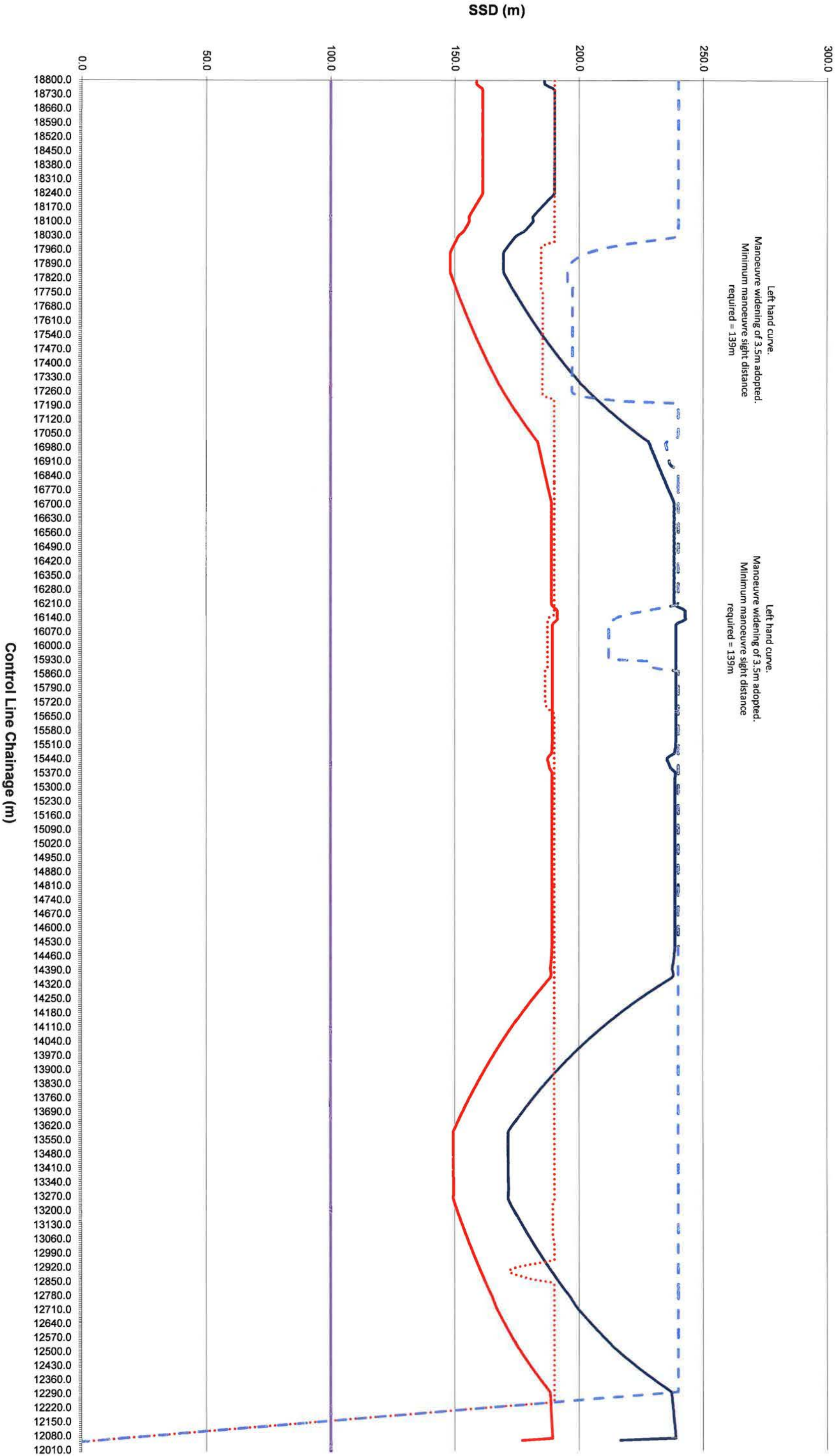
Stopping Sight Distance
Control Line MC10 L2

Design Speed 100 km/h
Reaction time 2.0 sec
Car Coefficient 0.36
Truck Coefficient 0.28



Left hand curve.
Manoeuvre widening of 3.5m adopted.
Minimum manoeuvre sight distance
required = 139m

Left hand curve.
Manoeuvre widening of 3.5m adopted.
Minimum manoeuvre sight distance
required = 139m

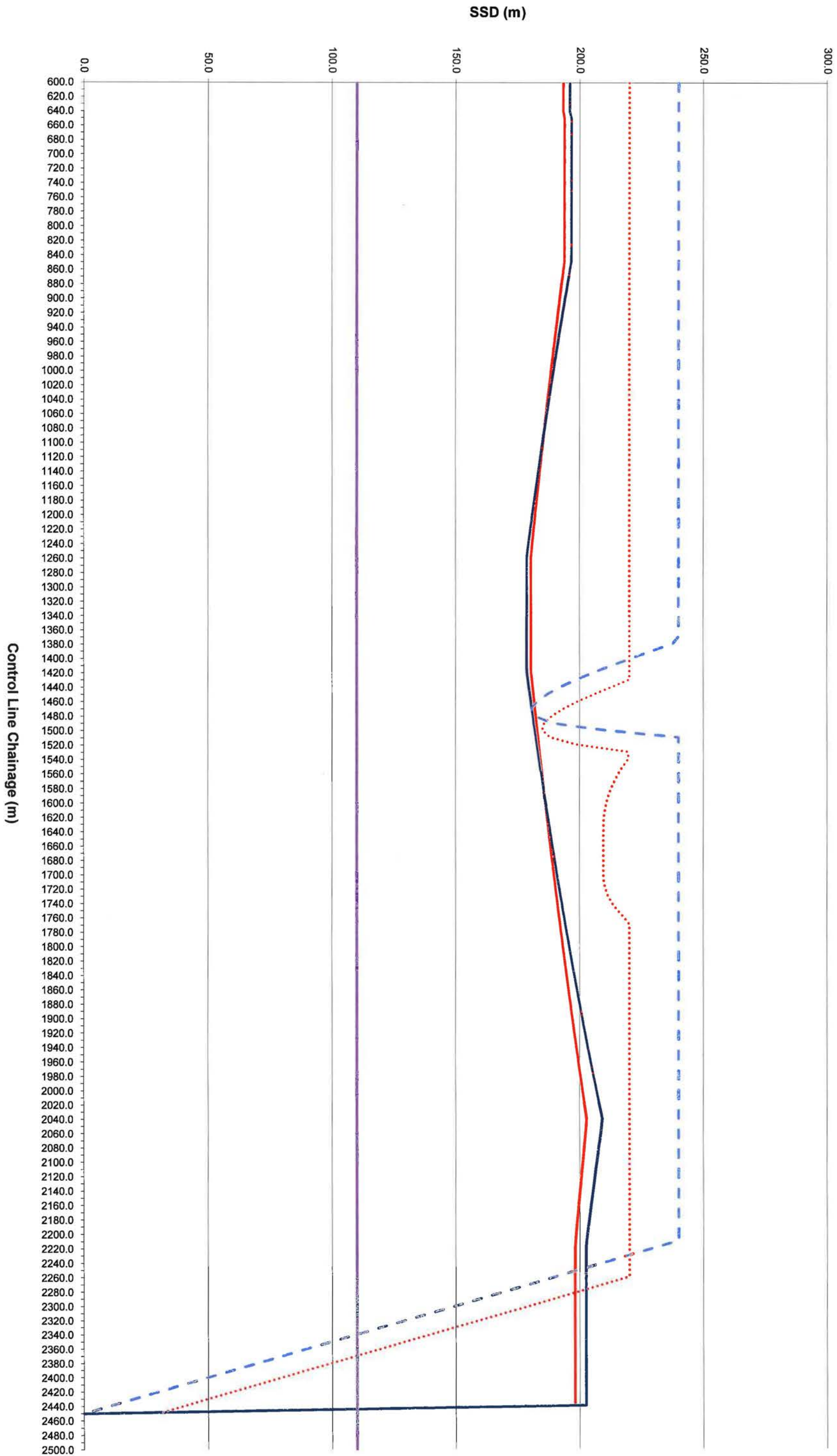


TSRC
PART 2 - CLARIFICATION QUESTION
A.1.2 – Road Geometry & Road Safety
Attachment for T94

Stopping Sight Distance
Control Line MC00 L1

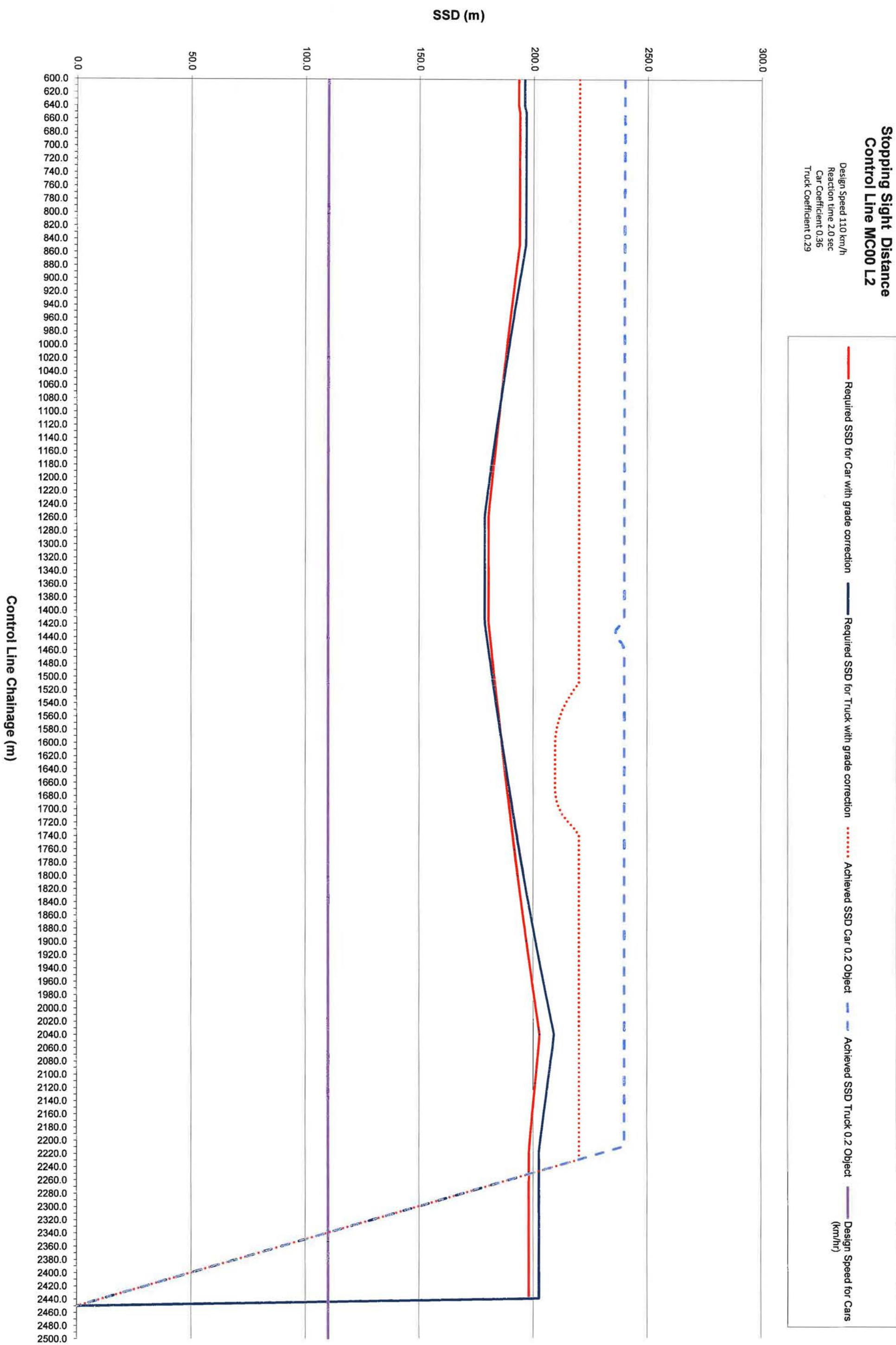
Design Speed 110 km/h
Reaction time 2.0 sec
Car Coefficient 0.36
Truck Coefficient 0.29

Required SSD for Car with grade correction Required SSD for Truck with grade correction Achieved SSD Car 0.2 Object Achieved SSD Truck 0.2 Object Design Speed for Cars (km/h)



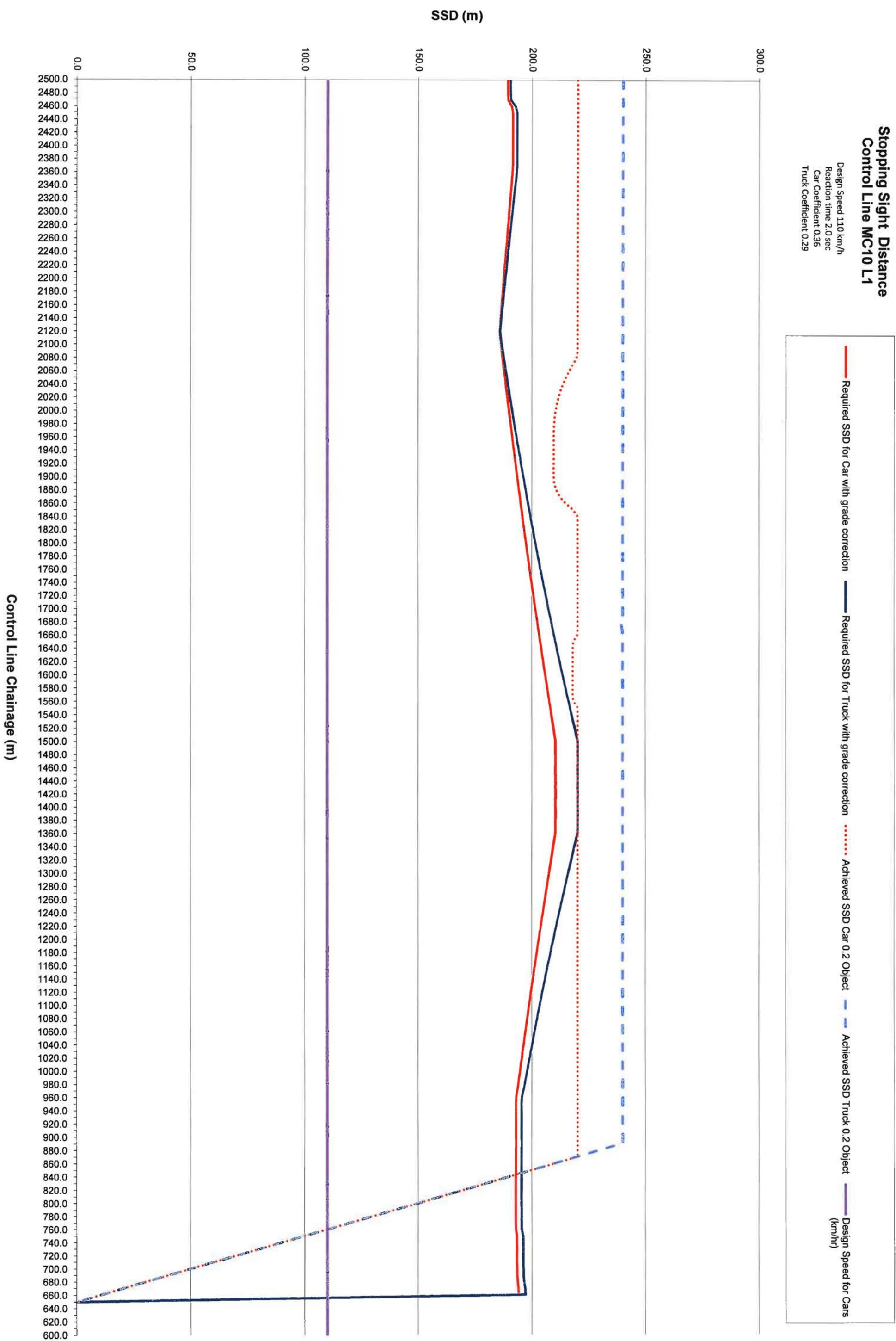
Stopping Sight Distance
Control Line MC00 L2

Design Speed 110 km/h
Reaction time 2.0 sec
Car Coefficient 0.36
Truck Coefficient 0.29



Stopping Sight Distance
Control Line MC10 L1

Design Speed 110 km/h
Reaction time 2.0 sec
Car Coefficient 0.36
Truck Coefficient 0.29



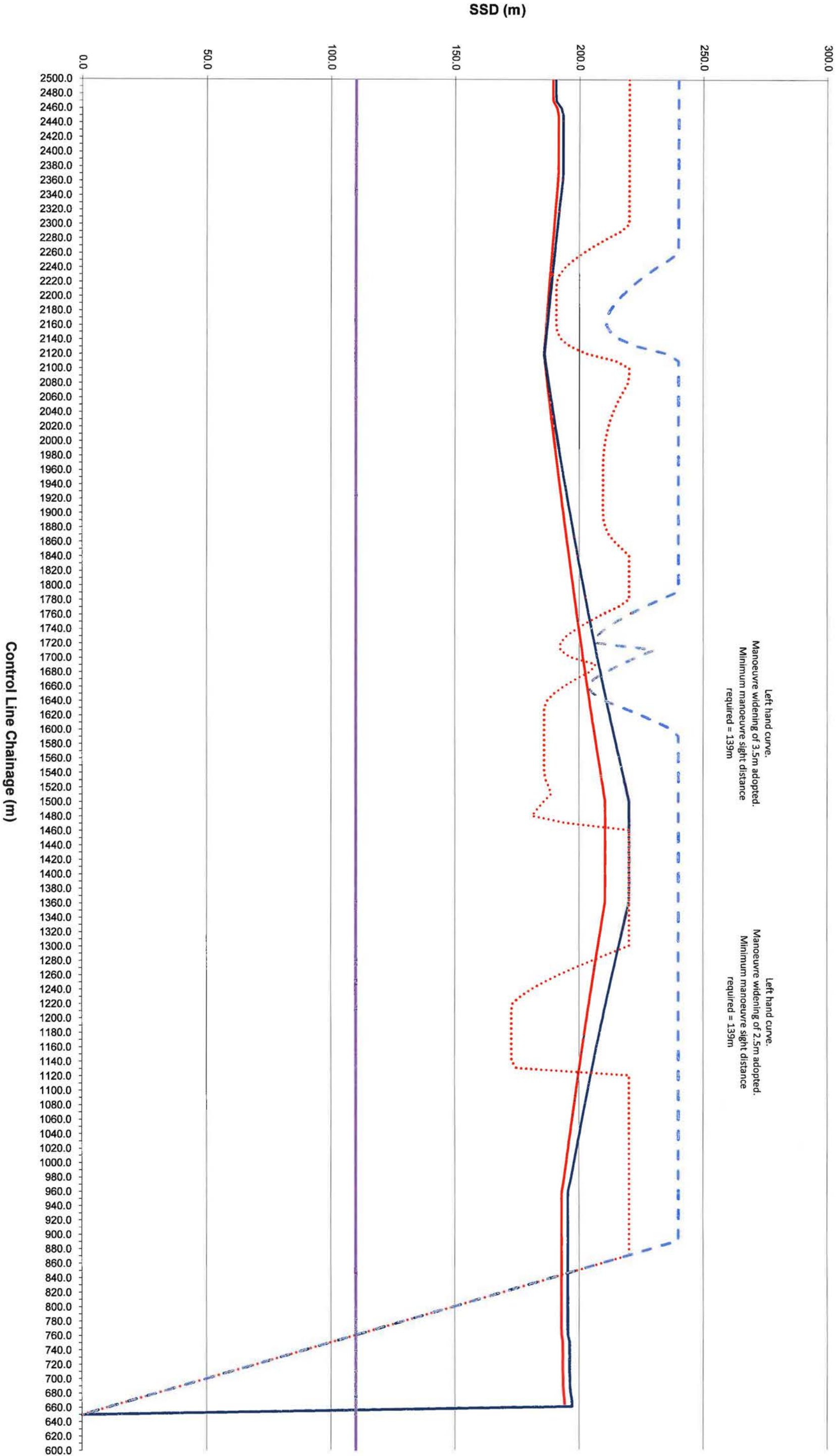
Stopping Sight Distance
Control Line MC10 L2

Design Speed 110 km/h
Reaction time 2.0 sec
Car Coefficient 0.36
Truck Coefficient 0.29

Required SSD for Car with grade correction Required SSD for Truck with grade correction Achieved SSD Car 0.2 Object Achieved SSD Truck 0.2 Object Design Speed for Cars (km/h)

Left hand curve.
Manoeuvre widening of 3.5m adopted.
Minimum manoeuvre sight distance
required = 139m

Left hand curve.
Manoeuvre widening of 2.5m adopted.
Minimum manoeuvre sight distance
required = 139m



Warrego Highway (East) Grade Separated Intersection

Technical State Clarification Questions – NEXUS (03.02.02.19)

The Technical State Clarification Question T98, issued on 1 April 2015, is the following:

The State requests that the Proponent provides a general layout and longsection that describes a system interchange between the Warrego Highway east and the Toowoomba Second Range Crossing.

The system interchange must:

- comply with the DTMR Road Planning and Design Manual
- comply with Austroads Guide to Road Design Part 4C: Interchanges and as specified below;
- be configured as a two lane exit consistent with Figure 2 a (i) or Figure 4C-6 of the TMR Supplement to Part 4C and consistent with Figure 11.3 of Austroads including an auxiliary lane that is not less than 300m long;
- westbound route from the existing Warrego Highway to the Toowoomba Second Range Crossing being the through route (i.e. vehicles travelling westbound in either existing lane from the Warrego Highway to the Toowoomba Second Range Crossing must be able to effect that manoeuvre without needing to change lanes);
- be configured as a major branch connection generally* consistent with Figure 11.8: of Austroads with the eastbound route from the Toowoomba Second Range Crossing to the Warrego Highway being the through route (i.e. vehicles travelling eastbound in either lane of the Toowoomba Second Range Crossing to the existing two lane section of the Warrego Highway must be able to effect that manoeuvre without needing to change lanes).

**Notwithstanding Austroads Part 11 the lower traffic volume from the Toowoomba Second Range Crossing may be in the right hand carriageway to facilitate the through route requirements;*

- not provide for any other traffic movements;
- not include any single lane carriageways (i.e. all carriageways must be two lanes west of the point where they merge or diverge; and must be two lanes plus auxiliary lanes as appropriate [in terms of configuration and length] on the mainline east of that point);
- include lighting at all merges and diverges; and
- avoid any impact up to the ARI 2000 years flood level along Gatton Creek (Lockyer Valley Regional Council has concerns about even larger floods, bank stability and vegetation retention along Gatton Creek).

Please advise what impact, if any, this has to your Proposal including program, cost or other related items. Please response by close of business on 20 April 2015.

Conformance

Nexus has developed an alternative interchange arrangement for the Warrego Highway (east) Interchange which complies with the Performance Specification and the additional requests in the Technical State Clarification Question T94. By complying with the Performance Specification the design also complies with the TMR Road Planning and Design Manual and Austroads Guidelines.

1 Design Overview

1.1 General

The intersection between the Warrego Highway (east) and the Tollroad has been developed as a system interchange to provide high speed directional connections between these two roads. Key features of the interchange are:

- The priority route between the Warrego Highway (east) and the Tollroad,
- All ramp connections are developed for a 110km/h design speed,
- The Warrego Highway (westbound) to Tollroad movement passes over the existing Warrego Highway (eastbound),
- The new infrastructure does not impact the Q2,000 flood extends as reported for Gatton Creek,
- Allowed traffic movements:
 - > Warrego Highway westbound to Tollroad westbound
 - > Warrego Highway westbound to Warrego Highway westbound
 - > Tollroad eastbound to Warrego Highway eastbound
 - > Warrego Highway eastbound to Warrego Highway eastbound

2. Traffic

Not used

3. Road & Safety

Key design criteria

The following key design criteria have been used to develop the design:

Design Speed

A design speed of 110km has been used for all movements.

Priority

The through route shall be from the Warrego Highway east of the interchange to the Tollroad.

Exit / diverge arrangement

The diverge arrangement shall comply with Austroads Guide to Road Design Part 4C: Interchanges and be configured as a two lane exit consistent with Figure 2 a (i) or Figure 4C-6 of the TMR Supplement to Part 4C and consistent with Figure 11.3 of Austroads including an auxiliary lane that is not less than 300m long.

Figure 4C-6 - Example of two-lane exit for a freeway or major divided road

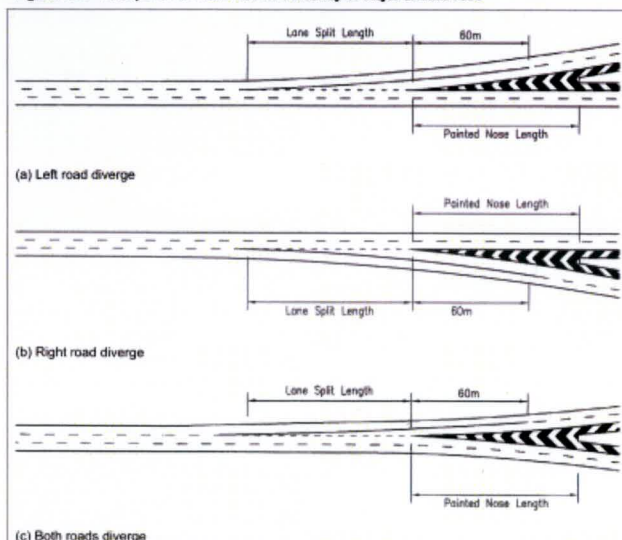
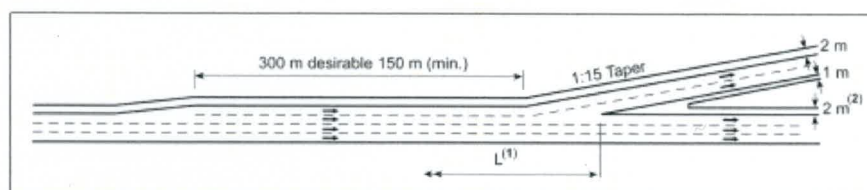


Figure 1 - Two Lane exit (extract TMR Supplement to Austroads Part 4C)



[1] L = distance between exit ramp and preceding entry ramp. Refer to Section 6.6.6 and Table 6.4 of the Guide to Traffic Management - Part 6: Intersections, Interchanges and Crossings (Austroads 2007).

[2] Indicative only. Refer to the Guide to Road Design - Part 3: Geometric design (Austroads 2009a).

Note:

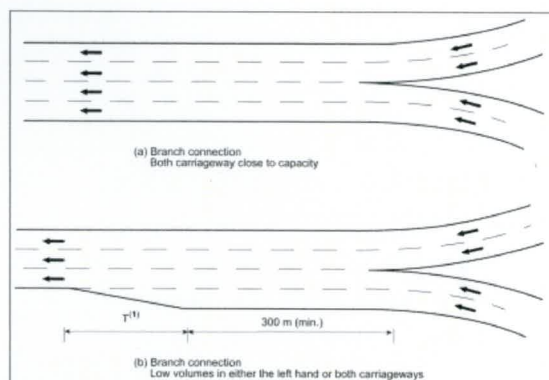
For nose detail, refer to Figure 11.1(c) - Nose detail B.

Figure 11.3: An example of two-lane exit for a freeway, freeway or major divided road

Figure 2 - Two Lane exit (extract Austroads Part 4C.)

Merge arrangement

The merge arrangement from the Warrego Highway eastbound onto the Tollroad shall comply with the below Figure.



Note: T = taper length based on a rate of lateral shift of 0.6 m/s.

Figure 11.8: Major branch connection

Figure 3 - Two Lane Entry (extract Austroads Part 4C)

Design description

Refer to the following drawings for details:

Table 1 | T94 Response Design Drawings

Number	Drawing Title
TSRC-NX-94-RD-AL-SKT-581 to 587	General Arrangement Drawing
	Long Sections

Figure 4 below illustrates the T94 modified layout for Warrego Highway (east) Interchange.

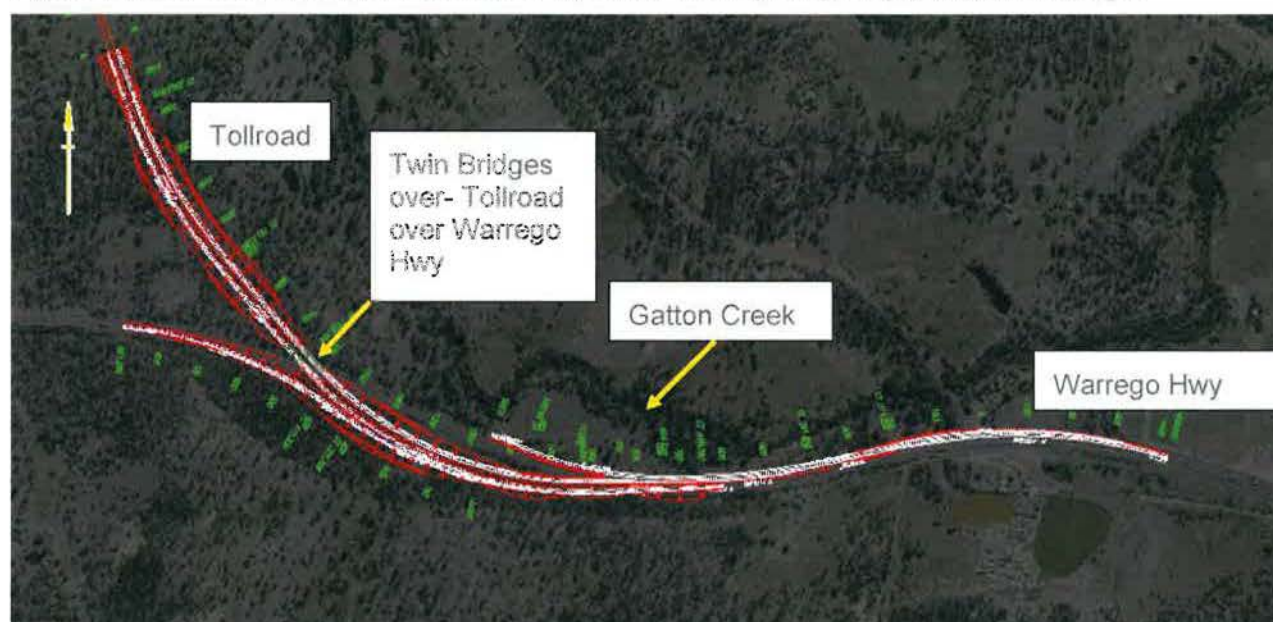


Figure 4 Warrego Highway (east) Interchange

This option is a grade separated directional interchange which provides the following traffic movements:

- > Warrego Highway westbound to Tollroad westbound
- > Warrego Highway westbound to Warrego Highway westbound
- > Tollroad eastbound to Warrego Highway eastbound
- > Warrego Highway eastbound to Warrego Highway eastbound

Key features

- The priority alignment is from the Warrego Highway (east) to the Tollroad,
- The Warrego Highway westbound to Tollroad westbound will be elevated over the existing Warrego Highway eastbound carriageway,
- For drivers to remain on the Warrego Highway westbound carriageway a dual left hand exit is provided,
- The existing Warrego Highway eastbound will be retained on its existing alignment with the exception of a 400m section between chainages 650 and 1,100 which is realigned to tie-in with the Tollroad to Warrego Highway connection.

- The Warrego Highway eastbound will merge with the Tollroad as a two lane ramp and will merge over approximately 950m (i.e. dropping from 4 lanes to 2 lanes).
- The Warrego Highway eastbound and Tollroad merge arrangement has been developed to accommodate the Postmans Ridge intersection,
- Twin bridges are required to span across the Warrego Highway eastbound carriageway.

Sight distance conformance data is provided in Attachment A.

4. PUP

The most significant service identified in the vicinity of the Warrego Highway (east) interchange is a Telstra Optic Fibre (28 core). The Tender Design identified that approximately 2km of this service would be impacted by the new interchange.

Also, as the tie-in between the Tollroad and the Warrego Highway has shifted to the east, an additional overhead electrical service will also require relocation. While there is no information available on this service it appears to be a low voltage connection (based on visual inspection). Approximately 200m of the service will need to be removed and relocated.

5. Pavement

The pavement design for the road and ramps is unchanged from the Tender Design. This pavement is described in Table 1 below:

Table 1 | Pavement Design

Full Depth Asphalt	
Surfacing, DG14HS	50
PMB waterproofing seal	Y
Intermediate, DG14HS	50
Base, DG20HM	240
Prime + seal	Y
Improved layer (Cement modified)	150
Subgrade CBR	5%

In addition to the new pavement, it is possible to strengthen/overlay the merge area where the Tollroad ties into the existing Warrego Highway. However, no information is available about the existing pavement configurations, or structural and functional condition. While no information is available, an overlay thickness of approximately 200mm thick asphalt may be appropriate; which will consist of 50mm DG14HS surfacing layer + 50 mm DG14HS intermediate layer + 100 mm DG20HM base layer.

6. Geotechnical

From the start of the alignment to chainage 1300 the Warrego Highway East Interchange traverses alluvium associated with Gatton Creek. The alluvium is described as stiff to very stiff silty clay and is underlain by residual soils of the Gatton Sandstone member. For the remainder of the alignment the

geology comprises the interbedded weathered siltstone and sandstone rocks of the Gatton Sandstone member.

The approach embankments for the Warrego Highway overpass are greater than 10m height. The embankment cross-section therefore requires a single 4m wide bench where the height exceeds 10m. The embankment side slopes are 1v:2h. Based on the adjacent cuts the material that can be used in these embankments will comprise residual soil and extremely and moderately weathered siltstone and sandstone. These materials typically produce Class A and B material once compacted in place and a homogenous embankment profile can be adopted.

The founding conditions for the embankments are competent and typically comprise stiff and very stiff soils. Foundation preparation will comprise clearing and grubbing and stripping of a minimum 400mm topsoil.

The residual soils are moderately to highly reactive, therefore for the low-height sections of the embankment (less than 1.5m), 0.7m depth of remove and replace is required.

A small cut is required at the start of the alignment. For this section a 1v:2h batter is required.

7. Drainage

The design of the drainage for the revised Warrego Highway (east) interchange (T94) is in accordance with the principles set out in Schedule A Sub-schedule A1 - D1 Drainage Tender Design Report.

Below is a summary of the difference between the Tender Design - Conforming Proposal and the Warrego Highway (east) interchange re-design:

- The interchange is proposed to be constructed on the southern side of the existing Warrego Highway. All the infrastructure elements associated with the interchange re-design are located outside of the 2,000 year ARI flood extents as predicted in the Lockyer Creek Flood Risk Management Study (SKM, 2014) (refer to Figure 5), aside from one sediment basin at chainage 860. Due to the compact dimensions of the sediment basin, the impact of the basin on the regional Gatton Creek flood conditions will be negligible.

The proposed drainage design maintains the same hydraulic and water quality performance as the Conforming Proposal design.

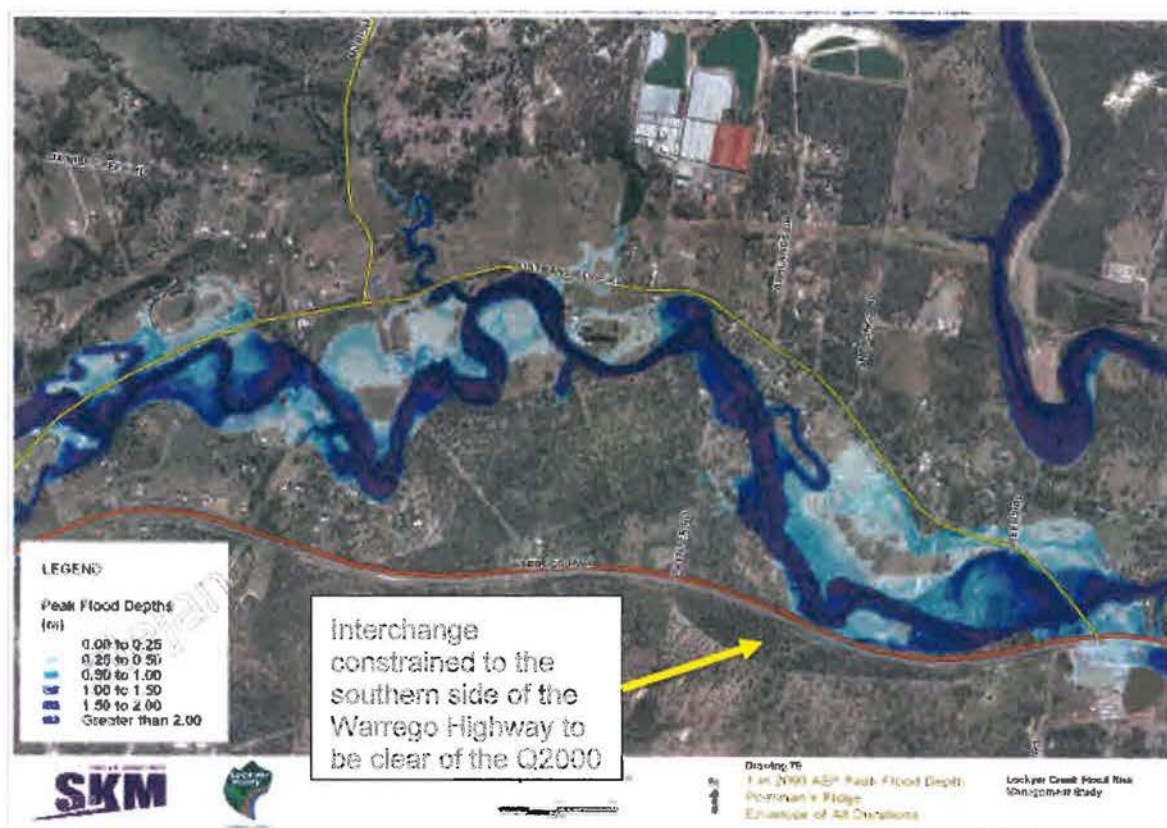


Figure 5: Q2000 Flood extents at Warrego Highway (east) interchange

8. Noise

It is not expected that the revised geometry of the interchange will impact the noise modelling completed for the Tender Design.

9. Structures

BR01 – Warrego Highway East Overpass (twin bridges)

The BR01 - Warrego Highway (east) Bridges carry the TSRC over the Warrego Highway eastbound lanes. The bridges are both single span structures; 35.0m long between abutments.

Each abutment is supported by a spread footing on moderately weathered sandstone with the abutments retained by reinforced earth walls. The clearance under the bridge (to the Warrego Highway) is 6.1m.

The bridge is on a relatively high skew of 60 degrees.

The deck for the eastbound bridge is 11.5m wide while the westbound bridge is 11.7m wide, with the difference a result of sight widening requirements. The deck consists of a 200 mm (minimum) thick slab with 10 mm thick waterproof membrane and 60 mm thick deck wearing surface. It is also on a 3% superelevation and has a fixed joint at each abutment. A link slab is provided at the pier support which provides deck continuity through the in-situ topping slab.

The bridge has 1,100 mm high medium performance concrete barriers.

A 6 m long relieving slab (measured perpendicular to abutment headstock) will be provided at both Abutments A and B.

11. ITS

The ITS scheme will not be impacted by the revised interchange layout. From a function perspective over height detection, VMS, and CCTV infrastructure is still required.

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.2 – Road Geometry & Road Safety
Attachment for T165

TENDER DESIGN

29/6/2015 @ 2:28pm

DETAILS & DIMENSIONS ARE SUBJECT TO REVIEW OR
FURTHER DEVELOPMENT DURING DETAILED DESIGN

TOOWOOMBA-CECIL PLAINS ROAD
SIGNALISED INTERSECTION

[illegible]

TENDER DESIGN

29/6/2015 @ 2:27pm

DETAILS & DIMENSIONS ARE SUBJECT TO REVIEW OR
FURTHER DEVELOPMENT DURING DETAILED DESIGN

WARREGO HIGHWAY (WEST)
SIGNALISED INTERSECTION

TRUCK REST AREA

WILLET ROAD

										Associated Job Nos		Survey Data		Scales 0 10 20 30 40m Dimensions shown in metres except where shown otherwise		LOCKYER VALLEY RC AND TOOWOOMBA RC				TOOWOOMBA SECOND RANGE CROSSING DESIGN ALTERNATIVE AREA 94 (T165) GENERAL ARRANGEMENT LAYOUT				 Queensland Government																	
										Datum		GDA 94				WARREGO HIGHWAY – GORE HIGHWAY																									
										Auxiliary Drg Nos		Horiz. Grid				CTL CHGE 26700 – 29050 (MCOO)																									
										Height Origin						Reference Points																									
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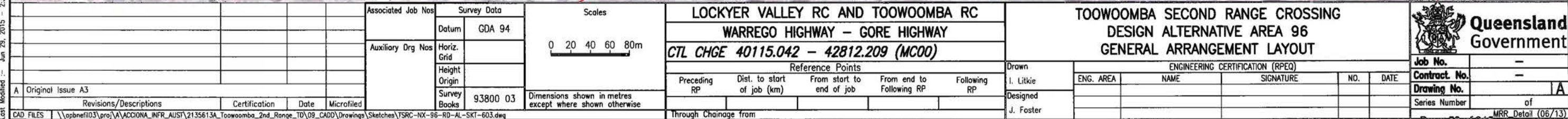
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PART 2 - CLARIFICATION QUESTION
A.1.2 – Road Geometry & Road Safety
Attachment for T166



					Associated Job Nos		Survey Data		Scales		LOCKYER VALLEY RC AND TOOWOOMBA RC				TOOWOOMBA SECOND RANGE CROSSING MURPHYS CREEK ROAD (T166) GENERAL ARRANGEMENT LAYOUT				 Queensland Government							
							Datum				GDA 94		WARREGO HIGHWAY - GORE HIGHWAY													
													CTL CHGE 614.293 - 41187.882 (MCOO)													
					Auxiliary Drg Nos		Horiz. Grid						Reference Points													
							Height Origin						Preceding RP Dist. to start of job (km) From start to end of job From end to Following RP Following RP													
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29/6/2015 @ 2:32pm

DETAILS & DIMENSIONS ARE SUBJECT TO REVIEW OR
FURTHER DEVELOPMENT DURING DETAILED DESIGN



TSRC
PART 2 - CLARIFICATION QUESTION
A.1.2 – Road Geometry & Road Safety
Attachment for T174

TENDER DESIGN

13/7/2015 @ 5:11pm

DETAILS & DIMENSIONS ARE SUBJECT TO REVIEW OR
FURTHER DEVELOPMENT DURING DETAILED DESIGN

TRUCK REST AREA



WARREGO HIGHWAY

TOOWOOMBA SECOND RANGE CROSSING
WARREGO HIGHWAY TRUCK REST STOPS

0 10 20 Page 400 of 215

3 A.1 3 Pavement (P1, P2)

3.1 Executive Summary

This preliminary Pavement Design Report details Nexus Infrastructure's Tender Design for pavement as part of the TSRC Project. A number of options and sensitivity analyses were undertaken to determine the most cost-effective and value-for-money pavement solution. Consideration was given to initial construction and maintenance costs, constructability, performance criteria, sustainability and potential traffic disruptions due to maintenance. The overall design process and recommendations are summarised below:

- Three different pavement options were investigated and developed through detailed analysis:
 - > Full Depth Asphalt (FDA)
 - > Deep Strength Asphalt (DSA)
 - > Flexible Composite (FC)
- For the section from Warrego Highway West to Gore Highway, an additional high quality granular pavement option was also considered
- A number of alternatives were considered, e.g. staged construction, high modulus base, cement stabilised sub-bases with higher stiffness and different asphalt surfacings
- The options were assessed in terms of design life, risk of failure, maintenance requirements, whole-of-life performance and compliance to the specified performance criteria
- Assessment of the pavement composition options included a sensitivity analysis of the effect of variations in input parameters and material properties
- Any of the pavement compositions could have been proposed, as the expected performance would be very similar, and all comply with the Department of Transport and Main Roads (DTMR) pavement design standards
- Any Dense Graded Asphalt (of standard DG14HS) or Stone Mastic Asphalt (SMA) can be used as surfacing, but the SMA appears to have slightly better performance benefits.

Nexus Infrastructure will mitigate pavement performance risk by using recommended pavement design procedures, standard materials, realistic heavy vehicle loading factors (which include Type 1 road trains and B-doubles) and appropriate subgrade California Bearing Ratios (CBRs).

3.2 Subgrade

3.2.1 Assessment of CBRs

Using the above methodology and the results of the statistical analysis of laboratory testing and presumptive values, the following design CBR and swell values have been determined for use in the tender design. These assumptions and determinations will be reassessed in the detailed design phase on the basis of further investigation and testing of materials proposed for subgrade use.

3.2.2 Design Assumptions

In 'cut-to-fill' transition areas (i.e. small 20-50 m long sections), the CBRs as per adjoining areas are adopted, assuming that suitable subgrade replacement or treatment will be carried out.

3.3 Environmental Conditions

3.3.1 Drainage

Refer to A.1 – Design, Geotechnical Element, G1 Geotechnical and Geological Report, and the Drainage Element, D1 Drainage Design Report, which both provide further detail on drainage. The following is a summary of relevant information from the reports.

- A review of the subgrade conditions along the alignment identified expansive soils and variable groundwater conditions as key risks to the pavement design. Drainage blankets have been provided at selected locations within the cuttings and subgrade replacement provided for low height embankments (<1.5 m) and cuttings less than 2 m.
- The subgrade replacement has been complemented by 1V:4H and good surface drainage to ensure shrink-swell effects on the carriageway are minimised
- Foundation drainage blankets have been provided in both embankments and cutting subgrades where significant seepage is expected
- It has been assumed that seepage inflows will be higher in the more weathered materials; therefore, for the Tender Design it has been assumed that a drainage blanket will be required where the weathering is MW or worse, while no drainage blankets are assumed for cuttings with expansive soils. The extent of drainage blanket will need to be confirmed at Detailed Design through further investigation and groundwater monitoring
- The drainage blanket will comprise a 300 mm thick drainage blanket wrapped in geotextile. The drainage blanket detail is not a standard MRTS treatment; however, it is consistent with Austroads and RMS R44 recommendations. This detail is proposed as a 'special' treatment in accordance with MRTS04
- Provision of an upstream drain and basal drainage blanket for all embankments built on colluvium.

3.4 Pavement Design

3.4.1 Sustainability

Sustainability has been a key consideration during evaluation of the pavement design options. Opportunities for use of local materials have been identified and will be analysed further during Detailed Design.

3.4.2 Shoulders

The TMR Pavement Design Supplement allows shoulders to be non-structural and granular, but the surfacing must be the same as that of the adjacent lanes. The shoulders were therefore designed to be non-structural.

3.5 Risk Management

3.5.1 Subgrade Properties

The subgrade CBR values have a significant effect on the thickness of the pavement and the need for subgrade treatment, i.e. the 300 mm select fill or soft subgrade treatment. This is in particular for flexible pavements where the difference in base thickness could be as high as 100 mm.

To mitigate this risk, the tender design has been developed based on results from 86 CBR tests that were analysed to determine the range of possible CBR values and to identify the locations (and percentages) of each of these CBR categories. Allowance was made for 300 mm additional material in areas where the subgrade was <3%.

The design subgrade CBR values will be reassessed as more information becomes available and the road design is developed. As a result, the pavement thickness will be revised based on a further review of this information and new data obtained during the detailed design phase.

3.5.2 Water

The presence of water through moisture ingress can have a detrimental impact on pavements and could cause isolated pavement failures (deformation and potholes) and increased maintenance.

To mitigate this risk, Nexus Infrastructure's Tender Design provides drainage layers in all rock cutting and subsoil drains in all cuttings. During construction, water seepage may be identified and this will be managed by provision of thicker drainage blankets, provision of deeper subsoil drains or using special drains such as herringbone drains.

3.5.3 Pavement Materials

Nexus Infrastructure will implement a quality system to ensure pavement construction meets the required specification.

3.5.4 Sensitivity of Pavement Material Properties

Specifications and Materials

Standard technical specifications and materials commonly used for road construction in Queensland were used. This reduces the risk of material availability, material quality and issues during construction.

Nexus Infrastructure has investigated the availability of materials to deliver pavement materials that meet the required specifications.

Maintenance

The pavements were designed to have structural lives of 20 (side roads) and 30 (main line). Therefore, no rehabilitation would be required during the life of the pavement, only routine maintenance in the form of cracking sealing, joint repair and patching and periodic maintenance in the form of resealing (e.g. mill and overlays) and texture treatments.

3.6 Conclusion

For design of road pavements, DTMR adopts the fundamental pavement design principles presented in Austroads Publication AGPT02. Taking into account local conditions in Queensland, such as locally available materials, local environmental conditions, loadings and expected pavement performance, DTMR has published a supplement to AGPT02 to complement the design guidelines provided by Austroads for use in DTMR projects.

The DTMR Supplement also provides guidance on selection of pavement types based on traffic and key issues to be taken into account in the selection and design of pavement types, including construction and maintenance considerations, environment, subgrade evaluation and economic comparison of design options.

As presented in this Report, Nexus Infrastructure has considered all these design parameters in identifying applicable pavement types and carrying out preliminary pavement designs that take into account key issues, including issues presented in the DTMR Supplement. An evaluation of different pavement options has been carried out that included sustainability, constructability, operational and maintenance issues over the whole-of-life of the pavement.

A risk assessment has also been carried out to identify, evaluate and minimise the risks involved.

Nexus Infrastructure is confident that we have recommended the most appropriate pavements that are both compliant with the robust design requirements and provide value for money.

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.3 – Pavement

Question ID	Report Reference	Performance Specification Reference	Question	Proponent Response
T1	A1.3	Volume 4 Returnable Schedule, Element P1	We note that your Proposal uses High Strength Granular pavement. As this is an innovative approach to pavement can you please advise what measure(s) Nexus is taking to satisfy itself with respect to the pavement's fitness for purpose over the 25 year concession period?	The design of the pavement west of the Warrego Highway (west) Intersection has been developed in accordance with TMR guidelines (TMR Pavement Design Supplement) and considers the traffic loadings, design life, support conditions, drainage requirements and pavement materials. The 2013 TMR Pavement Design Supplement: Supplement to 'Part 2: Pavement Structural Design' of the Austroads Guide to Pavement Technology, Table Q6.1 states that the typical material type used in the base layer of sealed unbound granular pavements for traffic loadings of up to 3,000 daily ESA in the year of opening, is a High Standard Granular (HSG) material, using appropriate project specifications for this HSG layer. Section 6.2.1 lists the important factors to be considered in the use of an unbound granular material, which have been incorporated into the design. The pavement Nexus is proposing includes a base layer of a High Standard Granular (HSG) material. This material has a higher specification than Type 2.1 with the additional requirements being a tightening of the grading, higher compaction, and repeated load testing (RLT) to confirm that the layer will not deform excessively over its design life. These additional project-specific requirements are specified in the Pavement Note 3 of the Pavement Details Drawings. By using this material, the design has considered a stiffness of 500MPa which is recommended in the TMR design supplement. In addition to the pavement material, the pavement design has carefully considered subgrade conditions and management of sub-soil drainage.
T3	A1.3	Volume 4 Returnable Schedule, Element P1	It is unclear what Pavement reliability factor the Proponent has adopted for the Toll Road. Please advise what has been used in your Proposal?	The pavement reliability level used was 95% as per the Table Q2.12 of the 2013 TMR Pavement Design Supplement: Supplement to 'Part 2: Pavement Structural Design' of the Austroads Guide to Pavement Technology. The project reliability level of 95% (reliability factor of 1.00 as per Table 6.15 of the Austroads Guide to Pavement Technology Part 2) is shown in the CIRCLY outputs in Appendix 5 of the Pavement Report. There is a print error in the 5th page of the Appendix 5, where it shows that the project reliability is not defined. However, this does not affect any calculations as the reliability factor of 1.00 (which corresponds to a reliability level of 95%) is correct.
T28	A1.3	Volume 4 Returnable Schedule, Element P1	From your Proposal it is not evident that your lower structural pavement standard in the shoulders complies with the requirements as noted in Annexure 1 section 2.7(d)(i)A. With specific reference to Clause 2.4 of TMR's Pavement Design Supplement the main areas that need further clarification to demonstrate compliance are: 1. The total pavement thickness of the shoulder should be the same as the adjacent trafficked lane. 2. The shoulder should have the same surfacing, seal and intermediate layer courses as the adjacent trafficked lane. 3. A lower standard shoulder is not used on the high side of one-way crossfalls as this could result in moisture entering the pavement. Please confirm your compliance with these requirements, and/or provide further details in respect to the approach taken.	TMR's Pavement Design Supplement was used as pavement design guideline and Clause 2.4 (point 2) recognises that a "shoulder to a lower structural standard" can be used. With reference to Volume 4 Returnable Schedule, Element P1 Pavement Design Report, our design for the granular pavements has shoulders with the same pavement configuration as the main line while the sections of FDA (and deep strength DSA) incorporate shoulders of lower structural standard. All sections have shoulders of the same overall thickness and surfacing as their adjacent traffic lanes. Our responses to the three points raised in the clarification question are the following: 1. We confirm that the pavement including shoulders will be constructed on a continuous subgrade and that the thickness of the shoulder pavement will match that of the mainline pavement adjacent to it. The thickness of the FDA pavement on the mainline varies (100 mm DG14 plus DG20 from 185 mm to 300 mm on 150 mm improved layer, i.e. maximum of 550 mm). While Table 13 of Returnable Schedule P1 Pavement Design Report describes the average thickness of shoulder as 550mm, it will in fact match the adjacent pavement thickness at each location. 2. The shoulder has the same surfacing as the FDA (and/or DSA) pavements, i.e. 50 mm DG14 DG14HS surfacing, a PMB waterproofing seal and DG14HS intermediate layer. 3. The TMR Pavement Design Supplement indicates that "a lower standard shoulder is typically not used". The concern is not structural but aims to ensure the potential for ingress of water into the pavement is avoided. Nexus' pavement design has addressed this concern through the use of a cement modified material as shoulder material and the asphalt surfacing layer made continuous with the adjacent mainline pavement. The modified material has a low permeability and is not sensitive to moisture. This design ensures that moisture is very unlikely to enter into the pavement.
T55	A1.3	Volume 4 Returnable Schedule, Element P1	Your returnable element P1, table 7 specifies a 5000MPa Modulus (Category 1) for the Cement treated base. As this results in a higher strength, thinner pavement there is an increased risk of reflective cracking. Please confirm that the potential reflective cracking issues are addressed in your Proposal and/or provide supporting information in response to this clarification.	Nexus' submission provides preliminary design details for a Full Depth Asphalt (FDA) pavement with no cement stabilised layer. The submission acknowledges that an equivalent Deep Strength Asphalt may be provided as an alternative. Should Nexus adopt such a deep strength asphalt pavement it would incorporate a cement stabilised layer constructed from a category 1 material (28 day UCS of 3.5 to 4.5 MPa – Table Q6.4 in TMR PDS). Two moduli were studied for this category 1 material, 3,500 MPa (Table Q6.4) and 5,000 MPa (Austroads Guide Part 2, Table 6.7). In both options for the studied DSA pavement (category 1 material with moduli of 3,500MPa and 5,000MPa), the thickness of the total required asphalt layers are in excess of 175 mm, which is considered to be sufficient to address potential reflection cracking. Table Q2.6 in TMR PDS recommends a cover of 175 mm dense graded asphalt on a lean mix concrete (with modulus of >5,000 MPa) and the RMS Supplement version 2.1 (Table 1) recommends a minimum asphalt thickness of 175 mm on a cemented material with modulus of 5,000 MPa.

4 A.1 4 Geotechnical (G1, G2)

Executive Summary

4.1.1 Earthworks

- Nexus Infrastructure has adopted a strategy to maximise the re-use of site won materials where possible. To achieve this Nexus Infrastructure has used 3d geological modelling techniques (using Rockworks 3d) to determine the proportion of materials within critical cuttings and combined this with a comprehensive review of laboratory testing results to determine proportions/volumes of MRTS04 classified material. The Rockworks 3d modelling has been adopted for the cuttings with complex geology and/or when sufficient geotechnical data is available.
- Statistical analyses of laboratory testing has been undertaken to determine the classification of each material won in cuttings. This assessment shows that the majority of materials excavated should be suitable for re-use as general embankment fill or rockfill.
- Basalt and sandstone comprise the majority of materials within the cuttings. Residual and extremely to highly weathered sandstone generally meeting MRTS04 Class A or B classifications. The properties of the residual basaltic soil are expected to be variable. The majority of materials will be able to be re-used in the core of zoned embankments, however the high to very high plasticity materials will be unsuitable for re-use. Extremely to highly weathered basalt is expected to provide a good quality embankment fill material, meeting Class A or B classifications.
- Some residual soils derived from sedimentary rocks and weathered rocks that meet Class A or B classifications, do not meet the Emerson Class criteria. These materials will need to be used in the core only and protected by an outer zone of Class A/B material.
- Based on the geological assessment petrographic analysis and x-ray diffraction testing the basalt encountered on the project can be split between two types; massive and vesicular/amygdaloidal.
- Unsuitable materials from cuttings are expected to primarily come from the residual basalt due to high to very high plasticity. Colluvial material excavated for remove and replace under embankments is also assumed to be unsuitable for re-use.
- Moisture conditioning requirements have been assessed based on the MRTS04 classifications and the maximum dry density testing results. These assessments show that minimal conditioning will be required for Class A to B materials. Class C and D materials derived from basalt will require the addition of water to meet MRTS04 requirements.
- Excavatability assessments show that some blasting is required in the rocks containing slightly weathered sedimentary rocks. Additional blasting is required in the basalt due to the high strength and variable fracture spacing.

4.1.2 Bridge and structure foundations

- A review of each bridge location revealed that 11 bridge locations have suitable founding conditions with no potential for scouring to allow the use of high level pad/strip footings.
- Due to the presence of competent rock and high levels at most bridge locations, the preferred piling type for the project is cast-in-place piles, where high level pads are unsuitable.
- Culverts located within existing gullies or water pathways will require the removal of unsuitable materials and the construction of a 0.5 m thick geotextile wrapped rockfill founding layer.

Design Inputs

4.2 Surface Movement Assessment

The following section summarises the methodology and findings for the estimated characteristic surface movements of the highly reactive clays that may experience ground movement from moisture changes. The reactive clays have been identified predominantly in the western section of the TSRC alignment.

4.2.1 Design Options

To assess the required replacement depth for various embankment heights two movement criteria have been considered:

- Criteria 1 – 25 mm differential surface movement based on the performance specification
- Criteria 2 – An increased differential surface movement of 40 mm, assuming:
 - > The beneficial effects of low permeability pavement layers, moisture conditioning of the subgrade to EMC and flat batters (1V:4H) for embankments less than 3 m height will practically assist in reducing the surface movement to below 40 mm. This recommendation is supported by the guideline developed by Transport and Main Roads (WQ35, September 2014) for pavements in expansive soils of Western Queensland which provides guidance for the selection of paving materials and type cross sections for roads on expansive soils ("black soils") in a dry environment. This guideline recommends that by maintaining batter slopes of 1V:4H or flatter on all embankment fills up to 2 m the risk of shoulder and pavement edge cracking and deformation will be reduced. If steeper batter slopes are adopted longitudinal cracking will be more prevalent.
 - > The additional replacement depth presented in these tables can either be conventional remove and replacement with non-reactive material or in situ lime stabilisation. Both methods provide similar technical outcomes; therefore the choice of an appropriate method will be governed by economic factors.
 - > The depth of removal/stabilisation presented in the tables is based on movement criteria alone. The subgrade strength will improve through the remove and replace but has not been considered in this section of the report.

Option 1 – 25 mm surface movement

Achieving the 25 mm surface movement criteria the following remove and replace depths are required:

- Embankments up to 1.5 m height
 - > Total remove and replace depth – 1.1 m
 - > Topsoil stripping – 0.4 m
 - > Additional remove and replace depth – 0.7 m
- Cuttings up to 2 m height
 - > Pavement depth – 0.6 m
 - > Additional remove and replace depth – 0.7 m.

Based on the above the following diagrams display the replacement / stabilisation options for a typical embankment and cutting section using average soil shrinkage index value of 4.5%.

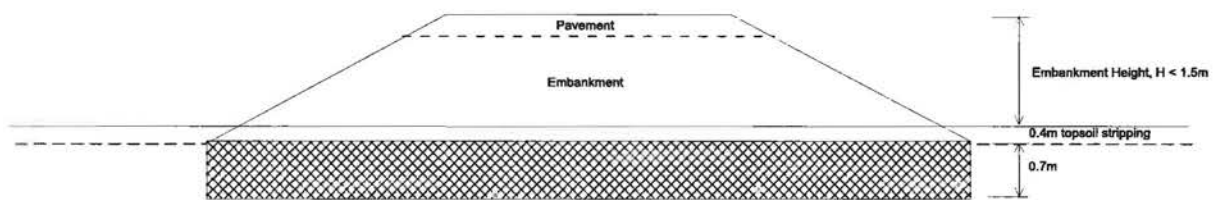


Figure 1: Replacement depth for typical embankment section

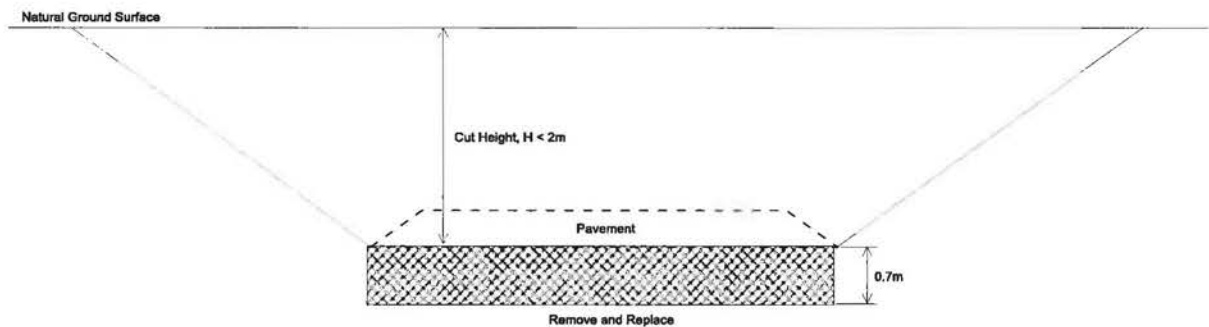


Figure 2: Replacement depth for typical cutting section

As shown in the above diagrams, the pavement thickness for the cuttings is included in the total cut height.

Option 2 – 40 mm surface movement

Achieving the 40 mm surface movement criteria the following remove and replace depths are required:

- Embankments up to 1.5 m height
 - > Total remove and replace depth – 0.7 m
 - > Topsoil stripping – 0.4 m
 - > Additional remove and replace depth - 0.3 m
- Cuttings up to 2 m height
 - > Pavement depth – 0.6 m
 - > Additional remove and replace depth – 0.3 m.

Based on the above recommendations the following diagrams display the replacement / stabilisation options for a typical embankment and cutting section using the average soil shrinkage index value of 4.5%.

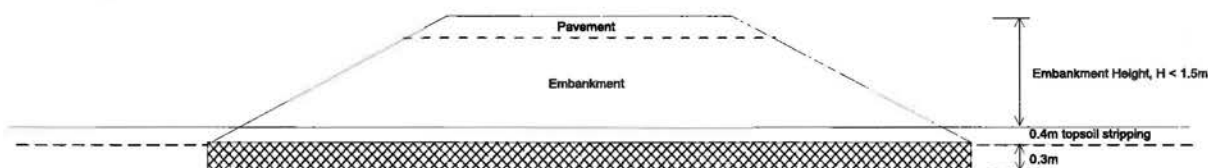


Figure 3: Replacement depth for typical embankment section

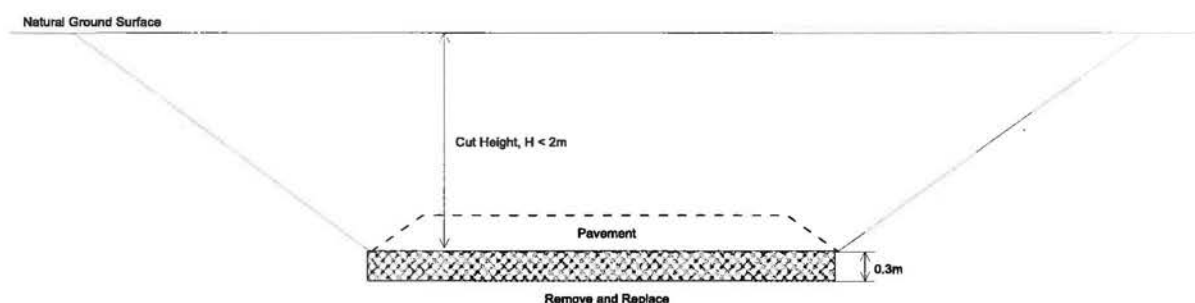


Figure 4: Replacement depth for typical cutting section

The depth of replacement has been assessed for surface movements of 25 mm and 40 mm, using an average soil shrinkage index of 4.5%. As per the summaries, if the movement criteria are relaxed to 40 mm, then there is a significant reduction in the depth and therefore volume of remove and replace.

Aside from the economic difference, the preferred option needs to take into consideration the risk of excessive movement over the pavement's lifetime. Option 1 is a lower risk because it analytically meets the performance specification requirements using a standard assessment method. The residual risks relate primarily to the material properties assumed in the analysis. Option 2 still has the uncertainty over material properties; however the risk exposure increases because it relies on subgrade moisture conditioning, low permeability pavement materials and 1V:4H batters for low-height embankments to limit pavement surface movement. These elements cannot be analytically confirmed to meet the performance specification, but have practically been shown by TMR (in WQ35) to be effective. Due to the uncertainty over performance, further maintenance may need to be included with this option

4.2.2 Recommendations

To minimise maintenance requirements over the 25 year period Option 1 has been incorporated in the concept design. To further reduce the risk of future cracking and enhance the asset, the defensive measures outlined for Option 2, i.e. 1V:4H batters and subgrade moisture conditioning are also proposed. The following table summarises the recommended treatment measures:

Table 3: Recommended Treatment Measures for Expansive Soils

Embankment/Cut Height (m)	Total remove/replacement depth (m)
-2 to 1.5	1.1 (with 0.4 m topsoil removal)
Others	0

The excavated expansive soil will be replaced with Class A/B material. The excavated material can be re-used in the core of zoned embankments where specifications requirements are met.

4.3 Cutting and Subgrade Treatment

4.3.1 Treatments

The required treatment cutting will be based on the condition of the in-situ (subgrade) material observed following excavation and it is likely that treatment measures proposed below may change.

Table 4: Cut floor treatment options

Treatment Type	Description
A - Compact Existing	Applicable for all cuttings where the material in the cut floor exceeds the minimum required CBR and classification values. Allows for localised areas of unsuitable material to be removed and replaced as necessary
B - Replace with general fill	Applied where expansive soils (as described above) or the minimum required CBR and/or classification values for the material in the cut floor are not met. Treatment involves over excavation and replacement with suitable Class A/B material
I - Special - Drainage blanket	Used in combination with other treatment options and used where the cut floor is likely to intercept water and/or where water is anticipated to drain into the cut floor

In addition to the above backfilling of over-excavation/over-break within rock cuttings shall be backfilled with lean mix concrete or cement stabilised pavement material in accordance with MRTS04.

4.3.2 Drainage Blanket

Limited groundwater information is currently available for each cutting, however, based on the geology and the presence of high permeability layers within both the sedimentary and basalt units, after high rainfall events it has been assumed that seepage will flow from perched aquifers. On this basis pavement drainage has been provided. A drainage blanket is specified where seepage or water is expected to pond within the cutting floor.

A 300 mm thick drainage blanket wrapped in geotextile is recommended. The drainage blanket detail is not a standard MRTS treatment; however, it is consistent with Austroads and RMS R44 recommendations. This detail is proposed as a "special" treatment in accordance with MRTS04. The specification for the drainage blanket is as follows:

- Drainage blanket for subgrade and foundation drainage applications shall be crushed or granular material conforming to the following material requirements:

> Grading:

Property	Requirement
Maximum dimension	125 mm
Percentage passing:	
19.0mm AS sieve	0-15%
1.18mm sieve	0-5%
0.075mm sieve	<0.5%

- > Coefficient of Uniformity ($C_u = D_{60}/D_{10}$) shall be greater than or equal to 5
- > Ten percent fines value (wet) as per Test Method Q205B shall be a minimum of 50 kN
- > Percentage of +19 mm fraction with $I_s(50) < 1 \text{ MPa} = 10\%$ (max)
- > Durability
 - Conformance with MRTS04 Clause 19.2.13 Rock fill material requirements

Foundation Assessment

4.4 Deep Foundations

4.4.1 Design Methodology

According to the DTMR Geotechnical Design Standard – Minimum Requirements, the design of socketed piers must satisfy the following:

- Ensures that there is an adequate margin of safety against the possibility of collapse under working loads
- Limits settlement of the piers and the differential settlement between the piers to values that are consistent with performance requirements of the superstructure
- Recognises the overriding influence of site geology, construction methodology and quality control adopted, on rock mass properties and overall design
- Limits the mobilisation of peak side resistance when there is uncertainty as to the ultimate capacity in end bearing
- Undertakes an iterative design methodology reviewed on the basis of socket inspections to validate the geotechnical model and the design assumptions, in particular the load transfer mechanism adopted between the shaft and the base
- As a means of promoting wall stability and socket cleanliness, permanent liners will be installed to the top of the socket
- As a means of promoting friction between the concrete used in forming the pile and the shaft/base of the socket, bentonite or polymer slurry will not be used in excavating the pile/socket.

Based on the above, for the design of pile lengths on this Project, the following assumptions have been used:

- Steel liners advanced to the top of HW rock, unless geological considerations require further driving (eg highly fractured material, presence of clay seams or core losses)
- No contribution to resistance from the cased section of the pile. The applied load is assumed to be taken purely by the rock socket via a combination of sidewall shear and base resistance
- Minimum socket length for each pile has been taken to be two pile diameters.

The primary tool for the design of vertically loaded piles for this site is the serviceability design method according Rowe and Armitage (1987). The ultimate limit state shall also been checked using AS2159-2009 Piling – Design and Installation, with appropriate estimates of the ultimate skin friction and end bearing capacity.

Instrumentation and Monitoring

4.5 Instrumentation

Preliminary planning of instrumentation and monitoring of the performance of cut and fill sections has been undertaken as part of the tender design. During the bulk excavation or construction of fill embankments, provision for instrumentation and monitoring is necessary to monitor the safe performance of the structures during the construction period and under all operating conditions. The proposed instrumentation includes:

- Permanent survey monuments to measure movement (x,y,z) at critical cut slopes.
- Settlement plates and survey markers at critical embankments
- Settlement markers at critical infrastructure e.g. QR rail track and New England Highway

- Inclinometers at the– QR rail track east of New England Highway
- Inclinometer at Cut 21 where an ancient land slip has been identified
- Surface extensometers at the eastern portal to monitoring slope movement in colluvium
- High pressure gas pipeline monitoring points to monitor construction vibration and movement
- Vibrographs to monitor the vibration of sensitive receivers – high pressure gas pipeline, QR rail track, New England Highway, and private properties above tunnel

The proposed monitoring locations are provided in Table 5. Trigger alarm levels (e.g. green, amber and red), frequency of monitoring and risk management plans will be developed during the detailed design stage.

Table 5 Instrumentation and monitoring requirements

Feature		Instrumentation Type	Purpose	Comments
Cuts		Survey monuments, at crest and at regular vertical intervals. Inclinometer in Cut 21 where an ancient land slip is identified.	To detect early occurrence of slope instability due to cutting (i.e. change in natural slope equilibrium)	Ancient landslips are identified in aerial photograph interpretation and in BH113 at Cut 21. Other cuts contain colluvium/ scree at interface between basalt and sedimentary rocks
Embankments and RSS walls		Settlement plates during construction Settlement markers during construction and operation Inclinometers at embankment toe	To monitor settlement rates and magnitude for pavement construction	Embankment constructed on colluvium and in expansive clay
High pressure gas pipeline		Vibrographs, survey markers	To monitor construction vibration including excavation by blasting within acceptable limit	High pressure gas pipeline is located at the vicinity of New England Highway and possibly on creeping slope
QR line / QR access road		In-place-Inclinometers and real-time monitoring / early warning system, Electronic levelling beam (ELB) Settlement gauges Surface extensometers Vibrograph	To monitor possible ground movement as a result of cutting and bridge construction in area of active slope movement and construction induced vibration including blasting	This area section requires construction of viaduct above the QR track and access road

A structural assessment and condition survey will be carried out for all structures present along the alignment that may be affected by the construction activities. Structural assessment will involve detailed examination of factors such as construction method and sequence, structural continuity, foundation types and layouts, building / pipe line / rail line orientation and soil/structure interaction.

The assessment results will be incorporated in the construction sequence and monitored with instrumentation to ensure the integrity of the structure is maintained and services are uninterrupted.

4.6 Monitoring Frequency

The frequency of monitoring of the instrumentation will be dependent on the performance of the design feature (cut, fill etc) during construction and operation. Monitoring for critical infrastructure such as the QR rail embankment and high pressure gas lines will be undertaken automatically using data-loggers and a web-based interface, whereas less critical items such as settlement monitoring will be undertaken manually. An indicative estimate of the monitoring frequency for each of the instruments is shown in Table 6.

Table 6. Monitoring Frequency

Instrumentation Type	Monitoring Frequency
Survey Monuments	- Weekly during construction - Monthly for the first year after construction and yearly thereafter if movement is occurring
Vibrating Wire Piezometer (VWP)	Automated data-loggers with data downloaded weekly
Inclinometers - In place remote measurement and manual	- Automated data-loggers for eastern portal during construction - Manual measurement for remaining inclinometers with monitoring undertaken weekly during construction - No monitoring post-construction unless movement identified during construction
Vibrograph	Automated data-loggers
Surface Extensometers	Weekly during construction
Electronic Leveling Beam (ELB)	Automated data-logger during construction
Settlement Plates	Fortnightly during construction
Settlement Markers	- Fortnightly during construction - Monthly for the first year after pavement construction and yearly thereafter

Operations and Maintenance Considerations

Nexus Infrastructure will be responsible for all toll road operations together with ongoing inspections and maintenance activities for the rock and soil batters, batter treatments, soil nail walls, rockfall fences and associated infrastructure. The following provisions have been made in the design of the cut batter and embankment stabilisation for these operation and maintenance activities.

- All structural or stabilisation components must have a nominal 100 year design life.
- Soil batter treatment which minimises erosion by incorporation of topsoil and hydro seeding or hydro mulching. Occasional access will be required to spray for weeds or to remove rubbish
- Soil batter stabilisation using soil nails and either shotcrete (limited locations) or TECCO mesh (or approved equivalent) facing requiring minimal inspections and maintenance
- Design of batter slope bench configurations to maximise the capture of rock falls on the upper benches
- Rock batter stabilisation using rock bolts (with or without mesh facing) requiring minimal maintenance and infrequent inspections

- Potential rock falls due to erosion are protected/secured by shotcrete or TECCO mesh (or approved equivalent). Rock fall fences are provided at the toe of each slope as a final protection measure
- Landslide flow barriers are provided across selected gullies to protect against slope failures from outside of the road corridor from impact the roadway or clogging culverts
- Rock fall fence requiring infrequent clean-up of rock debris and/or repair.

4.6.1 Slope Risk Assessment

It is recommended that an inspection methodology based on New South Wales Roads and Maritime Services (RMS) (previously named as Roads and Traffic Authority, RTA) Guide to Slope Risk Analysis (Document No. TO-GDL-(TBA), Version 4 dated March 2011) is adopted for the slope and ground support maintenance purposes. In this method, a detailed visual inspection is carried out followed by a slope risk assessment. This risk assessment ranks the slope into Assessed Risk Levels (ARL). The highest risk level is ARL 1 and the lowest is ARL5. ARL 1 and 2 will require either remedial measures installed or require monitoring / inspection on a periodic basis. ARL 4 and 5 are generally considered stable and there are no identified risks to property, maintenance staff or the general public and do not require any specific remedial works. Based on this method of assessment, any repair works (if required) can be prioritised and an appropriate inspection period can be determined. The cut slopes for TSRC have been designed to ARL 4 or 5 ratings.

Should any cutting be identified as ARL3, remedial measures may be necessary or otherwise the frequency of inspection increased to monitor for any further deterioration.

The visual inspection could typically be carried out from the floor or benches of the cutting using binoculars or similar for the higher cutting heights. The use of an elevated, safe work platform vehicle may also be necessary if a closer inspection is required, such as detailed spot inspections if irregularities are observed. Sufficient space is available on the benches or adjacent to the road on both sides of the cutting to permit these inspections to take place during normal road operations.

Vehicular access is provided to all benches on the cuttings. Whilst it is not expected that future works will be necessary to stabilise potentially loose blocks of rock that may develop over the 100 year design life, such a requirement cannot be precluded, depending on the rate at which further deterioration of the rock mass and associated joints occurs. The ongoing inspection regime should therefore include inspection by an experienced geotechnical engineer or engineering geologist to assess if additional stabilising works are necessary, again adopting the RTA methodology. Any structural elements should also be inspected at the same frequency.

Specific maintenance and inspection requirements are described below

4.6.2 Ground Support

All soil nail, shotcrete facing, rock bolts and mesh facing are specified to have a 100 year design life and regular maintenance is generally not expected. Periodic visual inspection on the cutting faces including shotcrete and mesh facing is recommended. Inspection at the end of construction period followed by an inspection one year after the end of construction is recommended to confirm the performance of the installed ground support systems. Inspection of all sub-surface drainage and weep holes would also need to be carried out to check for blockages. Thereafter a minimum inspection frequency of once every 5 years is recommended or after high rainfall events.

4.6.3 Soil Batters

The 1V:2H soil batter for the embankments and shallow cutting depths will be topsoiled and hydro seeded/hydro mulched with a low maintenance grass mix.

A 4m wide bench is provided on all embankment batters for every 10m height. On the soil and low strength sedimentary cut batters the batter width is increased to 5m and the vertical interval reduced to 7m to reduce surface erosion and ongoing maintenance.

Visual inspection of the 1V:2H batters is recommended at least every 5 years and immediately after high rainfall events.

4.6.4 Maintenance of Rock Fall Fence

Rock fall fencing is to be constructed using galvanised components to provide a nominal 100 year design life. No maintenance is generally expected other than infrequent clean-up of rock debris. Replacement of fence panels may however be required if the fence is damaged by the fall of oversized rocks.

Visual inspection are recommended at least annually to identify any need for replacement of fence panels. Specific work procedures must be adopted to allow replacement of fence panels which may necessitate access by vehicles, and where these are located away from the vehicle access points. Inspection or repairs to rockfall fences would also be required following rock or vehicle impacts.

Geology and Geotech (G2)

4.7 Key Design Features

The key design features incorporated in the cut and embankment designs to meet the minimum requirements and mitigate these risks are summarised below:

4.7.1 Embankments:

- The embankment design adopted by Nexus Infrastructure takes into consideration key factors such as the steep sidelong topography to the east of the New England Highway, expansive soil to the west, variable groundwater conditions, potential fill materials and the significant embankment heights
- Batter angles of no steeper than 1V:2H have been used in all embankments
- Four metre wide benches for every 10 m embankment for all fill materials to minimise erosion and promote long term global stability
- Through an understanding of the mass-haul and available fill materials, Nexus Infrastructure has adopted a zoned embankment strategy that maximises the re-use materials without compromising long-term stability and performance. The zoning east of the New England Highway has been adopted to protect dispersive sedimentary soils, while in the west it has been used to shield moisture sensitive residual black soils. The zoning strategy also centralises zonation to large height embankments, therefore maximising the storage volume at these locations and allowing the use of homogenous sections elsewhere. This strategy aids in improving the efficiency of earthworks operations.
- Based on our significant experience in remediating landslides in South East Queensland, Nexus Infrastructure has recognised that foundation preparation and providing sufficient drainage to embankment materials is essential to maintaining long-term stability. However, Nexus Infrastructure also understands that any foundation preparation must take into consideration the potential destabilisation caused by temporary excavations. The following measures have been used:
 - > Embankment foundations between CH8000 and CH16500 will found on weak, potentially unstable, colluvial soils. These soils vary in thickness from 0.5 m to up to 8 m. To limit the amount of colluvial material excavated and spoiled, foundation replacement has been limited to the removal of loose surficial soils. Where more competent colluvium, deeper than 0.5 m is present, a rock filled toe trench has been included on both sides of the embankment. The rock filled toe trench extends beyond the depth of colluvium keying into the underlying rock strata. The trench is connected with a 1 m thick, geotextile wrapped drainage blanket. The combination of the trench and drainage blanket will ensure groundwater levels are controlled and long-term stability is maintained throughout the design life.
 - > Elsewhere, when the key trench is not required, to limit the impact of groundwater on the long-term stability of fill embankments, a full width foundation drainage blanket has been adopted for all embankments where transverse slopes that exceed 1V:8H
- Large height embankments built on moisture sensitive black soils are required to the west of the New England Highway. To reduce the likelihood of long term degradation and instability of batter slopes due to foundation softening, toe replacement will be provided for heights above 10 m.
- Revegetation (topsoil and hydro seeding or hydro mulching) of all embankment slopes to minimise erosion on ongoing maintenance
- Embankment foundations in the vicinity of creek crossings will require the removal of loose foundation soils down to a competent layer to maintain long-term stability and reduce long-term settlement
- Long-term embankment settlements are expected to be limited to creep of the compacted fill. The magnitude of settlement is expected to range from 0.25% to 0.5% of the embankment height,

translating to approximately 150 mm over 40 years at the highest embankments. To reduce maintenance requirements caused by long-term total and differential settlement the following strategy is proposed:

- > Use General Fill – Class A/B (sandstone and basalt only) for the large height embankments
- > Place an additional 1-2 m fill material at each major embankment location to surcharge the embankments to limit the future creep magnitude
- > Allow an additional 3 month preload period prior to the construction of pavements
- > To complement the final two points, settlement monitoring, in the form of settlement plates and surface markers are proposed at each of these embankments. Monitoring would continue throughout the construction period and be measured against theoretical estimates.

4.7.2 Cut Excavations:

- Nexus Infrastructure will design the cut slopes based on the following philosophies:

- > Provide a stable batter configuration with minimal need for slope reinforcement where practical
- > Mitigate erosion of cut batters
- > Reduce the risk of rock fall.

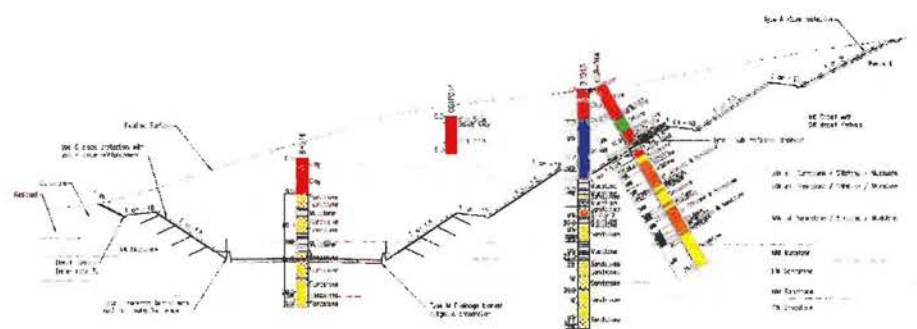


Figure 5: Cut Cross Section Example

- Detailed analysis of 10 cuttings has been undertaken using information gathered from the TMR (2003) and Coffey (2014) geotechnical investigations. The analysis has been compared to the observed batter performance in similar ground conditions within the Toowoomba region. Past performance highlights the following key points regarding slope stability:
 - > Due to favourable bedding orientations, with dip angle less than 10 degrees, large failures through bedding in sedimentary rocks are unlikely. Most failures that have occurred are small and due to differential erosion/weathering of mudstone/claystone layers, sheet erosion of weaker sandstone and small slumps in mudstone/claystone slopes
 - > Failures in the basalt are generally small wedge or planar failures due to unfavourable defect orientations
 - > Observations of basalt in the QR railway cuttings is generally performing adequately, however, regular maintenance is required to clear rock debris
 - > Larger failures may be possible where the basalt overlies the sedimentary rocks within a cutting. Sub-surface drainage is critical in controlling the stability of these slopes especially at the contact zone (unconformity).
- Based on the above the following cut geometries have been adopted:
 - > Batter angles varying from 1V:2H in residual soils to 1V:0.5H in slightly weathered basalt and sandstone
 - > Five metre wide benches for every 7 m height interval in the weaker, weathered sedimentary and basalt rocks to promote better overall global stability over the 100 year design life, reduce erosion of low strength material to catch rocks from falling onto the carriageway and for maintenance access
 - > Four metre wide benches for every 10 m cutting height in the strong, less weathered sedimentary and basalt rock.
- Where the stability of the slope or risk of rock fall cannot be controlled by slope angle and benching alone, slope face protection/support, reinforcement and drainage will be provided to

ensure long-term slope stability, durability and safety. Slope protection or face support is required for a number of cuts along the alignment to mitigate against the erosion of susceptible material, ensure local and global stability and reduce the risk of rock fall. The following measures have been used:

- > Topsoil and hydro seeding for 1V:2H and 1V:1.5H batter slopes
- > Tecco Mesh and Tecmat Erosion Protection for large areas of batter slopes steeper than 1V:1.5H slopes in sedimentary rocks. The application of TECCO mesh with Tecmat (or approved equivalent) will reduce the likelihood of rock blocks from falling due to erosion of underlying mudstone/siltstone layers. This system would enable growth of vegetation, therefore providing a sustainable slope protection.
- > Shotcrete is provided for small area applications in sedimentary rocks and for slope protection in moderately weathered or worse vesicular/ amygdaloidal basalt, where long-term durability is expected to be poor. All shotcrete applications will be coloured to match with geological formation and provided with a woodfloat finish. Due to the complexity of basalt flows the application of shotcrete during construction will be based on an observational approach.
- > Spot bolting will be required to restrain local wedges and toppling blocks. This is likely to occur more often in the basalt than the sedimentary rocks
- > Pattern bolting has been kept to a minimum and has only been applied where site constraints have limited the batter geometry (Cut 21 and 27) or where kinematic planar failures are identified as a risk (Cut 35). Pattern bolting ranges in spacing from 1.5 m to 2 m with lengths ranging from 3 m to 10 m adopted.
- > Sub-horizontal drainage is recommended in Cut 21 and 25 where the basalt flows unconformably overlie low permeability claystone/mudstone of the Heifer Creek Sandstone, creating potential instability. Drainage is required in Cut 24 and 26 to actively manage pore-water pressures in the interbedded sandstone and mudstone layers. Sub-horizontal drains are 75 mm diameter and typically 4 m long at 2 m spacing. This is subject to confirmation during construction.
- > Nexus Infrastructure has adopted a proactive approach to rock fall prevention. Active measures such as shorter and wider benches, spot-bolting or removing rock fall hazards and protecting erosion prone layers will be adopted to eliminate the requirement to provide high energy rock fall fences. A low energy chain wire fence is provided at the toe of each slope to catch small rock falls/debris
- > Debris fencing is recommended between CH12000 and CH16500 to reduce the risk of large debris flows or rock falls from clogging culverts and leading to embankment instability.

4.8 Embankment Design Recommendations

4.8.1 Embankment Zoning Strategy

Based on the material re-use assessment presented in A.1 -- Design, Geotechnical Element, G1 -- Geological and Geotechnical Report, the project does not have sufficient Class A or B earth fill to adopt a homogenous embankment section for the entire alignment. Therefore, to maximise the re-use of materials won from cuttings, zoned embankments are required. The embankment zoning strategy adopted for the TSRC alignment has been developed based on a consideration of the following factors:

- Sub-surface conditions
- Sufficient embankment height to include a core zone
- Centralising zoned embankment sections to maximise the number of homogenous embankment sections, therefore improving construction efficiency
- Mass haul considerations, i.e.
 - > Quantity and location of cuttings with Class A/B earth fill
 - > Quantity and location of cuttings with Class C/D earth fill material

- > Avoiding transportation of earth fill materials over long distances
- Meeting the required embankment stability factor of safety
 - Meeting the minimum dimensional requirements for core zones stipulated in MRTS 04 and as modified in Agreed Exception No. 3

4.8.2 Batter Slopes and Benching

Based on the results of the slope stability analysis a standardised slope profile has been adopted for embankment Types A, C and D. The profile includes 1V:2H batter angles with 4 m wide benches at 10 m intervals.

The Type B embankment has a single batter at an angle of 1V:4H as it is only applied to embankments with height less than 10 m.

Type E has a single vertical reinforced soil wall without any bench.

Foundation Excavation Treatments

Based on the foundation and groundwater conditions presented above, the following foundation improvement requirements are recommended for the bulk earthworks. These recommendations are required in addition to the subgrade replacement requirements presented later in this report.

- CH5800 to CH41400
 - > For colluvium less than 0.5 m thick:
 - All loose, unstable colluvium and slope wash materials is removed as part the initial clearing, grubbing, topsoil stripping and foundation benching.
 - > For colluvium greater than 0.5 m thick:
 - Loose materials are initially removed to stiff or better foundations
 - A toe trench, minimum 10 m base width, is then excavated on both sides of the embankment slope, down to extremely weathered material as shown in Figure 6. Both trenches are backfilled with compacted rockfill wrapped in geotextile
 - The trenches are connected by a 1 m thick geotextile wrapped drainage blanket, which is placed on a benched slope. The trench enhances the embankment stability by working as both a foundation key and groundwater interception trench to control pore-water pressures.

Foundation Drainage - Eastern Section

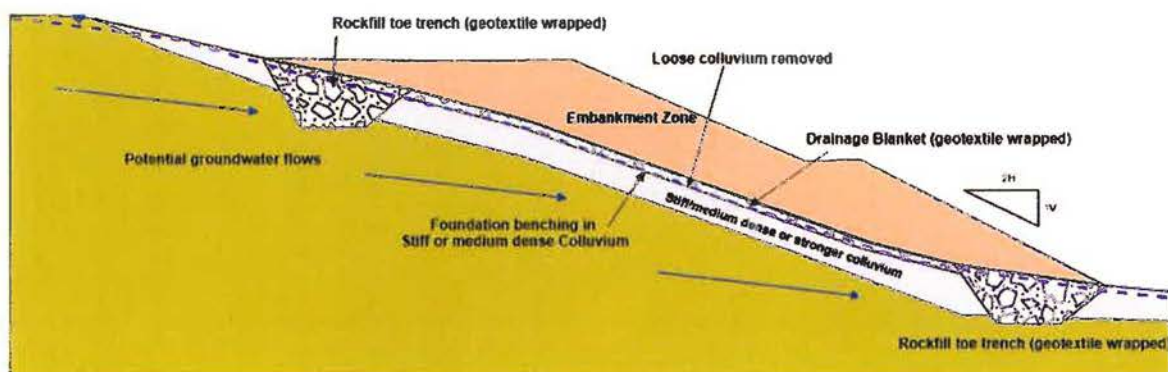


Figure 6: Foundation excavation and drainage in colluvium

- > Scree material is to be excavated to extremely weathered to highly weathered materials.
- CH17480 to CH41400

- > For embankments greater than 12 m height construction on residual basalt (black soil), this material is to be removed at the toe of the embankment, to 1 m to 1.5 m depth and replaced with compacted Class A/B material.

For all other areas foundation excavation is only required where sidelong embankments have natural transverse slopes greater than 7 degrees. This is discussed in the subsequent section. Nevertheless, loose surface soils are removed as part of the topsoil stripping to expose stiff foundation conditions.

Foundation Benching and Drainage

In accordance with MRTS04 Clause 14.3.3 foundation benching is required in the following situations:

- Transverse slope greater than 7 degrees (1V:8H) – Toe bench to be provided
- Transverse slope greater than 14 degrees (1V:4H) – Full embankment benching to be provided.

The use of drainage blankets is recommended to enhance embankment stability by lowering excessive pore-water pressure that could build up at both the foundation interface and within the lower layers of the embankment fills. The drainage blanket in combination with the toe trenches is particularly important in the areas where the embankments are to be founded on colluvial material and the location of the groundwater table or seepage points is uncertain. The drainage blanket also serves to mitigate against tunnel erosion with dispersive foundation soils.

Foundation drainage blankets have been adopted for embankments when the following criteria are satisfied:

- Embankments that are located on natural transverse slopes greater than 7 degrees (1V:8H)
- Embankments with heights greater than 10 m (measured from toe to crest)
- Embankments that are constructed with fill materials other than entirely with rockfill or sandstone.

The thickness of the drainage blanket is assumed to be 1 m and to extend for the full width of the embankment foundation cross-section. The drainage blanket will be wrapped with a non-woven geotextile separation fabric. It is assumed that the drainage blanket material can be sourced from the medium to high strength sandstone excavated from Cuts 9 to 15. The 1 m thickness has been adopted to ensure there is sufficient flow capacity to account for larger than expected seepage flows.

A summary of the foundation benching and drainage requirements is presented in Table 7 below.

Table 7: Foundation benching and drainage requirements

Embankment Height	Maximum Natural Transverse Slope Angle		
	< 7 degrees	7 degrees < 14 degrees	> 14 degrees
< 10 m	Nil	Toe benching	Full benching
> 10 m	Nil	Toe benching and drainage blanket	Full benching and drainage blanket

Other Embankment Formation Treatments

Major embankment preparation treatments for the alignment have been discussed in the preceding section. For all other areas, following the completion of clearing and grubbing, topsoil stripping and removal of unsuitable material, the exposed ground surface for all embankments will be scarified and re-compacted in accordance with MRTS04 Clause 12.

In addition to the above requirement, where the foundation of embankments is subject to inundation, located on natural water pathways or where the groundwater level is high, appropriate foundation drainage should be provided.

Q100 flood maps have been reviewed along the alignment and where embankments are predicted to be inundated, a 0.5 m thick, geotextile wrapped drainage blanket is required, place above the existing surface level.

4.8.3 Erosion Protection

The surfaces of all fill slopes are protected against erosion through the use of appropriate batter slopes and benches, embankment zoning and landscaping. A summary of the protective measures is provided below:

- Batter slopes and benches
 - > The maximum batter slope is 1V:2H with minimum 4 m wide benches at 10 m vertical intervals
- Embankment zoning
 - > Non-dispersive Class A/B material is used in the outer zone of zoned embankments
 - > Non-dispersive Class A or B material will only be used in homogenous sections
- Landscaping
 - > All batter slopes are protected by a 100 mm thick layer of topsoil and hydroseeding/hydromulching.

4.9 Settlement Analysis

4.9.1 Assessment Methodology

All embankments will undergo a certain amount of settlement. The magnitude of settlement at the crest of the final embankment profile will comprise the following components:

- Fill settlement
 - > Short term – Elastic settlement – occurs immediately during fill placement and following the application of traffic loads
 - > Long term – Creep settlement – occurs during fill placement and for a period of years after construction
 - > Long term – Hydro-consolidation or collapse settlement – occurs due to saturation
- Foundation settlement
 - > Short term – Elastic settlement – occurs immediately during fill placement and following the application of traffic loads
 - > Long term – Primary consolidation
 - > Long term – Secondary compression.

Once topsoil and loose materials are removed during foundation preparation, the ground conditions at natural (base) ground level of embankments are expected to be competent i.e. stiff or better. Therefore, the magnitude of foundation settlements is assumed to be nominal, i.e. less than 50 mm. This settlement is expected to occur during the construction period and have no adverse effect on the embankment performance.

Elastic settlement of the fill will occur immediately and have no long-term impact on the performance of the road. Hydro-consolidation or collapse is not expected to be a major issue for fill embankments where proper foundation drainage is provided to limit saturation.

The remaining component of long-term settlement is creep. Creep settlement (self-weight) of fill embankments is generally not an issue when heights are less than 20 m or where the change in slope is small. For the TSRC alignment, fill embankments in excess of 20 m height are required between CH10680 and CH15660 over narrow, v-shaped gullies. Due to the large embankment heights and changes in grade, creep settlement of the fill can potentially impact the long-term performance of the pavements. According to Sherard and Cooke (1987) post-construction time dependent deformations are observed for more than 30 years after construction, typically at a gradually reducing strain rate.

For most types of fill there is a linear relation between creep compression and the logarithm of time that has elapsed since the load was applied, and a simple settlement model can be derived for self-weight creep: meaning the settlement that occurs when stress and moisture conditions do not change, which can be expressed by the equation (Charles, 2008):

$$\Delta s = \alpha H \log \left(\frac{t_2}{t_1} \right)$$

Where:

Δs = change in settlement

α = creep strain rate (per log cycle)

H = height of fill embankment

t_2 = end time -- assessed for 25 years for the project performance specification and 40 years for the Geotechnical Design Standard – Minimum Requirements

t_1 = end of construction -- 15 months for placement of final pavement

The creep strain rate has been estimated for fill materials found along the TSRC alignment using the empirical results of Waddell and Wong (2005) and Hunter and Fell (2002). The assumed strain rate for each material and the applicable reference is shown in Table 8 below.

Table 8: Creep strain rate

Embankment material	Composition	α = creep strain rate (per log cycle)
General Fill -- Class A to D	Sandstone, siltstone, mudstone and basalt mixtures	0.01% (Waddell and Wong, 2005) for sandstone-shale material
General Fill -- Class A and B	Sandstone or Basalt only	0.005% (Waddell and Wong, 2005) for sandstone material only
Abutment Fill	Class A compacted to 98% MDD or Rockfill	0.075% (Hunter and Fell, 2002) for compacted gravels or high strength rockfill with H<20 m

4.9.2 Main Alignment

An assessment of the total creep settlement along the TSRC alignment has been undertaken, assuming the parameters for General Fill -- Class A to D. If the differential settlement resulting from the creep has also been assessed at 20 m intervals.

Bridge Abutments Design

4.10 Bridge Abutment Recommendations

Generally the foundation materials at each bridge abutment are competent and there is only a need to remove material in excess of standard MRTS04 clearing and grubbing and topsoil stripping where the additional thicknesses of loose or soft-firm material are encountered. The depth of remove, and remove and replacement, at each abutment has been determined by the boreholes or test pits closest to the bridge alignment. Preparation at the abutment is only requirement within the 25 m structure zone.

Cut Slope Design

4.11 Cutting Design Recommendations

4.11.1 Batter Slopes and Benching

The batter and bench configuration has been selected to provide slopes with minimal need for slope reinforcement, to mitigate erosion and reduce the risk of rock fall. Two typical batter and bench configurations are proposed and have been summarised previously; further details on the criteria for select batter configurations are presented below.

The proposed geometry is generally expected to address the stability, erosion and rock fall issues. In some instances however, the presence of underlying weaker layers such as extremely weathered claystone, mudstones or coal seams may lead to slope instability. In these instances slope reinforcement of flatter batters will be required for these sections to achieve the required stability

Local and Global Stability of Slopes

Shallower batters (1V:2H to 1V:0.75H), 7 m high with 5 m wide benches are proposed for less competent material to ensure the local and global stability of slopes is satisfied without the need for large quantities of slope stabilisation. Steeper batters (1V:0.75H to 1V:0.5H), 10 m high with 4 m wide benches are proposed for more competent material where the rock mass strength was high. Slightly weathered sandstone of the Ma Ma Creek Sandstone formation and moderately to slightly weathered basalt were deemed suitable for this latter configuration while shallow batters are proposed for all other materials intersected across the projects.

Erosion Susceptibility

Shallower batters (1V:2H to 1V:0.75H), 7 m high with 5 m wide benches are proposed for materials susceptible to erosion to reduce surface flow velocities and lengths over batter faces. Extremely to highly weathered sandstone and extremely to moderately weathered siltstones, mudstones and claystones are considered to be susceptible to erosion. This is based on assessments of rock core and observations of existing cuts where competent sandstone has been undercut by eroding siltstone and mudstone.

Rock Fall Risk

Shallower batters (1V:2H to 1V:0.75H), 7 m high with 5 m wide benches are proposed for materials more prone to sources of unstable blocks in order to reduce the potential velocity of blocks and provide a wider bench to catch any loose debris. Sedimentary units interbedded with highly weathered sandstone or highly to moderately weathered siltstone and mudstones, which may erode away and undercut more competent materials, are considered to be potential sources of rock fall. Despite observations, highly to moderately weathered susceptible basalt material was generally not considered a high risk in this instance, as face protection would likely be required for these materials to mitigate degradation.

4.11.2 Slope Face Protection and Face Support

Slope face protection is required for a number of cuts along the alignment to mitigate erosion, prevent degradation of susceptible material, ensure the stability of the batters, and mitigate rock fall hazards. Green solutions have been recommended where practical and cost-effective for aesthetic reasons.

Topsoil and Hydroseeding

Topsoil for 1V:2H batters and hydroseeding for 1V:1.5H batters are proposed to prevent erosion while providing a green treatment. The use of drought tolerant eco-turf will also be considered.

Geobrug's Tecco Mesh and Tecmat Erosion Protection (or approved equivalents)

A high tensile mesh (eg Tecco Mesh) in conjunction with erosion protection matting (eg Tecmat) and hydro seeding is proposed for batter slopes steeper than 1 on 1.5 in sedimentary material that require

face support or erosion protection. This is recommended to reduce the risk of rock falls caused by more competent blocks being undercut by erosion of these materials.

Materials considered susceptible to erosion include extremely to highly weathered sandstone and extremely to moderately weathered siltstones, mudstones and claystones. This is based on assessment of rock core and observation of existing cuts where competent sandstone has been undercut by eroding siltstone and mudstones.

Shotcrete

Shotcreting face protection and support is also recommended for batter slopes steeper than 1V:1.5H where Tecco Mesh (or approved equivalent) is deemed unsuitable. This facing treatment is proposed for small areas in sedimentary materials susceptible to erosion protection such as thin weathered mudstone layers, as well as basalt material susceptible to degradation. Shotcrete has been recommended rather than Tecco Mesh (or approved equivalent) in order to mitigate infiltration of water into the cut batter that would lead to degradation of the basalt.

The need to protect many sections of the exposed basalt material is based on the results of petrographic analysis, which indicates that many sections of the basalt comprise a high secondary minerals content (typically >30%) lending to accelerated degradation of the rock mass strength. This is supported by recent inspection of basalt stock piles at the pilot tunnel as well as basalt rock core from TMR 2003 geotechnical investigation. Materials most susceptible to degradation were noted to generally be described as vesicular and / or amygdaloidal and were recorded in numerous boreholes intersecting basalt across the project.

During construction it is recommended that the application of shotcrete to protect basalt is based on an observational approach. It is also recommended that further testing / assessment is carried out to determine the susceptibility of the basalt to degrade. The extent of shotcrete currently proposed for cuttings has been based on the assessment of rock logs and core at each cut.

4.11.3 Slope Reinforcement

Spot bolting or pattern bolting is recommended in locations where slope stability or kinematic analyses indicate slopes will have an inadequate stability without slope reinforcement. Batter geometry has generally been developed to limit the need for slope reinforcement. As a result these reinforcement measures are generally expected to be minimal and most often only required to address local instability issues. Larger scale slope reinforcement are only recommended where site constraints limit batter geometry or kinematic planar failures are identified as a risk.

Spot Bolting

Rock bolts, typically 3 m long in accordance with MRTS04, are recommended to support unstable blocks that cannot be removed during construction and pose a rock fall hazard. Based on preliminary kinematic analysis this treatment will likely be required in sections of the basalt material to mitigate toppling and wedge failures. Spot bolting may be required in sedimentary units where isolated random defects are intersected, however the extent of treatment in these materials is likely to be minimal.

Pattern Bolting / Soil Nailing

Pattern bolting / soil nailing, typically 3 m long at 2 m centre spacing, in accordance with MRTS04, is recommended to support unstable local batter slopes. Local pattern bolting of individual cut batters is generally expected for 1V:1H or steeper batters intersecting weak layers such as extremely weathered to highly weather siltstone, mudstones or claystone and coal seams.

Larger scale pattern bolting / soil nailing, typically 6 to 10 m long at 1.5 to 2.0 m spacing are recommended in isolated locations where site constraints limit batter geometry or kinematic planar failures are identified as a risk

4.11.4 Sub-surface Drainage

Sub-surface drainage is recommended at some locations to actively manage pore-water pressures at the batter face. Sub-surface drainage recommended generally consists of sub-horizontal drains typically 4 m long at 2 m spacing.

Sub-horizontal drainage is also recommended for thick extremely weathered mudstone, claystone and coal seams to actively manage pore pressures in these materials.

4.11.5 Rock Fall and Debris Flow Protection

A proactive approach has been adopted for the management of rock fall and debris flow across the site in conjunction with passive rock fall and debris flow protection measures. These proactive measures include:

- Adopting suitable batter and bench geometry to limit the rock fall risk; shallower batter angles and wider benches are generally recommended for materials identified as likely sources of rock fall.
- Proactive retention (eg spot bolting) or removal of rock fall hazards identified during construction; spot bolting or removal of blocks greater than 200 kg that pose a risk is recommended.
- Mitigating erosion of sedimentary materials susceptible to erosion and undercutting of more competent rock masses.
- Provision of debris flow fences at the locations shown in the following figure to stop shallow landslides and debris flows originating from the adjacent basalt cap from clogging up drainage structures. A SL-150 shallow landslide barrier (or approved equivalent) with 5 m post spacing has been assumed for each location

In conjunction with these proactive measures the following rock fall protection is proposed as a final line of protection:

- CH 0 to 18,440:
 - > Concrete barrier with chain wire fence (1.2 m high) at the base of each cut for all slopes steeper than 1 on 2.
- Cut 18,440 to 40,250 (Cut 30 to end of alignment)
 - > Chain wire fence (1.2 m high) offset approximately 3.2 m from the base of each cut for all slopes steeper than 1 on 2.

The chain wire fence is to be in accordance with TMR Standard Drawing No. 1602. Initial rock fall modelling indicates that this protection would have sufficient capacity and height to retain blocks up to 200 kg in size based on a fence capacity of 10 kJ.

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.4 – Geotechnical

Question ID	Report Reference	Question	Proponent Response
T40a	A1.4	We are unable to locate planned Geotechnical Investigation (GI) for the delivery phase of the project or confirm your compliance TMR minimum design guidelines for Geotechnical Investigation (GI). Please either identify the location of this information within your Proposal or provide the information in response to this question, and confirm your compliance with TMR minimum standards.	Nexus confirms it will comply with the TMR minimum design guidelines for Geotechnical Investigation (GI). The proposed Geotechnical Investigation (GI) as part of the delivery phase includes the following: - Cuts – boreholes to 3 m below the base of the cutting - Packer testing in the cuttings - Embankments – test pits and boreholes - Installation of groundwater water monitoring bores within the cuts and embankments - Bridge foundations to TMR standard (two per pier / abutment per bridge) - seismic refraction for some cuts and embankments - D9 rippability testings in some cut locations - Mapping of boulders, landslips and scree slopes - Laboratory testing for material classification, strength, rock strength, lime demand for expansive soils, CBR and pavement testing
T41	A1.4	We are unable to locate and confirm the proposed methodology for assessment and treatment of weak material within Marburg formation. Please either identify the location of this information or provide details in respect to: 1. Potential treatment types proposed, including stabilisation and surface protection where applicable 2. Methodology for onsite identification and application of alternative treatment types. 3. Proposed management of approvals process and program for reactive treatments.	In response to point number 1 A.1 – Design, Geotechnical Element, G2 – Cut and Embankment Stability Strategy Report, Section 4.5.4 provides an overview of embankment foundation preparation requirements, including areas of weak material within the Marburg Formation (east of the tunnel). Section 6.7.3 and Section 6.7.4 provide detail for surface protection in cuttings in the presence of weak layers. Drawings GE-01 to GE-17 shows the proposed slope protection details for each cut along the alignment, with typical detail sections and analysis of critical sections. Drawings GE-26 to GE-35 shows the proposed embankment foundation treatments along the alignment, with typical details sections. For ease of reference we have included Nexus Infrastructure’s submission for G2 – Cut and Embankment Stability Strategy Report (Appendix T41a) and the drawings referenced within this response (Appendix T41b). In response to point number 2 All design parameters that are critical to the geotechnical design (including earthworks and structural foundations) will be documented on the detailed design drawings. These assumptions will be derived from existing site investigations and lab testing and supplemented by a further rigorous geotechnical investigation and testing program following project award. During construction all assumed geotechnical parameters will be verified by a suitably qualified team of geotechnical engineers / geologists who will be located on site. The geotechnical design parameters will be verified by means of reviewing test results, and logging of geology in cuttings or piles (including defect mapping in cuttings). The results of these tests / observations will confirm the design or otherwise. Where the geology is different from that assumed in the design, the on-site staff will pass the information back to the design team who will revise the design. Depending on the scale of the changes to the design either of the following will occur: - Minor change – a Site Notification (or similar) will be issued advising the construction team of the changes - Major change – the design will be revised and submitted through the review process. Also, for various stabilisation treatments such as rock bolting etc., the design will include different treatments for various scenarios encountered on site. In these instances the site geotechnical team will direct the construction team of the requirements. In response to point number 3 The management of the approval process will depend on the significance of the difference between the assumed and actual geotechnical conditions. Considering this, the proposed process is outlined below.
T41 cont	A1.4		Changes where alternatives are proposed on the IFC drawings: - The on-site geotechnical team will assess the geotechnical conditions and in each particular case provide direction to the construction team as to which of the nominated treatments is to be selected. This is applicable for extent of protection, spot bolting etc. The advice from the design team to the construction team will be via a Site Notification (or similar) Where there is only a minor difference between the design and actual geotechnical conditions: - In this scenario, the site geotechnical engineer will pass the test results and observations to the designers who will review the design. Where minor changes are required these will be issued to site via a Site Notification (or similar). Where there are significant differences between the design and actual geotechnical conditions: - In this scenario, the site geotechnical engineer will pass the test results and observations to the designers who will review the design. Where significant changes are required the design drawings will be updated and will be issued through the standard review process (including the IR). The program expectations for approval of reactive treatments is as follows: - Changes issued through Site Notifications. IR would not have an approval gate however would be copied into correspondence for information. - Changes that require a change to the design drawings will be issued through the IR. Working collaboratively it is expected that the IR would provide comments within 10 working days. Note: The submitted PDF version of the A.1 – Design, Geotechnical Element, G2 – Cut and Embankment Stability Strategy Report had a formatting error and did not show some of the table headings, which contains key information as part of the design. The submitted Word version was formatted correctly. Appendix T41a has been amended to correct the formatting error.

Question ID	Report Reference	Question	Proponent Response
T42	A1.4	We are unable to locate and confirm the proposed methodology for assessment and treatment of weak material within the Main Range Volcanics formation. Please either identify the location of this information or provide details in respect to: 1. Potential treatment types proposed, including stabilisation and surface protection where applicable 2. Methodology for onsite identification and application of alternative treatment types. 3. Proposed management of approvals process and program for reactive treatments.	In response to point number 1 A.1 – Design, Geotechnical Element, G2 – Cut and Embankment Stability Strategy Report, Section 4.5.4 provides an overview of embankment foundation preparation requirements, including areas of weak material within the Main Range Volcanics formation (west of the tunnel). Section 6.7.3 and Section 6.7.4 provide detail for surface protection in cuttings in the presence of weak layers. A.1 – Design, Geotechnical Element, G1 – Geological and Geotechnical Report, Section 11.2 details the findings for the estimated characteristic surface movements of the highly reactive clays, which are commonly found in the Main Range Volcanics formation. Section 11.2.3 details the design options. Drawings GE-01 to GE-17 shows the proposed slope protection details for each cut along the alignment, with typical detail sections and analysis of critical sections. Drawings GE-26 to GE-35 shows the proposed embankment foundation treatments along the alignment, with typical details sections. For ease of reference we have included Nexus Infrastructure's submission for G2 – Cut and Embankment Stability Strategy Report, with amended table formatting, (Appendix T41a), G1 – Geological and Geotechnical Report (Appendix T42), and the drawings referenced within this response in Appendix T41b. In response to point number 2 All design parameters that are critical to the geotechnical design (including earthworks and structural foundations) will be documented on the detailed design drawings. These assumptions will be derived from existing site investigations and lab testing and will be supplemented by a further rigorous geotechnical investigation and testing program following project award. During construction all assumed geotechnical parameters will be verified by a suitably qualified team of geotechnical engineers / geologists who will be located on site. The geotechnical design parameters will be verified by means of reviewing test results, and logging of geology in cuttings or piles (including defect mapping in cuttings). The results of these tests / observations will confirm the design or otherwise. Where the geology is different from that assumed in the design, the on-site staff will pass the information back to the design team who will revise the design. Depending on the scale of the changes to the design either of the following will occur: - Minor change – a Site Notification (or similar) will be issued advising the construction team of the changes - Major change – the design will be revised and submitted through the review process. Also, for various stabilisation treatments such as rock bolting etc., the design will include different treatments for various scenarios encountered on site. In these instances the site geotechnical team will direct the construction team of the requirements.
T42 cont	A1.4		In response to point number 3 The management of the approval process will depend on the significance of the difference between the assumed and actual geotechnical conditions. Considering this, the proposed process is outlined below: Changes where alternatives are proposed on the IFC drawings: - The on-site geotechnical team will assess the geotechnical conditions and in each particular case provide direction to the construction team as to which of the nominated treatments is to be selected. This is applicable for extent of protection, spot bolting etc. The advice from the design team to the construction team will be via a Site Notification (or similar) Where there is only a minor difference between the design and actual geotechnical conditions: - In this scenario the site geotechnical engineer will pass the test results and observations to the designers who will review the design. Where minor changes are required these will be issued to site via a Site Notification (or similar). Where there are significant differences between the design and actual geotechnical conditions: - In this scenario the site geotechnical engineer will pass the test results and observations to the designers who will review the design. Where significant changes are required the design drawings will be updated and will be issued through the standard review process (including the IR). The program expectations for approval of reactive treatments is as follows: - Changes issued through Site Notifications. IR would not have an approval gate however would be copied into correspondence for information. - Changes that require a change to the design drawings will be issued through the IR. Working collaboratively it is expected that the IR would provide comments within 10 working days.

Question ID	Report Reference	Question	Proponent Response
T123	A1.4	Durability of materials to be encountered during construction is important to the selection of material properties for design and long term performance of structures. Amygdaloidal basalt and vesicular basalt has been identified as susceptible to accelerated weathering, similarly some materials within the Marburg formation are known to weather preferentially. These materials are not specifically defined as to be excluded from construction as rockfill and Class A/B materials, as such they present a risk to long term performance. Please provide further detail on how has the identification and application of these materials been considered in construction. Furthermore how has the change in material properties over the design life been accounted for?	Report A1 – Sub-Schedule Design – G1 Preliminary Geological and Geotechnical Report discusses material re-use in Section 10.6. As per Section 10.6.2 the amygdaloidal and vesicular Basalt is currently excluded as a rockfill material due to potential durability issues. Based on the laboratory testing information that is currently available it has been assumed that the MW and SW amygdaloidal and vesicular basalt will primarily comprise Class B/B* material, with a minor percentage of Class C or worse. Laboratory testing will be undertaken during the detailed design investigation to confirm the properties, extent and potential re-use of the amygdaloidal and vesicular basalt. As shown in the slope stability analysis contained in Appendix A of G2 – Preliminary Cut and Embankment Stability Strategy Report, where lower quality materials have been assumed in the core of the embankments, reduced shear strength parameters have been adopted. These parameters reflect the long-term degradation of these materials. This will be reviewed and refined following further laboratory testing at the detailed design stage.

5 A.1 5 Hydrology and Drainage (D1)

5.1 Executive Summary

Nexus Infrastructure's design for drainage has been developed to reflect the Performance Specification and the whole-of-life cost/benefit of the various drainage elements in mind. In doing so Nexus have addressed potential project risks, durability, performance, operational issues and safety along with community expectations. Nexus have also given appropriate attention to the environmental effects of the Project, specifically water quality management and flooding.

The drainage system design includes:

- Cross drainage, including bridges and concrete culverts
- Table and catch drains
- Longitudinal drainage of the road surface
- Water quality and spill control devices.

Treatment of the subsurface drainage is included in the Pavement Design.

The drainage design will avoid or minimise any potential damage or loss that may result from or be contributed to by water discharge as a consequence of the Project Activities or Project Works.

Specifically, the drainage design:

- Provides flood immunity and control of hydraulic impacts at the crossing of watercourses
- Manages the quality and quantity of stormwater, providing devices that treat the stormwater and retain the run-off as close as possible to its sources so the drainage system changes the existing water regime to the smallest amount practicable
- Is integrated with the construction process and the planned drainage requirements so the total investment in drainage infrastructure is minimised and maintenance access is available to all devices during construction and operational conditions
- Preserves existing elements, including natural channels and wetland and riparian vegetation in areas not otherwise directly affected by the Project
- Requires minimum and straightforward maintenance to maintain the appropriate level of performance for the management of the quality and quantity of stormwater.

The drainage design achieves these performances by providing an effective, balanced and integrated arrangement of the cross and longitudinal drainage elements with the road geometry and the local catchment conditions.

Nexus Infrastructure has considered the need for resilience in its drainage design to significantly reduce the consequences of any future extreme storm conditions. The vulnerability to such events was highlighted by the dramatic consequences of the January 2011 floods around Toowoomba. To achieve the required functional outcomes during design conditions, as well as maintain operations and limit maintenance during extreme conditions, our proposal tailors the drainage design to the specific project conditions, including consideration of:

- High debris load along the escarpment of the Great Dividing Range
- Highly dispersive soils on the plateau of the Great Dividing Range
- Steep terrains and fast flow velocities.

All design principles and solutions applied in the drainage design are suited to the project specific conditions and, insofar as operational safety is concerned, exceeds the performance expectations from the technical specification without adding cost to the Project. This includes culverts designed to cater for blockage, drains lined and sized for events in excess of the design conditions, and integrated solutions for the design of culverts, energy dissipation and channel protection.

To further enhance the performance of the proposed tender design, the drainage design includes innovative elements to achieve or exceed the required outcome while reducing capital and whole of life operational costs, such as:

- Use of debris deflectors at the culvert inlets along the escarpment of the Great Dividing Range, which can effectively contain large quantities of debris of all sorts without compromising the culvert's performance and physical integrity
- Use of reinforced grass that has a significantly lower level of erodibility than natural vegetation, is more cost effective than concrete, and provides sustainable batter protection that is integrated with the landscape design
- The design of the cross drainage structures has been updated to account for the critical management of debris and scour.

The outcome is a drainage design proposal that is safe, complete, supported by approved methodologies and achieves all performance requirements.

5.2 Cross Drainage

5.2.1 Management of Debris

The Warrego Highway climbing the Toowoomba Range experienced significant blockages from debris during the January 2011 floods (compared with what is normally experienced in Australian coastal catchments) which jeopardised the safety of the highway to some unexpected extents.

To avoid the repeat of unsafe conditions during severe storms, the design incorporates mitigating features commensurate with the catchment characteristics and the associated debris risks:

- For all catchments outside of the escarpment (CH700 to CH5000 and CH16900 to CH41200), the conditions are similar to the traditional Queensland conditions upon which the QUDM and the Road Drainage Manual have been derived. As a result, the Nexus Infrastructure Tender Design incorporates the requirements from the two reference documents as stated:
 - > Pipe blockage: QUDM Table 10.4.1 recommends allowing for a 25% pipe blockage due to sediment build-up, unless this type of blockage is unlikely to occur. QUDM table 7.11.1 states that a pipe will be self-cleaning at a minimum velocity 0.7 m/s in a 1 year ARI storm. The 1 year ARI flood predictions from the design models show that the minimum velocity in the proposed culverts is 1.7 m/s, and are therefore self-cleaning. Therefore the 25% pipe blockage allowance of the pipe from sediment build up is not required.
 - > Inlet blockage: QUDM recommends allowing for a 20% inlet blockage in the design storm. This allowance was integrated in the design calculations, when determining the headwater levels for the blocked culverts. The proposed pipe diameters are approximately 20% larger than the minimum unblocked size that generates conforming flood conditions.
- For all catchments climbing the escarpment (CH5000 to CH16900), the type of debris expected is essentially boulders, tree limbs and logs from steep mountain streams or gullies, transported as bed load and floating. The source of the boulders is from bed and/or bank erosion or landmass movements. This material can easily block the entrance to a culvert. Based on HEC-09 from the US Federation Highway Administration, the Nexus Infrastructure Tender Design incorporates debris deflectors, which are structures placed at the culvert inlet to deflect the major portion of the debris away from the culvert entrance. They are normally V-shaped in plan with the apex upstream. The debris deflectors are designed so that the angle at the apex of the deflector is between 15° and 25°, and the total area of the two sides of the deflector is at least 10 times the cross-sectional area of the culvert inlet, allowing for up to 90% blockage of the debris deflector before the hydraulic performance of the culvert crossing is negatively affected. The base width and height of the deflector is at least 1.1 times the respective dimensions of the culvert. An example of a debris deflector is shown on Figure 7. Debris deflectors are provided at the inlet of 15 culverts along the escarpment.



Figure 7. Example of inlet steel rail debris deflector (Source: HEC-9, Debris Control Structures)

5.3 Longitudinal Drainage

5.3.1 Design Concept

The longitudinal drainage design proposed by Nexus Infrastructure intends to limit the use of underground pipe networks and drainage structures. To achieve the strategy, the longitudinal drainage design was developed in conjunction with other design disciplines such as civil for the geometric alignment, geotechnical and landscape architecture for batter treatment and stability.

The different Tollroad profiles between the eastern section (east of the New England Highway) and the western section (west of the New England Highway) allow different opportunities for the longitudinal drainage, which have been implemented in the design:

- Along the eastern sections, the road profile includes a concrete barrier in the median, which collects runoff in superelevation sections, concrete barriers along the inside shoulders in the cuts, and guardrails along the inside shoulders in fill. As a result, the following system is proposed to drain the road runoff:
 - > In fill and normal crossfall, allow runoff from the road surface to sheet flow over the batter down to the toe of the embankment or to the first bench of the fill embankment, if available. The batter will be treated with reinforced grass; Profile's GreenArmor product or equivalent is proposed. GreenArmor consists of a UV stabilised nylon mesh in-filled with hydraulically applied mulch containing selected grass species suitable for the site conditions. This system provides immediate and effective long-term erosion protection capable of withstanding much higher velocities than standard vegetated protection measures. The system also leads to low ongoing maintenance requirements. A diagrammatic image of the GreenArmor product is shown in Figure 8 below. The verge will also be treated with reinforced grass to maintain the uniform sheet flow from the road to the batter face.



Figure 8 Reinforced vegetation profile

- > In cut and normal crossfall, the focus is to convey the road runoff within the shoulder to allow for discharge at the cut/fill interface. By allowing the runoff to be conveyed within the road shoulder (extending a maximum of 1 m into the traffic lane) it reduces the need for pits and pipes in the shoulder of the road. This approach complies with the TMR requirements regarding flooded width, which require a minimum of 2.5 m of lane to remain free from floodwaters during the design rainfall event.
- > In super-elevation, the runoff from the superelevated section is collected in the outside shoulder along the median concrete barrier, similar to the inside shoulder in normal crossfall in cut. Where the capacity becomes insufficient, TMR standard concrete gullies and underground pipes are included in the system, which generally discharge at the next cut / fill interface.
- Along the western sections, the road profile includes a V drain at the interface between cut batters and the road profile, allowing for the conveyance of the road runoff to the next cut / fill interface.

Concrete barriers are not provided, avoiding the need to capture flow in shoulders. The longitudinal drainage in this section of the TSRC is all managed through sheet flows and open channels. In fill, sheet flow onto the batter is allowed as in the eastern section. Where median drainage is provided, field inlets pits and outlet pipes are provided as required, including at all sag points, to discharge water from the median drains to the natural drainage paths in the surrounding environment.

The longitudinal drainage system relies heavily on open channels. The following sub-sections describe the individual elements of the drainage system.

Catch Banks, Catch Drains and Table Drains – Locations, Types, Cover

Banks and drains are provided as part of the TSRC drainage system under the following circumstances:

- Catch banks in the following situations:
 - > Where there is deemed to be a low risk of flow discharging from the surrounding land down the cut batter, a catch bank is used to divert this flow around the cut face and toward the downstream drainage path, in many cases the cross drainage culverts
 - > Where road runoff is collected in table drains at the toe of embankments for conveyance to water quality basins and the external catchment also flows towards the embankment, a catch bank is used to separate the external runoff from road runoff and divert the external catchment around the water quality basins
 - > In all cases the toe of the catch bank is stabilised with reinforced grass, ie GreenArmor or approved equivalent as described above.

- Catch drains at the top of the cuts where there is a risk of the external catchment flowing into the alignment. In this situation, catch drains are used in parallel with catch banks to prevent external flows from flooding the road at natural cross drainage points in cuts. The catch drains are complemented with catch banks to augment the capacity of the capture. The combined conveyance achieved by the design is in excess of the 100 year ARI. The catch drains convey clean water from external catchments to the downstream cross drainage pathway.
- Cut drains, within the western section of the TSRC, at the interface between the cut face and the road. The cut drains capture the runoff from the cut face and the road surface. The cut drains convey the runoff to the next cut/fill interface where it is discharged via a level spreader or to a table drain for conveyance to a water quality basin, if required.
- Table drains at the toe of the fill embankments within environmentally sensitive areas where water quality treatment and provision for spill containment is provided. The table drains convey the road runoff discharged down batters or from cut/fill interfaces toward the water quality basins. Where appropriate, table drains also receive discharge from pit and pipe networks requiring conveyance to water quality basins.

The cut drains are included in the road design model, as a V drain with 1 in 4 batters. The bottom of the cut drains is below the pavement level, allowing free draining of the pavement sub-surface flows.

The proposed catch and table drains consist generally of trapezoidal channels cut across the fall of the land. The Nexus Infrastructure Tender Design includes two standard channels, both with 1 m base width, side slopes of 1 in 2 and depths of 0.4 m and 0.5 m, each allowing for 0.15 m freeboard. The standard drawings for the drains are included in the drainage typical details in Appendix 9.

All combined, the drains described above account for approximately 68 km of open channels along the Tollroad and ancillary roads.

In areas where the alignment is in fill and the land naturally falls towards the fill embankment, rather than providing a drain at the toe of embankments to convey runoff from the surrounding land to cross drainage culverts, the toe of the embankments are to be stabilised using reinforced vegetation (GreenArmor or approved equivalent) as described for the protection of batters above. This product is capable of withstanding high velocities and will protect the toe of embankments from erosion. Where this situation occurs in environmentally sensitive areas and road runoff is to be conveyed via table drains at the base of embankments toward spill capture or water quality basins, this reinforced turf will be applied to a catch bank on the upstream side of these table drains. This allows for separation of 'clean' runoff from the natural catchment, from that requiring treatment within the basins. This scenario was also described above, under the Catch Banks Section.

As per Clause 2.8 (h) (iii) of the Design Performance Specification, the drains have been designed to have a minimum capacity of 10 year ARI. Hydrology was undertaken using the Rational Method (AR&R) 1987 to calculate the design runoff from catchments discharging to open drains. The drains themselves were sized using the Manning's equation, adopting the average slope for each drain. Analysis of the drains identified that two standard cross-sections could be adopted for the majority of the open drains required along the alignment. For the few drains where the standard cross-sections were not appropriate, individual cross-sections were determined and documented on the drainage drawings in Appendix 9.

Note that the table drain section determined at the downstream end of the drain, where the conveyed flow is at its maximum from the full catchment runoff, has been assumed to be applied over the entire drain's length. This assumption is conservative, as the conveyed runoff at the start of the drain would be limited due to the reduced catchment contribution. The catch drain design will be optimised at detailed design, including the cross-section shape, based on incremented catchment areas and based on construction methods.

Pits and Pipes – Location, Types

The pipe network assists in conveying the road runoff away from the carriageways when the capacity of the gutter is exceeded. Nexus Infrastructure proposes to use the standard DTMR concrete gully pits, including lintels at the kerbs and barriers.

The pit spacing is a function of gutter capacity, contributing catchment area, longitudinal grade, pit capture capacity and design performance requirements. All have been calculated and optimised using combined hydrology and hydraulic spreadsheets utilising the rational method for road runoff and the Manning's formula to calculate gutter capacities. The spreadsheet also calculated the pit inlet capacities and allowed for the recommended pit blockage factors detailed in the DTMR Road Drainage Manual: Table 11.2.10.1.

With the steep grades experienced along the route, especially climbing the escarpment, the capture rate from the pits is challenged, and additional pits are included to ensure all gutter flows are captured before any change in crossfalls.

The hydraulic grade lines (HGLs) within the pipes were assumed to be parallel to the pipe. However, to account for the local losses generated at the pits, the capacity of the pipe was assumed to be half of its actual size, and that it would not run full. The minimum pipe size used is 375 mm and the pipe grades are in accordance with the DTMR Road Drainage Manual: Table 11.2.19. For critical areas in the longitudinal drainage network, such as the trapped sag in the main alignment under the Mort Street interchange, the longitudinal drainage was fully modelled using the 12d drainage modelling package, which accurately calculates pit structure losses and the resulting hydraulic grade levels.

Longitudinal pipework can generally be RCP class 2 as these pipes are typically located at the top of the road embankment and are not subjected to loadings from high fills. However, for construction traffic — and to avoid the possibility of breakage due to large plant — class 3 and 4 pipes are proposed for the smaller diameter pipes up to 900 mm diameter.

Bridge Drainage

The majority of bridges have sufficiently wide shoulders to convey the entire bridge runoff to the end of the bridge, therefore removing the need for any drainage on the bridge itself. However some bridges have insufficient shoulder capacity to convey the entire road runoff, or there may be a superelevation rotation on the bridge, and for these bridges we have proposed a pit and pipe drainage system to intercept the flow from the bridge deck.

The proposed bridge drainage system is comprised of small galvanised steel pits which are cast into the bridge deck and outlet to fibre-reinforced concrete pipes which are suspended under the bridge. The pipes are generally located in between the Super T girders to make them less conspicuous to vehicles travelling underneath the bridges.

At the end of each bridge the pipework will discharge through the bridge abutment and into a pit and pipe system that will discharge at a convenient location from the embankment, where it will be directed to the nearest water quality treatment if required.

5.4 Scour Protection

5.4.1 Cross Drainage Culvert Outlets

Three levels of energy dissipators are envisaged for the design:

1. Rock rip rap apron: A simple rock rip rap apron can be provided at culvert outlets for velocities as high as 5 m/s, as documented in Figures 9.15 (a) and (b) of DTMR's Drainage Design Manual
2. Rock rip rap basin: For pipe velocities between 5 m/s and 6 m/s, a rip rap basin must be provided as a minimum, which consists of armouring a pre-formed scour hole
3. Concrete structure: For pipe velocities between 6 m/s and 7 m/s, a concrete drop structure with a stilling pool must be provided.

As pipe velocities and outlet velocities increase, the cost and/or footprint of the energy dissipator also increases. As a result, the culvert design strategy aims at achieving conditions compatible with the provision of rock rip rap aprons, which is a standard culvert outlet treatment.

The design guidelines from Figures 9.15 (a) and (b) of DTMR's Drainage Design Manual have been derived from tests and experience. The recommended apron dimensions are meant to be sufficient

for a natural hydraulic jump to occur within the length of the apron, and therefore dissipate the energy over the resilient rock surface before the flow returns to its natural channel environment and behaviour. The great majority of the Nexus Infrastructure culverts are designed to achieve outlet velocities lower than 5 m/s, with either rock rip rap aprons or rock rip rap basins provided where required.

The most constraint conditions are where the pipe velocities cannot be slowed below 6 m/s and where the culvert outlets halfway through the fill embankment, forcing concentrated flows to run along the 2:1 embankment face. In the latter condition, the flows could become further accelerated and compromise any flexible structure (rock rip rap) that has not been tested for the specific conditions. As a result, Nexus Infrastructure advocates the use of concrete energy dissipators, similar to dam spillways. Such structures have been studied extensively by the US Army Corps of Engineers, and the design conditions and procedures are documented in HEC-14, Hydraulic Design of Energy Dissipators for Culverts and Channels, and have been adopted by the DTMR Road Drainage Manual.

The use of concrete provides dual benefits: the resilience of the structure is fixed and cannot be compromised during a flood, unlike rock rip rap which can move uncontrolled, and the determination of the hydraulic design conditions is precise due to the fixed geometry and roughness, again unlike rock rip rap.

So for pipe velocities between 6 m/s and 7 m/s, a concrete ramp along the fill embankment and a concrete stilling pool is proposed. Where the pipe outlets high enough in the fill embankment that benches are provided below the outlet level, Nexus Infrastructure proposes to use the benches to provide intermediate stilling basins to break the energy in steps before the toe of the embankment.

5.4.2 Cross Drainage Culvert Inlets

Some of the culverts on the Project are located at low points in road cuttings, where the catchment runoff has to drop down to the culvert inlet level over a short distance. To facilitate this drop, a reinforced concrete drop chute is proposed, which extends from the existing surface at the top of the road cutting to the concrete channel at the culvert inlet.

The depth of the flow at the culvert inlet has been calculated using the structure loss charts A2-36 and A2-3 from the Queensland Urban Drainage Manual 2013, with the higher of the two calculated water surface elevation levels adopted. The drop chute was assumed to be the upstream pipe for the purposes of this calculation.

A debris collection fence has been provided at the top of the drop chute to prevent debris from collecting at the culvert entrance. The debris fence will also act as a safety fence to prevent maintenance workers from slipping down the drop chute.

5.5 Longitudinal Drainage Outlets

All longitudinal drainage outlets will require scour protection downstream of the headwalls. A simple rock rip rap apron can be provided at outlets for velocities as high as 5 m/s, as documented in Figures 9.15 (a) and (b) of DTMR's Drainage Design Manual.

Some longitudinal drainage systems in high embankments cannot outlet directly to ground level, as the outlet pipes would need to be too steep. For these systems the longitudinal pipe system will outlet into a batter chute part way up the earthworks batter. The batter chute will be constructed of reinforced concrete and will convey the flows safely to the ground level where a rock pad will be provided to protect the ground from scour.

5.6 Open Drains

Open drain depths and velocities have been calculated using the Manning's formula. An analysis of the permissible velocities in the grass channels was carried out in accordance with the DTMR Road Drainage Manual: Table 8.6.1.3. It is acknowledged that the characteristics of the black soils experienced on the top of the range are highly dispersive and prone to erosion. The results showed

that velocities as low as 1.2 m/s could cause scour in the channels lined with the expected grass cover.

Mostly due to the longitudinal grades experienced along the Project, the velocities for the majority of the longitudinal open drains exceed 1.2 m/s and therefore a concrete lining is proposed to protect these drains from scour. Reinforced grass could also be considered as an alternative, and its use will be reviewed and determined at detailed design.

The culverts generally require minor channel diversion at the inlets and outlets. The bed velocities in these channels varied between 1 m/s and 5 m/s, and a rock lining is proposed to protect these channels from scour. The rock lining D50 and thickness were designed in accordance with the DTMR Road Drainage Manual: Figure 8.10.2(b).

5.7 Creek Diversions

The Nexus Infrastructure design does not include any creek diversions.

A few gullies, such as at chainages CH1000 and CH24200, are proposed to be locally re-aligned at culvert inlets and outlets to facilitate a smooth hydraulic transition between the open channel flows and the culverts flow. However, these re-alignments are limited in numbers and extents, and preserve the existing natural flow characteristics outside the corridor.

5.8 Water Quality

The purpose of this section is to describe our general approach to management of water quality for the Toowoomba Second Range Crossing Project (TSRC).

5.8.1 General Approach

The TSRC project traverses three definable catchment types:

- urban catchment of northern Toowoomba (Gowrie Creek to Warrego Highway (west),
- forest and woodland upper catchments of Sandy Creek and Gatton Creek to the east (Warrego Highway (east) to Gowrie Junction Creek)
- agricultural catchment of the Western Downs plateau to the west of Toowoomba (Warrego Highway (west) to Gore highway)

For each catchment type it is proposed to develop water quality control measures in response to the catchments environmental values, water quality objectives and statutory obligations.

5.8.2 Urban catchment

The load-based objectives for urban stormwater objectives listed in the Queensland Water Quality Guidelines 2009 will be adopted for Gowrie Creek to Warrego Highway (West).

5.8.3 Forest and woodland upper catchments of Sandy Creek and Gatton Creek

The Queensland Water Quality Guidelines 2009 provisions are not applicable to catchments outside urban area. To establish water quality compliance requirements for the project in the upper Sandy Creek and Gatton Creek catchment, consideration must be given to the specific requirements and intent of *Environmental Protection (Water) Policy 2009* (EPP Water) and *Queensland Water Quality Guidelines 2009*.

The catchment is listed in Schedule 1 of the EPP (Water) as the Lockyer Creek environmental and the environmental values nominated in Column 2 of Schedule 1 Column 2 are the Lockyer Creek Environmental Values and Water Quality Objectives July 2010. Of the listed values the most applicable to the upper catchment regional ecosystems and vegetated habitat (and the default when multiple values are listed) are related to **aquatic ecosystems**.

Section 2.6 of *Queensland Water Quality Guidelines 2009* recommends a "holistic approach" to management of aquatic ecosystems noting that changes in hydrology, habitat and physical form may have a greater impact than chemical/biological change in many Australian waterways.

The proposed approach to compliance for Water Quality requirements of the EPP Water, in consideration to the risk to aquatic ecosystems values for the upper catchments of Sandy Creek and Gatton Creek focusses on measures to:

- Maintain close to natural flow of intersected drainage lines to minimise changes in hydrology, habitat and physical form
- Reduce, through management measure, progressive rehabilitation and engineering design, the potential for erosion mobilisation of sediments

An outline of potential design stage compliance measures are listed below.

Possible Design Treatments

- Location and placement of intersection / cut off drains discharges overland flows, minimises water velocity and concentration of water at discharge points.
- Maintenance of the profile of natural drainage lines in bridge design.
- Limitation of vegetation clearance footprint to the minimum requirement for the project. Stage clearing and rehabilitation during construction to minimise the exposed soil footprint.
- Effective rehabilitation measures for disturbed areas; selected to match the specific location, slope and soil type; quick to establish and durable,
- Scour protection measures applied to all locations where water velocity and volume exceed environmental design limits.
- Culvert designed to flow velocities limits at discharge, aprons and /or incorporate downstream energy dissipation devices and scour protection.
- Lined drainage channels grades / profiles are design to minimise erosion.
- Physical design of batter and treatment to reduce erosion and sediment
- Landscaping, treatments and finishes to prevent erosion and sediment mobilisation.
- General design principals applied for preventing concentration of stormwater runoff and control of velocity in the selection of the number and spacing of culvert and drainage structures.

Load based objectives described in the *Queensland Water Quality Guidelines 2009* will not be assessed in this area.

5.8.4 Agricultural catchment of the Western Downs plateau to the west of Toowoomba

The water ways and drainage lines in the project catchment west of Toowoomba are in the upper reaches of the Condamine River which is not listed in Schedule 1 of the EPP Water. Under Section 6 of the EPP Water the environmental values to be enhanced or protected are as listed in Section 6 (2) -- however this section does not provide any guidance that is actually useful.

This western catchment is flat, cleared of natural vegetation and the dominant use is cropping and agriculture. The most applicable water quality value relates to protection of water for agricultural use. The risk to these values from the construction and operation of the TSRC project is very low and can be met by the application of standard rural road and highway design practices.

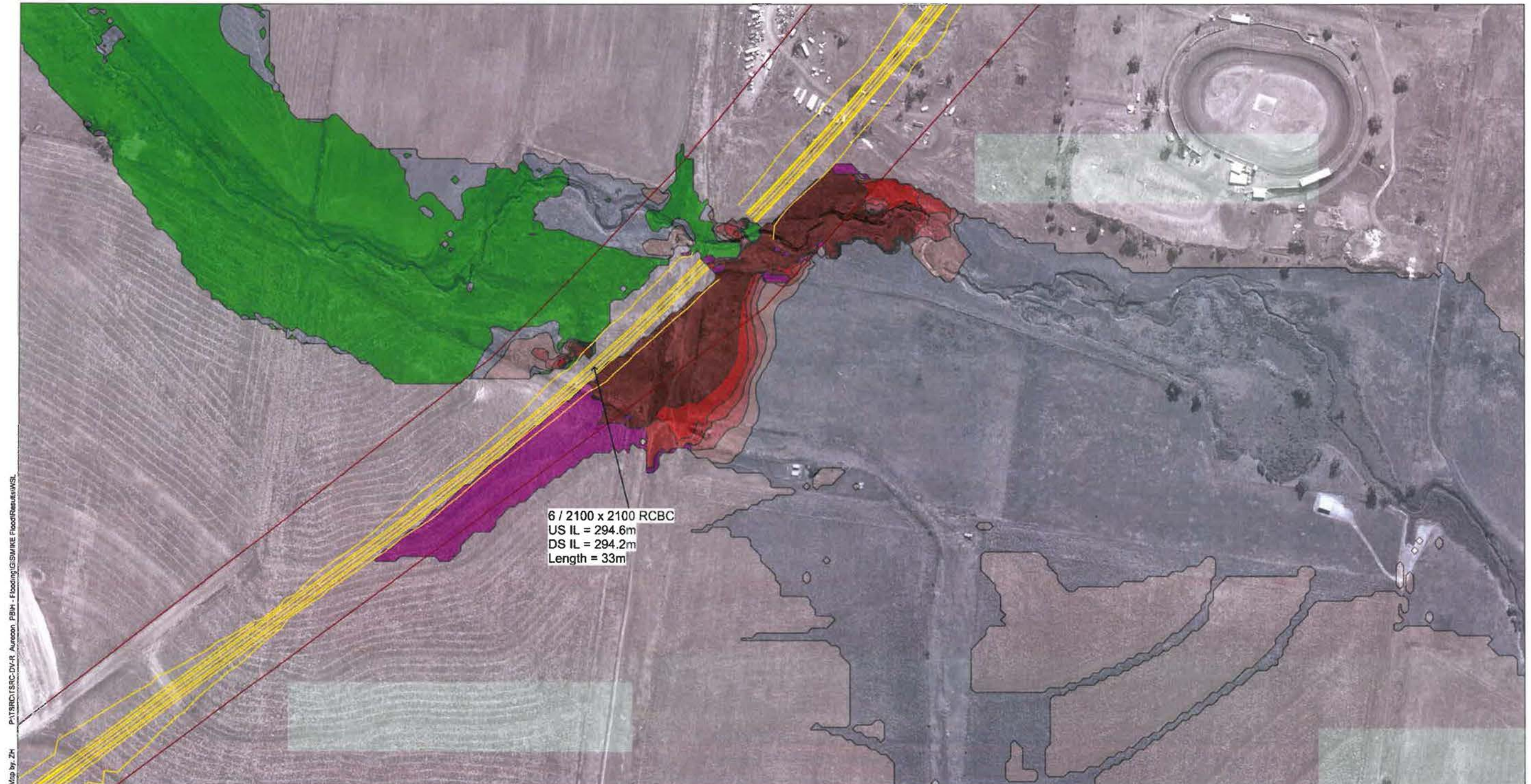
There are also potential spiritual and cultural values associated with the water way in at least one location in this catchment. Compliance with these values should be picked up under project cultural heritage compliance management measures.

Load based objectives described in the Queensland Water Quality Guidelines 2009 will not be assessed in this area.

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.5 – Hydrology & Drainage

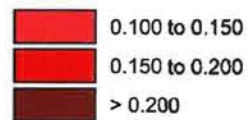
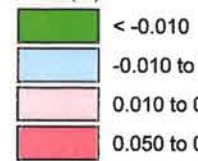
Question ID	Report Reference	Question	Proponent Response
T19	A1.5	It is not evident that the Proponent has addressed the requirement of Annexure 01 clauses 2.8(e), 2.8 (h)(ii) and 2.8(h)(v) to ensure flow paths are returned to their original flowpaths prior to exiting the site with consideration for the soil conservation plans and the Soil Conservation Act 1986. Please either identify the location of this information within your Proposal or provide the information in response to this question.	As stated in Section 9 of the Drainage Design report, our design does not include any creek diversions, which would redirect flows away from their existing flowpaths. All flowpaths exiting the road corridor are retained. Where local re-alignment of the flowpaths are necessary around the cross drainage inlet or outlet for geometric reasons, the extent of re-alignment is contained within the corridor and protected with rock rip rap. The location and extent of the works around the existing flowpaths are indicated as Type 1(R) on the Drainage Drawings (DD-01 to 35). A copy of the Drainage Design Report is included for ease of reference (Appendix 19).
T77	A1.5	We are unable to locate or confirm that compliance of Annexure 01, Clause 2.8(e) is achieved with regard to Temporary Works activities in particular that all Temporary Works have no impact on pre-construction conditions (inundation levels, flows, velocities) in all events up to and including a 100 year ARI storm event. Please confirm your compliance with these requirements, and what impact, if any, this has to your Proposal including program, cost or other related items.	Nexus confirms compliance with Annexure 01, Clause 2.8(e), in particular, that our proposed Temporary Works will not worsen preconstruction conditions (inundation levels, flows, velocities) outside the site during any event up to an ARI 100 year flood event. While our full suite of Temporary Works designs will be completed post award, we confirm the following key process controls will underpin our compliance: - To mitigate the potential flooding impact of earthworks embankments and provide effective environmental controls we intend to install the permanent drainage system and the sediment basins prior to the bulk earthworks activities. - Our submitted program of works proposes installing the permanent drainage system during the 'dry season'. - Our proposal for the construction of the structures does not involve plans for river/creek diversions or other provisional drainage systems with the potential to affect the pre-construction drainage conditions. - All costs associated with Temporary Works are included within Nexus' Proposal.
T87	A1.5	We are unable to confirm that your Proposal will maintain appropriate fish passage along all necessary waterways crossings as defined in the Department of Agriculture and Fisheries guidelines in accordance with Clause: 1.3.5.2 of Annexure 06: Performance Specification – Part 1 Please confirm your compliance with these requirements, and what impact, if any, this has to your Proposal including program, cost or other related items.	Nexus Infrastructure confirms that the arrangements for waterway crossings as currently proposed in our submission comply with Clause 1.3.5.2 of Annexure 06: Performance Specification – Part 1. as stated in A1(D1) Drainage Design Report, 3.1. Each of the waterways with potential fish movements (assessed from existing data-room reports and GIS mapping information) is proposed to be spanned with a bridge and any piers required for such structures are so located as to not disrupt the existing waterway flow regimes. These bridge structures therefore have no detrimental post-construction impact on fish passage. The use of bridge structures also reduces the impact surrounding the waterway during construction and rehabilitation, reducing the risk element of sedimentation entering the waterway systems. Other drainage lines which Nexus proposes will be crossed with culvert structures are ephemeral. We have assessed these are not conducive to fish movement due to no standing water (or water only flowing during rain events), existing modifications and/or terrestrial vegetation composition along the drainage contour. Accordingly, Nexus confirms that maintaining appropriate fish passage involves no modifications, program impacts or additional costs to its proposal.
T108	A1.5	The State has reviewed your response to T21 and identifies that the Drainage Report omits an afflux map for Dry Creek, and furthermore that this report notes there is in excess of 1m afflux at the project boundary in this area. The State requests that you provide in response to this question an afflux map for Dry Creek using afflux filters that show +/-10mm afflux (ie no impact) and 50mm increments of afflux levels above this. Furthermore can you please confirm there is no actionable nuisance with consideration to TRC's Planning Scheme for future developments?	The Dry Creek flood afflux map appears to have been inadvertently replaced by a duplicate of the Westbrook Creek afflux map in the Returnable Schedule Element D1. The correct map - Figure 8.11 - is included as part of this response (Appendix T108). From Figure 8.11, it can be seen that some afflux greater than 10mm occurs on land outside of the project corridor. This land is listed as rural in TRC's future planning scheme and is not earmarked for development. The amount of increased inundation is considered not to be actionable nuisance for the following reasons also listed in Section 5.3.5 of the Returnable Schedule Element D1: • The design does not increase the inundation duration along the main flowpath, • The increased inundation does not increase tangible damages, • The increased inundation does not prevent main access and egress to properties, or • The increased inundation does not prevent the continuation of all ongoing property activities.

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.5 – Hydrology & Drainage
Attachment for T108



Legend

Afflux (m)



MC00 Design

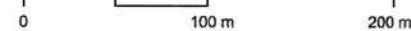
Road Corridor

Areas previously dry now wet

Notes:



A3 scale 1:4,000



Date: 30/01/2015 Version: 0 Job No: 244671
Projection: MGA Zone 56

Toowoomba Second Range Crossing

Dry Creek

Figure 8.11: 1% AEP Predicted Afflux

6 A.1 6 Noise (N1)

6.1 Executive Summary

For projects undertaken with the State for the Department of Transport and Main Roads, the standard noise prediction year is 10 years from the date of construction completion. This is called the 10 year horizon. For this Project, Annexure 03: Performance Specification – Operations and Maintenance: Attachment 1A: Key Performance Indicators, Item 18 Noise (Compliance) requires that the Project complies with the Code of Practice for the Contract duration. To design for this case, calculations for the 25 year horizon were also undertaken and mitigation measures developed.

6.2 Project Criteria

6.2.1 Application to this Project

As the Contract Term for this Project is 25 years, and the Code of Practice only assesses roads to a 10 year horizon, there is a level of ambiguity regarding the criteria for the final 15 years of the Project.

For the TSRC Project, we confirm the new road criteria are applicable to the Project from the Date of Tollroad Completion and for the following 10 years. After this time, the Tollroad will be considered an existing road and therefore the upgraded road criteria will apply.

6.3 Conclusion

The noise impacts of the proposed motorway upgrade have been assessed for two different options. Through the use of at-façade treatments, at a limited number of isolated locations, it is calculated that there will be no residual noise exceedance impacts as a result of the Project.

There are a number of receivers in elevated positions above the proposed road alignment. At these locations, noise mitigation within the road corridor is not a feasible option and they have consequently at-façade treatments have been adopted. Additionally, there are a number of receivers in isolated locations which require treatment. At these locations, while noise levels could be reduced using extensive noise barriers, such a solution is not considered reasonable from a cost efficiency perspective and consequently at-façade treatments have been adopted.

For the Tender Design, the 10 year horizon road traffic noise levels were calculated. In addition to this, Annexure 03: Performance Specification – Operations and Maintenance: Attachment 1A, Key Performance Indicators Item 18 Noise (compliance) requires the Project to comply with the Code of Practice for the duration of the Contract Term. To design for this case, calculations for the 25 year horizon were also undertaken and mitigation measures developed.

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.6 – Noise

Question ID	Report Reference	Performance Specification Reference	Question	Proponent Response
T48	A1.6	Volume 4 Returnable Schedule, N1	We note that your Proposal has modelled noise levels using the standard DTMR CoRTN noise model pavement and calibration corrections. The mix of heavy vehicles on the Tollroad is significantly higher than on previous DTMR road projects for which the pavement and calibration corrections were derived. Please confirm what mitigation measures the Proponent proposes to take to satisfy themselves that the noise model will accurately calculate noise emission from the Tollroad given the unusually high proportion of heavy vehicles in the traffic flow mix.	Our proposal has modelled noise emissions in accordance with the specific criteria set forth in the proposal requirements, that is, in accordance with the requirements of the Transport Noise Management Code of Practice. We have also made some correlations to studies we have done on recent projects where traffic volumes have included a high percentage of heavy vehicles (up to 30%). Post construction measurements on such projects show that the results from the proposed model were accurate. Further to this, we have successful experience in other jurisdictions which supports the robustness of our modelling e.g NSW. We are satisfied that the noise model on which our tender proposal relies is sufficient to accurately calculate the noise emissions from the Tollroad for the purposes of a preliminary noise/acoustics design report.

7 A.1 7 Structures (Incl. Bridges, Major Culverts and Retaining Walls) (S1, S2, S3)

Structures Design

7.1 Executive Summary

The Nexus design is based on proven bridge construction methods and technologies, well known and understood in South East Queensland. The design incorporates the following:

- Spans and girder sizes and numbers are minimised, consistent with clearance requirements
- Substructures with minimal use of piled foundations, adopting shallow spread footings wherever possible
- Replaceable items such as bearings and joints are minimised. "Propped" structures, which eliminate the need for expansion joints, have been utilised where conditions are suitable
- Inspection galleries are provided at all abutments, for safe and simple bridge inspection and bearing replacement.

By these means, conventional and well known techniques are used in efficient and effective ways to give a reliable, cost effective and low maintenance solution.

Innovative arrangements are used where appropriate to achieve best whole-of-life cost solutions. For example, "Transfloor" precast transverse spanning deck panels are used in place of girders to minimise the number of girders and mass of the structure, including the subsequent size of the substructure, and to reduce the number of replaceable items such as bearings. The use of precast deck panels is a well-known technique in steel girder bridge design and construction and the details are readily adaptable to concrete girder bridges. The design has recognised the cost associated with the construction of permanently lined cast-in-place bored piles and has instead utilised shallow footings, wherever competent rock is found at a shallow depth.

7.2 Relationship to Project Objectives

The design is focussed on delivering best value, whole-of-life outcomes by using proven technologies to minimise the construction cost and future O&M costs. Working within the requirements of the Project Specifications, DTMR's Design Criteria for Bridges and Other Structures and the Australian bridge design code, the design:

- Minimises spans and girder sizes and numbers, consistent with clearance requirements
- Minimises use of piled foundations, adopting shallow spread footings wherever possible
- Minimises replaceable items such as bearings and joints.
- "Propped" structures, which eliminate the need for expansion joints, have been utilised where conditions are suitable
- Inspection galleries are provided at all abutments, for safe and simple bridge inspection and bearing replacement.

The Nexus Infrastructure Tender Design solution is robust and elegant with low risk solutions that will achieve timely delivery. Innovative solutions have been used where appropriate to give the best outcomes mostly in the nature of using proven technologies in innovative ways.

The design aims to minimise the environmental impact during and post construction by careful selection of pier locations, especially at watercourse crossings.

The bridges are designed to present a consistent appearance to the road user, with uniformity of materials, pier and headstock shapes and spanning arrangements. The design incorporates the urban design concepts in the precast barrier outer panels and abutment treatments.

Design Standards and Criteria

7.3 Design Standards

In accordance with the design criteria, we have adopted a minimum exposure classification for concrete structures of B2, which is in excess of that required by AS 5100 but which will help to provide durable, low maintenance structures.

The design of waterway crossings allows for bridge scour, hydraulic and debris loadings due to extreme flood events which are of particular concern at Gatton Creek Bridge. The design ensures that all the bridges on the TSRC are above the 2,000 year average recurrence interval (ARI) flood event ensuring a high level of flood immunity.

Methodology

7.4 Substructure

7.4.1 Design Principles

Where competent rock levels are encountered at shallow depths, abutment embankment heights are low and groundwater levels are below founding level, bridges are supported on spread footings founded on competent rock. This foundation type provides cost efficient design and simple form of construction, avoiding costly permanently lined pile solutions.

Where competent rock levels are encountered at deeper depths and abutment embankment heights are more substantial, bridges are supported on cast in place piles with permanent steel liners socketed into competent rock.

All foundations are located to avoid known existing below ground services.

Piers and abutments at Reinforced Soil Structure (RSS) walls are typically cast in-situ reinforced concrete circular columns and headstock.

Bridge abutments typically include 1(V) to 1.5 (H) spill through batters square to headstock with Type 2 (reinforced concrete) abutment protection. Inspection and maintenance platforms, formed in the spill through abutment protection or RSS wall top, are provided at each abutment to facilitate bridge inspection and bearing replacement.

For abutments comprising RSS walls, columns are sleeved with permanent, lightweight liners or compressible layers for the full length of the column within the reinforced soil block.

7.5 Superstructure

Bridge decks are designed using precast prestressed concrete (PSC) Super-T girders or standard deck units with a composite cast in-situ reinforced concrete top slab, waterproof membrane and deck wearing surface. Standard, conventional deck arrangements have been adopted in most cases, with some decks utilising transverse precast panels to reduce girder numbers.

Deck unit and Super-T girders are simply supported with elastomeric bearings. Link slabs are provided over piers to minimise deck joints and are designed to accommodate girder rotation.

Some bridge spans have been designed using larger Super-T girder depths than would normally be required, combined with "Transfloor" type transverse precast panels to reduce the number of girders required. This design innovation delivers an efficient and cost effective structural design and maintenance solution, by reducing the overall mass of the structure and the number of bearings. The

use of transverse precast panels spanning between girders is an established practice for steel girder bridges and the detailing is easily adaptable to concrete girder bridges.

All Super-T girders are orientated vertically to reduce the risk of rollover during construction. For high skew bridges ($> 45^\circ$), girder end skew is 45° and the ends of girders will be staggered to suit the bridge skew. Super-T girders are supported on elastomeric bearings on reinforced concrete pedestals. Diaphragms are provided at the ends of Super-T girders to facilitate future bridge jacking and bearing replacement and to provide stability of the girders during pouring of the concrete deck.

Bearings and movement joints have been selected using standard components to simplify construction and cost efficiency. Bearings are designed as elastomeric bearing strips and movement joints are selected as strip seal type joints wherever possible. For high skew bridges ($> 45^\circ$), movement joints include finger plate type joints custom made to suit the skew movement of the bridge.

7.6 Operations and Maintenance Design Considerations

For steel post and rail barriers, the hot dipped galvanised steel protective coating system has been selected to provide a life in excess of 40 years with minimal maintenance.

To eliminate future inspection and potential replacement of stressed bars, transverse stressed deck units have not been utilised.

Maintenance and inspection platforms are provided at abutment embankments, together with stairs, handrail and walkways to facilitate inspection and bearing replacement.

Jacking shelves are provided on headstocks to enable bridge deck jacking and bearing replacement.

Elastomeric bearing strips have been selected to simplify replacement and minimise future maintenance costs.

Link slabs are provided over piers to minimise deck joints. Movement joints at abutments have been selected using standard strip seal type joints wherever possible, to simplify replacement and minimise future maintenance costs.

Deck unit and Super-T girders are designed as simply supported ensuring that future deconstruction of the bridge superstructure at the end of its useable life can be carried out in a straightforward and safe manner.

7.7 Environment

During the Detailed Design Phase the precise location of each pier will be refined using detailed information on the condition of the site, especially the nature of the watercourses. An erosion and sediment control plan will be developed for the construction of each bridge to control the environmental impacts of the Works. Following completion each site will be restored to a condition similar to that prior to construction.

7.8 Future Widening

Throughout the Tender Design care has been taken to allow for possible future widening of the TSRC. The design approach has been to avoid structural arrangements that would be prohibitively difficult to widen from a technical or commercial point of view. The generally simple structural forms adopted may be widened in the future if required.

VMS and Static Sign Structure

VMS signs are proprietary signs, with the proposed substructure comprising of a single 1.2 m cast in place bored piled, unlined, or two 900 mm diameter cast in place bored piles with permanent liners, connected with a pilecap. The choice of either of these footing types will depend on the geotechnical conditions at each sign site.

Risk Management

The approach to risk management adopted in the preparation of the structural design has been to identify the key risks associated with the structural solution and provide solutions which address these risks in a comprehensive and cost effective way.

The key risks addressed by the structural design are as follows:

- Safety risks to Users
- Construction risks
- O&M risks.

7.9 Safety Risks to Users

The structural solutions have addressed the safety risks to Users by providing solutions that are structurally sound and can support all the necessary design actions in accordance with AS 5100 including structural self-weight, traffic loads, collision loads, flood and debris loads, earth pressure loads, wind loads, seismic loads and loads due to thermal effects.

The bridges have all been designed to provide flood immunity to the 2,000 year ARI event.

The structural design solutions are inherently durable and low maintenance which will help to ensure that User safety does not get compromised by structural deterioration.

A risk assessment has been carried out to identify the performance level of traffic barriers required on each bridge. A risk assessment has also been carried out to identify if throw screens are warranted on overbridges.

Durability

7.10 Exterior Atmospheric Exposure

7.10.1 Air Quality

A B2 classification will be adopted for all exterior atmospherically exposed concrete

Design and Construction Methodologies to Achieve Durability

7.11 Design and Construction Issues

Numerous design and construction issues can have a negative impact on durability and compromise the Design Life. Below is a list of frequently encountered problems that need to be avoided:

- Design does not facilitate proper drainage
- Lack of accessibility for inspection and maintenance
- Selection or supply of materials with inadequate durability for given environment
- Complex design affecting concrete placement and compaction
- Incorrect design or execution of joints
- Congested reinforcement
- Inadequate reinforcement at re-entrant corners
- Improper placement of reinforcement
- Insufficient depth of cover
- Tight schedules
- Inadequate crack control
- Movement of formwork
- Inadequate curing of concrete
- Inadequate compaction of concrete
- Incorrect mix proportions of concrete
- Poor quality finishing
- Adverse conditions during construction (e.g., wind, extreme temperatures) and failure to take precautions (e.g., hot weather concreting practices)
- Dissimilar metal corrosion
- Incorrect or inadequate surface preparation prior to coating application
- Inadequate, inconsistent or unclear documentation
- Specifications not followed
- Changes in design during construction phase
- Insufficient workforce skills
- Lack of workforce commitment to quality
- Inadequate inspection and testing procedures.

Although some of the above construction defects can be rectified to some degree, the end product is rarely as good as the original and may present continual maintenance problems throughout the life of the structure. Furthermore, in many cases there is only one opportunity to achieve a particular requirement, such as proper curing. Once that opportunity is lost the durability of the structure may be compromised.

7.12 Improving Durability Outcomes

In this Report it has been assumed that every effort to avoid the types of defects described above will be made and that 'Best Practices' will apply. However, it is also recognised that construction defects do occur in reality and need to be mitigated and rectified.

Inspection during the Construction Phase allows identification of issues that potentially impact long term durability is of critical importance to ensure construction defects are prevented and that any identified defects are remedied in such a manner as to maintain the target service life. Recommended actions are as follows:

- Inspection and identification of defects such as:
 - > Improper placement of reinforcement
 - > Inadequate curing of concrete
 - > Inadequate crack control
 - > Movement of formwork
 - > Incorrect execution of joints
 - > Inadequate compaction of concrete
 - > Incorrect mix proportions or non-compliance of concrete
- Ensuring protective precautions are taken under adverse conditions (e.g., wind, extreme temperatures)
- Prevention of contamination of materials or early exposure of cementitious materials to river water
- Verification that materials supplied meet specifications
- Verification that materials are placed and installed as specified
- Identification and recording of non-conformances
- Investigation of non-conformances and identification of measures and improved site practices to prevent recurrence
- Rectification of defects to ensure Design Life is still achieved.

Inspection and Maintenance Requirements

7.13 Inspection and Maintenance Activities

To achieve the required service life, regular inspection and maintenance of the TSRC structures is essential. DTMR Level 1, 2 and 3 inspections will be required throughout the life of the structures. Inspection may include, but is not limited to, the following tasks:

- Regular Inspection (every one to five years):
 - > Visual inspections and reporting of observed deterioration and defects such as rust stains, cracking, spalling, aggregate pop-outs, ponding of water on surfaces
 - > Non-destructive or other testing on the condition of the bridge substructures and superstructures and tunnel lining
 - > Detailed inspection of protective coatings on steelwork
 - > Inspection of expansion joints and bearings
- Detailed Condition Monitoring (every ten years):
 - > Instrumentation for measuring performance (e.g., embedded electrodes to monitor reinforcement corrosion)
 - > Inspection and testing for deterioration of bridge and tunnel elements:
 - Pile caps and lower sections of piers.
 - Upper sections of pier columns
 - Headstocks
 - Girders
 - Deck
 - Abutments and wingwalls
 - Traffic barriers
 - Steelwork within tunnel
 - Road signs and gantries
 - Drainage system
 - > Half cell potential surveys to determine corrosion activity of reinforcement if required
 - > Core sampling and analysis for carbonation in different exposure environments to verify durability modelling and predict remaining life
 - > Corrosion rate monitoring of reinforcement
 - > Trend analysis of findings of inspection data
- Servicing and Remedial Action:
 - > Cleaning of road surfaces, expansion joints, drainage system and outlet structures
 - > Repair or replacement of deteriorated components and materials
 - > Maintenance and repair of protective coatings every ~15-25 years
 - > Timely response to identified potential defects.

Further details on relevant inspection procedures and reporting are given in the DTMR Bridge Inspection Manual (Second Edition, 2004).

7.14 Maintenance Triggers

Appearance of visual defects or damage that may compromise Design Life or results of detailed inspection indicating corrosion activity should trigger maintenance to rectify the cause of deterioration and prevent continued deterioration. This should include, but is not limited to:

- Physical damage such as vehicle impact

- All forms of cracking
- Spalling or exposed reinforcement
- Corrosion of metallic elements
- Surface deterioration such as softening, exposure of aggregate, pop-outs
- Porous or honeycombed concrete
- Efflorescence
- Surface dampness
- Joint deterioration or ineffectiveness
- Deterioration of any prior repairs (e.g., crack injection, patches etc)
- Rust stains
- Blocked drains
- Ponding of water on surfaces
- Fire damage
- Settlement, deflections and heaving
- Deteriorated protective coatings.

Summary of Durability Requirements

7.15 Reinforced Concrete

The durability requirements for reinforced concrete are summarised in Table 9. These are based on the minimum requirements from a combination of the project requirements for minimum AS 5100.5 B2 exposure classification and the modelling above, and are in addition to the requirements for adequate curing. S40 refers to concrete with $w/cm < 0.48$ and minimum cementitious content of 390 kg/m³. S50 refers to concrete with $w/cm < 0.40$ and minimum cementitious content of 450 kg/m³.

Table 9: Summary of Concrete Durability Requirements

Environment	Structural Elements	AS 5100.5 Concrete Exposure Classification	Minimum Durability Requirements
Buried	Piles, pile caps, abutments, wingwalls, footings, culverts, drainage elements, tunnel lining, retaining walls	B2	25% fly ash S40 concrete and 55 mm cover
Atmospheric (Exterior)	Bridge superstructure (piers, girders, headstocks, deck, barriers), retaining walls	B2	25% fly ash S40 concrete and 55 mm cover or 25% fly ash S50 concrete and 45 mm cover

7.16 Steelwork Protection in Exterior Environments

Coating options for steelwork in exterior environments are presented below.

Table 10: Examples of Protective Thermal Spray Zinc and Hot Dip Galvanised Coating Systems according to AS/NZS 2312 (2002) for C2 Environment

	Thermal Spray Zinc or 85% Zn/15%Al 100 µm (TSZ 100)	Thermal Spray Zinc 200 µm + sealant (TSZ200S)	Hot Dip Galvanised 55 µm (HDG 390)	Hot Dip Galvanised 70 µm (HDG 500)	Hot Dip Galvanised 85 µm (HDG 600)
Time to first maintenance C2 (years)	25+	25+	15-25	25+	25+

Table 11: Examples of Protective Inorganic/Organic Coating Systems according to AS/NZS 2312 (2002) and AS/NZS 2312.2 (2014) for C2 Environment

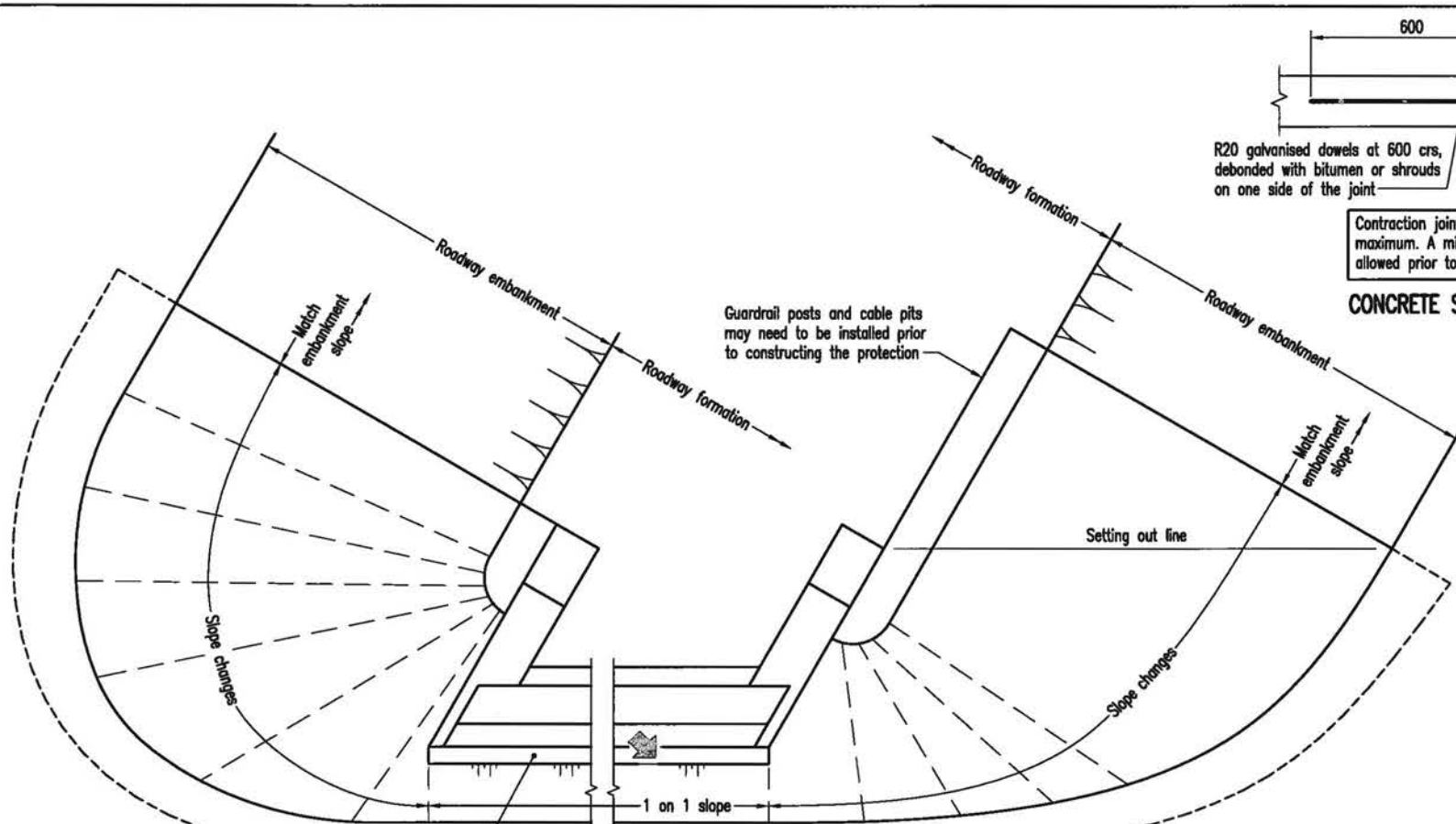
	System 1 (PUR5)	System 2 (EHB6)	System 3 (EHB4)	System 4 (IZS2)
Surface Preparation	Sa 2.5	Sa 2.5	Sa 2.5	Sa 2.5
Primer	Zinc-rich epoxy (75 µm DFT)	Zinc-rich epoxy (75 µm DFT)	Zinc rich epoxy (75 µm DFT)	Waterborne inorganic zinc silicate (75 µm DFT)
Intermediate Coat	High build epoxy (200 µm DFT)	High build epoxy MIO (125 µm DFT)	High build epoxy (200 µm DFT)	
Top Coat	High solids polyurethane (2-pack) (50 µm DFT)	High build epoxy MIO (125 µm DFT)		
Time to first maintenance C2 (years)	25+	25+	25+	25+

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.7 – Structures

Question ID	Report Reference	Performance Specification Reference	Question	Proponent Response
T29	A1.7	Volume 4 Returnable Schedule, Element S1 NX-BR03 - Gatton Creek Bridge BR03-01	We are unable to confirm that all of the geotechnical founding features that are required in accordance with Volume 4 Returnable Schedule, Element S2. Please confirm that the protection of substructures from scour will be in accordance with Clause 3.12 of the TMR "Design Criteria for Bridges and Other Structures". In particular please address the resilience of the 150mm RC abutment protection slab at the spill through abutment, particularly on its expected performance in a 100 year flood event where anticipated flood velocities exceed 6.0m/s.	We confirm that the protection of substructures from scour will be in accordance with Clause 3.12 of the TMR "Design Criteria for Bridges and Other Structures". At Gatton Creek, unfortunately the LVRC flood model was not made available and as such a detailed assessment of scour at this location could not be made. From coarse models developed for the Tender our predicted velocities were below 6.0m/s and an allowance for scour protection has been made. During detailed design, when the velocities are confirmed, then the bridge scour protection will be designed to comply with this requirement. Nexus can confirm that there will be no additional cost to the State as a result of detailed design development of the bridge scour protection.
T30	A1.7	Volume 4 Returnable Schedule, Element S1 NX-BR08 - TSRC Viaduct BR08-03 & BR08-04	We are unable to locate a description of the form or construction method for the hollow piers (2-4) that is required in accordance with Volume 4 Returnable S1. Please either identify the location of this information within your proposal or provide the information in response to this question.	The construction methodology chosen for the construction of piers (2-4) of bridge NX-BR08 - TSRC Viaduct is the Climbing Formwork methodology. This methodology is described in A.1 Sub-Schedule – Construction: B2 Construction Methods – Section 4.3.3 (Blade Walls and Columns), however we have omitted the words 'hollow piers' from the 'Climbing Formwork' sub-section. For clarity, the sentence should say: "Due to the large heights of the blade walls, hollow piers and columns, climbing formwork will be utilised on the following bridge structures:" For ease of reference we have included B2 Construction Methods as Appendix T30 to this response.
T31	A1.7	Volume 4 Returnable Schedule, Element S1 NX-BR09 - Gowrie Creek Bridge BR09-01	We are unable to fully identify the bridge inspection access and maintenance access procedures and clearances that are required in accordance with Volume 4 Returnable Schedule, Element S1. Your drawings indicate inspection platforms at each abutment, however safe access paths to inspection platforms and safety barriers/handrails are not shown. Please either identify the location of this information within your Proposal or provide the information in response to this question.	Bridge inspection access and maintenance access where there is a spill through abutment, including at Gowrie Creek bridge, will be detailed in accordance with TMR standard drawing 1542 / 1543. For ease of reference we have included these drawings as Appendix T31 to this response. Safe access paths to the platforms consistent with these standard drawings will be developed during detailed design.
T76	A1.7	Volume 4 Returnable Schedule, Element S2 Performance Specification, Annexure 01, Section 2.5, Table 2-3 (Minimum acceptable widths)	The bridge width provided on drawing BR04-02 (2No. 3.5m lanes and 2No. 1.0m shoulders) is not in accordance with the Performance Specification for the Murphy's Creek Road Overpass, which requires 1.5m wide shoulder widths and 2.0m wide footpaths, and as such is less than the required bridge width (2No. 3.5m lanes, 2No. 1.5m shoulders and 2No. 2.0m wide footpaths). Please confirm your compliance with these requirements, and what impact, if any, this has to your Proposal including program, cost or other related items.	Nexus confirms that in order to comply with the Performance Specification, the structure in drawing BR04-02 needs to reflect a widening of additional 5m. Nexus confirms the additional cost due to this widening is already included in our estimate.
T86	A1.7	Volume 4 Returnable Schedule, Element S2 Bridges - Report - Section 4.4	The Proposal has considered the use of "Transfloor" precast panels in conjunction with traditional T-girder structures. The use of this type of transverse panel on PSC T-girders raises the following issues that need to be addressed: - T-girders will have varying hogs which will affect the seating of the deck panels on the top flange; - T-girder flanges will be required to support transverse deck panels, wet concrete and construction loads; - Increased torsional effects on the T-girders due to the proposed construction sequence; and - The continuity of deck reinforcement will be disrupted. Please confirm how you will address these issues.	Nexus Infrastructure's proposal addresses the issues raised as follows: - The potential for adjacent Super-T girders having varying hogs can be accommodated by using relatively narrow transfloor panels - The Super-T girders are designed to accommodate construction loads and assisted by temporary bracing as required. - The Super-T girders are designed to accommodate the torsional effects of asymmetric loading due to construction sequence. - The continuity of bottom transverse deck reinforcement will be maintained by providing transverse reinforcement over the top of the transfloor panels at the panel ends to lap with the transfloor panel. While Nexus appreciates that it has become the norm in Queensland to utilise Super-T girders side by side and put a minimum thickness concrete slab on top, that approach has generally been driven by a view to minimising the labour component without seeking to optimise structural efficiency. Our proposal to spread the Super-T girders apart in association with transfloor panels comes from an appreciation that greater structural efficiency can be gained from the Super-T girders. Our proposal complies equally with the Performance Specifications, has equivalent structural performance and is quite a common solution in other jurisdictions.
T95	A1.7	Volume 4 Returnable Schedule, Element S1 -BR08 - TSRC Viaduct (Drawings BR08-01 to BR08-04)	It is not evident that you have provided sufficient evidence on how your bridge inspection access and maintenance procedures will be managed as required in Volume 4 Returnable S1. In particular the split-deck viaduct is at a considerable height and will require the inspection of bearings to be most likely be carried out by an Under Bridge Inspection (UBI) Unit. Please confirm that there will be no additional cost or other implication to your Proposal for bridge inspection access and maintenance and that you provide a minimum clear width of 2.0m between the viaduct bridges.	Nexus Infrastructure confirms its intention to use an Under Bridge Inspection Unit for inspections and maintenance of the viaduct structure. Nexus Infrastructure confirms that there will be no additional cost or other implication to our Proposal for bridge inspection access and maintenance The proposed bridge arrangement complies with the Performance Specification and associated TMR Guidelines. However, the suggested 2.0m separation between structures appears as an added requirement. At present the viaduct structures do satisfy this requirement for the majority of the length however there is section where the separation tapers down to approx. 1.7m. The design can be adjusted to achieve the suggested 2.0m separation distance if that is deemed to be required, with no additional cost or other implication to our Proposal.
T111	A1.7	Volume 4 Returnable Schedule, Element S1 Alternative Solution	From your Alternative proposal for Bridge BR23 - New England Highway Overpass, can the proponent please provide a brief description of the construction sequence for this structure noting the construction staging required for: 1. Constructing the bridge structure, including the substructure and bridge deck; 2. Construction stages in excavating the TSRC.	We propose to construct Bridge BR23 – New England Highway in the following sequence: 1. Construct temporary northbound and southbound carriageways of the proposed New England Highway (NEH) diversion to the west of the existing alignment. 2. Temporarily relocate the PUPs that are affected by the sequence of construction (water, electricity, communications and fibre). 3. Switch traffic flow from the existing NEH to the temporary alignment. 4. Excavate the tollroad cutting (east of the NEH diversion) using conventional methods including drill and blast techniques as necessary. 5. Construct the new NEH bridge structures in a conventional manner (foundations, piers, headstocks and decks). Deck units for spans 1&3 will be installed from behind the abutments and the central span from the base of the cut. 6. Permanently relocate the PUPs to their final locations. 7. Switch NEH traffic on to the completed bridge structures. 8. Complete the TSRC excavation west of the new bridge location. We attach Appendix T111 which incorporates construction staging drawings consistent with the above sequencing description. These drawings also indicate the extent of land and clearing works required for the temporary traffic diversions west of the existing NEH. Please refer to Clarification response L38 with regard to assumed site access constraints.

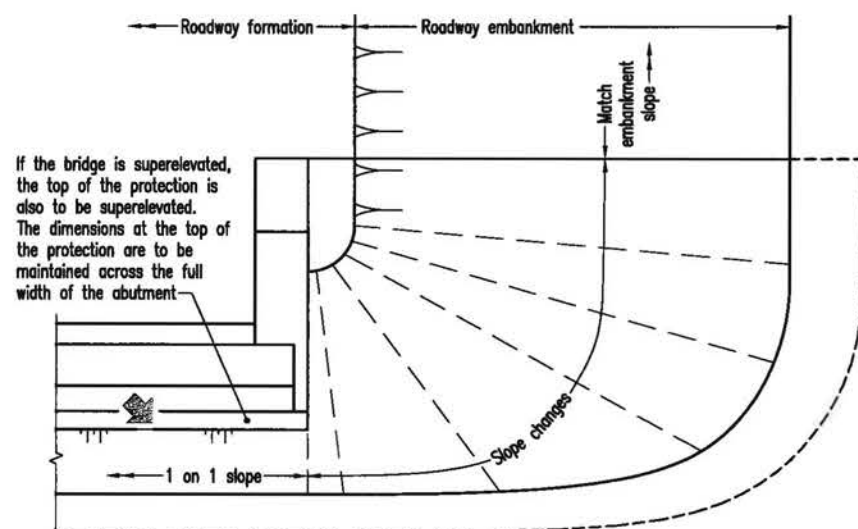
Question ID	Report Reference	Performance Specification Reference	Question	Proponent Response
T125	A1.7	Volume 4 Returnable Schedule, Element S1 and Exhibit A Table 3-1	Pursuant to Toowoomba Regional Council's (TRC) Toowoomba Regional Planning Scheme (TRPS), the proposed bridge over Gowrie Junction Road (BR13) needs to consider the TRC requirements for an upgraded Gowrie Junction Road/Ganzer Road/Holmes Road Intersection. A minimum clear width between bridge abutment walls of 47.0m is required, with provision for a central bridge support at 22.6m from the eastern abutment within a central median separation. Please provide an updated or alternative design, noting additional costs and associated implications for changing the form of this bridge including potentially modifying the span arrangement from 3-spans to a 2-span bridge to provide at least a clear width of 47m. Refer attached 'X16 - TWB1113-03-Issue 4' which demonstrates the clear width that is required at road level to achieve the future upgrade.	To comply with the new TRC requirements the bridge has been revised as per the sketch attached as Appendix T125. The impact in D&C cost is: \$517,000.00 There is no impact on Operations and Maintenance costs or Capex costs
T126	A1.7	Volume 4 Returnable Schedule, Element S1 and Exhibit A Table 3-1	Pursuant to Toowoomba Regional Council's (TRC) Toowoomba Regional Planning Scheme (TRPS), the proposed bridge over O'Mara Road (BR16) needs to consider the TRC requirements for an upgraded O'Mara Road/Meehan Road Intersection. A minimum clear width between bridge abutment walls of 48.0m is required, with provision for a central bridge support at 24m from the eastern abutment within a central median separation. Please provide an updated or alternative design, noting additional costs and associated implications for changing the span arrangement of this bridge to provide at least a clear width of 48m. Refer attached 'X17 - TWB1113-02-Issue 4' which demonstrates the clear width that is required at road level to achieve the future upgrade.	To comply with the new TRC requirements the bridge has been revised as per the sketch attached as Appendix T126. The impact in D&C cost is: \$621,000.00 There is no impact on Operations and Maintenance costs or Capex costs.
T127	A1.7	Volume 4 Returnable Schedule, Element S1 and Exhibit A Table 3-1	Pursuant to Toowoomba Regional Council's (TRC) Toowoomba Regional Planning Scheme (TRPS), the proposed Railway Bridge (BR10) over Mort Street needs to consider the TRC requirements for a minimum clear width of 25m between Pier 2 and Abutment 8 for the provision of installing future services. Please provide an updated or alternative design, noting additional costs and associated implications for increasing the clear width of this bridge span from 18m to at least 25m. Refer attached 'X18 - TWB1113-01-Issue 5' which demonstrates the clear width that is required at road level to achieve the future upgrade.	To comply with the new TRC requirements the bridge has been revised as per the sketch attached as Appendix T127. The impact in D&C cost is: \$334,000.00 There is no impact on Operations and Maintenance costs or Capex costs.
T128	A1.7	Volume 4 Returnable Schedule, Element S1 and Exhibit A Table 3-1	Pursuant to Toowoomba Regional Council's (TRC) Toowoomba Regional Planning Scheme (TRPS), the proposed Boundary Street Bridge (BR12) over the TSRC needs to consider the TRC requirements for two 3m wide footpaths to be provided, with one on each side of this bridge. A minimum clear width of 15m for the bridge is required for the provision of installing future services. Please provide an updated or alternative design, noting additional costs and associated implications for increasing the clear width of this bridge structure from 9m to at least 15m. Refer attached 'X18 - TWB1113-01-Issue 5' which demonstrates the clear width that is required at road level to achieve the future upgrade.	To comply with the new TRC requirements the bridge has been revised as per the sketch attached as Appendix T128. The impact in D&C cost is: \$2,188,000.00 There is no impact on Operations and Maintenance costs or Capex costs.
T129	A1.7	Volume 4 Returnable Schedule, Element S1 and Exhibit A Table 3-1	Pursuant to Toowoomba Regional Council's (TRC) Toowoomba Regional Planning Scheme (TRPS), the proposed bridge over Willet Road (BR14) needs to consider the TRC requirements for a minimum clear width between bridge abutment walls of 15m for the provision of installing future services. Please provide an updated or alternative design, noting additional costs and associated implications for increasing the length of this bridge structure to achieve a 15m clear width between abutment RSS walls. Refer attached 'X18 - TWB1113-01-Issue 5' which demonstrates the clear width that is required at road level to achieve the future upgrade.	To comply with the new TRC requirements the bridge has been revised as per the sketch attached as Appendix T129. The impact in D&C cost is: \$110,000.00 There is no impact on Operations and Maintenance costs or Capex costs.
T130	A1.7	Volume 4 Returnable Schedule, Element S1 and Exhibit A Table 3-1	Pursuant to Toowoomba Regional Council's (TRC) Toowoomba Regional Planning Scheme (TRPS), the proposed bridge over the FGG Coupers Road (BR19) needs to consider the TRC requirements for a minimum clear width between bridge abutment walls of 19m required for the provision of installing future services. Please provide an updated or alternative design, noting additional costs and associated implications for changing the form of this bridge including modifying the proposed span arrangement from 3-spans to a single span bridge and utilising abutment RSS walls instead of a spill-through abutment to provide at least a clear width of 19m. Refer attached 'X18 - TWB1113-01-Issue 5' which demonstrates the clear width that is required at road level to achieve the future upgrade.	To comply with the new TRC requirements the bridge has been revised as per the sketch attached as Appendix T130. The impact in D&C cost is: \$187,000.00 There is no impact on Operations and Maintenance costs or Capex costs.
T131	A1.7	Volume 4 Returnable Schedule, Element S1 and Exhibit A Table 3-1	Pursuant to Toowoomba Regional Council's (TRC) Toowoomba Regional Planning Scheme (TRPS), the proposed bridge over the Goombungee Road Underpass (BR22) needs to consider the TRC requirements for a minimum clear width between bridge abutment walls/pier supports of 25m required for the provision of installing future services. Please provide an updated or alternative design, noting additional costs and associated implications for changing the form of this bridge including modifying the proposed bridge structure and abutments to provide at least a clear width of 25m. Refer attached 'X18 - TWB1113-01-Issue 5' which demonstrates the clear width that is required at road level to achieve the future upgrade.	To comply with the new TRC requirements the bridge has been revised as per the sketch attached as Appendix T131. The impact in D&C cost is: \$170,000.00 There is no impact on Operations and Maintenance costs or Capex costs.

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.7 – Structures
Attachment for T31

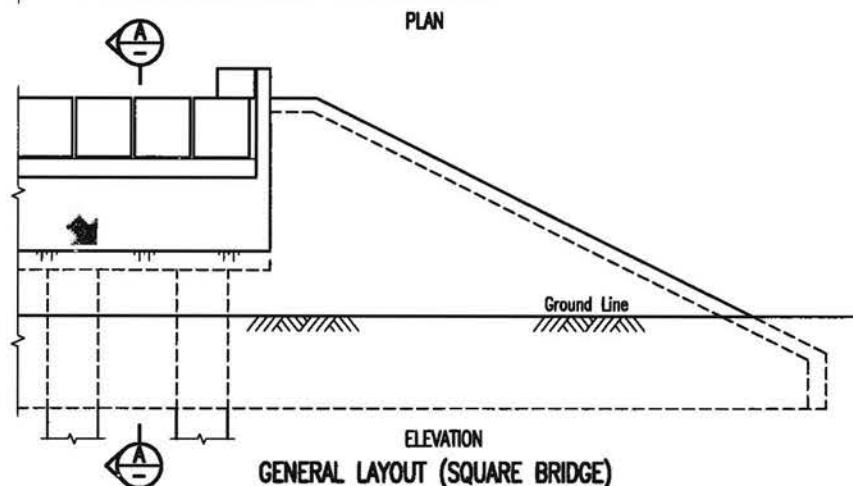


If the bridge is superelevated, the top of the protection is also to be superelevated. The dimensions at the top of the protection are to be maintained across the full width of the abutment

PLAN
GENERAL LAYOUT (SKEWED BRIDGE)



PLAN



DESIGN CRITERIA

The purpose of this drawing is to provide standard details only and fitness for purpose shall conform to AS 5100. The details shall be determined and certified by the bridge design engineer. Because every abutment protection is designed to suit its specific location, this drawing shall be read in conjunction with the project specific drawings.

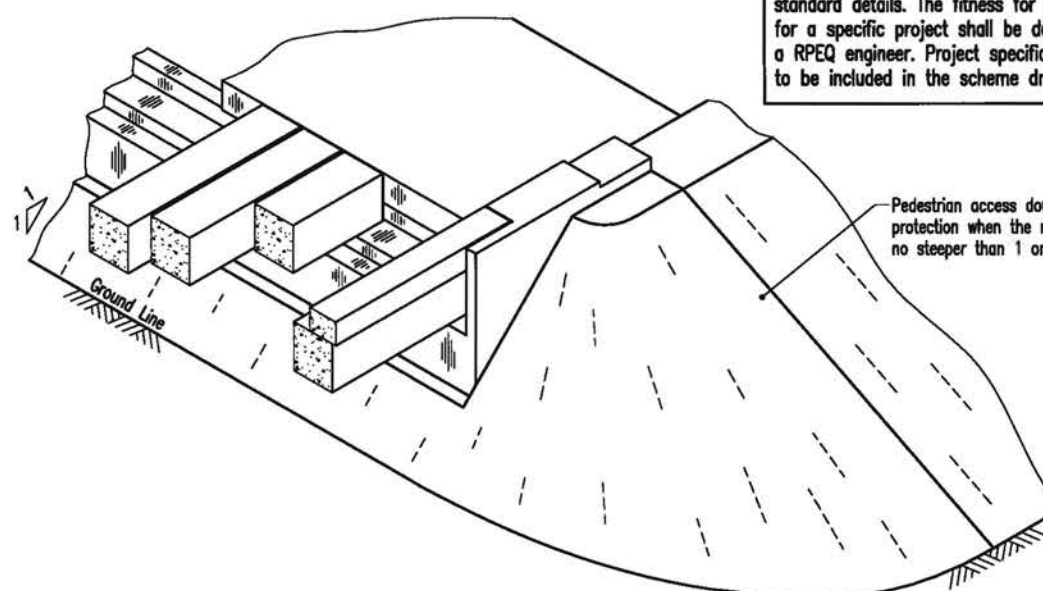
In accordance with Workplace Health and Safety requirements, abutment headstocks must be easily accessible to allow them to be inspected and maintained. Where the clearance is no greater than 1700 high, this can be done by walking around the base of the protection. If the clearance is greater than 1700, a platform shall be provided 1700 from the underside of the bridge (refer to Standard Drawing 1543).

Provided that the roadway embankment is no steeper than 1 on 2, access to the underside of the bridge shall be by walking down the side of the protection. If the embankment is steeper than 1 on 2, a risk assessment shall determine the best method of accessing the underside of the bridge. This may be by walking down the road embankment where it is not too steep, or by connecting a safety harness to a guardrail post for access down the protection. Roadway embankments steeper than 1 on 2 must be protected.

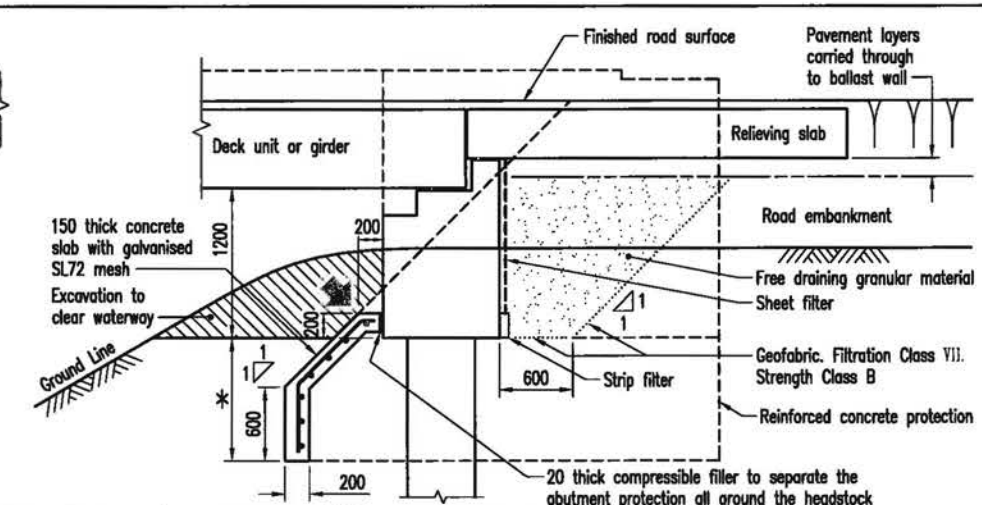
When designing abutment protection, consideration must be given to the strength of the subgrade material. The protection shall be constructed before the deck units/girders are erected on the end span.

The possibility of scour at the protection must be assessed at each abutment. The toe walls shown are only suitable for low scour situations. The protection may need to be modified in high scour situations.

Note: The purpose of this drawing is to provide typical standard details. The fitness for purpose of this drawing for a specific project shall be determined and certified by a RPEQ engineer. Project specific details may be required to be included in the scheme drawings.

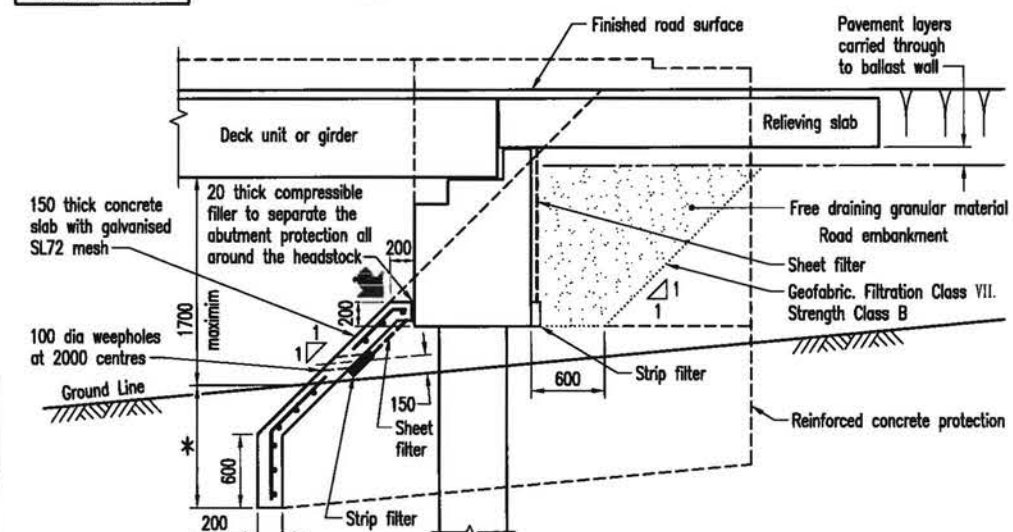


REINFORCED CONCRETE PROTECTION (SQUARE BRIDGE SHOWN - SKEWED BRIDGE SIMILAR)



*Refer to the project specific drawings for actual dimensions

SECTION A EXCAVATION TO PROVIDE 1200 CLEARANCE



SECTION A CLEARANCE BETWEEN 1200 AND 1700

NOTES:

1. CONCRETE class to be N25/20. Exposure classification B2.
2. STEEL REINFORCEMENT to be read in conjunction with Std Drg 1044. Reinforcing steel to be in accordance with AS/NZS 4671. Round bars Grade R250N. All reinforcing steel to be ACRS certified. Cover to be 75 minimum to the embankment face and 55 minimum to the sides of the slab and the weepholes. Reinforcement to be hot dip galvanised to AS/NZS 4680 where shown.
3. TACK WELDING for location purposes to AS/NZS 1554.3 Clauses 3.3.1 and 3.3.2. Welding consumables to be E4916, E4918 and W50X.
4. DIMENSIONS are in millimetres unless shown otherwise.
5. SETTING OUT POINTS shown thus

ASSOCIATED DOCUMENTS:

Main Roads Standard Drawings Roads Manual
Main Roads Specifications and Technical Standards Manual
Australian Standards:

AS/NZS 1554.3 Welding of Reinforcing Steel
AS 4671 Steel Reinforcing Materials
AS/NZS 4680 Hot-dip Galvanised (Zinc) Coatings on Fabricated Ferrous Articles
AS 5100 Bridge Design

Legislation:

Workplace Health and Safety Act
Workplace Health and Safety Legislation

REFERENCED DOCUMENTS:

Standard Drawings:
1044 Standard Hook, Lap and Bend Details and General Steel Reinforcement Information
1543 Type 2 - Reinforced Concrete Over Spillthrough - Greater Than 1700 Clearance

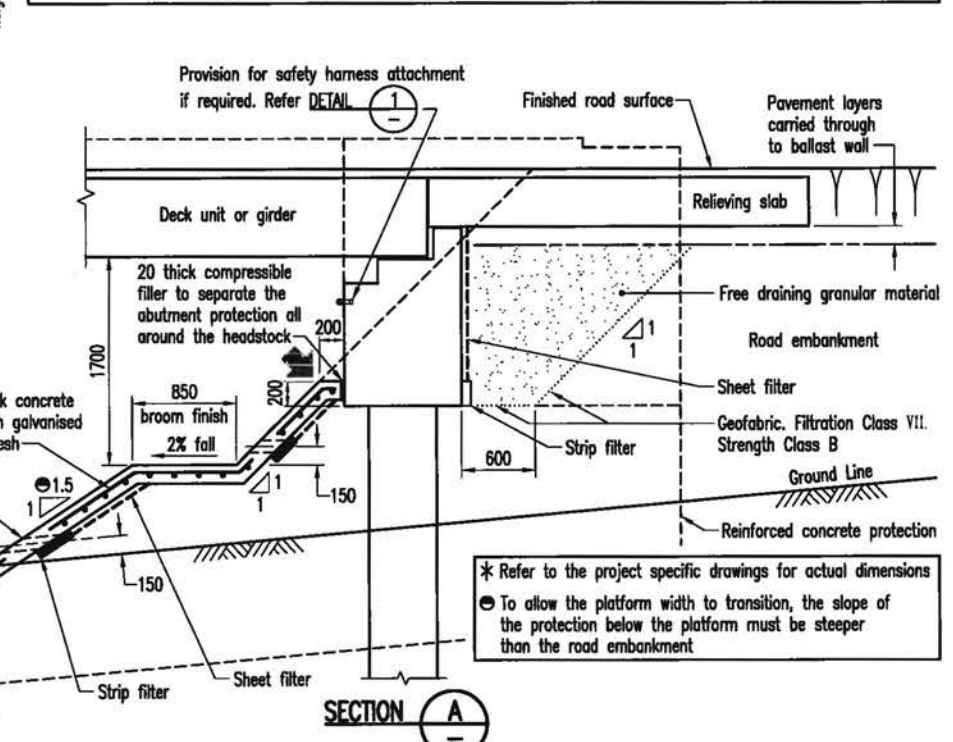
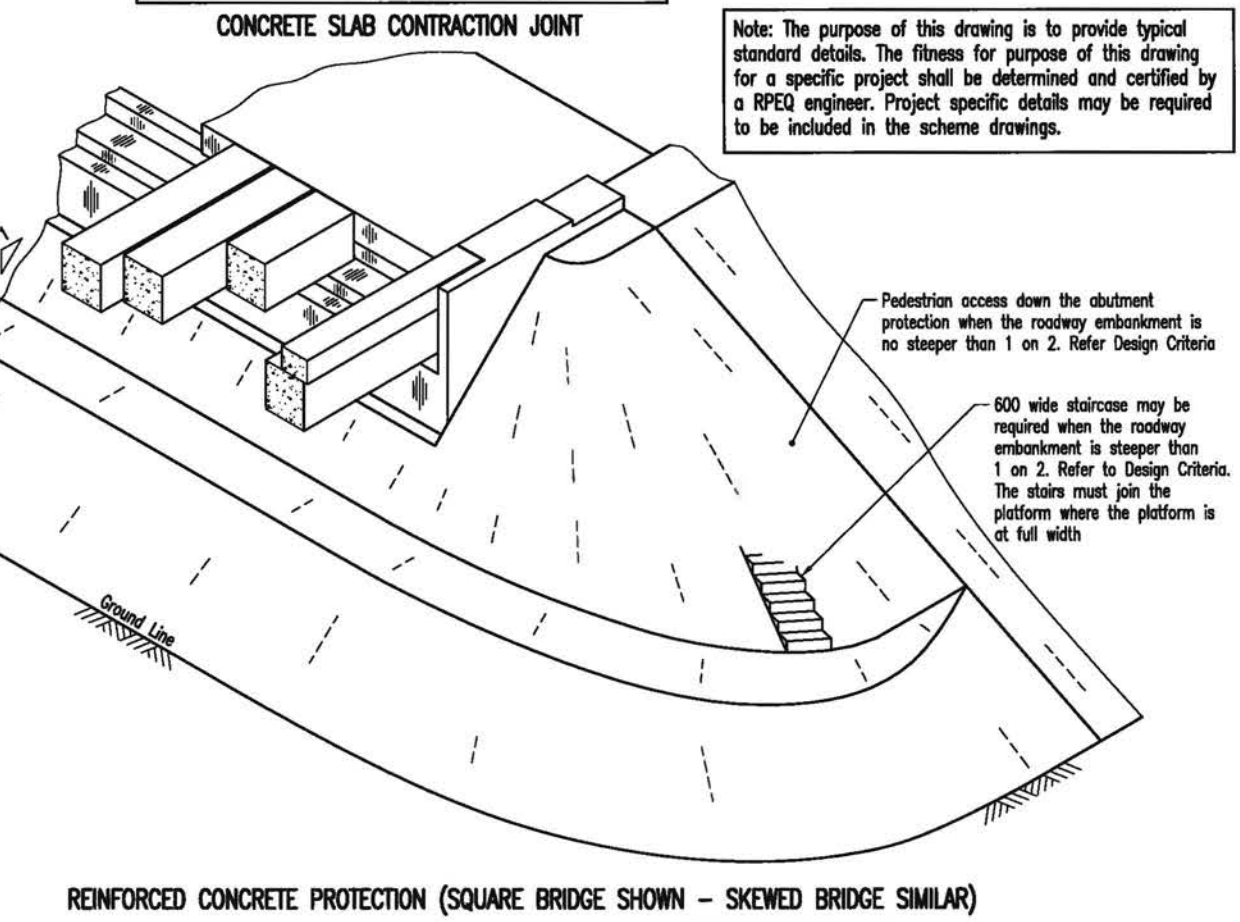
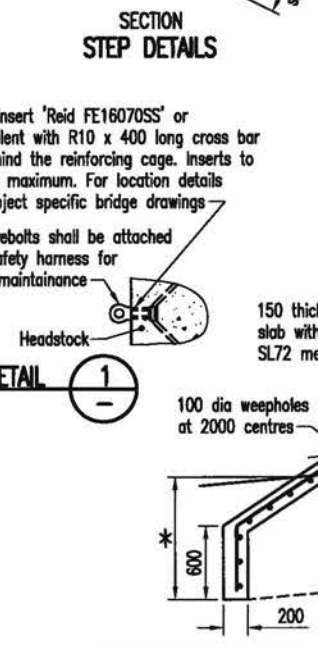
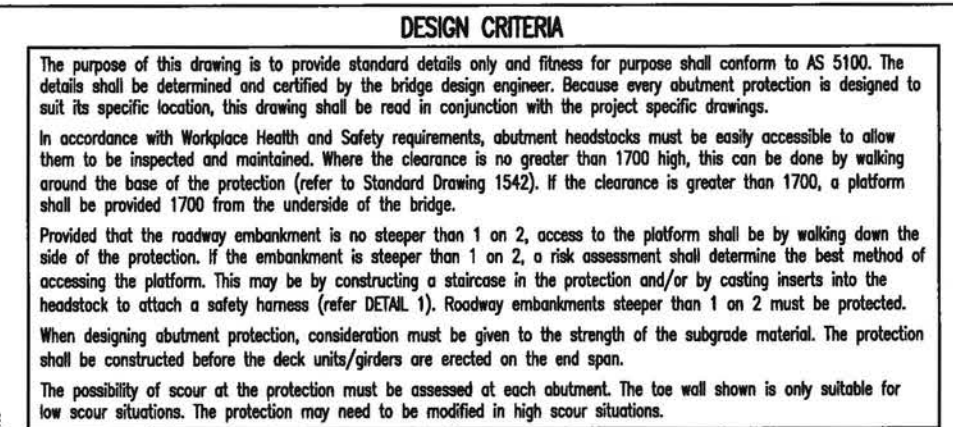
ABUTMENT PROTECTION

TYPE 2 -
REINFORCED CONCRETE
OVER SPILLTHROUGH -
UP TO 1700 CLEARANCE

Queensland Government
Department of Transport and Main Roads

A3 Standard Drawing No
Not to Scale 1542
Date 9/10

Page 121 of 215

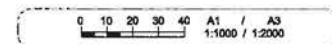
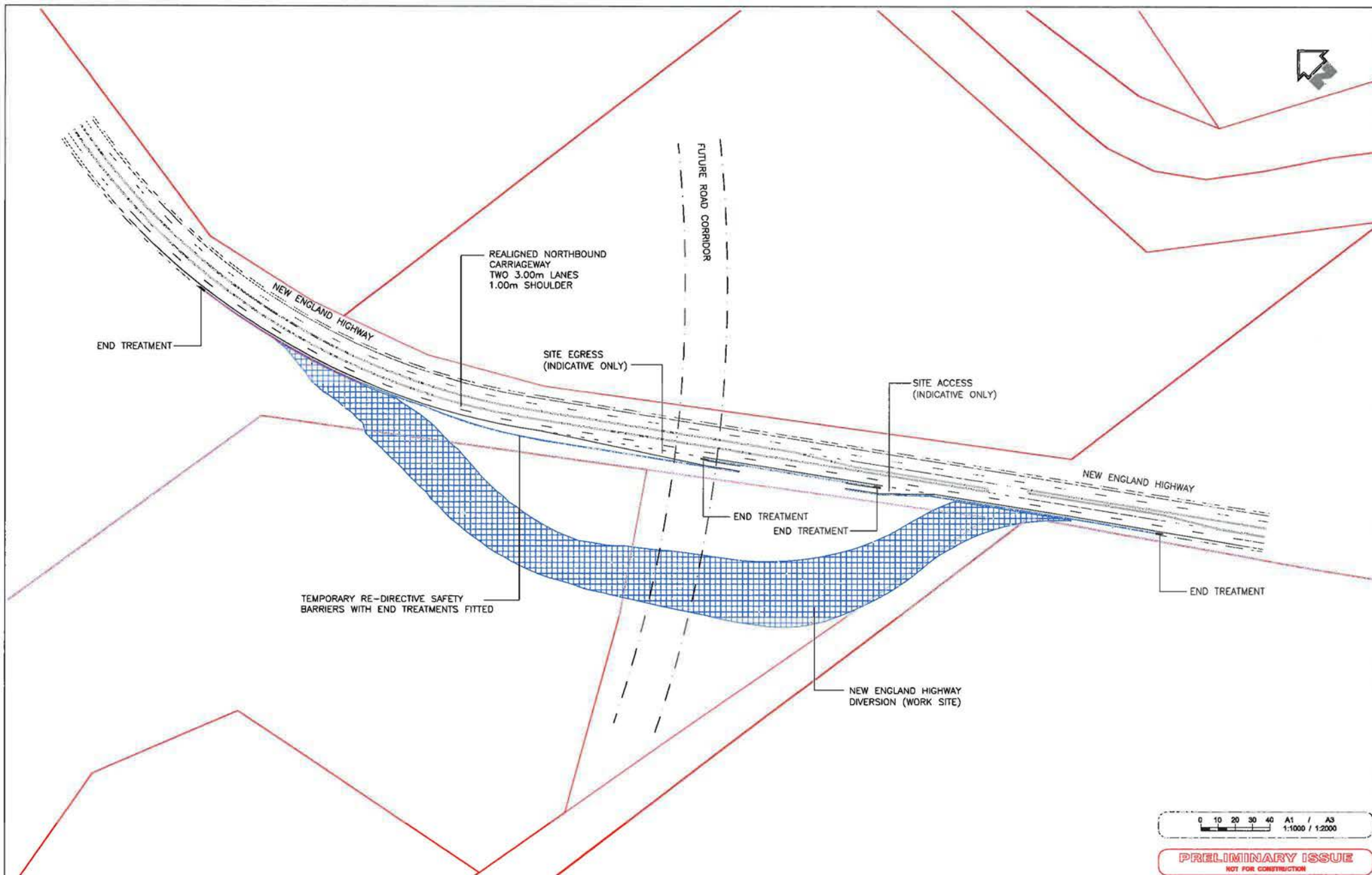


- NOTES:**
1. CONCRETE class to be N25/20. Exposure classification B2.
 2. STEEL REINFORCEMENT to be read in conjunction with Std Drg 1044.
Reinforcing steel to be in accordance with AS/NZS 4671. Round bars Grade R250N.
All reinforcing steel to be ACRS certified. Cover to be 75 minimum to the embankment face and 55 minimum to the sides of the slab and the weepholes.
Reinforcement to be hot dip galvanised to AS/NZS 4680 where shown.
 3. TACK WELDING for location purposes to AS/NZS 1554.3 Clauses 3.3.1 and 3.3.2.
Welding consumables to be E4916, E4918 and W50X.
 4. DIMENSIONS are in millimetres unless shown otherwise.
 5. SETTING OUT POINTS shown thus 

- ASSOCIATED DOCUMENTS:**
Main Roads Standard Drawings Roads Manual
Main Roads Specifications and Technical Standards Manual
- Australian Standards:**
AS/NZS 1554.3 Welding of Reinforcing Steel
AS 1657 Fixed Platforms, Walkways, Stairways and Ladders – Design, Construction & Installation
AS 2317 Collared Eyebolts
AS 4671 Steel Reinforcing Materials
AS/NZS 4680 Hot-dip Galvanised (Zinc) Coatings on Fabricated Ferrous Articles
AS 5100 Bridge Design
- Legislation:**
Workplace Health and Safety Act
Workplace Health and Safety Legislation
- REFERENCED DOCUMENTS:**
- Standard Drawings:**
1044 Standard Hook, Lap and Bend Details and General Steel Reinforcement Information
1542 Type 2 Reinforced Concrete Over-Spillways – Up to 1700 Clearspan

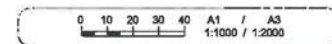
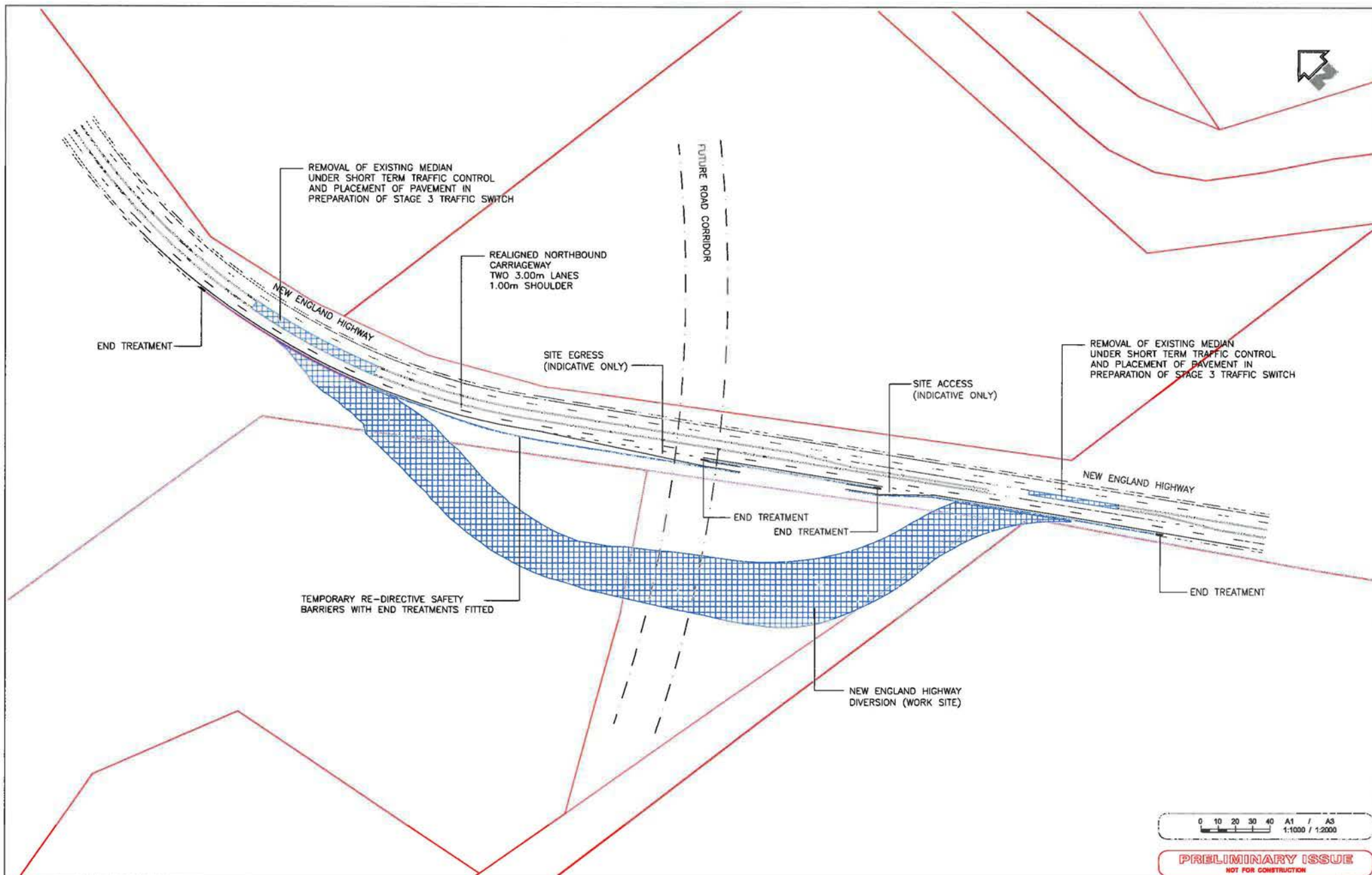
1542 type 2 - Reinforced Concrete Over Spillthrough - up to 1700 Clearance									
ABUTMENT PROTECTION		 Queensland Government							
		Department of Transport and Main Roads							
TYPE 2 - REINFORCED CONCRETE OVER SPILLTHROUGH - GREATER THAN 1700 CLEARANCE		A3	Standard Drawing No						
		Not to Scale	1543						
			Date 9/10						
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TSRC
PART 2 - CLARIFICATION QUESTION
A.1.7 – Structures
Attachment for T111



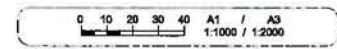
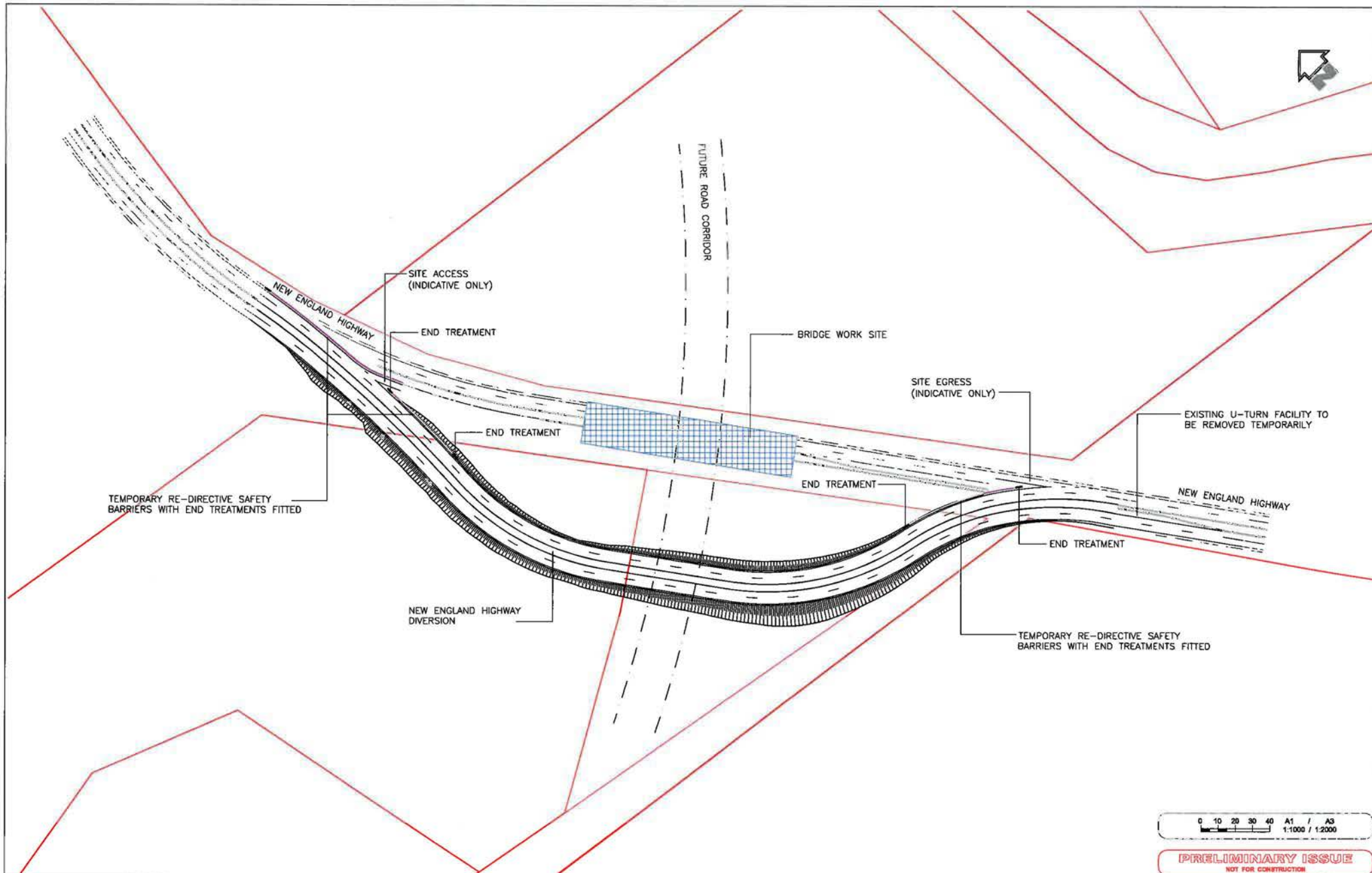
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION

This drawing is confidential and shall only be used for the purpose of this project.				Legend	Project	Construction Team	NEXUS Infrastructure	Designed: Date: Jed: 05/05/15 Drawn: Date: Jed: 05/05/15 Checked: Date: PH: 05/05/15 Approved: Date: PH: 05/05/15	Construction Traffic Management Drawing Construction Traffic Staging New England Highway Diversion Stage 1 Drawing No. _____ Issue _____
Issue	Date	Description	Appd						



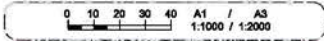
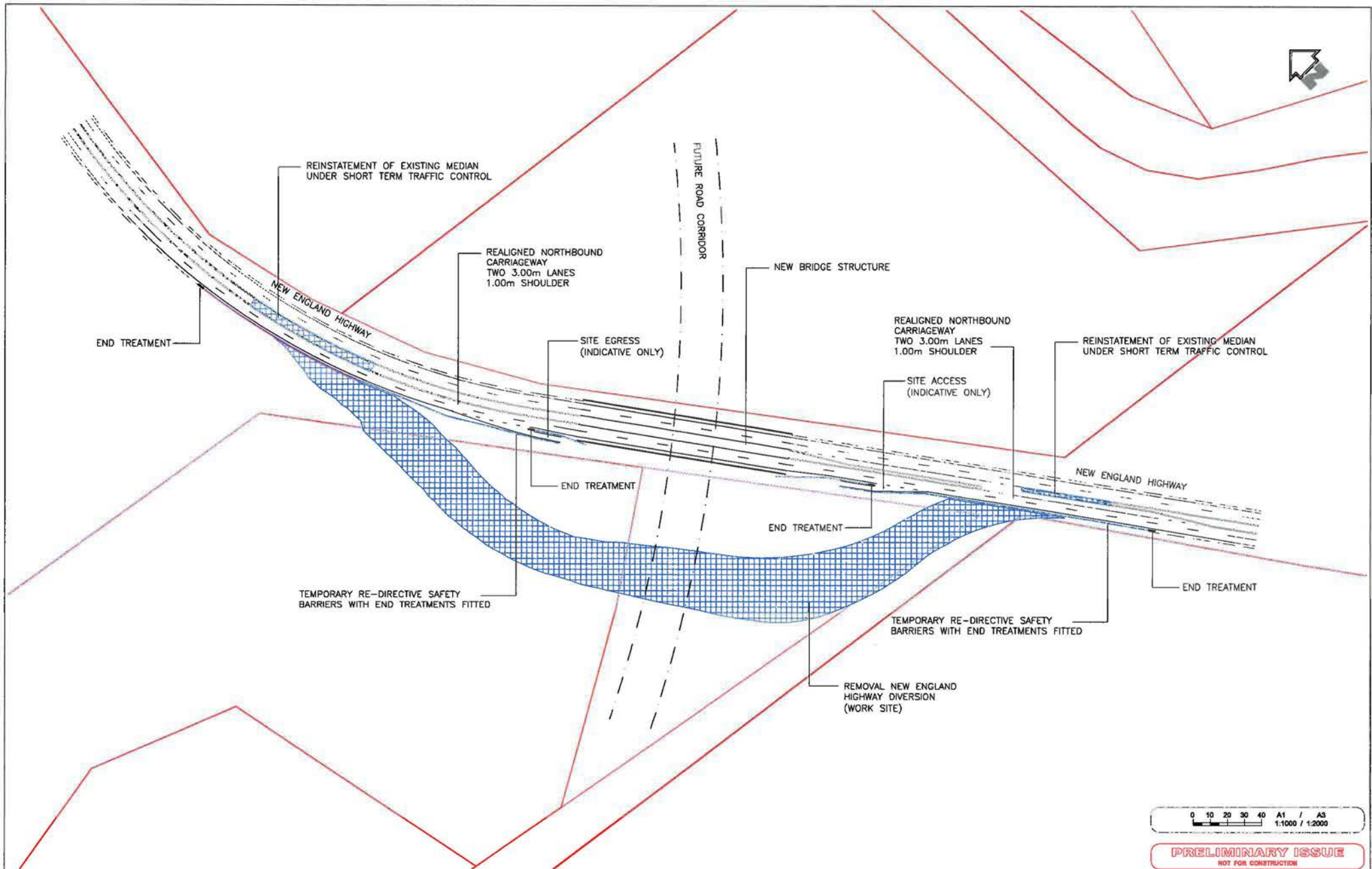
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION

This drawing is confidential and shall only be used for the purpose of this project.				Project		Construction Team		Designed: Date: 05/05/15 Drawn: Date: 06/05/15 Checked: Date: 06/05/15 PH: 06/05/15 PH: 06/05/15		Construction Traffic Management Drawing	
Legend				NEXUS Infrastructure				Construction Traffic Staging New England Highway Diversion Stage 2		Drawing No. _____ Issue _____	
Issue	Date	Description	Appd								



PRELIMINARY ISSUE
NOT FOR CONSTRUCTION

This drawing is confidential and shall only be used for the purpose of this project.				Legend	Project	Construction Team	Designed: Date: jst 05/05/15 Drawn: Date: 05/05/15 Checked: Date: 05/05/15 PH 05/05/15 Approved: Date: 05/05/15 PH 05/05/15	Construction Traffic Management Drawing Construction Traffic Staging New England Highway Diversion Stage 3 Drawing No. _____
Issue	Date	Description	Appd					
				NEXUS Infrastructure				



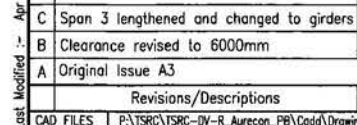
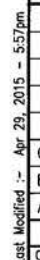
PRELIMINARY ISSUE
NOT FOR CONSTRUCTION

This drawing is confidential and shall only be used for the purpose of this project.				Legend	Project	Construction Team	Designed: Date: Jed: 05/05/15 Drawn: Date: Jed: 05/05/15 Checked: Date: PH: 05/05/15 Approved: Date: PH: 05/05/15	Construction Traffic Management Drawing Construction Traffic Staging New England Highway Diversion Stage 4 Drawing No. _____ Issue _____
Issue	Date	Description	Appd					
						NEXUS Infrastructure		

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.7 – Structures
For T125 Attachment refer to
Drawings

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.7 – Structures
For T126 Attachment refer to
Drawings

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.7 – Structures
Attachment for T127

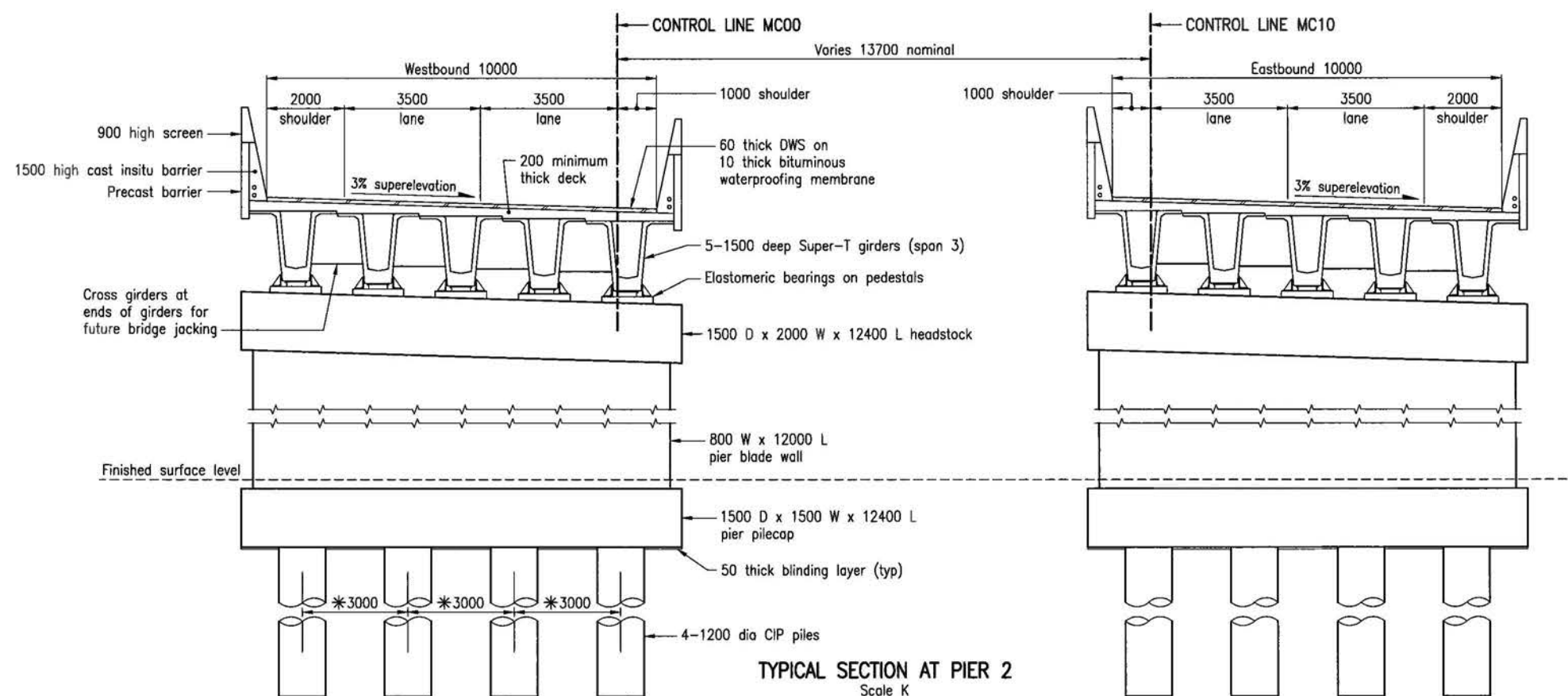
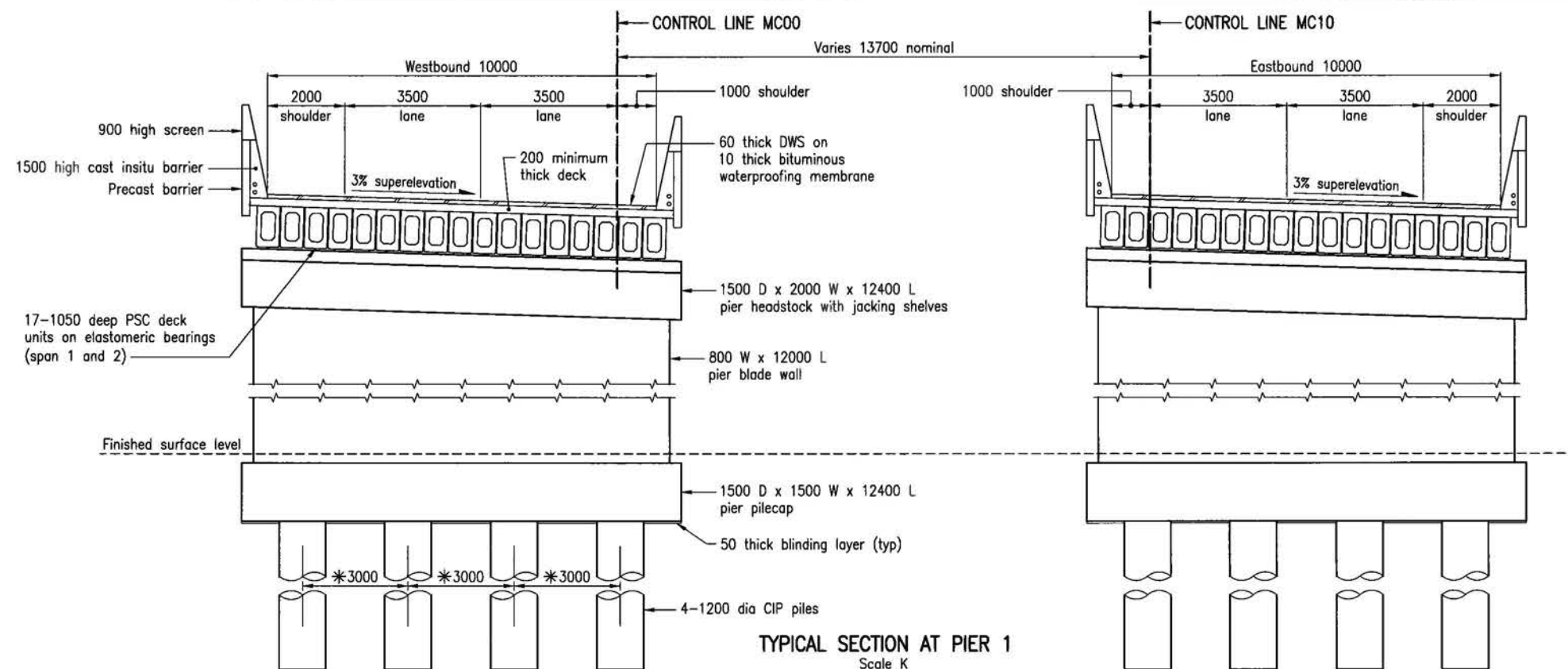


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	Revisions/Descriptions	Certification	Date	Microfile
CAD FILES	P:\TSRC\TSRC-IV-R Aurecon PB\Cadd\Drawings\TSRC-NY-10-ST-BR-ORG-001.dwg			



TENDER DESIGN

1/5/2015 @ 2:22pm

DETAILS & DIMENSIONS ARE SUBJECT TO REVIEW OR FURTHER DEVELOPMENT DURING DETAILED DESIGN

LEGEND

* Denoted measured along skew

May 01, 2015 - 2:22pm XREFS: 1: MRB_DETAIL_A1.dwg

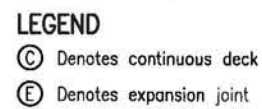
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Associated Job Nos				Survey Data				Scales				LOCKYER VALLEY RC AND TOOWOOMBA RC				Drawn: M. Haldane				TOOWOOMBA SECOND RANGE CROSSING				Queensland Government			
Datum				Horiz. Grid				K				WARREGO HIGHWAY - GORE HIGHWAY				Checked: R. North				RAILWAY BRIDGE				Job No.			
Auxiliary Drg Nos				Height Origin				0 1500 3000mm				614.293 - 41187.882 (MC00)				Verified: No.				GENERAL ARRANGEMENT - SHEET 2				Contract No.			
Survey Books				Dimensions shown in millimetres except where shown otherwise				Reference Points				Preceding RP				Design Reviews (RPEQ)				ENGINEERING CERTIFICATION (RPEQ)				Drawing No.			
Revisions/Descriptions				Certification				Date				From start to end of job				ENG. AREA				NAME				Series Number			
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B Span 3 changed to Super-T girders				A Original Issue A3																				Page 132 of 215			

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.7 – Structures
For T128 Attachment refer to
Drawings

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.7 – Structures
For T129 Attachment refer to
Drawings

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.7 – Structures
For T130 Attachment refer to
Drawings

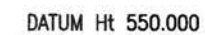
TSRC
PART 2 - CLARIFICATION QUESTION
A.1.7 – Structures
Attachment for T131



PLAN
Scale D

4/5/2015 @ 10:44am

DETAILS & DIMENSIONS ARE SUBJECT TO REVIEW OR
FURTHER DEVELOPMENT DURING DETAILED DESIGN



SIMPLIFIED LONGITUDINAL SECTION - MC00 (BRIDGE ON CONTROL LINE MC10 SIMILAR)

Scale 0



**Queensland
Government**

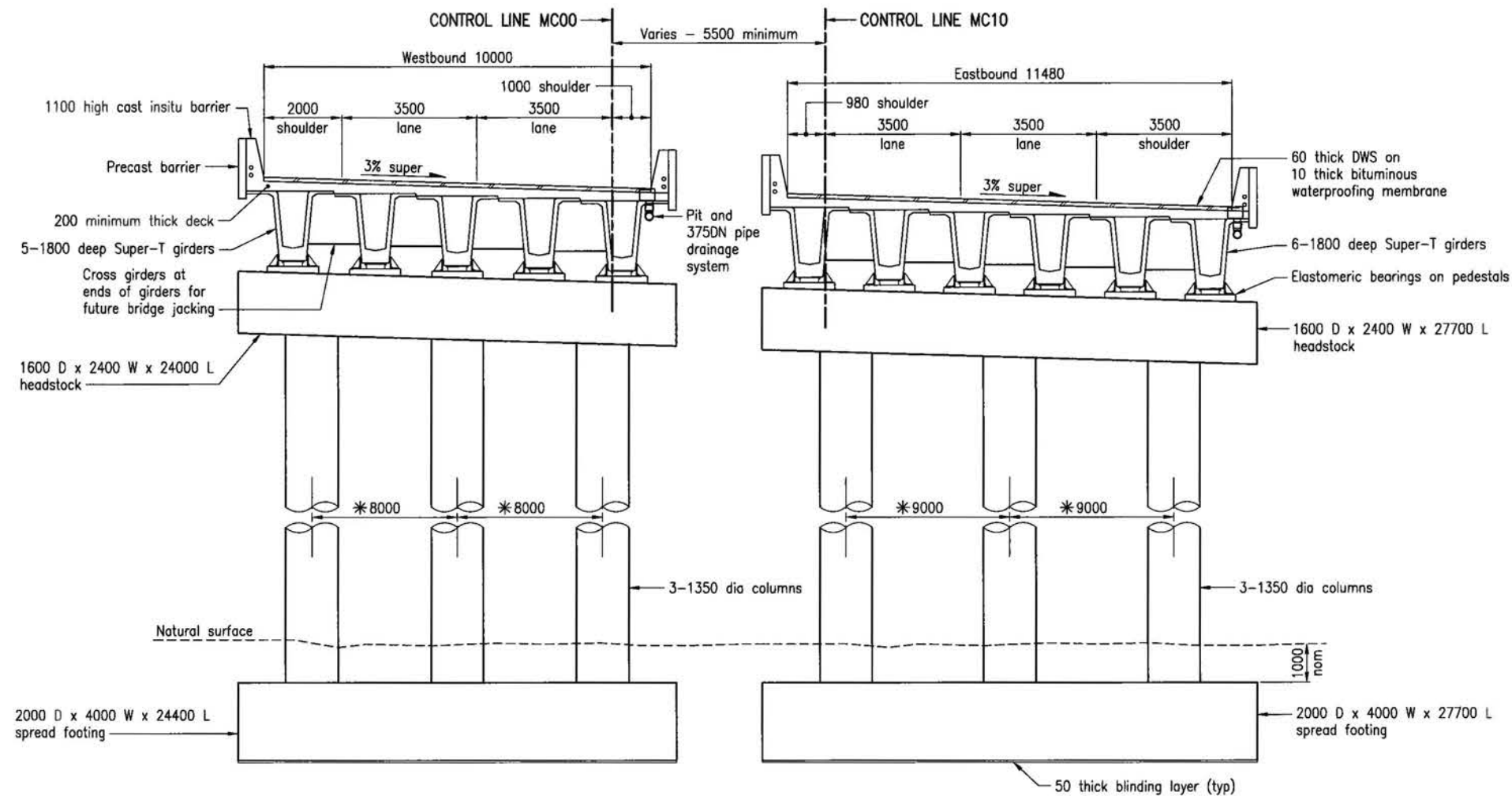
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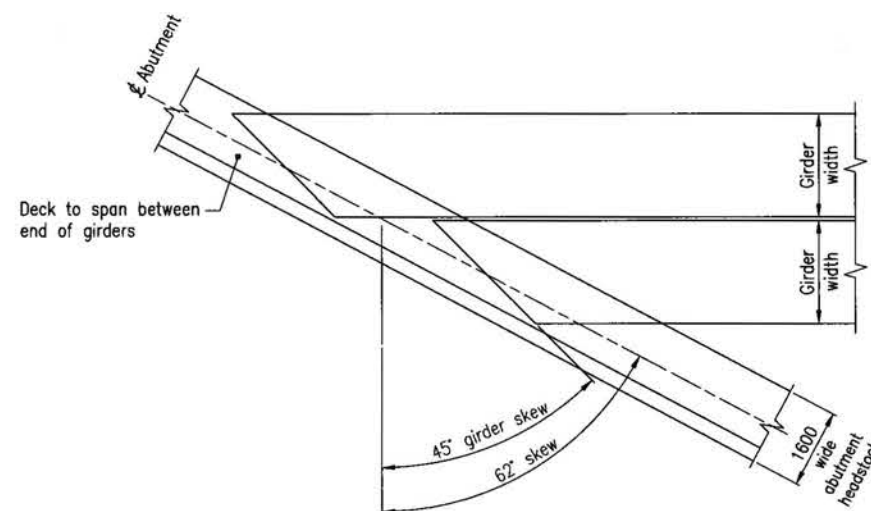
Drawing No.		B
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Series Number	BR22-01 of 02
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MRB Detail (06/13) BR Drgs 6 of 12
Page 137 of 215



TYPICAL SECTION AT PIERS
Scale K



SKEW DETAIL
Scale K

TENDER DESIGN

4/5/2015 10:46am

DETAILS & DIMENSIONS ARE SUBJECT TO REVIEW OR FURTHER DEVELOPMENT DURING DETAILED DESIGN

LEGEND

* Denoted measured along skew

BRIDGE DESIGN CRITERIA: AS 5100-2004				DESIGN LOADING: SM1600 and HLP400				DESIGN SPEED:				EARTHQUAKE ZONE: BEDC-1				BARRIER PERFORMANCE LEVEL: Medium				BRIDGE TYPE: RC Deck on Super-T Girders				BIS No.			
Associated Job Nos				Survey Data				Scales				LOCKYER VALLEY RC AND TOOWOOMBA RC				Drawn M. Haldane				TOOWOOMBA SECOND RANGE CROSSING				Queensland Government			
A Original Issue A3				Datum				K 0 1500 3000mm				WARREGO HIGHWAY - GORE HIGHWAY				Checked R. North				DESIGN ALTERNATIVE AREA 93				Job No. -			
Auxiliary Drg Nos				Horiz. Grid				Reference Points				614.293 - 41187.882 (MC00)				Designed No.				GOOMBUNGEE ROAD UNDERPASS - SHEET 2				Contract No. -			
Revisions/Descriptions				Height Origin				Preceding RP				Dist. to start of job (km)				Verified No.				ENGINEERING CERTIFICATION (RPEQ)				Drawing No. B			
Certification				Survey Books				From start to end of job				From end to Following RP				Design Reviews (RPEQ)				ENG. AREA				Series Number BR22-02 of 02			
Date				Dimensions shown in millimetres except where shown otherwise				Through Chainage from				No.				NAME				SIGNATURE				MRB Detail (06/13)			
Microfiled																NO.				DATE				BR Drgs 7 of 12			
CAD FILES																								Page 136 of 215			

8 A.1 8a Tunnel (Geometry & Structure) (TU1, TU4)

Not included

A.1 8b Tunnel (M&E / F&LS) (TU2, TU3)

Not Included

9 A.1 9 OMCS & ITS (O1, O2)

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.9 – OMCS & ITS

Question ID	Report Reference	Question	Proponent Response
T118	A1.9	The State is considering the following changes for Speed Camera facilities in the Performance Specification. This change includes that the Proponent provide Point to Point (P2P) Speed Camera facilities in accordance with the following; Conforming Design, Western side of the Range: • 90km Zone - bottom of range to change in speed near Eastern Tunnel Portal Conforming Design, Eastern side of Range: • Gore Hwy – Cecil Plains Road • Warrego West – Western Portal. If all of the Value Add Interchange Options are selected, the P2P locations would be limited to the Gore Hwy and the Western Portal. If the Alternative Option is selected, the P2P locations will be required at similar locations to the Conforming Design. All locations noted above are required in both directions. Proponents are required to provide all associated infrastructure including, maintenance area, pole, fibre and power (QP to supply camera) as noted in the attached document 'X09-X10 Camera Requirements'. The requirement for the U-turn bay within 1km can be relaxed. Please advise the impact, if any to your Proposal including program, cost or other related items to provide the above requirements.	Where possible, to provide electrical points of supply and safe access via maintenance bay's for the camera equipment, sites are proposed to be collocated within existing ITS sites. These are located as follows: Eastern side of the Range: • Ch9,000 (Warrego Hwy East – as there is no Point of Supply, solar power is proposed. Also note that this location will require a new maintenance bay. • Ch16,765 (Eastern Tunnel Portal), collocated with other devices. Western side of Range – cameras can be collocated with existing infrastructure: • Ch40,700 (Gore Hwy). • Ch31,600 (Cecil Plains Road) • Ch27,500 (Warrego West) • Ch17,860 (Western Portal). At each location the following will be provided (please refer attached drawings at Appendix T118/119): - 15m hinge pole with a cantilever outreach to mount two cameras, pole footings and guard rail (note that a pole will be provided for each carriageway) - one concrete plinth mounted Field Cabinet and Access Pad which will service both directions (where a road crossing conduits are provided), otherwise provide two field cabinets, one for each direction. - Provide electrical connection (use solar power and battery backup where there are no PoS (i.e. CH 9,000) - Provide approximately 100m of 1x100mm conduit (1C) lockable pit to service Field Cabinet and Gantry - Break into fibre optic backbone at lockable pit, provide FOSC and provide 12core SMOF cable to Speed camera Cabinet. - Speed camera equipment by QPS. The impact in D&C cost is: \$663,000.00 The total additional operations & maintenance costs for repairs, consumables and subcontract services involved in maintaining the cameras including track/parking area, barriers, poles, cabinets, power supply/solar panels as applicable, UPS/battery back-up over the O&M Phase are \$325,000 and additional Capex costs for refurbishment/replacement and Handback are \$268,000. (These costs have been included in the financial model, as requested by the State, submitted as part of our response to FC64 answer)
T119	A1.9	The State is considering the following changes for Speed Camera facilities in the Performance Specification. This change includes that the Proponent provide Mobile Site Speed Camera facilities in accordance with the following locations: • Approximate Ch3000 • Approximate Ch9000 • Approximate Ch14000 • Approximate Ch34000. All locations noted above are required in both directions. Proponents are required to provide all associated infrastructure including, maintenance area and safety requirements as noted in the attached document 'X09-X10 Camera Requirements'. The requirement for the U-turn bay within 1km can be relaxed. Please advise the impact, if any to your Proposal including program, cost or other related items to provide the above requirements.	Facilities required for the Mobile Site Speed Camera sites are provided in the attached Appendix T118/119. The sites will be provided at the following locations: - Ch2,800 WB & EB - Ch9,500 WB - Ch9,800 EB - Ch14,700 WB & EB - Ch34,000 WB & EB The impact in D&C cost is: \$269,000.00 There is no additional Operations & Maintenance costs or Capex costs over the concession term
T142	A1.9	Further to clarification question T118, can the Proponent please confirm that there are no impacts to their program to allow QPS access to site during construction for the installations of the P2P cameras?	Nexus Infrastructures confirms that providing site access to QPS during construction phase has no impact on our submitted program.

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.9 – OMCS & ITS
For T118&T119 Attachment refer to
Drawings

10 A.1 10 Landscaping and Environmental Design (L1, L2)

Environmental

10.1 Purpose and Scope of Report

Nexus' response describes how the environmental objectives and requirements detailed in the State Environmental Management Plan (EMP) and contained within the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) referral conditions have been assessed and incorporated into the Design.

Where specific environmental design criteria or objectives are detailed in the EPBC Act Referral conditions or where the State has established them in the existing EMP and EDR, Nexus Infrastructure has adopted these conditions. Where no available environmental design criteria have been documented, relevant legislation and practical, industry accepted standards and environmental due diligence criteria developed for specific environmental aspects of the project have been adopted.

10.2 Relationship to Project Objectives

Nexus will use web-based SiteMap GIS tool to manage, implement and measure environmental compliance management activities on the TSRC Project will achieve value for money outcomes for the State (see response to Schedule A2 B7 for further details).

This SiteMap system will provide a visual and site-specific compliance management tool to compliment the CMP. Finalising the CMP to the satisfaction of the State in accordance with Annexure 06: Performance Specifications – Environmental Management and statutory requirements will be key to the timely delivery of the TSRC Project.

Design Standards and Criteria

10.3 Performance Criteria

With respect to environmental design, management and compliance, the performance criteria is made up of four key areas. These include:

- Ensuring that the design complies with the Commonwealth and State environment and cultural heritage legislation and policy including any environmental or cultural heritage licence permits or approvals obtained for this Project in addition to the existing EMP, EDR and additional recommendations made in subsequent technical environmental reports as part of the Project
- Implementing and maintaining measures to preserve and protect the natural environment (including the protection of both indigenous and non-indigenous cultural heritage) on and immediately adjacent to the TSRC Project corridor
- Ensuring all applicable environment protection measures are identified through the Nexus Infrastructure CMP and implemented through subsequent EMP's prior to proceeding with any relevant works and maintained in compliance with their intended performance criteria for the duration that they are required
- Use the EMP and EDR provided by the State to inform the Project specific environmental design criteria contained within this Report that will be adopted into the final CMP.

10.4 Design Assumptions

As detailed in the response to A2 B7 [Environmental Management (Construction)], Nexus Infrastructure intend to use a CMP framework for statutory approvals and environmental compliance for the delivery of the Toowoomba Second Range Crossing Project in accordance with the *Transport Infrastructure Act 1994* (TIA). The response to A2 B7 also incorporates the State's comments in Notice to Proponents Numbers 44 and 48. The CMP will incorporate Detailed Design elements and site-specific information.

It is also assumed that the biodiversity offset process has been initiated by the State and that the offset obligations of Nexus Infrastructure will be finalised following Detailed Design and final constructability reviews.

Technical reporting provided by the State regarding sensitive habitats, particularly habitats which are known to contain threatened species and or habitat translocation plans for *Delma torquata*, have been used to inform the Tender Design.

Environmental Design, Management and Landscape Elements

10.5 Environmental Design Review

Following Financial Close, Nexus Infrastructure will undertake a review of this Report to finalise the environmental design criteria relating to environmental and cultural heritage approval, compliance and planning aspects for all stages of the TSRC Project.

The following elements inform the environmental design criteria and will be reviewed as part of the Detailed Design process and during development of the Compliance Management Plan:

- Environmental legislative requirements
- Environmental standards and guidelines
- Noise and Vibration
- Air quality
- Water quality
- Soils, topography and geomorphology
- Hydrogeology
- Hydrology and hydraulics
- Ecology
- Land use planning
- Socio-economic environment
- Cultural heritage
- Urban design and landscape.

The environmental design criteria, detailed in Table 29, have been adopted from the established criteria detailed in the EMP and EDR provided by the State or have been informed by relevant legislation and industry standards.

The environmental design criteria are subject to change, pending the Detailed Design phase and the finalisation of construction staging and planning following award. Further environmental design criteria will be developed in the event that any significant changes are made to the Tender Design or construction methodology to ensure that all site-specific elements are addressed.

Significant environmental design solutions which form part of the Nexus Infrastructure Tender Design can be found in Figure 9 to Figure 18.

In addition to Table 29 and Figure 9 to Figure 18, the following sections provide some detail on how the issues specified in Schedule A1 L2 will be addressed from a design perspective.

10.5.1 Retention and Protection of Existing Vegetation

Nexus Infrastructure has reviewed all available vegetation/ecological information regarding the TSRC [e.g. Supplementary Environmental Impact Assessment, EMP(P), Draft Translocation Management Plan *Delma Torquata*] and we have included ecologically significant areas of vegetation on SiteMap. As shown on Figures 1 to 10, minimal vegetation disturbance areas have been mapped to aid in their incorporation during the detailed design phase of the project. In addition, as detailed in our response to Schedule A2 B7, no-go areas (e.g. for vegetation protection) will be delineated with flagging tape and signed on-site during construction. Clearing and grubbing will only occur for the minimum area required for road construction and associated activities. Construction tool box talks, etc. will also emphasise both the ecological and the financial cost to the project of excessive clearing.

10.5.2 Temporary and Permanent Erosion and Sediment Controls

Temporary erosion and sediment control measures are addressed in the Nexus Infrastructure response to Schedule A2 B7. In summary, we will take the following measures:

- Use of Certified Professionals in Erosion and Sediment Control (CPESC) to review and approve Erosion and Sediment Control Plans
- Senior Environmental Project Engineers with training and experience in erosion and sediment control
- Use of dedicated erosion and sediment control construction and maintenance crews
- Use of EcoBlanket as the hydromulch process in order to efficiently and effectively manage poor soils throughout the corridor and rapidly provide ground cover across the site and
- Use of High Efficiency Sediment (HES) basins during construction. HES basins are largely automated in relation to addition of flocculants and have been proven to treat over 90% of runoff compared to 30% achieved using traditional designed and sized basins.

In addition, where possible temporary sediment basins have been located where permanent basins will eventually be installed. This allows for efficient use of resources and reduces earthworks impacts. Permanent erosion and sediment controls for the project are addressed in our response to A.1 - Design 06: Draining Element and include maintenance of ground cover, scour protection and use of sediment ponds.

10.5.3 Aesthetic Treatments Proposed

Nexus Infrastructure have completed a Landscape, Revegetation and Urban Design Plan for the TSRC Project. This Plan addresses aesthetic treatments.

The landscape design proposes a sensitive approach to the integration of the Project Works into their landscape setting; respectful of the landscape typologies, the route traverses and acknowledges the cultural heritage of the broader context. The Design Principles established for the Project translate into the Detailed Design as follows:

- *Integrate road infrastructure into its immediate context and mitigate landscape impacts*
 - > At the broader scale the landscape treatments respond distinctively to the differing landscapes of the eastern and western precincts of the Project; with large exposed areas of rock and more forested slopes in the east through to the more open forest and grass plains in the west.
- *Minimise environmental disturbance and rehabilitate disturbed natural environments through revegetation*
 - > The detailed refinement of the alignment has minimised cut and fill, achieving batters to minimise the Project's footprint

- > Revegetation of all fill batters extending 5m beyond the toe and to all soil cut batters, to the top slope of rock cuts where they lay back and 7m beyond the top.
- *Reflect the distinctive characteristics of each landscape zone through specific treatments*
 - > Localised ecosystems are reflected in the selection of plant species along the route. The palettes are a refined selection of the species from within the existing regional ecosystems that are commercially available and tried and tested in an infrastructure rehabilitation context
 - > To the east a greater balance of shrub and tree planting will be applied to mixes over those in the west.
- *Integrate drainage devices into the landscape using environmental management treatments and devices*
 - > Native grass planted swales will be applied across the Project with exotic grass treatments restricted to areas of high velocities
 - > Macrophyte planting will be used to mitigate any disturbance to waterways.
- *Integrate fauna fencing and movement corridors*
 - > Fencing and fauna connections are being provided to support existing fauna communities in accordance with the recommendations of the environmental design
 - > Locations for fauna crossings (underpasses) are:
 - Chainage 4,600
 - Chainage 6,700
 - Chainage 9,250
 - Chainage 12,000
 - Chainage 13,550
 - Chainage 15,170
- *Preserve and enhance existing view corridors to and from the road corridor*
 - > Key views to and from the corridor have been identified; with either mitigation screening for adjacent sensitive uses or preservation of views across the landscape.
- *Express the geology of the area through cut slope treatments*
 - > Cut slopes are left untreated where stable enough to do so as an expression of the geology of the area. The inclusion of shotcrete will be minimised for use in areas with potential instability and where possible alternative support systems will be utilised (i.e. tension mesh).
- *Provide noise mitigation through planted mounds where achievable*
 - > The project envelope is generous enough to facilitate the integration of noise mounds where required. These would be revegetated to provide additional screening.
- *Provide a safe road environment for all users*
 - > All DTMR standards have been adhered to, including sightlines and setbacks for frangible and non-frangible planting
 - > Screen planting has been integrated in consideration of solar glare for motorists
- *Consider visual treatment of structures such as bridges and walls to enhance visual quality and integrate with project theme and context*
 - > Structural elements within the Project have been developed with the engineers to enhance their visual quality, while being cognisant of the context and need for these to be understated and robust in their aesthetic
- *Streamline and simplify elevated structures to reduce visual impact*
 - > Parapets to bridges, piers, headstocks and abutments will be streamlined and integrated to simplify the aesthetic of constructed elements and minimise their visual impact on the landscape
- *Materiality of urban design elements to reflect corridor palette and be contextually appropriate*

- > A palette of distinct materials has been developed for the project drawing on the colours of the landscape, local rock, vegetation and the agricultural and cultural heritage of the area
- > An arrival element has been developed for the entry points to Toowoomba as described in the Landscape and Urban Design Report.
- *Minimise maintenance requirements*
 - > Beyond the establishment period, maintenance requirements have been minimised through the use of a moisture retaining product, planting of native grasses to negate the need for slashing and the use of native trees and plants to regenerate as a naturally sustaining ecosystem over time.

Table 12: Environmental Design Criteria

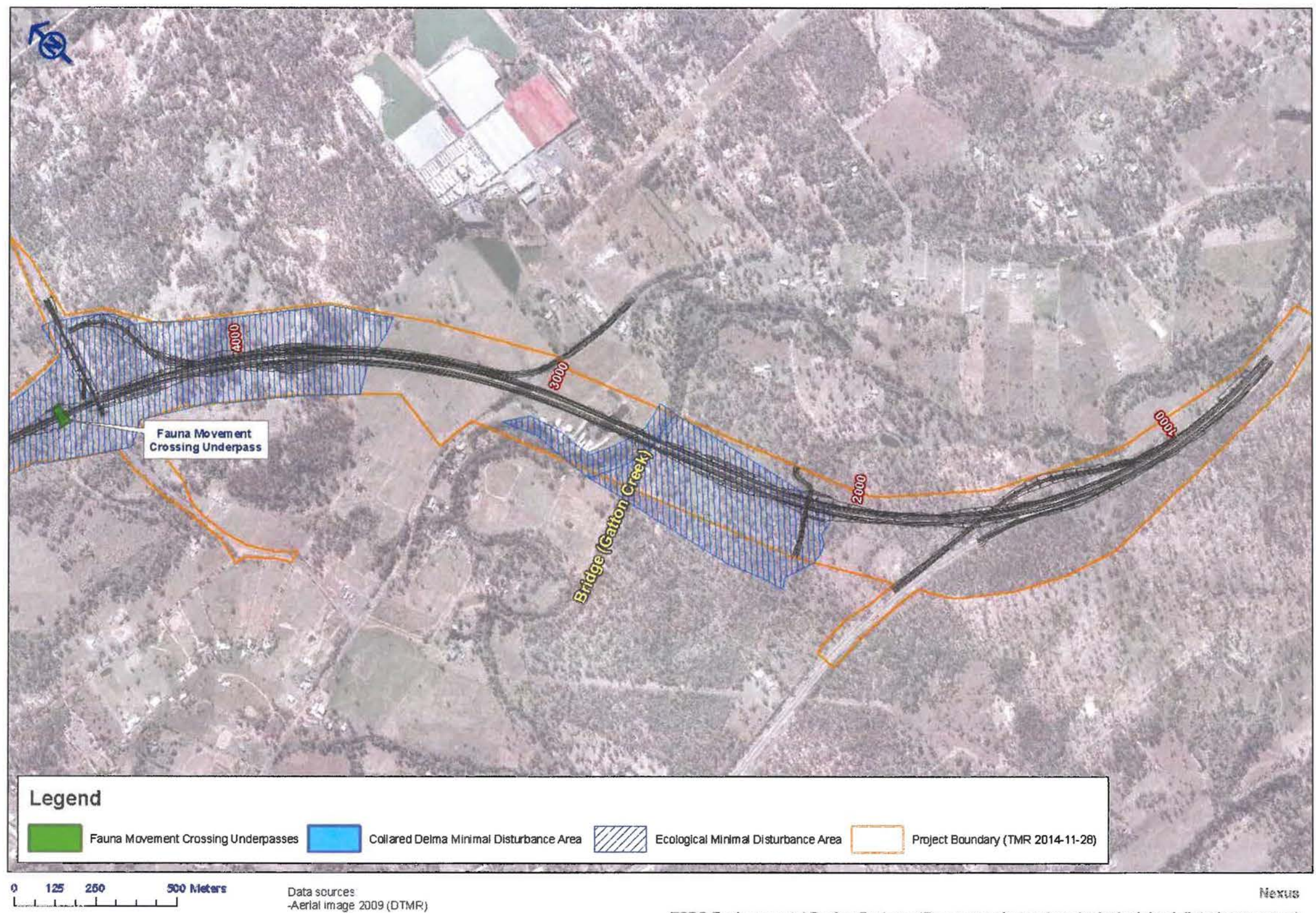
Ref. no.	Env. Element	Location/Design Element	Location (Ch)	Description	Recommended Action	Design Response	Responsibility	Actions to complete	Sign off
1.	Legislation / approval requirement	Entire Project	Project Wide	EPBC Act Referral conditions	Comply with EMP Planning document during construction and rehabilitation; and specific conditions including minimising disturbance through Collared Delma (and other MNES) habitat to protect species populations and minimise the need for biodiversity offset requirements.	- EMP Planning has been utilised during the design process to ensure that environmental mitigation measures have been included. This process has optimised the alignment to provide a better solution for the road while reducing impacts on ecologically sensitive areas. - Bridge structures at waterways and large gullies have also been developed with reference to the proposed mitigation measures developed from the concept designs that minimise disturbances to the creek environmental functioning and flow regimes. - Through optimising the design/alignment, the biodiversity disturbance has been minimised. Following detailed design and constructability reviews, the residual disturbance to adversely impacted significant biodiversity habitats within the project footprint will be calculated to produce the Project offset plan and to secure land additional to the lots stipulated within the referral document.	Design Team/ Constructability Reviewer	Detailed design footprint (inclusive of construction and maintenance requirements)	
2.	Legislation / approval requirement	Entire Project	Project Wide	EPBC Act Referral conditions	Timeframes and process for the offset requirements within referral conditions to be adhered to. Therefore provisions to lock the alignment and disturbance footprint must be committed to early in the detailed design phase. This will allow for calculation of the total disturbance to adversely impacted significant species habitat or biodiversity areas early in the detailed design process to more accurately assess the Offset provisions, requirements and to minimise the costs associated with the development of the Offset Plans.	- The TSRC Alignment has been optimised to reduce the design footprint in several areas of the existing alignment particularly within minimal disturbance areas. - During the detailed design phase of the project the construction team will review the alignment and site access/temporary works provisions with respect avoiding the sensitive areas identified in the EMP-Planning/EDR documents. - Through undertaking this early in detailed design, the calculations of offset requirements will be more accurate and therefore the Offset plan will be able to be developed and submitted for approval to meet the referral timeframes	Design Team/ Constructability Reviewer	Review conditions and include offset obligations within detailed design phase program	
4.	Noise and Vibration	Sensitive receptor interface as per engineering noise report	Refer A1 - N1	Noise	Noise modelling to be undertaken and mitigation strategies to be incorporated into the design	Noise and vibration modelling undertaken by SLR on behalf of the State has identified sensitive receptors that could be impacted by noise. Further information on the noise model and identification of sensitive receptors refer to A1 - N1.	Design Team	Review of Noise model and identification of mitigation measures and locations	
5.	Air Quality	Project footprint	Project wide	Dust impacts on sensitive receptors	Design alignment to consider sensitive receptors/residences to include vegetative buffers	Landscape and pavement design ensures no bare earth or dust emitting sources within the design	Design Team/Landscape Design	Assessment and location of sensitive receptors	
6.	Air Quality	Project Footprint	Project Wide	Dust impacts on sensitive receptors	Include constructability and potential stockpile/site office locations from constructability review in design as provisional or "potential" project elements for assessment of sensitive receptors	Construction team to adopt appropriate EMP Planning provisions and recommended mitigation measures to control dust and air quality issues within the future EMP Construction	Constructability Reviewer	Constructability review	
7.	Water Quality	All Creeks and major drainage lines	1,950 - 2,050 (Rocky Creek) 7,600 - 7700 (Six Mile Creek)	Reduced water quality downstream due to	Design is to comply with riverine protection exemption requirements and or suitable design to cause minimise the potential for	Bridge designs have incorporated environmental criteria listed within the Concept design EMP(P)/EDR where applicable (due to optimised bridge designs) to minimise impacts. The designs also allow for	Drainage Design Team	Designs of drainage lines and structures are not to impact flows or cause worsening of water quality	

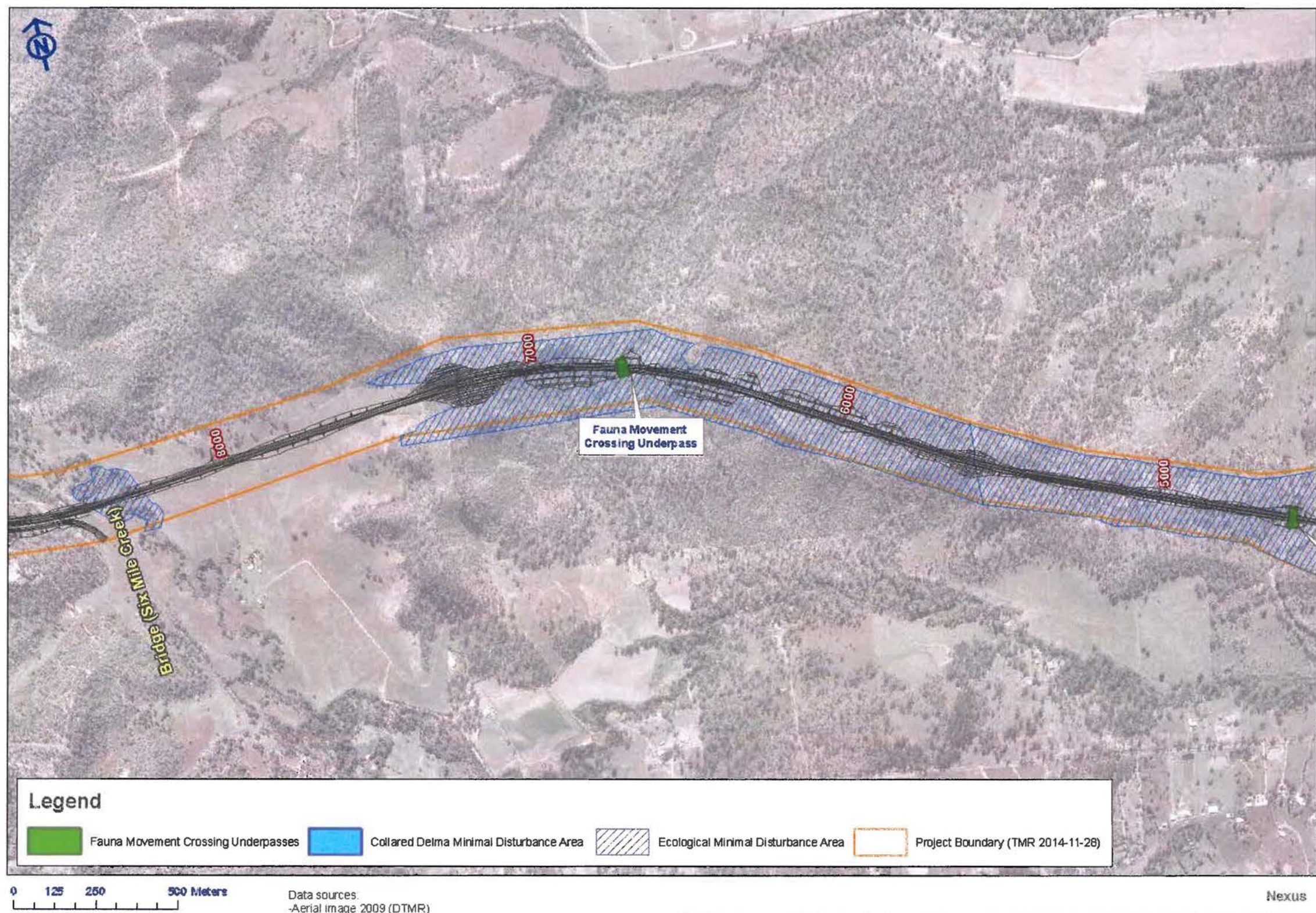
Ref. no.	Env. Element	Location/Design Element	Location (Ch)	Description	Recommended Action	Design Response	Responsibility	Actions to complete	Sign off
			16,300 - 16,350 (Unnamed Watercourse#1) 18,100 - 18,150 (Gowrie Creek) 28,800 - 28,850 (Dry Creek) 32,650 & 35,100 (Unnamed Watercourse#2) 36,200 - 36,250 (Spring Creek) 37,550 - 37,650 (Westbrook Creek)	interrupted flows	environmental harm at the creek crossing locations and downstream environments.	adequate environmental controls to be installed during the construction phase (EMP(C)).		as a result of the TSRC design	
8.	Water Quality	All creeks, major drainage lines	Project wide	Impact on creeks due to scour of creek bed and banks from increased velocity	Water flows are not to be reduced or increased as a result of the TSRC design	Where possible (due to bridge length and safe design principles), bridge piers have been located outside of the creek beds/flow channels to avoid disruption to water flows and turbulence. Where necessary the bridge designs incorporate creek bank stabilisation to minimise the risk of erosion or sedimentation. All drainage culverts include rock scour protection (refer A.1 Design Section D.1) with additional control measures to be considered to address the potential impacts identified in the EMP(P)/EDR document	Drainage Design Team	Drainage design to incorporate exiting flow rates into modelling to keep new arrangements consistent	
10.	Soils, topography and geo-morphology	Within sensitive environmental and more erosive and sodic soil areas - particularly those in more steep sections of the range	Project wide but particularly: 0 - 2,060 2,650 - 11,750 13,300 - 16,900	Erosion and land slippages	Incorporate stabilisation and consolidation of exposed surfaces through design and landscape plans, particularly in areas identified within the EMP(P)/EDR	Stabilisation of soils/rock has been a feature of the design process. Landscape design will address this in some areas (refer Landscape design within this section) and temporary works areas will be stabilised through hydro-mulching type treatments to consolidate and stabilise non landscaped batters/ embankments and other temporary works areas. Additional geotechnical assessments will also be undertaken during detailed design.	Design Team/ Geotech Team	Incorporate landscape designs into detailed design package	
11.	Soils/Water Quality	Permanent and temporary works areas	Project wide	Permanent and Construction Erosion Drainage and Sediment Control	Design pavement and drainage works to reduce velocity of stormwater runoff and scour protection of vegetated drainage lines and embankments/batter slopes. Construction EMP to include sub plans for Erosion Drainage and Sediment Controls specific for each project work area.	Permanent erosion, drainage and sediment control measures have been designed for the project as part of the drainage section of the submission. Construction element and/or temporary works erosion, drainage and sediment control plans and measures are to be further developed following detailed design and construction methodology to ensure requirements under the CMP and general environmental duty of care are addressed.	Drainage design team and construction/temp orary works and rehab teams	Sediment, drainage and erosion control plans are to be developed by a certified international Erosion Control Association (IECA) specialist once construction staging and final design have been completed. Additional revegetation/rehabilitation of temporary and permanent works to be addressed during construction and operational phases of the project.	

Ref. no.	Env. Element	Location/Design Element	Location (Ch)	Description	Recommended Action	Design Response	Responsibility	Actions to complete	Sign off
12.	Hydro-geology	Cutting	2,050 - 2,500 7,100 - 7,600 7,850 - 9,100 40,300 - 40,700	Groundwater intrusions	Incorporate ground water information into designs and drainage designs for cuttings	Drainage design has incorporated the management potential groundwater intrusions. Construction team is also assessing the optimal measures to treat potentially saline water prior to its release to the surrounding environment.	Drainage and Hydro-geology Design Team / Constructability Review	Review groundwater flow data	
13.	Hydrology and Hydraulics	All creeks, major drainage lines	Project wide and specific areas mentioned in point 7 and 8 of this table	Changed water flow regimes in local creek systems	Design criteria to achieve no change in existing creek flows/ velocity		Drainage / Hydraulic Design Team	Review hydrology reports and incorporate mitigation measures specific for each creek	
14.	Ecology	Greenfield locations particularly areas identified as fauna corridors	Specific culverts located at 4,600, 6,700, 9,250, 12,000, 13,550 and 15,170.	Loss of connectivity in threatened species habitats	Review Fauna mapping to identify threatened species locations and incorporate fauna sensitive urban design as per State specifications and project technical reports including fauna crossing locations and fauna exclusion fencing to maintain connectivity across the alignment	Fauna underpasses to accommodate for the practicable connectivity of fauna between habitat corridors severed by the new road. Fauna underpasses are minimum 3x3 metre structures to allow sufficient aperture to allow ambient lighting to enter the structures. One location also acts as emergency access which will not detract from the underpass use by fauna as its use for emergencies will be rare. Fauna exclusion fencing has also been used extensively to deter fauna species from accessing the road environment due to the design incorporating an impassable concrete barrier along the median.	Design Team and Constructability Review	Maintain linkages across threatened species habitat areas	
15.	Ecology/Visual Amenity	Predominantly on the Eastern side of Range		Retention and protection of existing vegetation	Reduce design footprint where practicable from an engineering and safety in design perspective and include endemic plant species within landscape design and temporary construction works rehabilitation plans	Design has been optimised to reduce impact on natural environment especially areas of remnant and high flora/habitat value. However construction access will remain a risk in this regard and the Construction environmental management particularly within the marked "minimal disturbance" areas will need to be specific and detail rehabilitation requirements as part of temporary works planning. Landscape Design plans have incorporated locally endemic species into landscaping plans to maintain character and environmental values in the area. Reduce construction footprint within mapped minimal disturbance areas.	Design and Construction	Incorporate landscape design aspects in to project delivery, construction and operational management plans	
16.	Ecology	As per project fauna reporting mapping - eastern portion of the range crossing		Loss and disturbance of Collared Delma habitat (in addition to other significant species including Koala, Glossy Black Cockatoo, etc)	Minimise project footprint through this area, maintain linkages with Collared Delma habitat and mark plans to show construction no-go and/or minimal impact areas	Design footprint has been minimised as much as possible through the known Collared Delma habitat however additional mitigating measures including the Collared Delma relocation plan and spotter catcher activities will be addressed in the Compliance Management Plan and the EMP(C)	Design Team / Constructability Review	Mark up drawings and have verified by ecologist/ environment lead	
17.	Ecology	Greenfield and identified significant biodiversity areas	Predominantly on the eastern side of the range	Offset requirements	Liaise with State to incorporate offset areas in detailed design - ensure construction phase CMP includes sequential clearing and involvement of spotter catchers etc	Design of the alignment through more sensitive areas has been minimised where possible however safe construction access and This is to be further developed following detailed design and temporary/construction works footprint	Project Environmental Leader / State	Document outcome of discussion regarding vegetation/ biodiversity options	

Ref. no.	Env. Element	Location/Design Element	Location (Ch)	Description	Recommended Action	Design Response	Responsibility	Actions to complete	Sign off
18.	Land-use planning	Airport lighting interactions	14,000 - 29,500	Road lighting and airport lighting confusion	Lighting in this area is to comply with Civil Aviation Regulation 94 (CAR94)	Detailed lighting plans will be undertaken during the detailed design phase of the Project and will address this issue for the areas of road in close proximity to the airfield	Design Team / Constructability Review	Clearly mark and locate proposed access points and tracks on plans for consultation with Project communications and stakeholder manager	
19.	Socio-economic	Identified privately owned/freehold lots immediately adjoining the alignment	TBA	Potential for minor amendments to the design alignment may impact on stakeholders	Early engagement with State regarding impacted property owners in location where design optimisations will result in impact on the existing property arrangements	To be further assessed during the detailed design phase	Design Team / Constructability Review	Identify any potential changes in design on impacted private property owners as soon as possible	
20.	Cultural Heritage	Significant sites identified through heritage assessments and reporting	As per EMP(P)/EDR	Impacts on Aboriginal Cultural Heritage	Mitigation measures within the Draft CHMP are to be factored into the design where possible to reduce impacts and passed on through construction phase CMP to ensure these areas are factored into the program	Existing CHMP's are to be updated during the detailed design phase of the project with the intent to maintain provisions that have been negotiated by DTMR.	Design Team / Constructability Reviewer	Review CHMP design requirements	
21.	Cultural Heritage	As per heritage reporting including Existing rail bridge (and associated structures), trees and other identified local heritage	As per EMP(P)/EDR	Impacts on non-indigenous cultural heritage	Mitigation measures associated with identified heritage structures are to be incorporated into the design	Landscape Design addresses some of the visual impacts that detract from the heritage value. Other mitigation measures that are identified in the EMP(P) / EDR document will be addressed during the detailed design phase of the Project	Design Team / constructability Reviewer	Review areas on heritage mapped within project allowance and proposed management measures within the project heritage report	
22.	Urban design and landscape	View-sheds of alignment from existing vantage points	0 - 8,700	Visual amenity	Consider the design of structures in green field areas with regard to line of sight into adjoining properties or from new structures within the surrounding area into the Project	Landscape design to incorporate schemes that are consistent with the area to assist in screening the road and preserve and enhance existing view corridors to and from the road corridor; with either mitigation screening for adjacent sensitive uses being proposed or preservation of views across the landscape. Species selected in the landscape plans are consistent with the naturally occurring vegetation or locally iconic species to complement the surrounding visual amenity	Landscape Design Team	Review visual amenity reporting and landscape design	
23.	Urban design and landscape	Predominantly through the greenfield/ecological sensitive sections of the alignment on the eastern side of the range	8,700 - 17,000	Landscape design	Retention of as much natural vegetation as possible and replant disturbed areas with vegetation consistent with that which is occurring pre-development as well as low maintenance landscape/ rehab treatments to be incorporated	The detailed refinement of the alignment has minimised cut and fill, achieving batters to minimise the Project's footprint. Revegetation is proposed to all fill batters extending 5m beyond the toe and to all soil cut batters, to the top slope of rock cuts where they lay back and 7m beyond the top. Localised ecosystems are reflected in the selection of plant species along the route. The palettes are a refined selection of the species from within the existing regional ecosystems that are commercially available and tried and tested in an infrastructure rehabilitation context.	Landscape Design Team	Incorporate landscape design into Detailed design	
24.	Soils/Land	Potential contaminated sites in close proximity to the alignment	Numerous along corridor refer Contaminated Land Register	Potential for leaching of contaminants	Avoid identified potential contaminated areas where possible in design and construction methodology	Design avoids direct interaction with the identified sites however additional soil testing may be required during the construction phase	Design and Construction Teams		

Ref. no.	Env. Element	Location/Design Element	Location (Ch)	Description	Recommended Action	Design Response	Responsibility	Actions to complete	Sign off
25.	Soils/ Contaminated Land	Old piggery	(CLR) (Coffey - August 2014) 2,800 - 3,000	Potential contaminated land	Properties identified as having contaminated land to be identified and further assessed during detailed design	If soil testing indicates that contaminants are present, depending on the extent, the area will either be capped and sealed or removed and taken to a regulated waste facility to avoid future issues.	Construction Team		





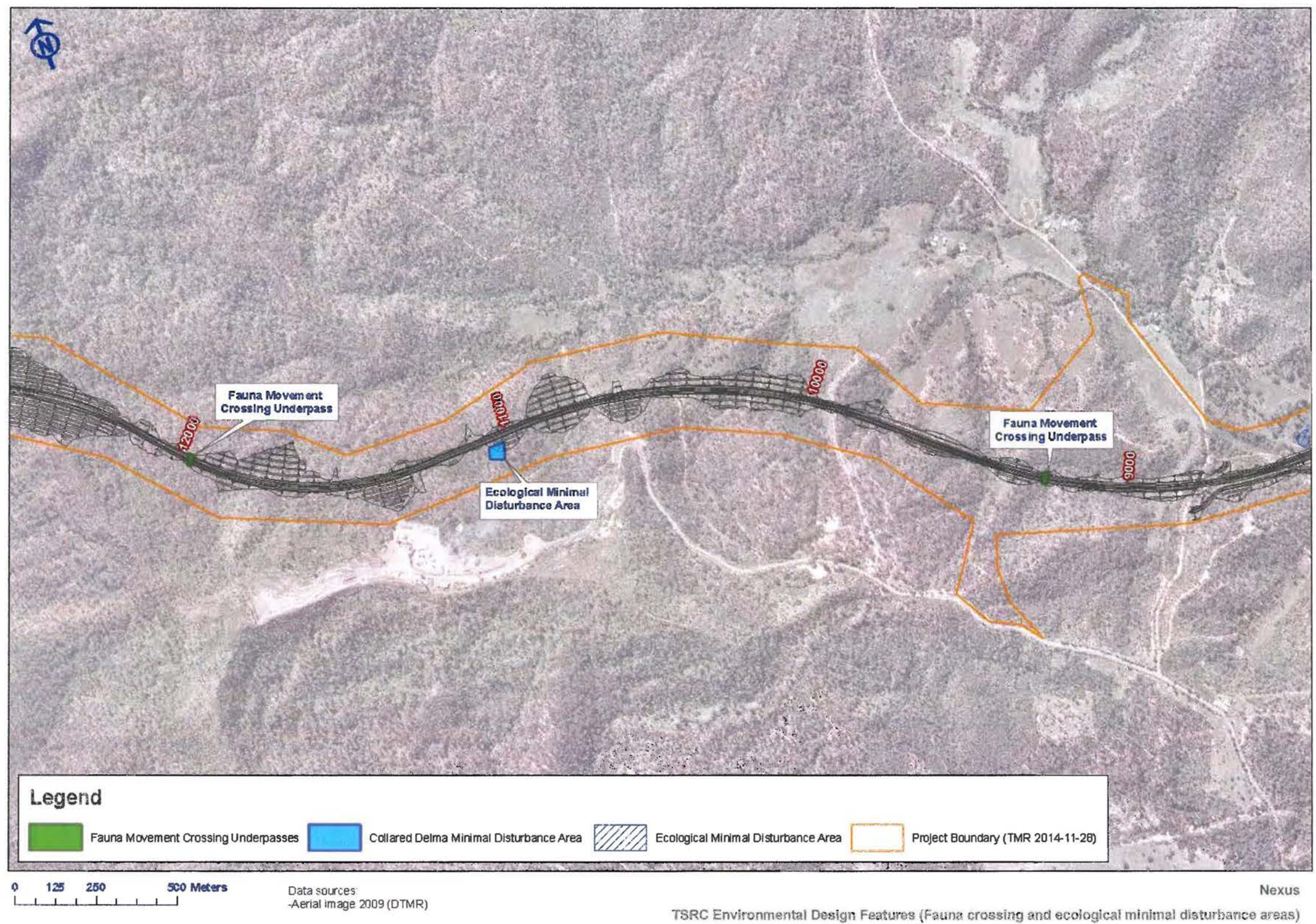


Figure 11: Significant Environmental Design Solutions

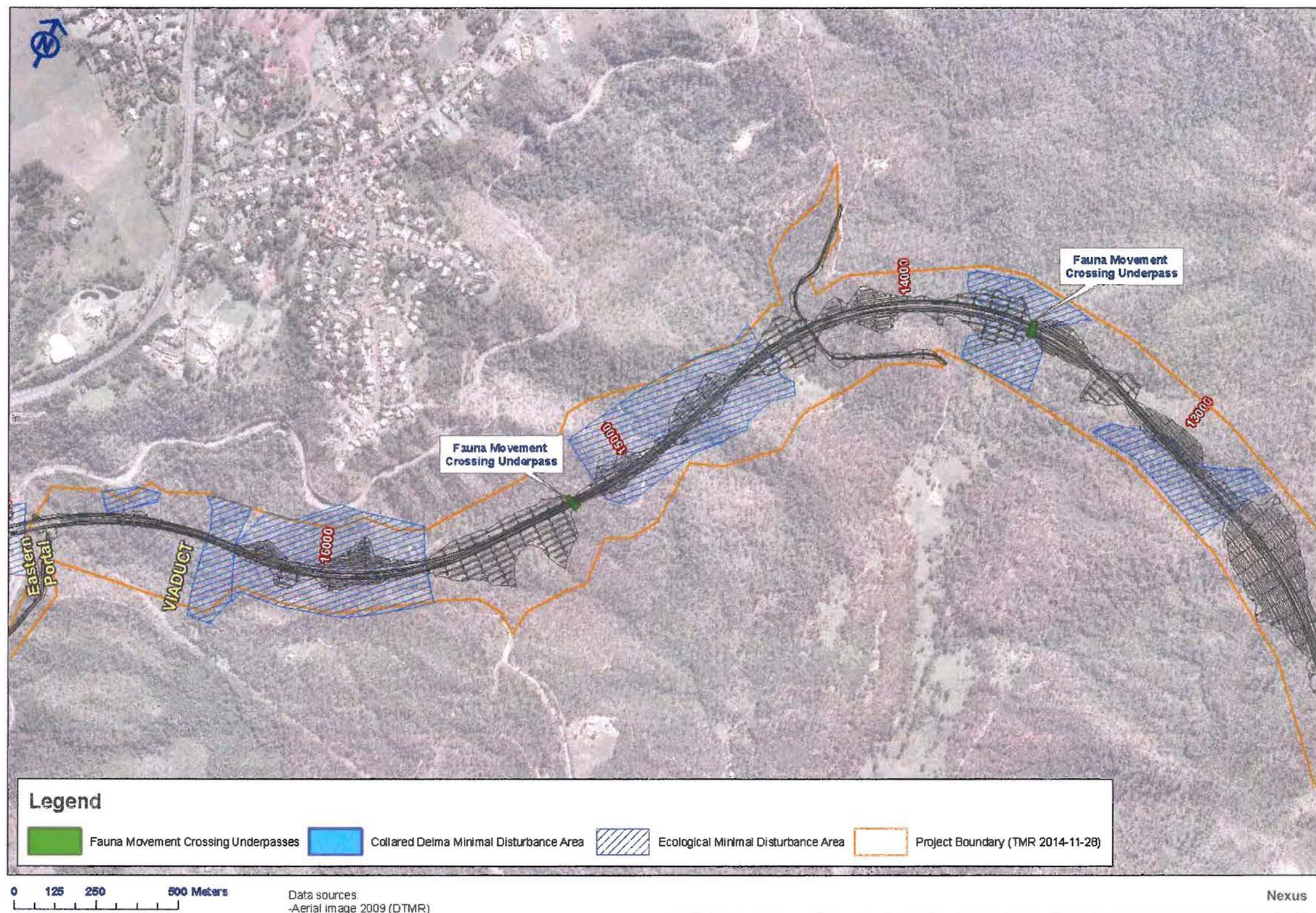
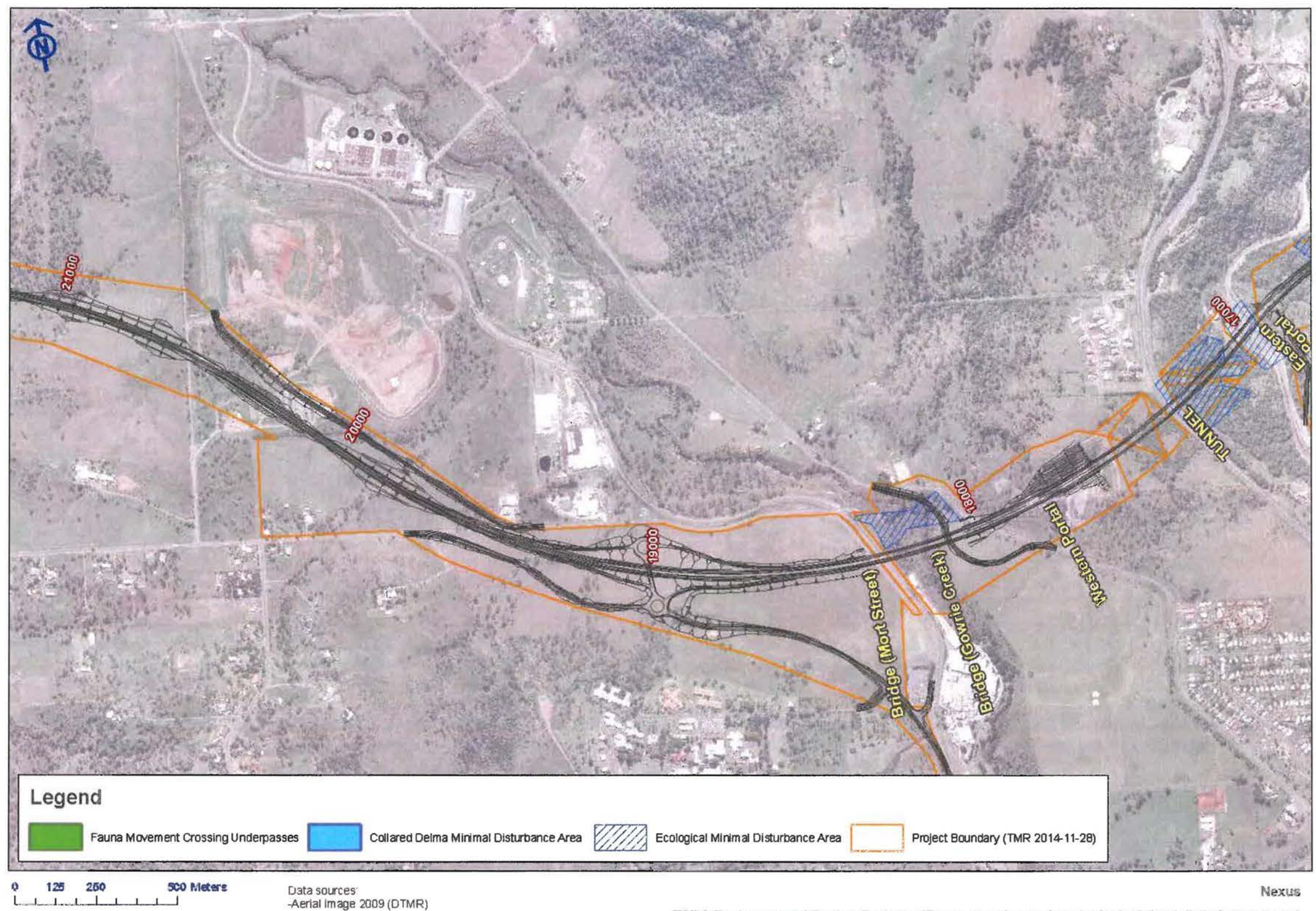
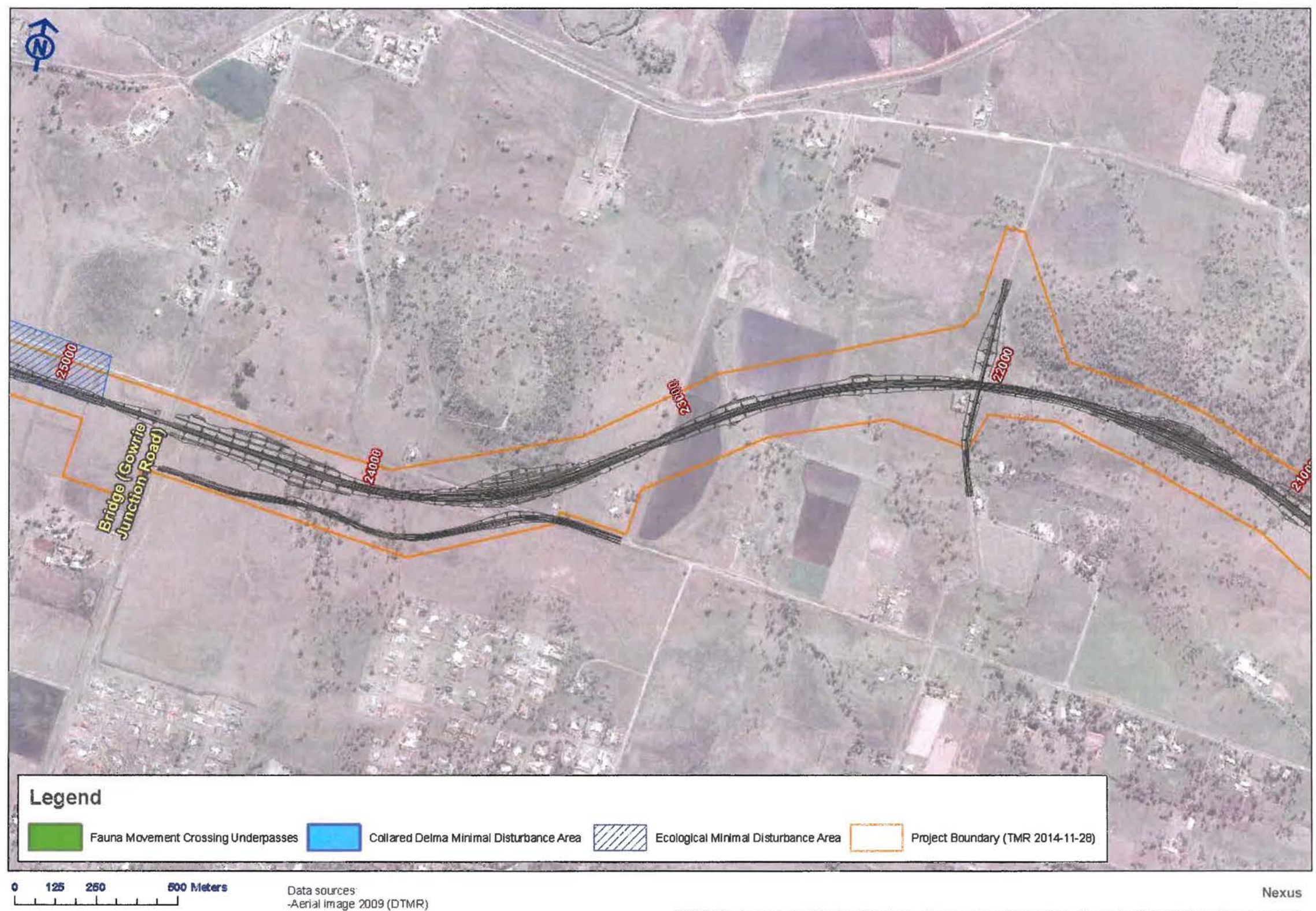


Figure 12: Significant Environmental Design Solutions



TSRC Environmental Design Features (Fauna crossing and ecological minimal disturbance areas)

Figure 13: Significant Environmental Design Solutions



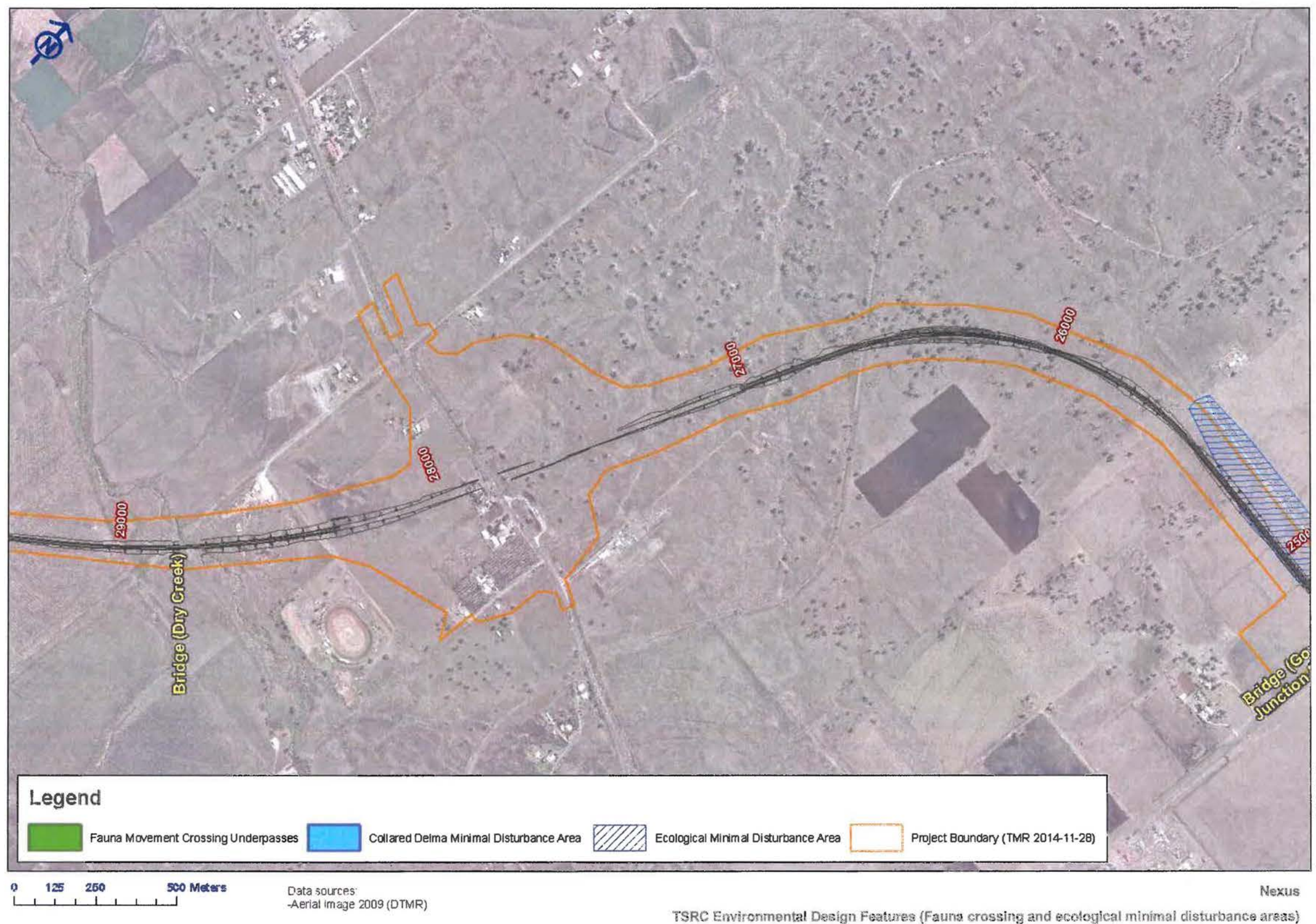
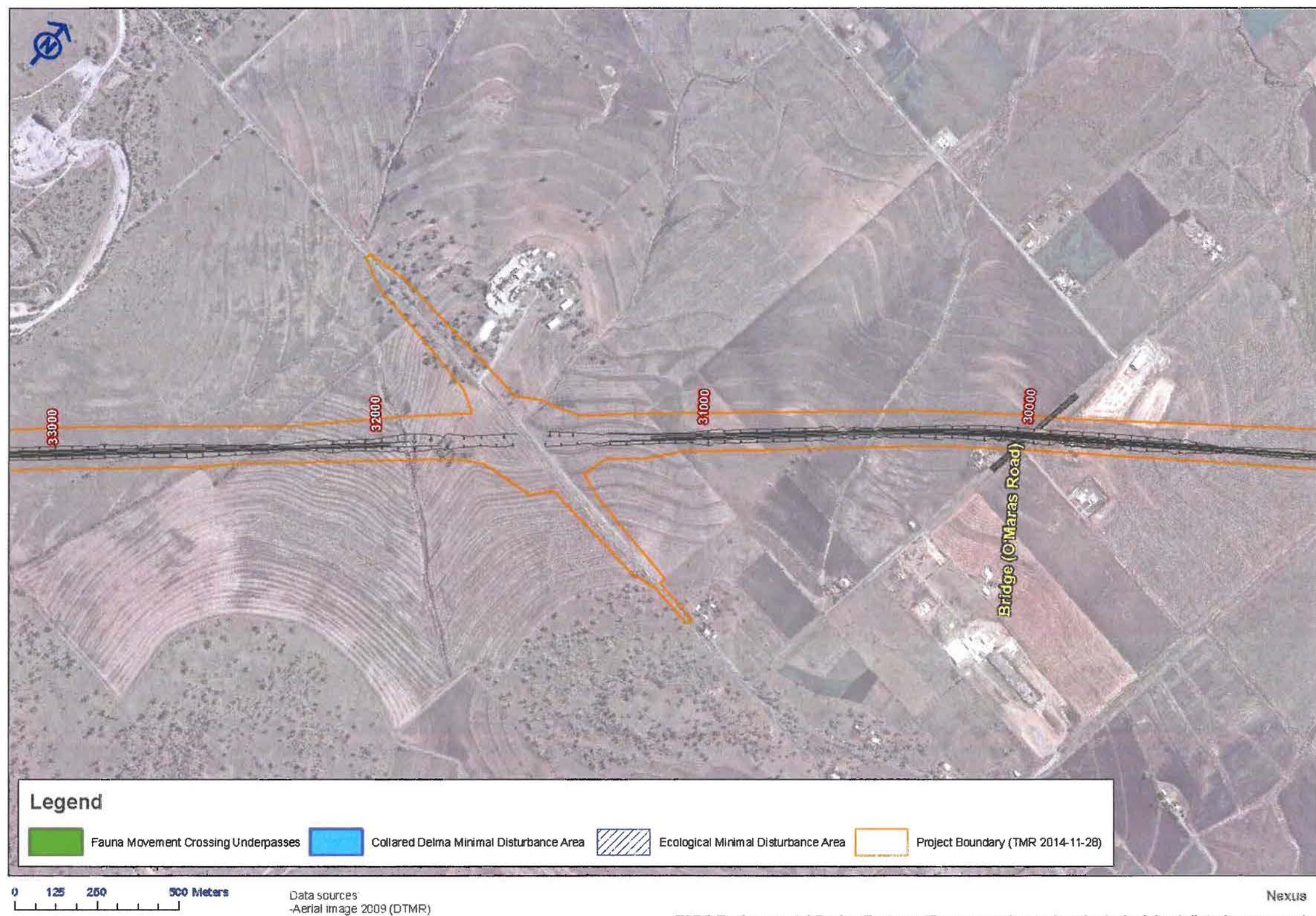
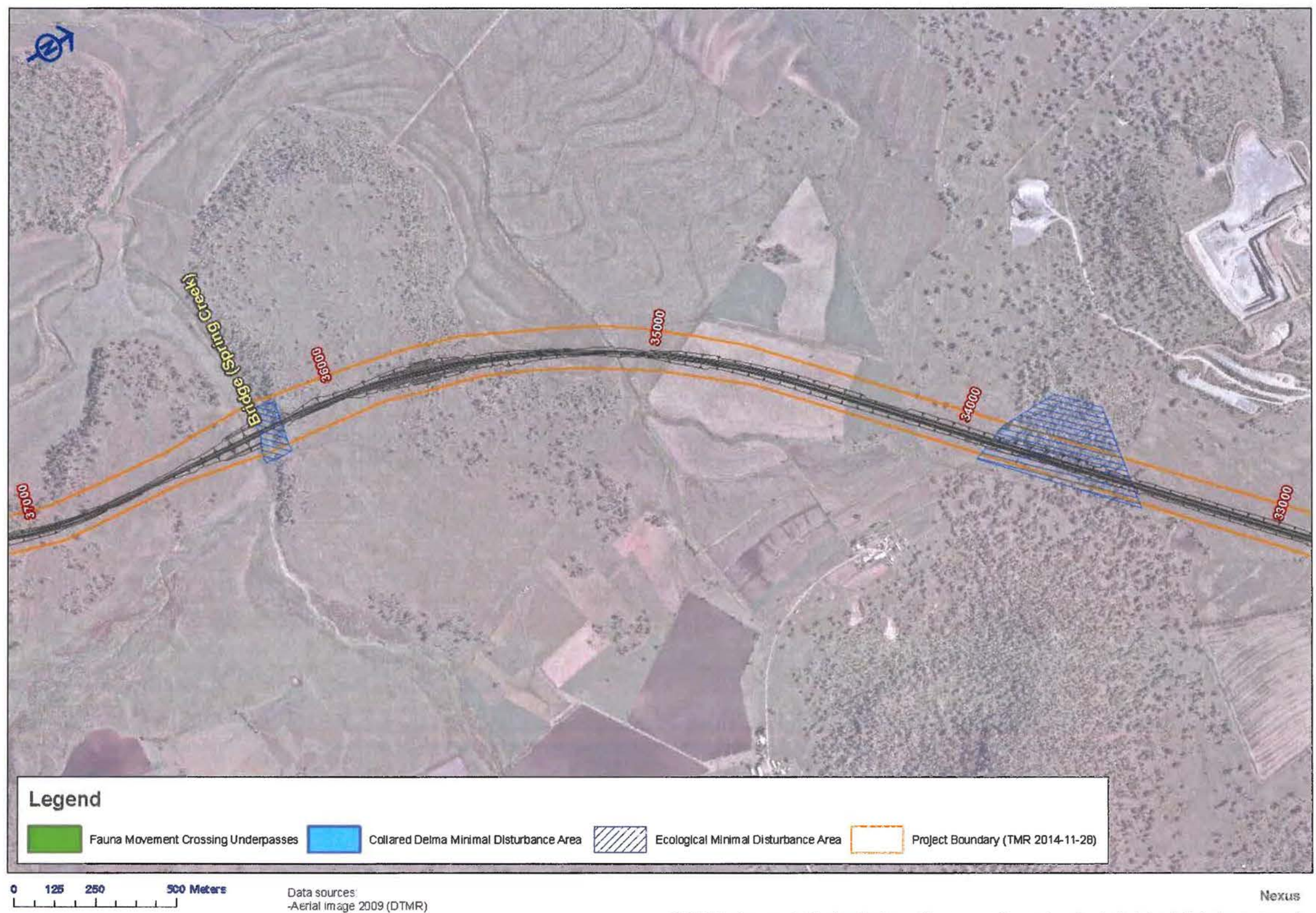


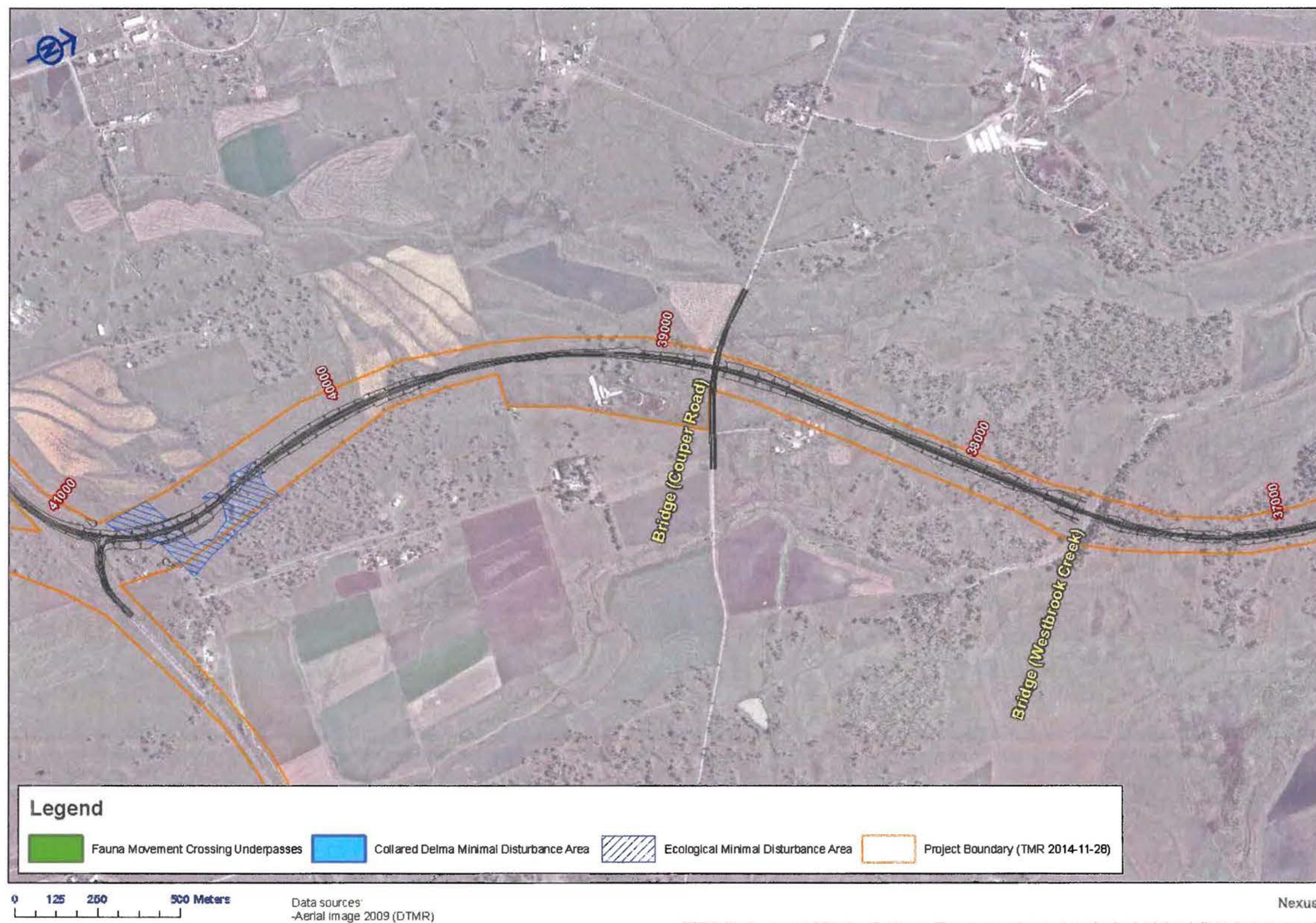
Figure 15: Significant Environmental Design Solutions



TSRC Environmental Design Features (Fauna crossing and ecological minimal disturbance areas)

Figure 16: Significant Environmental Design Solutions





TSRC Environmental Design Features (Fauna crossing and ecological minimal disturbance areas)

Figure 18: Significant Environmental Design Solutions

Environmental Approvals and Compliance

The project environmental and planning design approvals along with statutory approval compliance will be managed during the project through a project CMP approach. The response to A2 B7 details how Nexus Infrastructure intend developing and implementing the CMP.

10.6 Environmental Management

10.6.1 Environmental Management Plan (Construction)

Purpose and Scope

The Environmental Management Plan (Construction) (EMP(C)) identifies potential risks to the surrounding and downstream environments from the construction activities associated with the TSRC Project. It also outlines strategies, mitigation measures, responsibilities and timing for managing those risks and minimising the potential for environmental impacts.

The EMP(C) incorporates recommended actions from the Environmental Design Review (EDR) and EMP (Planning) (EMP(P)) in addition to specific details on individual conditions/requirements that may be imposed through the project specific Compliance Management Plan (CMP) in addressing statutory and regulatory obligations and requirements to ensure environmental due diligence is maintained throughout the construction phase. The construction works procedures and instructions that stem from the EMP(C) will be implemented by the construction team and amended to be site-specific and in accordance with Main Roads Technical Standards (MTRS) documents and guidelines.

The EMP(C) is intended for use and reference by all personnel, including sub-contractors and suppliers, working on the TSRC Project.

The EMP(C) will be a "living" document that will be subject to reviews and updates as the project progresses or as new management issues and measures develop. The content and structure of the EMP(C) will be created based on the detail within the CMP document once compiled. Further details of the EMP(C) and its relationship within the EMS framework are described in A2 -- Construction, B7: Environmental Management.

Implementation

Once developed with the relevant input from the construction team and following reviews of the detailed design EDR and CMP and technical standards, the EMP(C) will be able to be implemented upon site mobilisation as per the process in Figure 19.

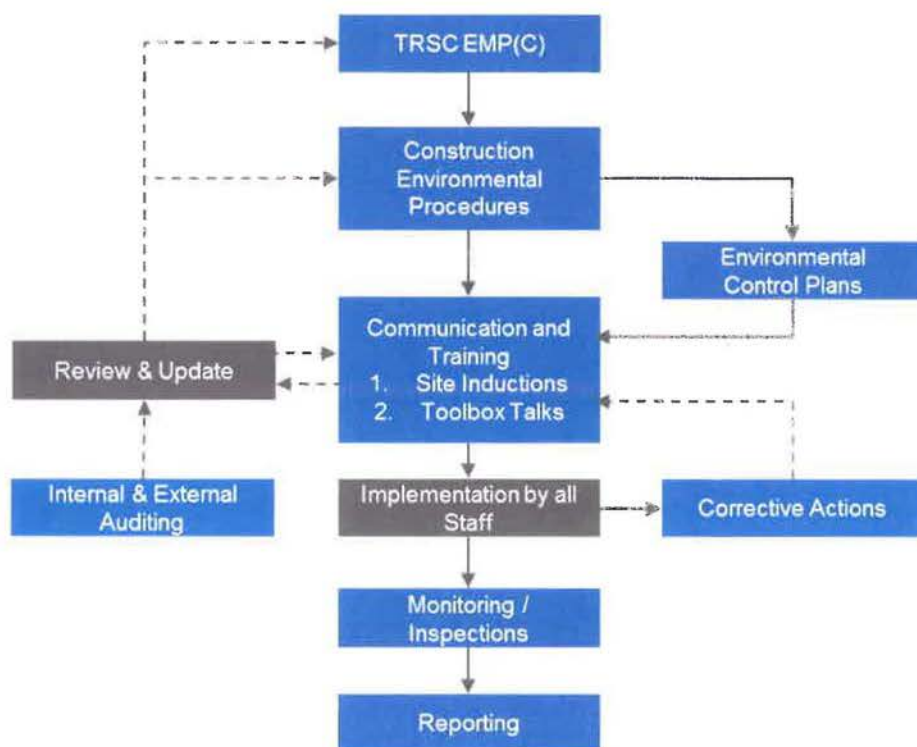


Figure 19: EMP(C) implementation process

10.6.2 Environmental Management Plan (Operation)

The EMP (Operations) (EMP(O)) developed prior to the handover phase of the project from construction to operation and maintenance, focuses on the operational and future maintenance activities and requirements of the finished Project. In particular the EMP(O) aims to minimise and manage the potential environmental impacts of proposed maintenance works. The O&M Phase of the infrastructure extends from completion of construction through till the end of the designed operational life and the project is either removed, upgraded or substantially altered and relies on the operator/owner adapting the contents of the EMP (O) to suit the changing operational conditions, changes in legislation and best practice procedures.

The environmental considerations in the EMP(O) focus on the maintenance requirements of the road and structures including the designated corridor and will include but not be limited to: CMP requirements, vegetation management, weed control, pavement and road furnishing maintenance and cleaning out drains, swales and culverts.

The EMP (O) will provide assurances that the conditions of required statutory legislation (referenced within the CMP) have been included in the O&M activities. Nexus Infrastructure will develop the EMP (O) following the finalisation of the Detailed Design, however approval or acceptance of the plan will be sought through the State to ensure that the controls and obligations listed within the EMP (O) are consistent with DTMR technical standards and CMP design requirements and environmental compliance standards.

As with the EMP (C), the operational phase will be able to apply the life of project SITEMAP geospatial system to assist in ongoing management and compliance obligations and requirements and as an audit tool moving forward for Nexus Infrastructure and any third party auditors.

10.7 Offset Strategy

Offset strategy is as outlined in Part 2 Construction – 7.4.2 “Management of Vegetation offsets and Delma torquate Habitat Offsets”.

Whilst the EPBC approval document stipulates that properties that have been acquired for the Project will be legally secured as part of the offset requirements, the full extent of the offsets will not be known until the State approves the CMP. It is assumed that the CMP will include offset ratios (developed through the States Offset Management Plan) in addition to the Nexus Infrastructure team finalising Detailed Design and associated constructability opportunities and reviews to finalise the disturbance footprint. Once the footprint is understood, additional species specific ecological assessments of the nature and extent of the disturbance area may be undertaken to calculate the offset requirements.

The CMP will reference both the Queensland Government Biodiversity Offset Requirements pursuant to the Biodiversity Offset Policies, and the EPBC Act offset requirements in which case the Project offset strategy and subsequent Offset Delivery (ODP) and Offset Management Plans (OMP) will be optimised to cater for multiple offset requirements.

As detailed in the response to A2 B7, Nexus Infrastructure appreciates that the State has initiated this process and will complete with inputs from the project following project award.

10.7.1 Offset Plans

In order to legally secure land for offset purposes, the Commonwealth and State will first have to approve an Offset Area Management Plan (OAMP) specific to the land identified for offsetting in addition to an ODP that will stipulate the process to deliver the offset objectives including securing land etc. Site-specific OMPs will be delivered for each offset area that is identified to meet the requirements of the CMP and will also be specific for the significant species habitat and/or threatened ecological communities that are subject to significant adverse impacts resulting from the construction of the project.

10.7.2 Translocation Plan

It is understood that the translocation plan for the Collared Delma (O2, 2014) will be finalised following the Detailed Design and identification of the Project footprint. The Collared Delma translocation plan will form part of the Significant Species Management Plan (SSMP) and Fauna Management Procedure (FMP), delivered as part of the EMS and EMP(C). It is also understood that the draft Collared Delma translocation plan (O2, 2014) has been developed on behalf of the State. It is important to consider, as other significant species in addition to more common species will be managed under the FMP and associated protocols to ensure environmental due diligence and achieve the requirements of the CMP. The Collared Delma translocation plan will be integrated as a sub-plan of the project EMP (C) including ongoing monitoring obligations and general ethical treatment and management of fauna species.

This plan is expected to be further developed as the Detailed Design and construction footprint is further defined and integrated into the Project geospatial SiteMap system to ensure specific requirements in the currently identified, and any additionally identified, Collared Delma habitat are included in construction methodology and management programs.

Conclusion

The environmental design criteria and compliance requirements and inputs to the engineering design of the TSRC Project have been addressed within this Report. This has been done through referencing the major environmental design criteria and identifying the environmental elements that require specific mitigation measures, compliance inspections, reporting and auditing through the construction and operational phases of the TSRC Project.

The EMP(C), refer to the response to A2 B7, will require the final CMP to ensure that the methodology applied to the D&C Phase is consistent with all compliance obligations and requirements.

The SiteMap GIS tool that Nexus Infrastructure will use to assist in implementing, monitoring and reporting on environmental and planning compliance and management plans through the D&C and O&M Phases will streamline this process.

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.10 – Landscaping & Environmental Design

Question ID	Report Reference	Performance Specification Reference	Question	Proponent Response
T56	A1.10	Volume 4 - Proposal returnable schedules L1	We are unable to locate your plant and seed schedule, quantities (number) including seed application rates which are a requirement of L1. Please either identify the location of this information within your Proposal or provide the information in response to this question.	Nexus' planting treatments are shown on the landscape drawings contained within the drawings folder in our submission and included as Appendix T56a to this response. The Index shows the planting type and plant densities. Please also refer to Section 6.1 Revegetation Palettes on page 30 of the Landscape Revegetation and Urban Design (LRUD) Report, (Appendix T56b to this response). Apologies, it appears that this report may have been erroneously omitted from our submission. Palettes and images are identified in Section 6.1 of the LRUD report. Specific mixes and rates will depend on the seed availability at the time of procurement as these are highly variable. Please refer to section 6.1 of the LRUD report for the seed mixes strategy and application rates.
T154	A1.10	Volume 4 - Proposal returnable schedules L1	Further to your response to T143, the State does consider that your Proposal complies with the Project Deed (Section 8) or the Performance Specification, specifically sections Annexure 06 Part 1.1; Annexure 01 Part 8.1 (h); and Annexure 06 Part 1.2.4 (a). As such Project Co. is required to include the provision of compensatory planting and revegetation as required under the EMP(P). Compensatory planting is defined in the EMP(P) to be 'the planting (either as seed or seedling) of a given flora species, which is a known food or habitat tree for a given fauna species, to compensate for the clearing of that flora species'. The EMP(P) proposes that compensatory planting be undertaken within existing cleared areas within the road corridor but outside of the limits of clearing, to compensate for vegetation cleared due to construction of the road. However that State identify that whilst the EMP(P) did not envisage compensatory planting to be undertaken on offset lands, but rather within the road corridor, this concept is not precluded. As such if Project Co. wish to pursue this option it would need to be negotiated with the State during Detailed Design of the total landscaping plan and offsets package to ensure the overall Project outcome is achieved. The TSRC Protected Plant Survey (EcoLogical, March 2014) will be provided to Proponents, together with other recent ecological survey information, together with the updated EMP()-version 4 2015, in the coming week. Please advise your compliance with the above requirements of the Project Deed and Performance Specification.	Nexus confirms it will comply with the Project Deed (Section 8) and the Performance Specification in relation to compensatory planting and revegetation as required under the EMP(P). Nexus Infrastructure is firmly committed to constructing and operating the TSRC with exceptional environmental outcomes including compensatory planting to balance habitat and food source vegetation lost during the construction process. Pre-clearance surveys will identify sites and species to be addressed through compensatory planting and our Landscaping and Revegetation Plan will identify the sites and endemic species for compensatory planting. Such planting will occur as both tubestock in high visual impact areas or infill planting and compensatory species will also be included in the seed mix used in the hydromulch process.
T159	A1.10	Volume 4 Returnable Schedule L1, L2	Further to your response to T136, the State does not require an "entry statement" for LVRC in Cor Ten steel. The State and LVRC require a simple sign indicating entry to LVRC in accordance with MUTCD part 6, section 1.14. Can you please identify the impacts to include this sign as part of your Proposal.	The cost of providing a simple sign indicating entry to LVRC in accordance with MUTCD part 6, section 1.14 is \$8,912. Compared to the \$212,000 LVRC entry statement in Cor Ten steel proposed as part of our response to T136 this will represent a saving of \$203,088.

TSRC
PART 2 - CLARIFICATION QUESTION
A.1.10 – Landscaping & Environmental Design
Attachment for T56



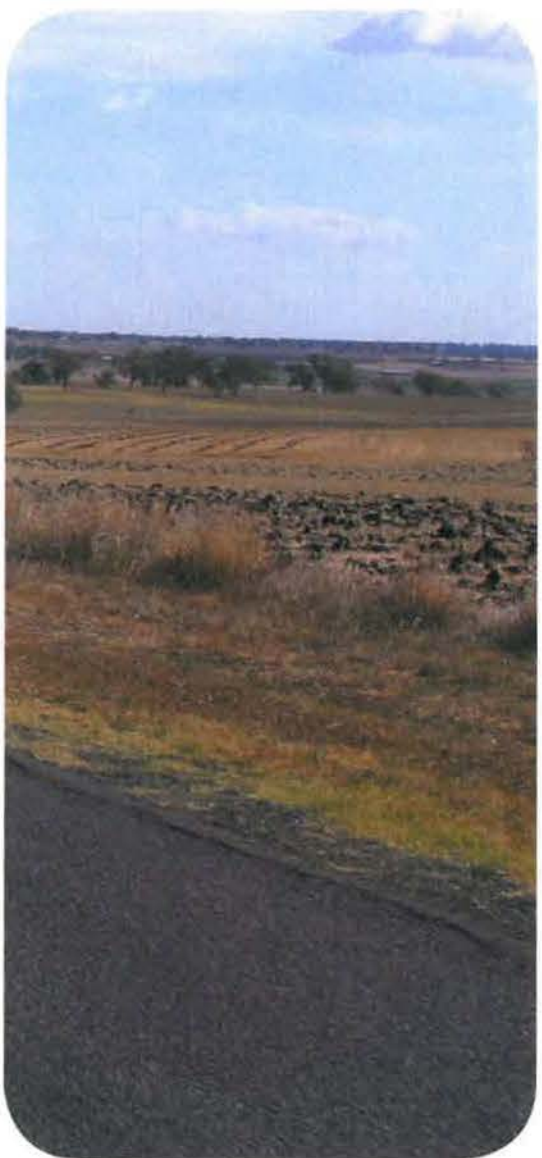
TOOWOOMBA SECOND RANGE CROSSING

09 FEBRUARY 2015

LANDSCAPE REVEGETATION AND URBAN DESIGN

DOCUMENT CONTENTS

- 1.0 INTRODUCTION
- 2.0 EXECUTIVE SUMMARY
 - 2.1 Design Principles
 - 2.2 Best Practice Design Approach
 - 2.3 Value for Money
- 3.0 ANALYSIS
 - 3.1 Land Use and Regional Ecosystems
 - 3.2 Landscape Features, Cultural Heritage, Opportunities and Constraints
 - 3.3 Regional Ecosystems Identification
 - 3.4 Landscape Sensitivity Analysis
- 4.0 THEMATIC RESPONSE - LOCAL CHARACTER & INFLUENCES
- 5.0 LANDSCAPE DESIGN
 - 5.1 Gateway Element: Toowoomba
 - 5.1 Concept Design: Warrego Highway (East) Interchange
 - 5.2 Concept Diagram: Mort Street Tunnel Portal & Interchange
 - 5.3 Concept Design: Mort Street Tunnel Portal
 - 5.4 Concept Design: Mort Street Interchange
 - 5.5 Concept Design: Warrego Highway (West) Signalised Intersection
 - 5.6 Concept Design: Gore Highway Interchange
- 6.0 REVEGETATION
 - 6.1 Revegetation
 - 6.2 Revegetation Details
- 7.0 URBAN DESIGN
 - 7.1 Portal Treatment (West)
 - 7.2 Walls and Screens
 - 7.3 Bridges and Parapets
- 8.0 OPERATIONS AND MAINTENANCE



1.0 INTRODUCTION

The Landscape, Revegetation and Urban Design (LRUD) Report forms part of the Nexus Infrastructure Consortium bid and describes the landscape and urban design approach to the project corridor in response to the project brief and in particular the project specific Landscape, Revegetation and Urban Design brief.

The report has been prepared in consideration of, and builds upon, the work previously done in the following documents in particular:

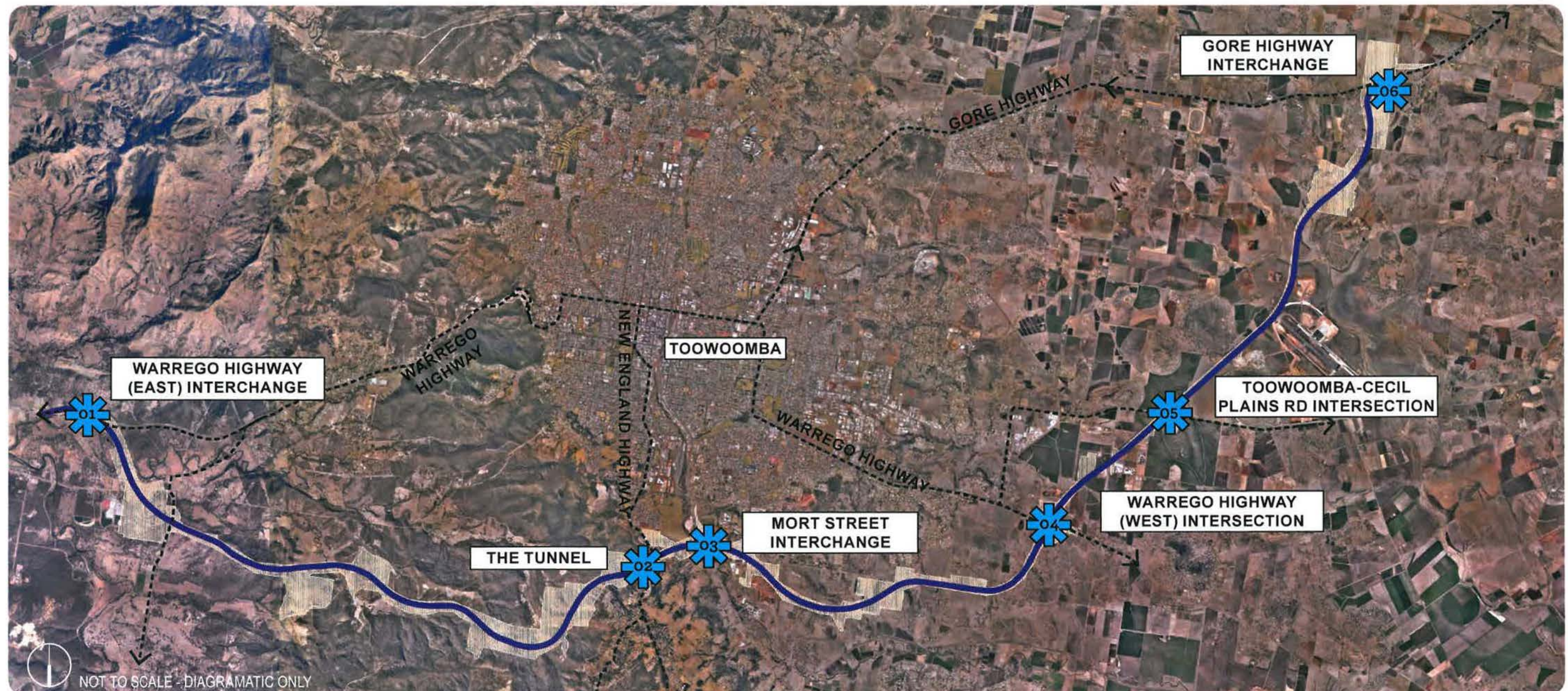
- Environmental Management Plan (Planning) and Environmental Design Report
- Toowoomba Bypass Compensatory Revegetation Drawings + Schedule of Treatments: 2003
- Toowoomba Bypass Detailed Planning Report - Landscape and Revegetation Design: Environment Branch Planning, Design & Environment Road Systems & Engineering

December 2003

- Toowoomba Bypass Planning Project, Soil Suitability Drawings: 2003
- TSRC_Rare Endangered and Vulnerable Species sighted in Flora Fauna surveys: 1996-2003
- EPBC Desk Top Assessment Draft V3 November 2012
- Toowoomba Bypass Project, Business Case Reference Report - Environmental Issues Report: Connel Wagner, April 2008
- Toowoomba Bypass Delma torquata Report: QLD Parks and Wild Life Services November 2006e with amendments February 2007

And with reference to:

- DTMR Road Landscape Manual Edition 2
- DTMR Landscape and Revegetation Works Specification MRTS16 (A-E)
- DTMR Environmental Management Specifications MRTS51
- Toowoomba Regional Council Planning Scheme
- Toowoomba Regional Council Street Tree Master Plan: Issue 07, 2011
- Lockyer Valley Regional Council Planning Schemes
- QLD Govt. Regional Ecosystems mapping: www.environment.ehp.qld.gov.au
- QLD Govt. CPTED Part A Essential features + Part B Implementation guidelines: October 2007
- Department of State Development, Infrastructure and Planning: DA Mapping
- DTMR mapping: Cultural Heritage, World Heritage, Nature Refuges, EPA Estates 2014.



2.0 EXECUTIVE SUMMARY

The Toowoomba Second Range Crossing traverses between two regional landscape typologies; the lower flatter agricultural plains of the Brisbane and Bremer Rivers and the elevated western downs extending inland from Toowoomba. The Range forms part of the Great Dividing Range transitioning across the following landscape zones identified in the 2003 EIA:

- The Eastern Helidon Plains; characterised by low, flat, semi-rural plains with pockets of dense bushland
- Range and foothills; characterised by steep, densely vegetated bushland
- Gowrie Creek Valley; classified as hilly to rolling landforms with increasingly sparse vegetation cover
- Western Downs, which extend inland from Toowoomba; classified as good agricultural land.

The route traverses topography extremes ranging from flat to steep escarpment; requiring significant modifications to the landscape topography to achieve the road design. As stated by the Toowoomba Bypass-Business Case Development Study Environmental Issues Report April 2008; the previous landscape and visual amenity studies carried out for the route identified specific landscape character zones along the proposed corridor, assessed the visual quality of the existing environment and the sensitivity and impacts of the proposal.

The Toowoomba Region Network Study (1997) and associated reports found that overall the proposed road will have a low-medium level of visual impact, but that there are a number of areas across the length of the route where visual impacts are high and require mitigation. The area of greatest concern was identified as that of the Range and foothills where the route traverses the steepest terrain requiring significant cuts and fills; potentially visible to a broad catchment.

The project corridor transects various plant communities, some of significant value and under threat. Various previous studies undertaken for the project have identified these existing environments and potential impacts, including:

- Fragmentation and reduction in size of plant communities and possible critical reduction of small numbers of plant species in the area through project related clearing
- Severance of important riparian corridors through project related clearing and disruption at creek crossings
- Weed spread through nutrient enrichment of watercourses and the generation of new edges within vegetation communities.

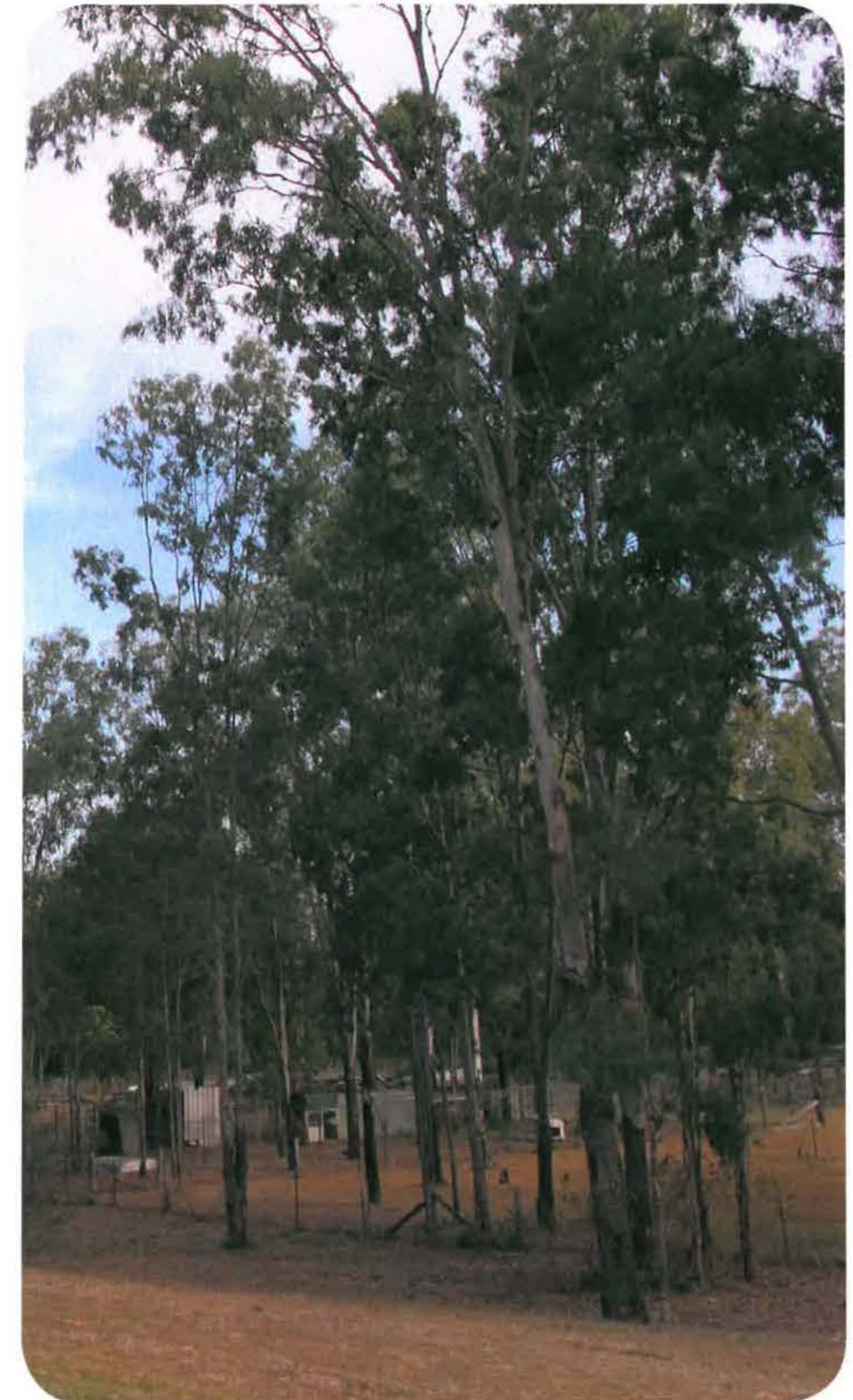
Some of the key plant communities identified as potentially impacted by the corridor include:

- Areas of Basalt Scree Vine Forest Regional Ecosystem (RE 12.8.21) listed as endangered
- Eucalyptus nobilis in the vicinity of the Gowrie Creek crossing.

The main fauna impacts identified by previous studies included:

- Habitat fragmentation
- Destruction of habitat for the Black Cockatoo and Collared Legless-Lizard
- Disturbance to important habitat features such as outcrops, scree slopes and gullies.

The proposed landscape, revegetation and urban design has been developed in close consideration of the engineering and environmental disciplines to ensure an integrated response to the above high level impacts and associated mitigation requirements. Firstly driven by the refinement of the route alignment to minimise impacts, including minimisation of cut and fill, thereby reducing the project footprint and landscape and visual impacts and subsequently through the implementation of the project LRUD design principles and detailed design resolution in the context of whole of life operations, maintenance and costs.



Existing character - Postmans Ridge Road

2.1 DESIGN PRINCIPLES

Drawing from the unique project context, the background documents and project brief, we have developed the following Design Principles to guide our approach to the design:

- Integrate road infrastructure into its immediate context and mitigate landscape impacts
- Minimise environmental disturbance and rehabilitate disturbed natural environments through revegetation
- Reflect the distinctive characteristics of each landscape zone through specific treatments
- Integrate drainage devices into the landscape using environmental management treatments and devices
- Integrate fauna fencing and movement corridors
- Preserve and enhance existing view corridors to and from the road corridor
- Express the geology of the area through cut slope treatments
- Provide noise mitigation through planted mounds where achievable
- Provide a safe road environment for all users
- Consider visual treatment of structures such as bridges and walls to enhance visual quality and integrate with project theme and context
- Streamline and simplify elevated structures to reduce visual impact
- Materiality of urban design elements to reflect corridor palette and be contextually appropriate
- Minimise maintenance requirements
- Fire management (especially east of the range).

2.2 BEST PRACTICE DESIGN APPROACH

In compliance with the project specific Landscape, Revegetation and Urban Design brief the corridor concept focuses on integrating the road infrastructure into its landscape and evolving urban contexts. The thematic approach including the colour palette, textures,

materials and plant palette reinforce an integrated approach to the Project, ensuring that landscape and visual impacts are mitigated through a high quality and subtle design approach.

The Nexus team's design approach addresses the State's vision for the Project through the following:

Projection of a **sense of place** that is compatible with the Project's landscape and evolving urban context:

- Application of hard and soft material palettes that respond to the project context
- Integration of the corridor into its landscape context through responsive species selection related to adjacent regional ecosystems
- Touching the ground lightly through minimising the project footprint.

Compatibility and advancement of the **vision** and **public image** of the State:

- Application of the restrained corridor theming
- High quality design resolution
- Legible infrastructure hierarchy and nodal treatments
- Durable and low maintenance materials.

Appropriately in **scale** with the project works:

- Corridor wide approach to theming and materials palettes
- Planting palette draws on the species of the adjacent plant communities to integrate the new works with the existing context
- Broad scale approach to maintenance considerations.

Earliest possible **stabilisation, restoration and enhancement** of all disturbed areas, staged progressively through construction to ensure minimum soil loss:

- Use of hydromulching as a method of immediate stabilisation including native grass mix
- Proposed hydromulch product: "Flexterra" proven to successfully reduce soil loss

- Planting of native tube stock/pots into hydromulch to enhance native species mix.

Integration of treatments along the corridor and with adjacent natural and built environments:

- Planting palette draws on the species of the adjacent plant communities to integrate the new works with the existing context
- Urban design theming of treatments distinctly references the existing landscape project context.

2.3 VALUE FOR MONEY

Value for money is the focus of the Nexus Infrastructure team. We believe that value for money can drive more innovative design solutions that are about timelessness and contextual responsiveness rather than bold day one design statements. This will be achieved through:

- Use of a restricted materials palette, proven to be durable, weatherproof, UV resistant, cost effective and low maintenance
- Repetition of design elements to reduce the cost of one offs
- Use of environmentally sustainable techniques that return value to the project over time, for example hydro mulching to minimise soil loss, use of native grasses to avoid the need for ongoing maintenance, planting of hardy drought tolerant species and use of low maintenance and low carbon materials
- Use of a light transition portal at the western tunnel exit to minimise ongoing electricity costs
- Minimising the project footprint where possible
- Use of the latest products and techniques in rehabilitation and revegetation developed over time with proven results
- Whole of life cost design with up front investment offset by long term gain
- Consideration of maintenance regimes, including safety in design.



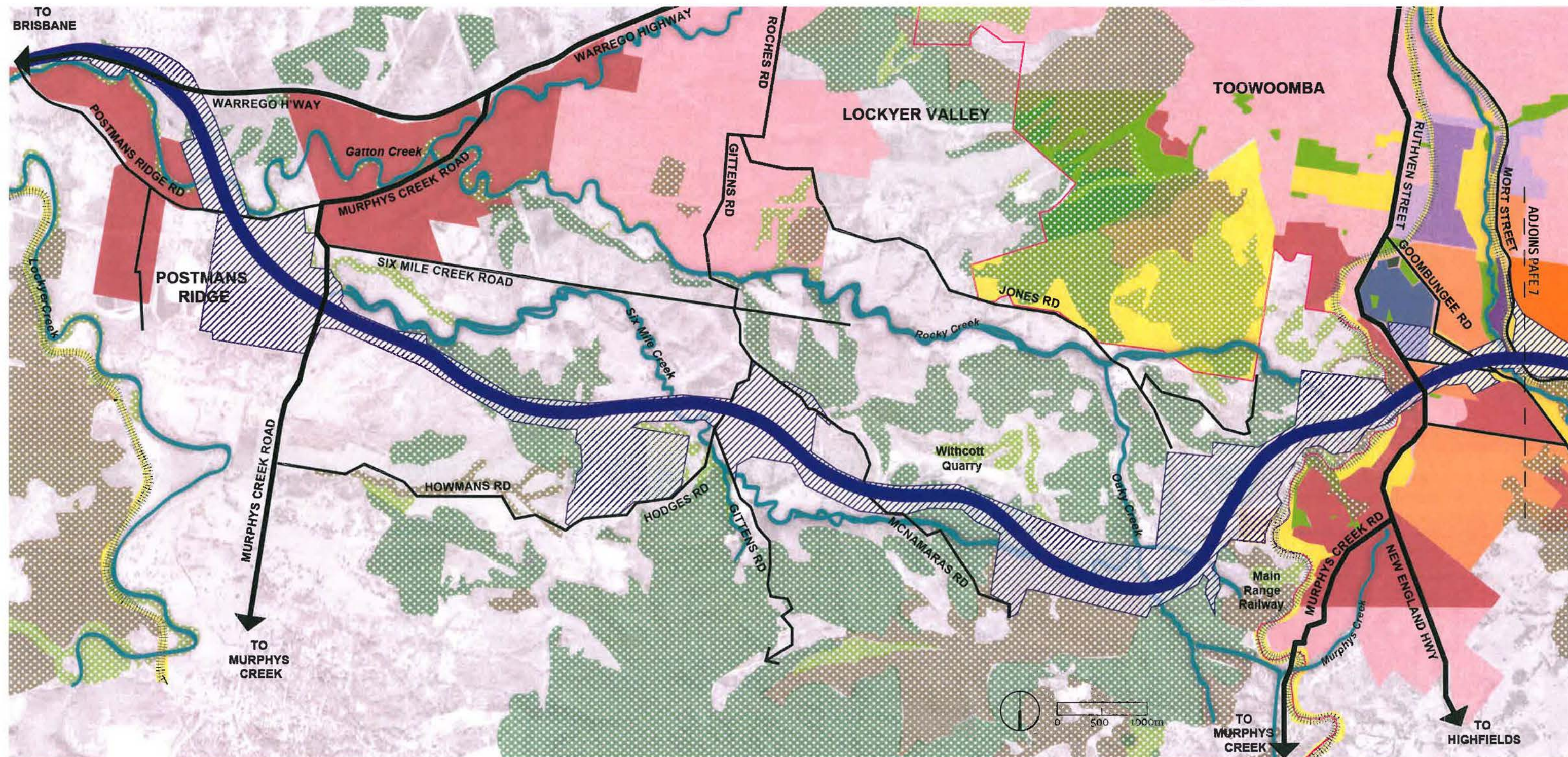
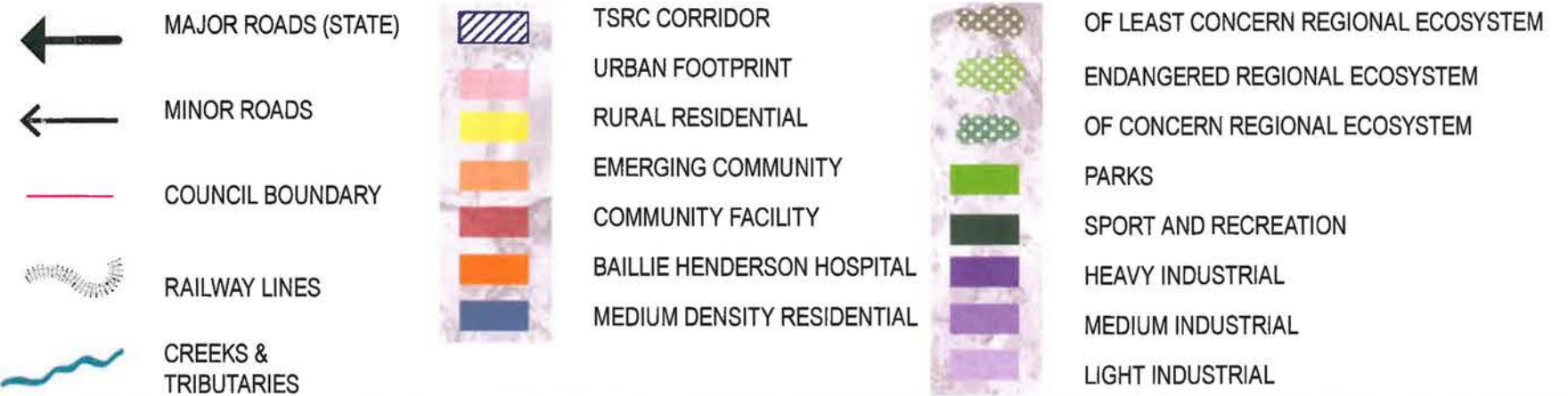
Hermitage/ Mort Street (Looking east)

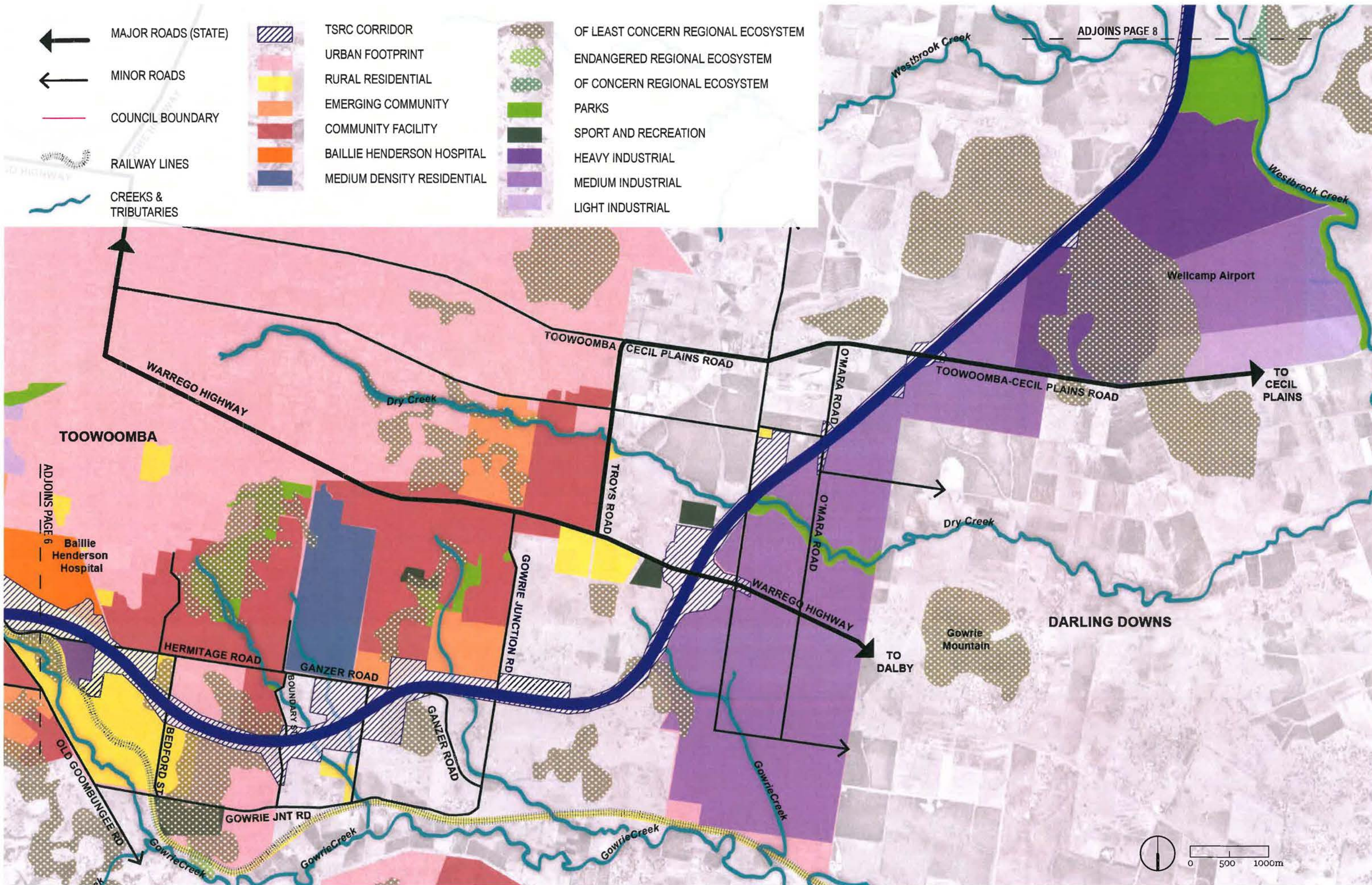
3.0 ANALYSIS

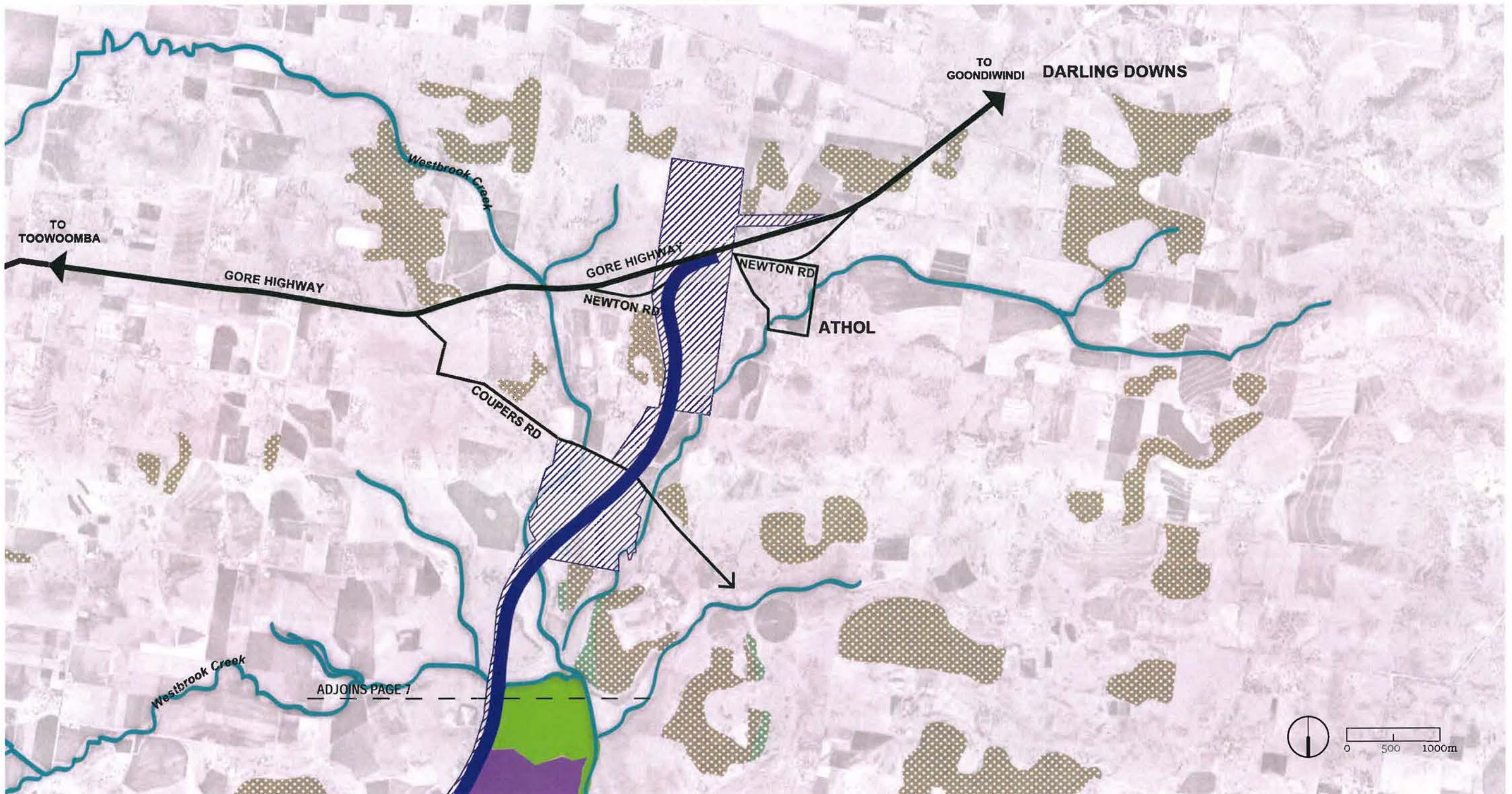
The site analysis undertaken for this phase of the Project has involved a physical site based analysis of the route and its context to identify landscape typologies, features, topography, views, opportunities and constraints. Review of background reports and recommendations has captured critical constraints and key elements that have influenced the route alignment and the landscape design proposal.

3.1 LAND USE AND REGIONAL ECOSYSTEMS

The following diagrams capture the land use mapping contained within The Lockyer Valley and Toowoomba Regional Council's Planning Schemes and The Department of State Development, Infrastructure and Planning: DA Mapping to establish both the existing and planned context for the Project, as well as ecosystems of concern.

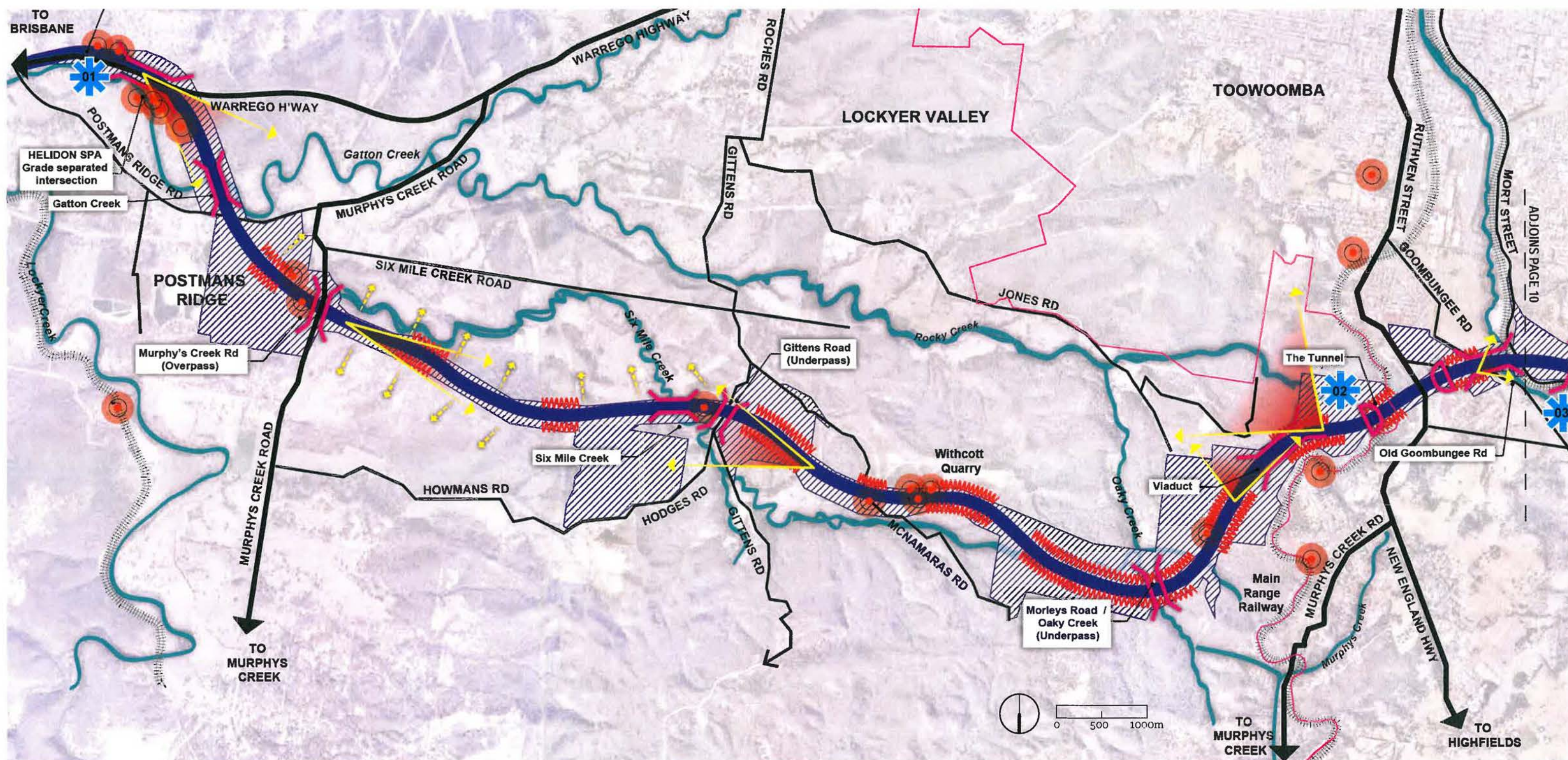
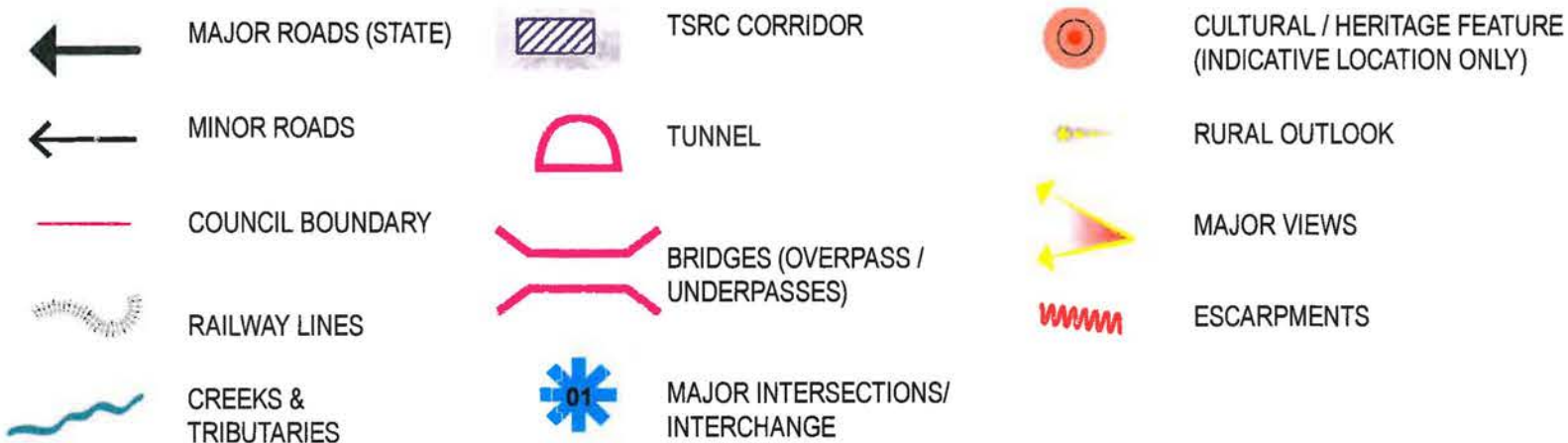


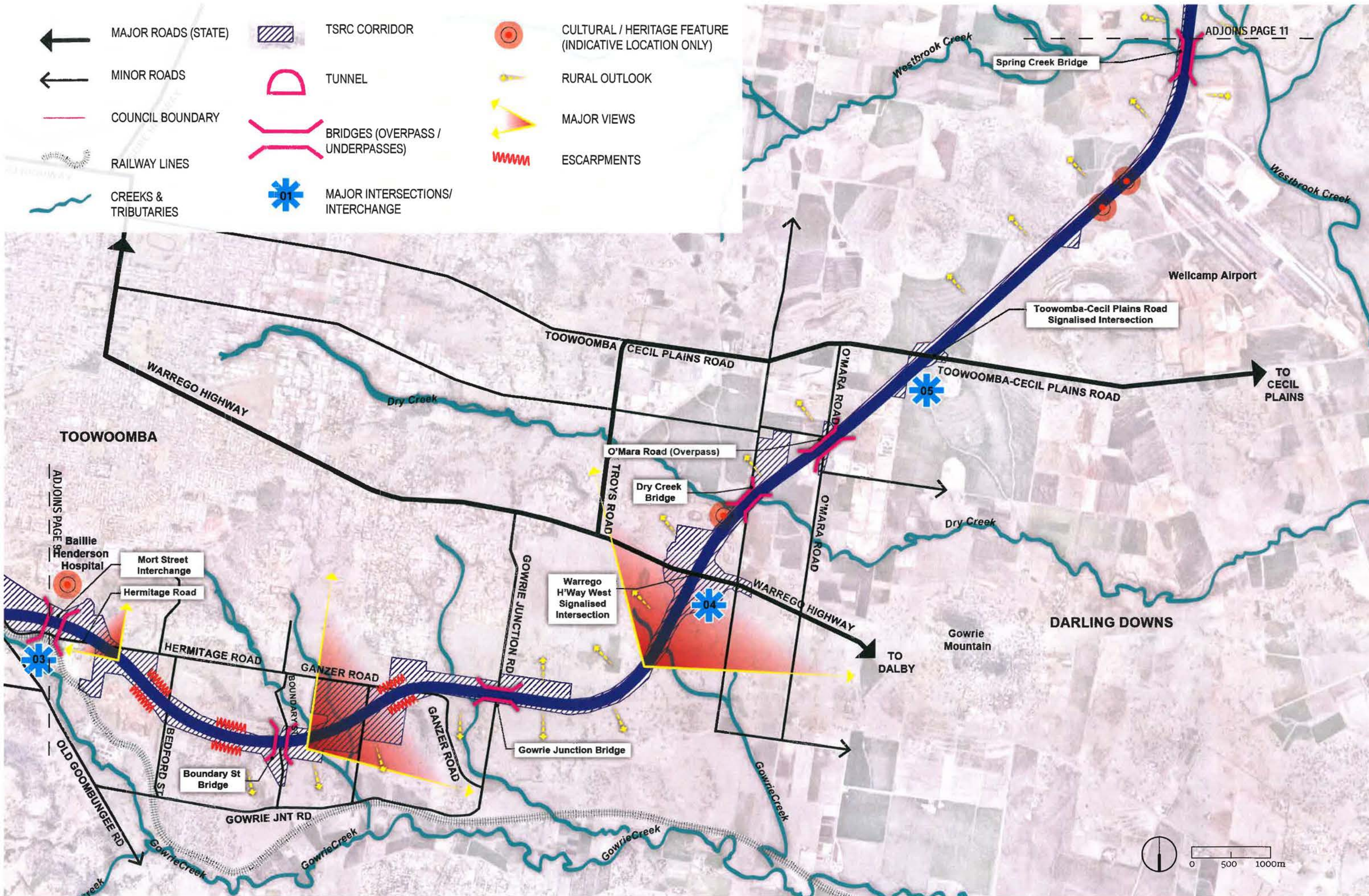


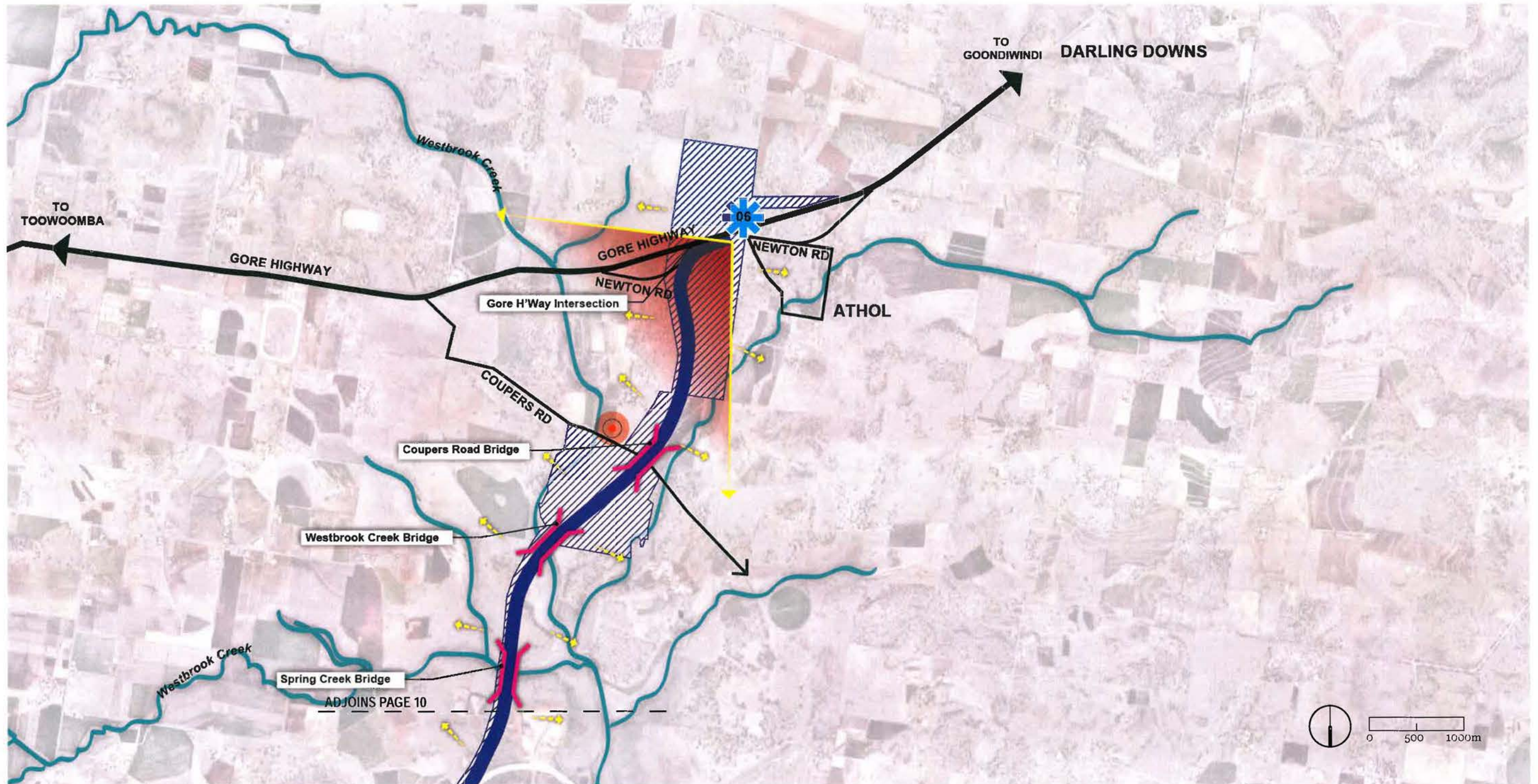
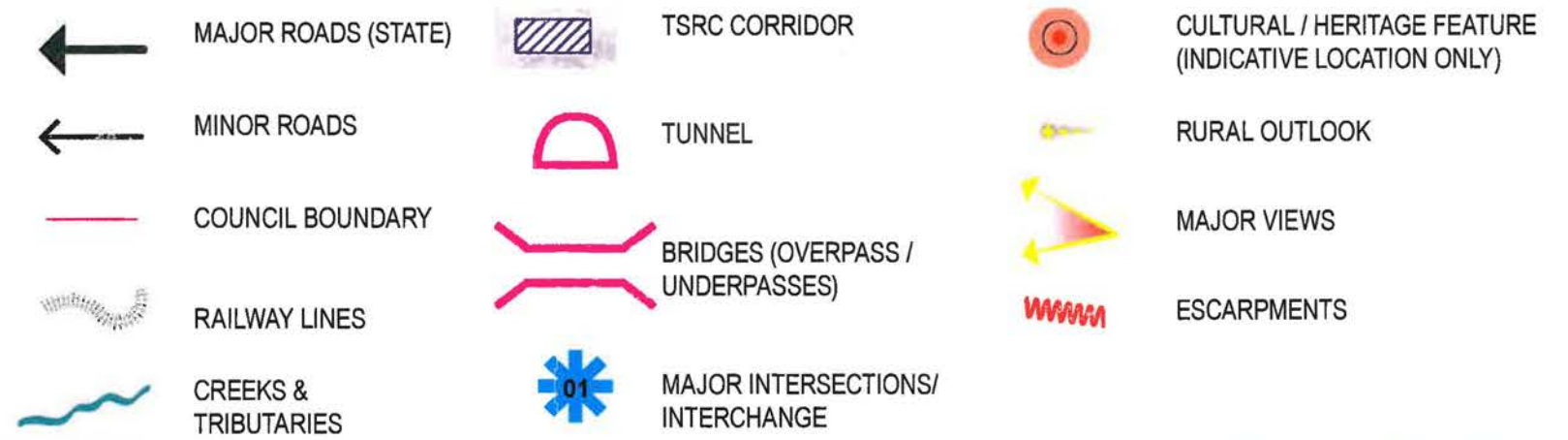


3.2 LANDSCAPE FEATURES, CULTURAL HERITAGE, OPPORTUNITIES AND CONSTRAINTS

The following diagrams capture the land use mapping contained within The Lockyer Valley and Toowoomba Regional Council's Planning Schemes and The Department of State Development, Infrastructure and Planning: DA Mapping and DTMR mapping: Cultural Heritage, World Heritage, Nature Refuges, EPA Estates 2014 to establish key landscape and cultural heritage features. These form a context for the identification of opportunities to be captured within the design and constraints that require consideration and mitigation.







5.1 TOOWOOMBA GATEWAY FEATURE

The design proposes sculptural identification of the arrival points into Toowoomba as they relate to the TSRC. The proposal is strongly landscape based, combining landform, broad swathes of native grasses and stands of trees as the setting for large scale, sculptural Cor-Ten steel letters reminiscent of agricultural materiality and the rusting remnants of disused farm machinery often seen in the landscape. In contrast, the chosen font is feminine and playful.



Cor-Ten Steel Lettering



Gateway Feature - Mort Street Interchange

The Proposed Gateway Feature consists of simple robust design, incorporating thematic elements which respond to local character.

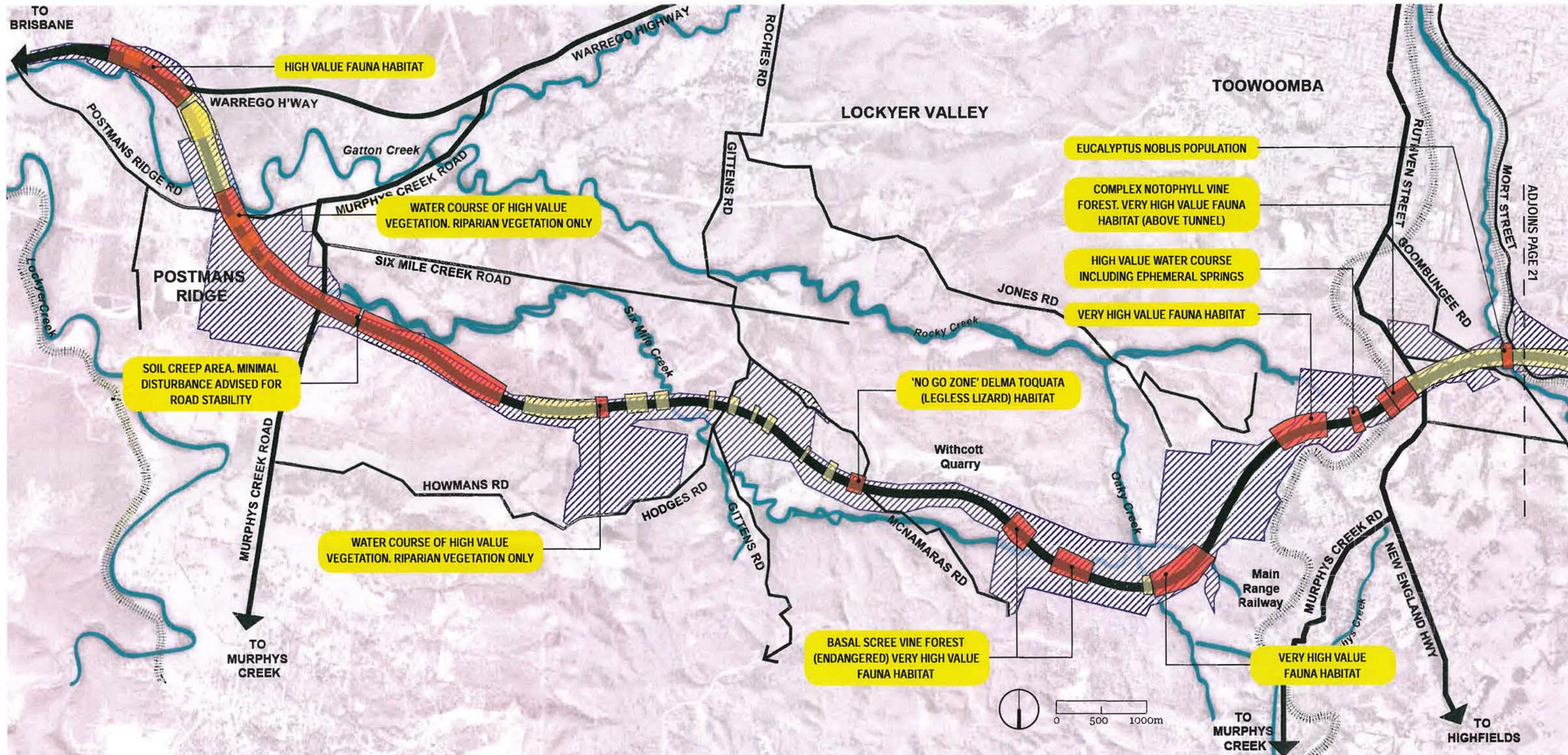
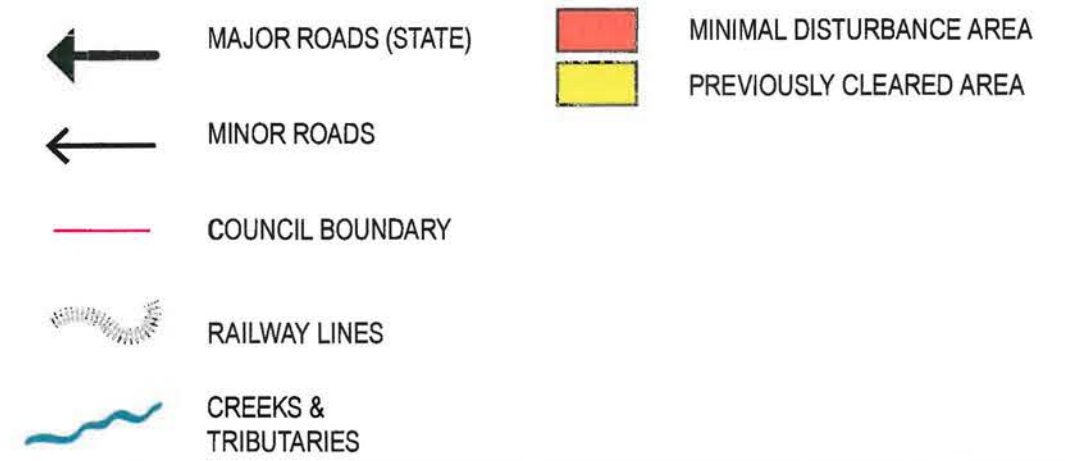
The proposed Cor-Ten steel letters are to be positioned prominently on sculptured batters leading into Mort Street Interchange along the TSRC route. Feature mass planted container species are proposed for immediate impact and colour. Species will include native grasses and flowering native perennial species, featuring sprays of violet flowers. Drawing on Toowoomba's "Garden City" theme, Jacaranda mimosifolia will feature as a backdrop to the lettering dispersed amongst tall stands of Eucalyptus species; referencing indigenous species of the area.

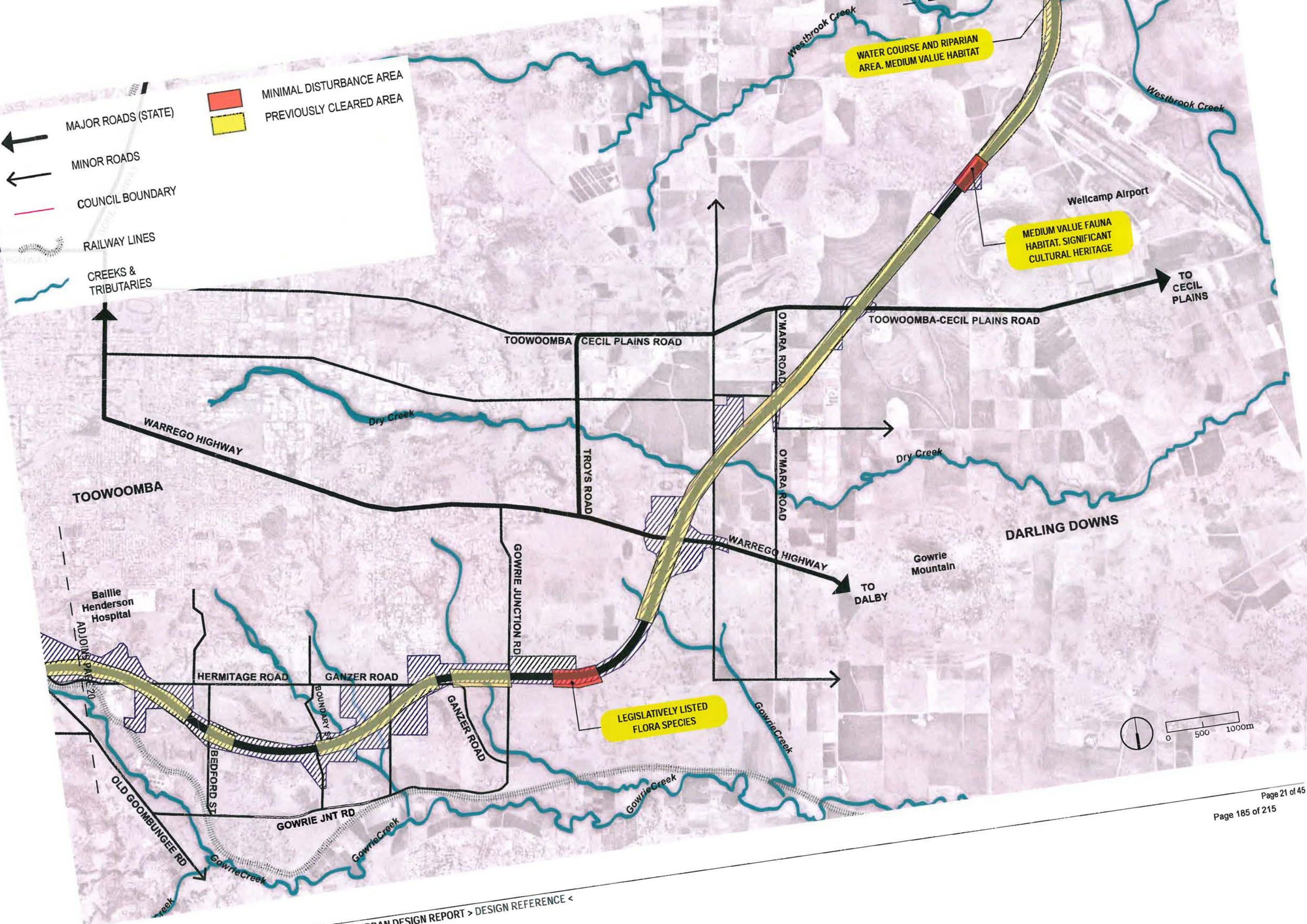




5.3 LANDSCAPE SENSITIVITY ANALYSIS

The following diagrams capture the areas of sensitivity and environmental and ecological significance documented in the Environmental Management Plan and Environmental Design Report and the Toowoomba Bypass Compensatory Revegetation Drawings + Schedule of Treatments: 2003; along the road alignment. This analysis establishes areas of previous disturbance which have a low sensitivity to further related disturbance as well as areas highlighted where disturbance should be minimised.





MAJOR ROADS (STATE)

MINOR ROADS

COUNCIL BOUNDARY

RAILWAY LINES

CREEKS & TRIBUTARIES

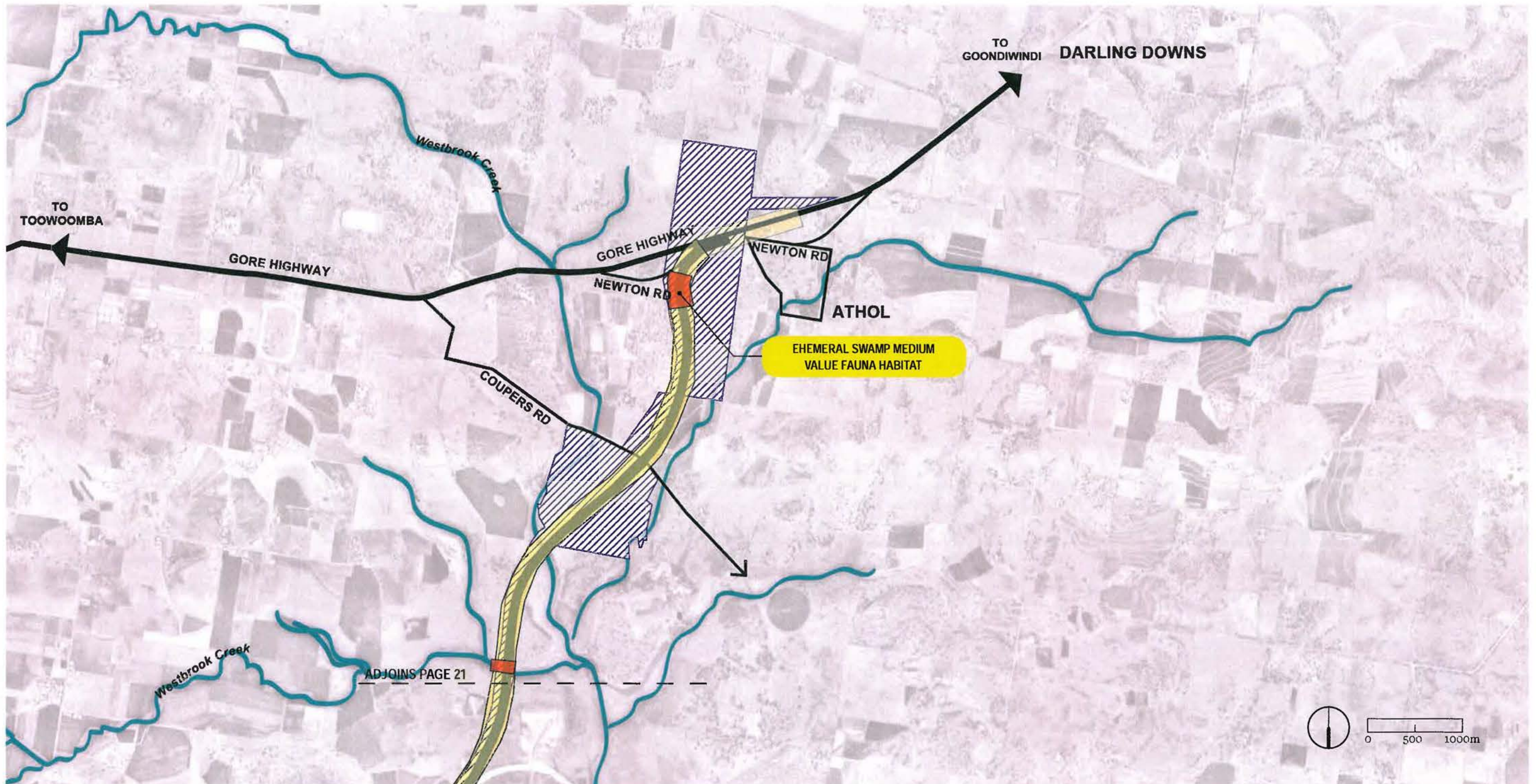
MINIMAL DISTURBANCE AREA
PREVIOUSLY CLEARED AREA

WATER COURSE AND RIPARIAN
AREA, MEDIUM VALUE HABITAT

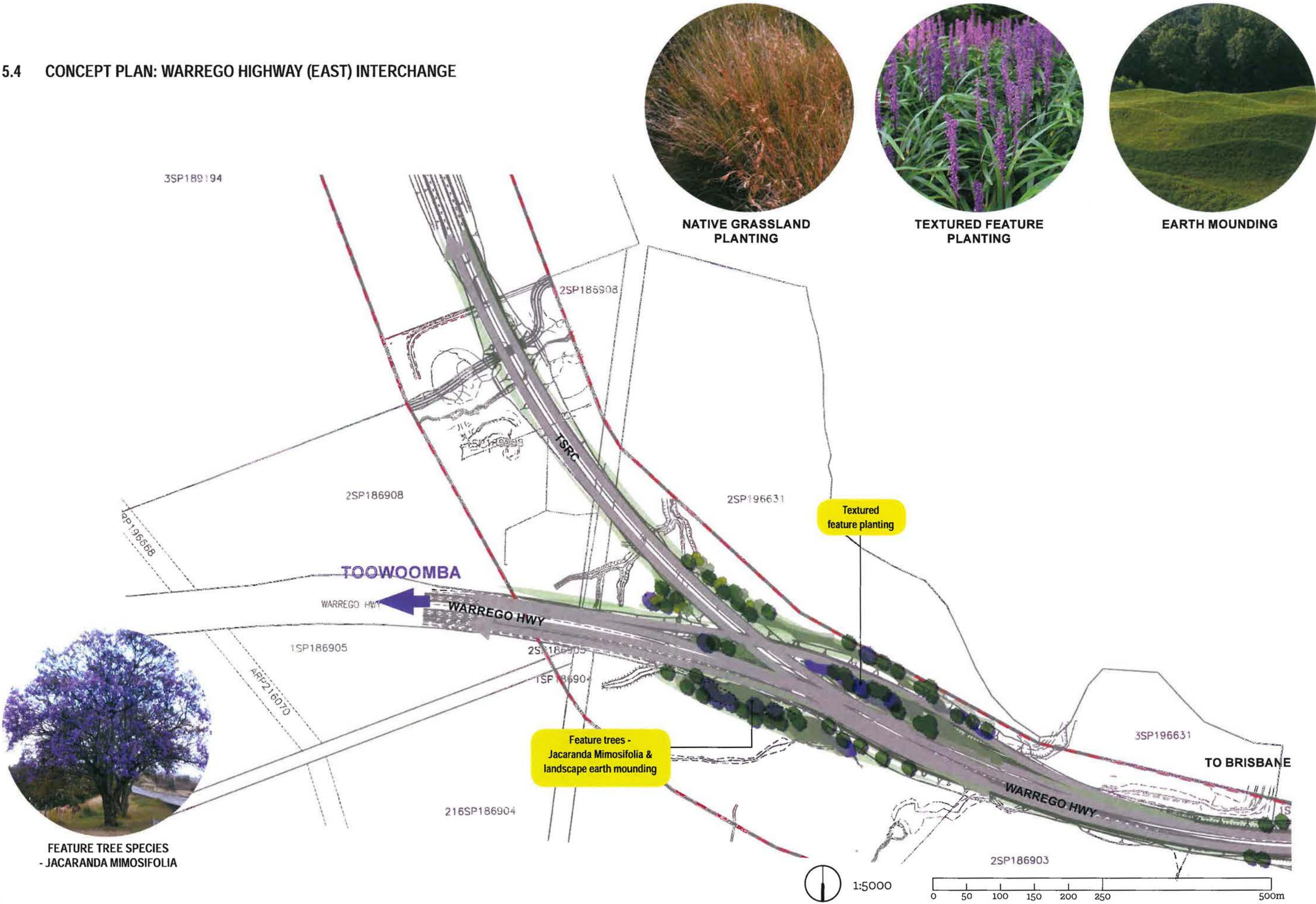
MEDIUM VALUE FAUNA
HABITAT, SIGNIFICANT
CULTURAL HERITAGE

LEGISLATIVELY LISTED
FLORA SPECIES

-  MAJOR ROADS (STATE)
-  MINOR ROADS
-  COUNCIL BOUNDARY
-  RAILWAY LINES
-  CREEKS & TRIBUTARIES
-  MINIMAL DISTURBANCE AREA
-  PREVIOUSLY CLEARED AREA



5.4 CONCEPT PLAN: WARREGO HIGHWAY (EAST) INTERCHANGE



5.7 MORT STREET INTERCHANGE



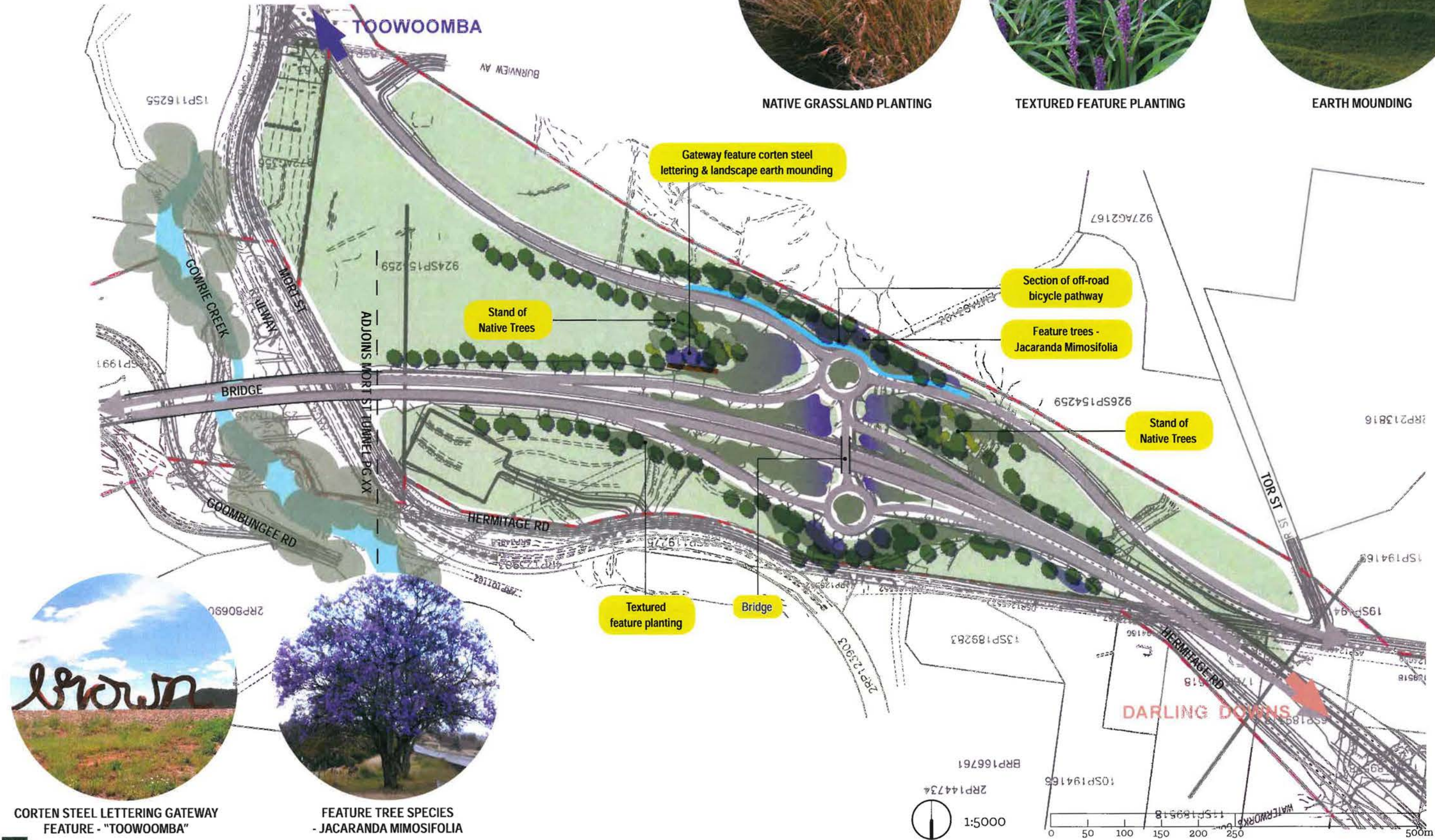
NATIVE GRASSLAND PLANTING



TEXTURED FEATURE PLANTING



EARTH MOUNDING



CORTEN STEEL LETTERING GATEWAY
FEATURE - "TOOWOOMBA"



FEATURE TREE SPECIES
- JACARANDA MIMOSIFOLIA

5.9 GORE HIGHWAY INTERCHANGE



NATIVE GRASSLAND PLANTING



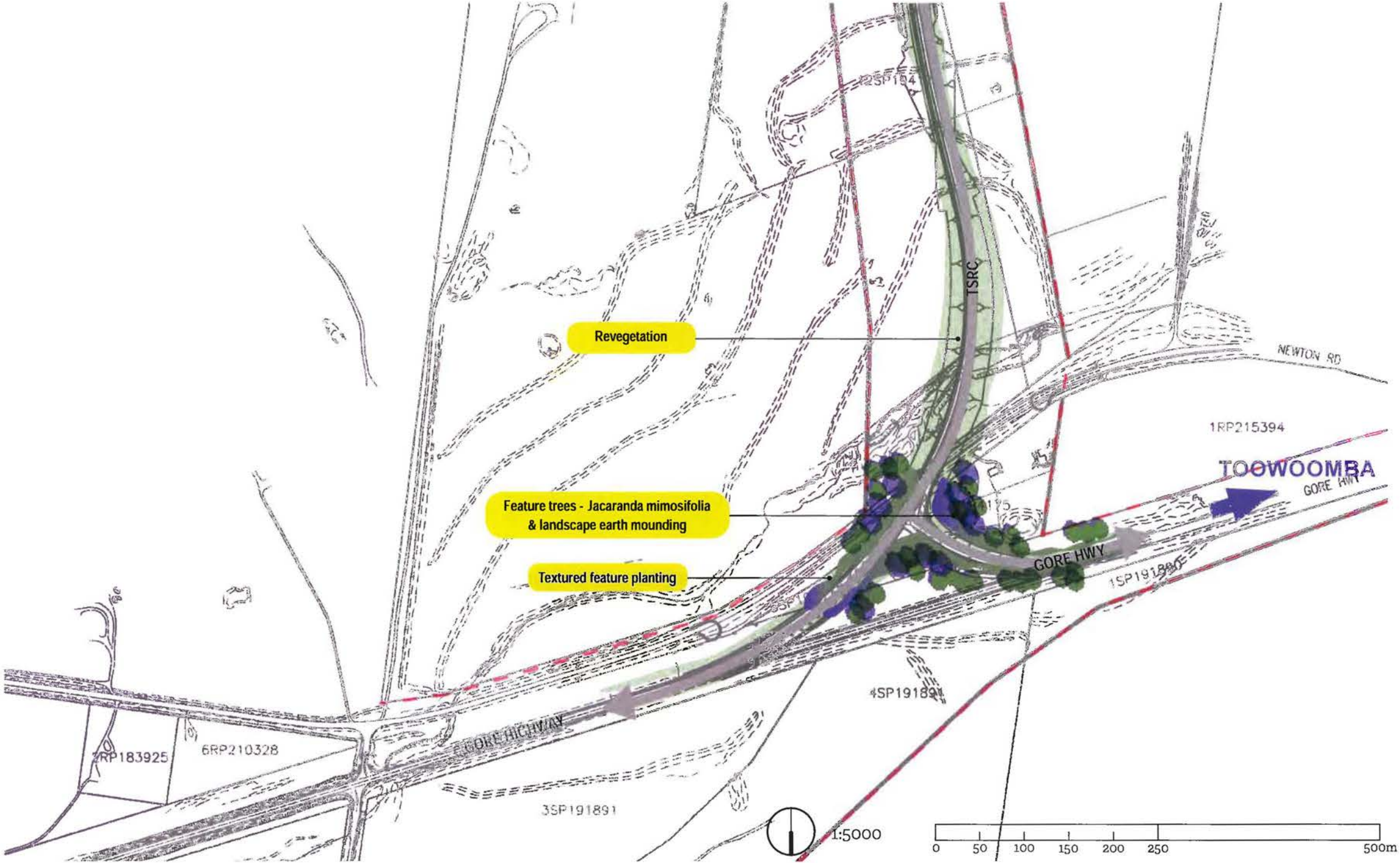
TEXTURED FEATURE PLANTING



EARTH MOUNDING



FEATURE TREE SPECIES
- JACARANDA MIMOSIFOLIA



6.0 REVEGETATION

The corridor palette focuses on reliable, low maintenance species that reflect the character of the broader landscape and also reference the existing regional ecosystems bordering the corridor.

- Planting within 2.5m of the road infrastructure will be restricted to native grasses
- Planting within clear zones will be limited to native grass, shrub and small frangible tree species palettes in response to the State restrictions on trees
- Planting within vehicle sight line set backs will be restricted to low growing native grasses and ground cover species
- The species palette will be native, hardy, drought tolerant and low maintenance
- Planted embankments have been designed to minimise the project footprint and maximise the retention of existing vegetation
- Drainage devices have been designed to allow for tree planting within them to mitigate the loss of existing vegetation
- Fauna connections below the infrastructure will be integrated with vegetation connections on either side including understory planting for refuge and to encourage habitat
- Use of existing soils has been maximised through ripping of existing profiles in-situ, minimised stripping of topsoil, use of improved site topsoil and hydromulching to minimise soil loss.



Postmans Ridge Road (Google Street View - Looking north west)



Postmans Ridge Road Character



Warrego Highway - Helidon Spa Entry (Google Street View - Looking north)



FLEXTERRA HYDRO MULCH
& SEED APPLICATION TO
GABIONS



FLEXTERRA HYDROMULCH TO
1:2 BATTERS



Athol Entry (Looking north east)

6.1 REVEGETATION PALETTES

All areas disturbed by the project works will be revegetated extending 7m beyond the top of works batters and 5m beyond the toe. Revegetation will ensure the Project is integrated into its landscape context through species selection and vegetation screening. Revegetation palettes will be specific to the adjacent Regional Ecosystem with particular consideration of sensitive environments.

Hydromulching is proposed to all revegetation areas as a means of achieving a reliable cover of vegetation in harsh inaccessible conditions. This application provides the necessary planting medium, nutrients and moisture control in a bound format that allows the seeds to germinate with minimal wash out from rain. This is also a value for money alternative as it negates the need for mulch which can be costly and high in maintenance and mimimises soil loss.

Planting of additional groundcover, shrub and tree species would be pit planted into the hydromulch once it has been applied. The seed mix to the bulk of the site would comprise only native grasses, with species dependent on supply at the time of construction. This provides the ability for the hydromulch to be applied to all areas including batters. Exotic grass species are proposed to high velocity flow areas only, such as drainage lines/ swales, to allow for quick establishment and erosion mitigation. Tree and shrub planting will be pit planted to ensure that the location of non-frangible species is controlled in accordance with DTMR safety setbacks.

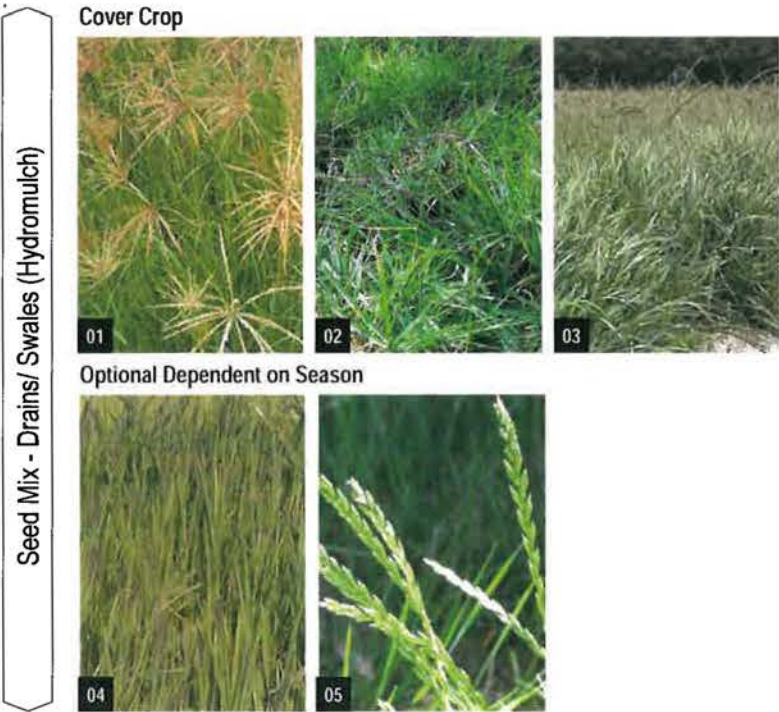
The planting matrix contains colonisation and successional species to ensure lower long term maintenance. Turf species are not proposed within the corridor as it is high maintenance and nutrient hungry to the detriment of other species and invades sensitive native vegetation environments.

Typical hydromulch mixes rely on grass as the pioneer species. Based on the successful testing of Millet or Rye we propose these as the establishment species as these die back and allow the other species to take hold.

HYDROMULCH NATIVE SEED MIX



HYDROMULCH SEED MIX - DRAINS/ SWALES (EXOTIC)



HYDROMULCH NATIVE SEED MIX

Cover Crop (1m Setback from road pavement edge)

- | | |
|--------------------------------|----------------------|
| 1. <i>Cymbopogon refractus</i> | Barbed Wire Grass |
| 2. <i>Dichanthium sericum</i> | Queensland Bluegrass |
| 3. <i>Lomandra longifolia</i> | Mat Rush |
| 4. <i>Themeda triandra</i> | Kangaroo Grass |

Optional - Dependent On Season

- | | |
|--|----------------------------------|
| 5. <i>Japanese Millet - Sterile hybrid</i> | (Warm Season-October to March) |
| 6. <i>Wimmera Rye - Sterile hybrid</i> | (Cool Season-April to September) |

NOTE: For total minimum application rates, refer to MRTS16C, table 6.3.3.2 - Native Seed Mix - Minimum Application Rates

HYDROMULCH SEED MIX - DRAINS/ SWALES (EXOTIC)

Cover Crop

- | | |
|----------------------------|----------------------|
| 1. <i>Chloris gayana</i> | Rhodes Grass |
| 2. <i>Cynodon dactylon</i> | Sahara Bermuda Grass |
| 3. <i>Paspalum notatum</i> | Bahia Grass |

Optional - Dependant On Season

- | | |
|--|----------------------------------|
| 4. <i>Japanese Millet - Sterile hybrid</i> | (Warm Season-October to March) |
| 5. <i>Wimmera Rye - Sterile hybrid</i> | (Cool Season-April to September) |

NOTE: For total minimum application rates, refer to MRTS16C, table 6.3.3.2 - Native Seed Mix - Minimum Application Rates

6.1.1 REVEGETATION AREA 1

RE: 12.8.21: BASALT SCREE VINE FOREST [ENDANGERED]
Semi-evergreen vine thicket with *Brachychiton rupestris* on Cainozoic igneous rocks. Usually southern half of bioregion.



PLANT SPECIES LIST

RE: 12.8.21: BASALT SCREE VINE FOREST [ENDANGERED]

NON- FRANGIBLE

Trees (Clear zone setback from road pavement edge)	
1. <i>Acacia maidenii</i>	Maidens Wattle
2. <i>Acacia salicina</i>	Willow Wattle
3. <i>Allocasuarina torulosa</i>	River She Oak
4. <i>Corymbia intermedia</i>	Pink Bloodwood
5. <i>Eucalyptus crebra</i>	Narrow Leaved Ironbark
6. <i>Eucalyptus melliodora</i>	Yellow Box

FRANGIBLE

Vines	
7. <i>Cissus antarctica</i>	Kangaroo Vine
8. <i>Eustrephus latifolius</i>	Wombat Berry
9. <i>Geitonoplesium cymosum</i>	Scrambling Lily

Non-RE: Grass, Herbs & Rushes (1m Setback from road pavement edge)	
10. <i>Dianella brevipedunculata</i>	Fruited Flax lily
11. <i>Dianella caerulea</i>	Blue Flax-lily
12. <i>Imperata cylindrica</i>	Blady Grass
13. <i>Lomandra longifolia</i>	Mat-rush
14. <i>Themeda triandra</i>	Kangaroo Grass

6.1.2 REVEGETATION AREA 2

RE: 12.9-10.7 EUCALYPTUS CREBRA WOODLAND (INCLUDING E. CREBRA WITH LOPHOSTEMON CONFERTUS GULLIES) [OF CONCERN]
Eucalyptus crebra +/- E. tereticornis, Corymbia tessellaris, Angophora spp., E. melanophloia woodland on sedimentary rocks.



PLANT SPECIES LIST

RE: 12.9-10.7 EUCALYPTUS CREBRA WOODLAND (INCLUDING E. CREBRA WITH LOPHOSTEMON CONFERTUS GULLIES) [OF CONCERN]

NON-FRANGIBLE

- Trees (Clear zone setback from road pavement edge)
- | | |
|----------------------------|------------------------|
| 1. Allocasuarina torulosa | River She Oak |
| 2. Angophora floribunda | Roughbark Apple |
| 3. Corymbia intermedia | Pink Bloodwood |
| 4. Corymbia tessellaris | Moreton Bay Ash |
| 5. Eucalyptus crebra | Narrow Leaved Ironbark |
| 6. Eucalyptus melliodora | Yellow Box |
| 7. Eucalyptus melanophloia | Silver-leaved Ironbark |
| 8. Lophostemon confertus | Brush Box |

FRANGIBLE

- Shrubs (2.5m Setback from road pavement edge)
- | | |
|--------------------------|------------------------|
| 9. Acacia concurrens | Black Wattle |
| 10. Acacia disparrima | Hickory Wattle |
| 11. Canthium odoratum | Shiny-leaved canthium |
| 12. Cassine australis | Red-fruited Olive Plum |
| 13. Indigofera australis | Australian Indigo |
| 14. Jacksonia scoparia | Dogwood |
- Grasses, Herbs & Rushes (1m Setback from road pavement edge)
- | | |
|--------------------------|-----------------|
| 15. Carex brunnea | Varigated Sedge |
| 16. Cymbopogon refractus | Barb Wire Grass |
| 17. Dianella caerulea | Blue Flax-lily |
| 18. Imperata cylindrica | Blady Grass |
| 19. Lomandra multiflora | Mat-rush |
| 20. Themeda triandra | Kangaroo Grass |
- Vines
- | | |
|---------------------------|--------------------|
| 21. Eustrephus latifolius | Wombat Berry |
| 22. Hardenbergia violacea | False Sarsaparilla |

6.1.3 REVEGETATION AREA 3

RE: 12.3.7 RIPARIAN 1 [NOT OF CONCERN]
Eucalyptus tereticornis, Casuarina cunninghamiana subsp. cunninghamiana +/- Melaleuca spp. fringing woodland



PLANT SPECIES LIST

RE: 12.3.7 RIPARIAN 1 [NOT OF CONCERN]

NON-FRANGIBLE

Trees (Clear zone setback from road pavement edge)

- | | |
|------------------------------------|------------------------|
| 1. <i>Acacia salicina</i> | Willow Wattle |
| 2. <i>Angophora floribunda</i> | Roughbark Apple |
| 3. <i>Casuarina cunninghamiana</i> | Riveroak |
| 4. <i>Eucalyptus crebra</i> | Narrow Leaved Ironbark |
| 5. <i>Eucalyptus tereticornis</i> | Red Forest Gum |
| 6. <i>Melaleuca bracteata</i> | Black Tea Tree |

FRANGIBLE

Small Trees (2.5m Setback from road pavement edge)

- | | |
|-----------------------------------|---------------------|
| 7. <i>Callistemon viminalis</i> | Weeping Bottlebrush |
| 8. <i>Callistemon salignus</i> | Willow Bottlebrush |
| 9. <i>Casuarina equisetifolia</i> | Sheoak |

Shrubs

- | | |
|-----------------------------|------------|
| 10. <i>Bursaria spinosa</i> | Blackthorn |
|-----------------------------|------------|

Grasses, Herbs & Rushes (1m Setback from road pavement edge)

- | | |
|---------------------------------|----------------------|
| 11. <i>Commelina diffusa</i> | Climbing Dayflower |
| 12. <i>Cymbopogon refractus</i> | Barb Wire Grass |
| 13. <i>Dichanthium sericeum</i> | Queensland Bluegrass |
| 14. <i>Imperata cylindrica</i> | Blady Grass |
| 15. <i>Juncus usitatus</i> | Common Rush |
| 16. <i>Lomandra longifolia</i> | Mat-rush |

Vines

- | | |
|----------------------------------|--------------|
| 17. <i>Eustrephus latifolius</i> | Wombat Berry |
|----------------------------------|--------------|

6.1.4 REVEGETATION AREA 4

RE: 12.3.7 RIPARIAN 1

Eucalyptus tereticornis, Casuarina cunninghamiana subsp. cunninghamiana +/- Melaleuca spp. fringing woodland



PLANT SPECIES LIST

RE: 12.3.7 RIPARIAN 1

[NOT OF CONCERN]

NON-FRANGIBLE

Trees (Clear zone setback from road pavement edge)

- | | |
|------------------------------------|------------------------|
| 1. <i>Acacia salicina</i> | Willow Wattle |
| 2. <i>Angophora floribunda</i> | Roughbark Apple |
| 3. <i>Casuarina cunninghamiana</i> | Riveroak |
| 4. <i>Eucalyptus crebra</i> | Narrow Leaved Ironbark |
| 5. <i>Eucalyptus tereticornis</i> | Red Forest Gum |
| 6. <i>Melaleuca bracteata</i> | Black Tea Tree |

FRANGIBLE

Small Trees (2.5m Setback from road pavement edge)

- | | |
|-----------------------------------|---------------------|
| 7. <i>Callistemon viminalis</i> | Weeping Bottlebrush |
| 8. <i>Callistemon salignus</i> | Willow Bottlebrush |
| 9. <i>Casuarina equisetifolia</i> | Sheoak |

Shrubs

- | | |
|-----------------------------|------------|
| 10. <i>Bursaria spinosa</i> | Blackthorn |
|-----------------------------|------------|

Grasses, Herbs & Rushes (1m Setback from road pavement edge)

- | | |
|---------------------------------|----------------------|
| 11. <i>Commelina diffusa</i> | Climbing Dayflower |
| 12. <i>Cymbopogon refractus</i> | Barb Wire Grass |
| 13. <i>Dichanthium sericeum</i> | Queensland Bluegrass |
| 14. <i>Imperata cylindrica</i> | Blady Grass |
| 15. <i>Juncus usitatus</i> | Common Rush |
| 16. <i>Lomandra longifolia</i> | Mat-rush |

Vines

- | | |
|----------------------------------|--------------|
| 17. <i>Eustrephus latifolius</i> | Wombat Berry |
|----------------------------------|--------------|

6.1.5 REVEGETATION AREA 5

RE: 11.3.25 RIPARIAN 2 [NOT OF CONCERN]
Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines



PLANT SPECIES LIST

RE: 11.3.25 RIPARIAN 2
[NOT OF CONCERN]

NON-FRANGIBLE

Trees (Clear zone setback from road pavement edge)

- | | |
|------------------------------------|-------------------|
| 1. <i>Acacia salicina</i> | Willow Wattle |
| 2. <i>Angophora floribunda</i> | Roughbark Apple |
| 3. <i>Casuarina cunninghamiana</i> | Riveroak |
| 4. <i>Corymbia tessellaris</i> | Moreton Bay Ash |
| 5. <i>Eucalyptus tereticornis</i> | Red Forest Gum |
| 6. <i>Eucalyptus nobilis</i> | Manna Gum |
| 7. <i>Eucalyptus orgadophila</i> | Mountain Coolibah |

FRANGIBLE

Small Trees (2.5m Setback from road pavement edge)

- | | |
|---------------------------------|---------------------|
| 8. <i>Callistemon viminalis</i> | Weeping Bottlebrush |
| 9. <i>Callistemon salignus</i> | Willow Bottlebrush |

Shrubs

- | | |
|-----------------------------|------------|
| 10. <i>Bursaria spinosa</i> | Blackthorn |
|-----------------------------|------------|

Grasses, Herbs & Rushes (1m Setback from road pavement edge)

- | | |
|---------------------------------|----------------------|
| 11. <i>Commelina diffusa</i> | Climbing Dayflower |
| 12. <i>Cymbopogon refractus</i> | Barb Wire Grass |
| 13. <i>Dichanthium sericeum</i> | Queensland Bluegrass |
| 14. <i>Imperata cylindrica</i> | Blady Grass |
| 15. <i>Juncus usitatus</i> | Common Rush |
| 16. <i>Lomandra longifolia</i> | Mat-rush |

Vines

- | | |
|----------------------------------|--------------|
| 17. <i>Eustrephus latifolius</i> | Wombat Berry |
|----------------------------------|--------------|

6.1.6 REVEGETATION AREA 6

RE: 11.8.5 EUCALYPTUS ORGADOPHILA OPEN WOODLAND [NOT OF CONCERN]
Eucalyptus Orgadophila open woodland on Cainozoic igneous rocks



PLANT SPECIES LIST

RE: 11.8.5 EUCALYPTUS ORGADOPHILA OPEN WOODLAND [NOT OF CONCERN]

NON-FRANGIBLE

Trees (Clear zone setback from road pavement edge)

- | | |
|-----------------------------------|------------------------|
| 1. <i>Acacia salicina</i> | Willow Wattle |
| 2. <i>Corymbia tessellaris</i> | Moreton Bay Ash |
| 3. <i>Eucalyptus crebra</i> | Narrow Leaved Ironbark |
| 4. <i>Eucalyptus melanophloia</i> | Silver-leaved Ironbark |
| 5. <i>Eucalyptus orgadophila</i> | Mountain Coolibah |

FRANGIBLE

Small Trees (2.5m Setback from road pavement edge)

- | | |
|-----------------------------------|--------|
| 6. <i>Casuarina equisetifolia</i> | Sheoak |
|-----------------------------------|--------|

Shrubs

- | | |
|-----------------------------|-----------------------|
| 7. <i>Canthium odoratum</i> | Shiny-leaved canthium |
|-----------------------------|-----------------------|

Grasses, Herbs & Rushes (1m Setback from road pavement edge)

- | | |
|-------------------------------------|----------------------|
| 8. <i>Chrysocephalum apiculatum</i> | Yellow Buttons |
| 9. <i>Cymbopogon refractus</i> | Barb Wire Grass |
| 10. <i>Dichanthium sericeum</i> | Queensland Bluegrass |
| 11. <i>Lomandra longifolia</i> | Mat-rush |
| 12. <i>Lomandra multiflora</i> | Mat-rush |
| 13. <i>Themeda triandra</i> | Kangaroo Grass |

Vines

- | | |
|----------------------------------|--------------|
| 14. <i>Eustrephus latifolius</i> | Wombat Berry |
|----------------------------------|--------------|

6.1.7 MASS PLANTING AREA 1

Feature mass planting of container stock to major intersections/ interchanges



PLANT SPECIES LIST

MASS PLANTING (MAJOR INTERSECTIONS/ INTERCHANGES)

NON-FRANGIBLE

- Trees (Clear zone setback from road pavement edge)
- | | |
|------------------------------------|------------------------|
| 1. <i>Casuarina cunninghamiana</i> | Riveroak |
| 2. <i>Corymbia tessellaris</i> | Moreton Bay Ash |
| 3. <i>Eucalyptus tereticornis</i> | Red Forest Gum |
| 4. <i>Eucalyptus crebra</i> | Narrow Leaved Ironbark |
| 5. <i>Eucalyptus melanophloia</i> | Silver-leaved Ironbark |
| 6. <i>Eucalyptus nobilis</i> | Manna Gum |
| 7. <i>Grevillea robusta</i> | Silky Oak |
| 8. <i>Jacaranda mimosifolia</i> | Jacaranda |

FRANGIBLE

- Small Trees (2.5m Setback from road pavement edge)
- | | |
|--------------------------------------|--------------------|
| 9. <i>Callistemon salignus</i> | Willow Bottlebrush |
| 10. <i>Corymbia citriodora dwarf</i> | Lemon Scented Gum |
| 11. <i>Corymbia ptychocarpa</i> | Swamp Bloodwood |
| 12. <i>Corymbia 'Summer Red'</i> | Summer Red |

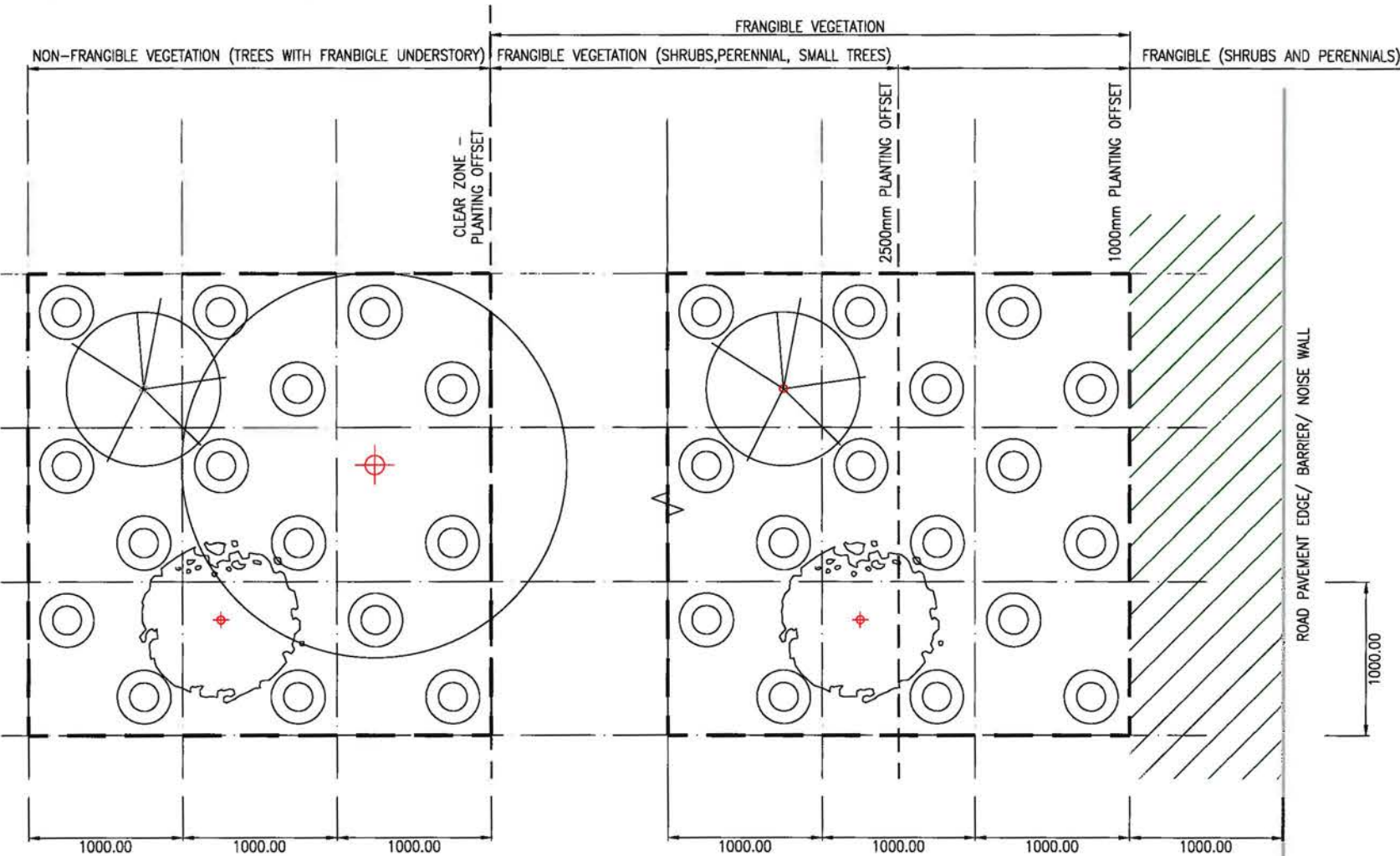
- Shrubs
- | | |
|------------------------------|-------------------|
| 13. <i>Acacia disparrima</i> | Lambs Tail Wattle |
| 14. <i>Acacia leiocalyx</i> | Hickory Wattle |

- Grasses, Herbs & Rushes (1m Setback from road pavement edge)
- | | |
|--------------------------------------|-------------------------|
| 15. <i>Commelina diffusa</i> | Climbing Dayflower |
| 16. <i>Dianella brevipedunculata</i> | Fruited Flax-lily |
| 17. <i>Dianella caerulea</i> | Blue Flax-lily |
| 18. <i>Dianella revoluta</i> | Flax-lily |
| 19. <i>Liriope 'Evergreen Giant'</i> | Liriope |
| 20. <i>Lomandra longifolia</i> | Mat-rush |
| 21. <i>Melaleuca thymifolia</i> | Thyme-leaf Honey-myrtle |
| 22. <i>Pennisetum 'Rubrum'</i> | Purple Fountain Grass |
| 23. <i>Scaevola aemula</i> | Fan Flowers |

- Vines
- | | |
|----------------------------------|--------------------|
| 24. <i>Hardenbergia violacea</i> | False Sarsaparilla |
|----------------------------------|--------------------|

6.2 REVEGETATION DETAILS

Plant Matrices
Typical Frangible and Non-Frangible Revegetation Matrices



NON-FRANGIBLE PLANTING MIX – TOTAL 2 PLANTS/ 1m²:

- Hydromulch Grass Mix (Refer to LRUD plant palette for species. For total minimum application rates refer to MRTS16C, Table 6.3.3.2 – Native Seed Mix – Minimum Application Rates)
- Pit planted mix of Trees species – Tubes @ 1 tree /10m²
- Pit planted Shrubs and Perennial Groundcover species – Tubes @ 2/m² (total – 2 Shrubs and 15 Perennials /10m²)

NOTE: Where used as screening to noise walls pit planting to be min 300mm pots

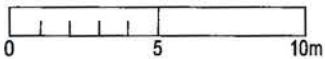
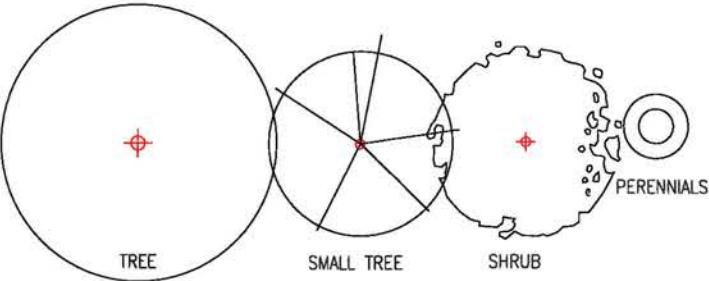
Refer to Landscape Revegetation and Urban Design Report (LRUD) for plant species palettes.

FRANGIBLE SCREEN PLANTING MIX –TOTAL 2 PLANTS/ 1m²:

- Hydromulch Grass Mix (Refer to LRUD plant palette for species. For total minimum application rates refer to MRTS16C, Table 6.3.3.2 – Native Seed Mix – Minimum Application Rates)
- Pit planted shrubs and perennial groundcover species – Tubes @ 2/m² (total – 2 Shrubs and 16 Perennials /10m²)

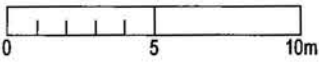
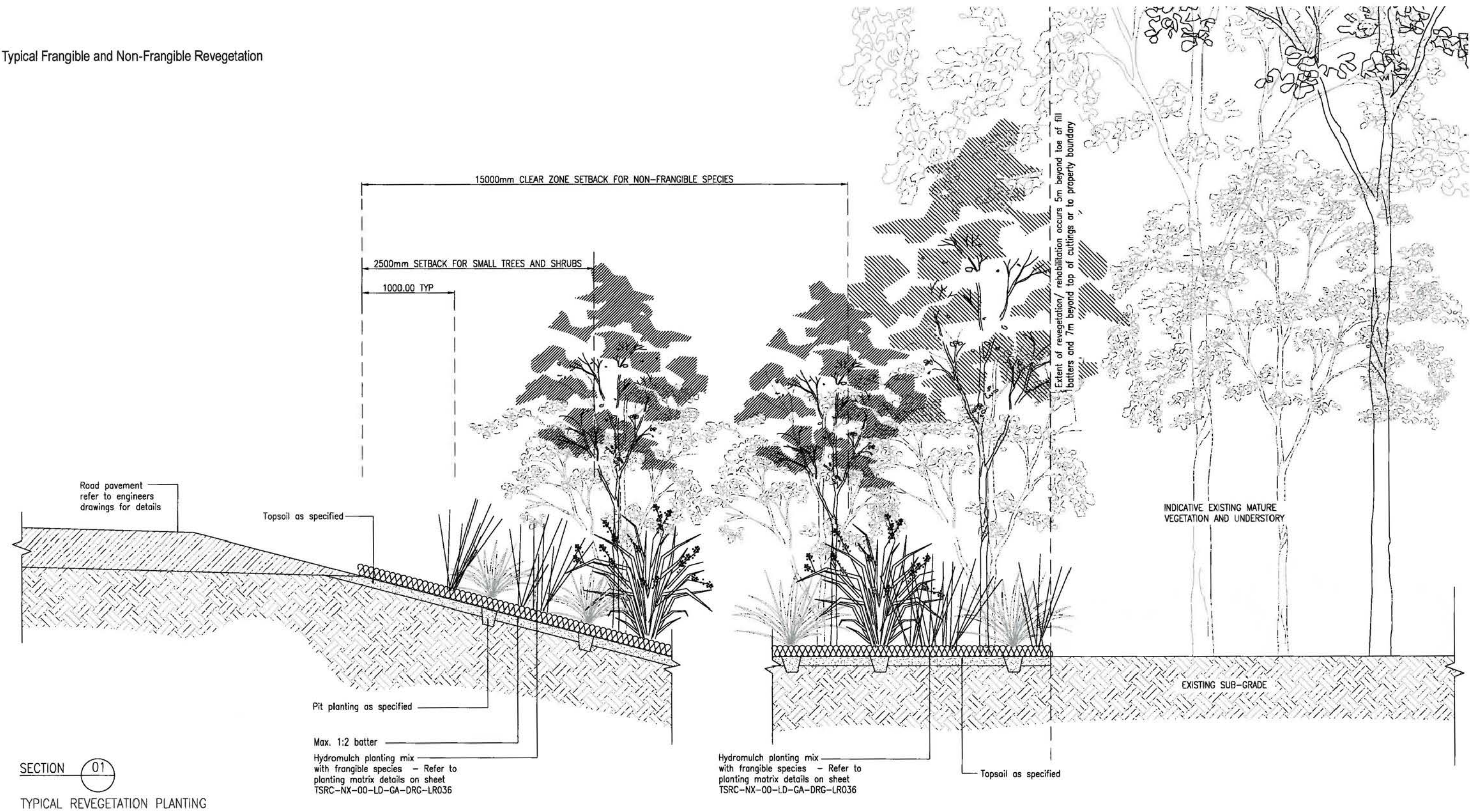
Note: Where used as screening to noise walls pit planting to be min 300mm pots

Refer to Landscape Revegetation and Urban Design Report (LRUD) for plant species palettes.



6.2 REVEGETATION DETAILS

Typical Frangible and Non-Frangible Revegetation



7.2 WALLS AND SCREENS

Three thematic options have been developed for application to walls and screens. Each proposed thematic response reflects, reinforces and responds to the surrounding region's natural beauty and iconic landscape character. These solutions provide thematic features along the TSRC landscape, grounding these functional elements within the regional landscape character and cultural identity.

Each of the three options offer ranging cost solutions. The intent being to provide options that deliver very high quality urban design outcomes while also achieving cost effectiveness. Individual planting palettes have been developed to align with and reinforce each option.

Option 1 - Preferred Option

Precast patterned concrete wall (2/32 Inn - Reckli), painted



NATIVE GRASSLANDS

Dulux Colourbond: Pale Eucalyptus

Option 1 - Preferred Option

As a precast concrete panel option; this off the shelf form liner provides a cost effective solution with a pattern reflective of the grass plains.

The walls will be painted in a Dulux Colourbond: Pale Eucalyptus colour to achieve a cohesive representation of the thematic response across the corridor.

Option 2

Aluminium frame with tinted glass panels



TOOWOOMBA VIOLET

Option 2

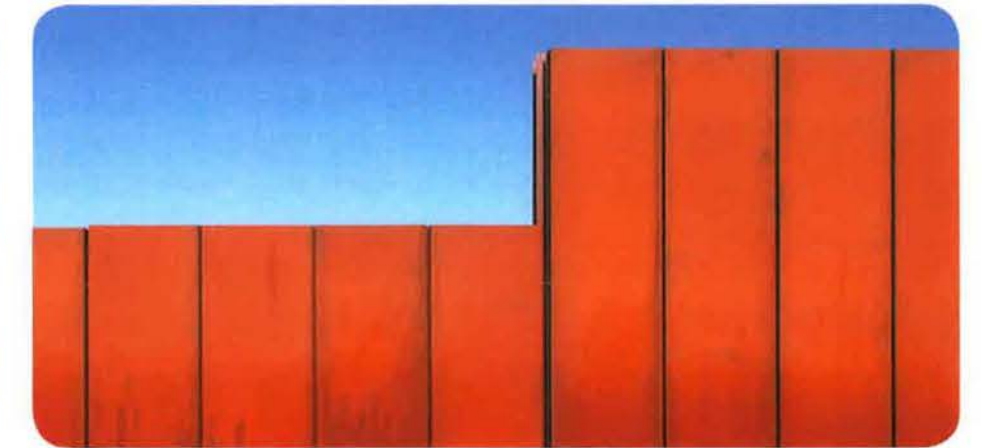
Barriers constructed from aluminium cladding frame sections, with tinted violet coloured glass panels to enhance views from the road corridor and to allow for coloured light to be thrown across surface planes. Violet has been chosen as an accent colour to respond to the social and heritage significance of Toowoomba's floral emblem the Sweet Violet - *Viola odorata*.

Option 3

Cor-Ten steel plate provides a striking colour in the landscape referencing the agricultural heritage of the area and hues of the rock formations.

Option 3

Cor-Ten steel panels



PATTERNS IN THE LANDSCAPE

7.3 BRIDGES AND PARAPETS

In keeping with the other urban design treatments for the corridor; simple, robust and effective shapes, geometries, textures and colours have been developed to respond to the unique open landscape characters of the TSRC. Cor-Ten plate cladding around the abutments and retaining walls (where required) are patterned and painted to match the walls. The vertical precast concrete barrier form integrates ribbing to reduce the visual height of these units. The barrier is painted in a lighter tone (Dulux CB Dune) to reduce any dominance within the landscape and beams, headstocks and columns will be painted a darker recessive colour (Dulux CB Basalt) to contrast with the natural landscape planting treatments. This treatment will be applied to visible bridges only which will include Warrego Highway East, Murphy's Creek Road, Mort Street and Boundary Street.



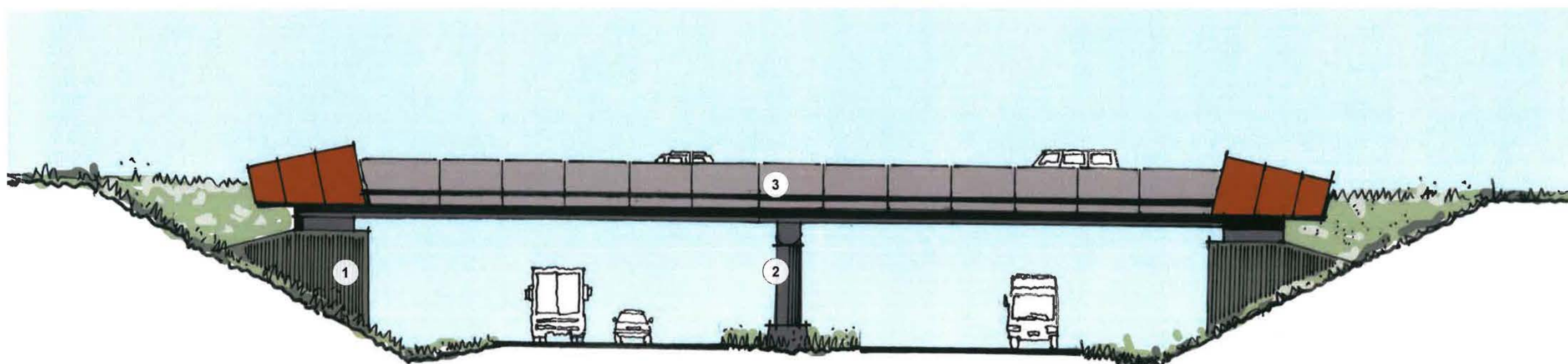
TEXTURED FEATURE PLANTING



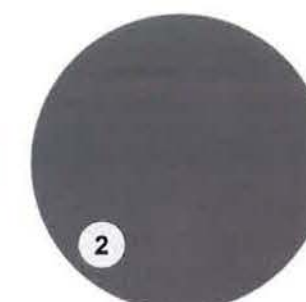
PATTERNED
PRECAST CONCRETE



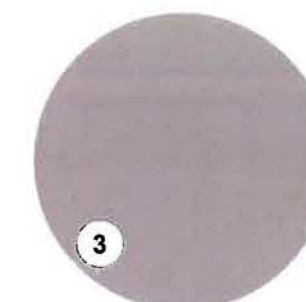
COR-TENSTEEL



COLORBOND
PALE EUCALYPTUS

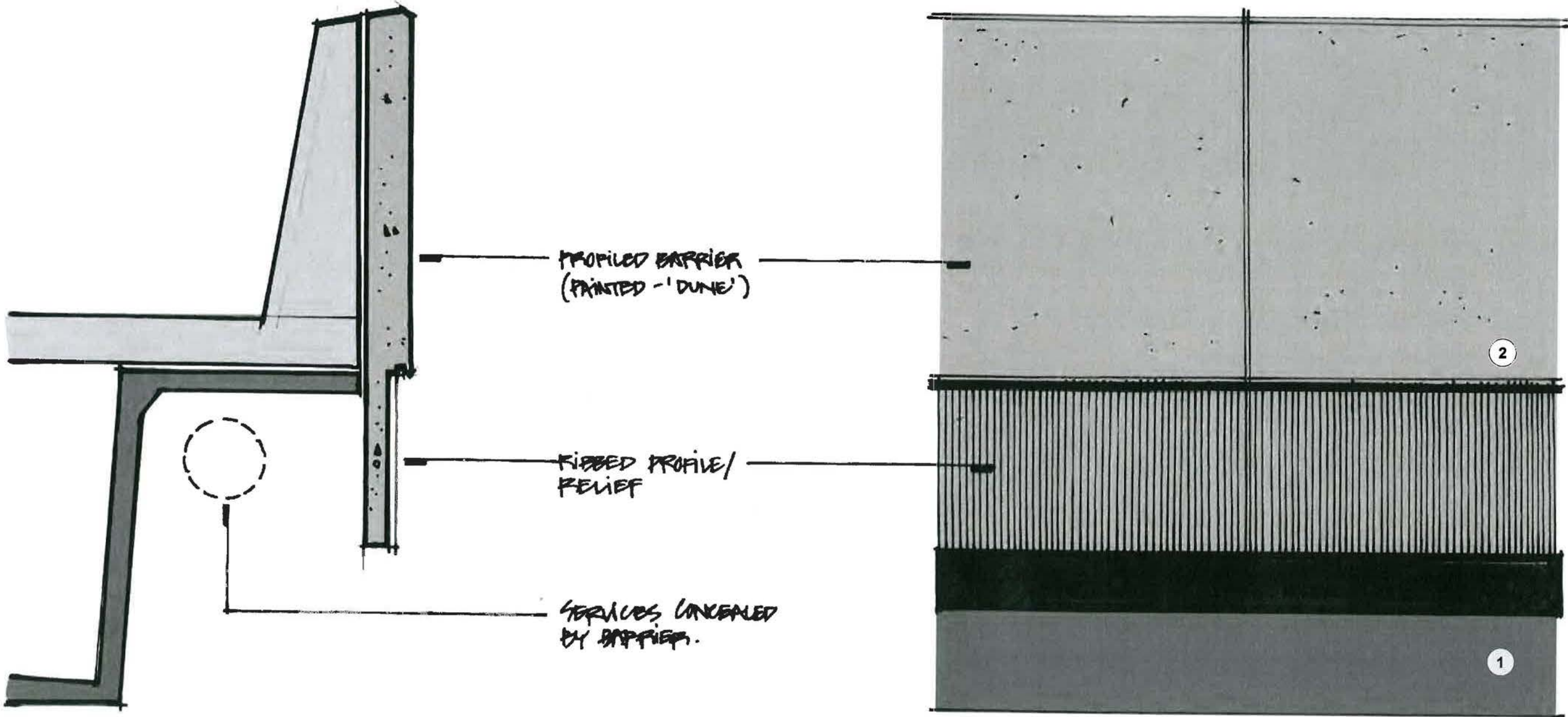
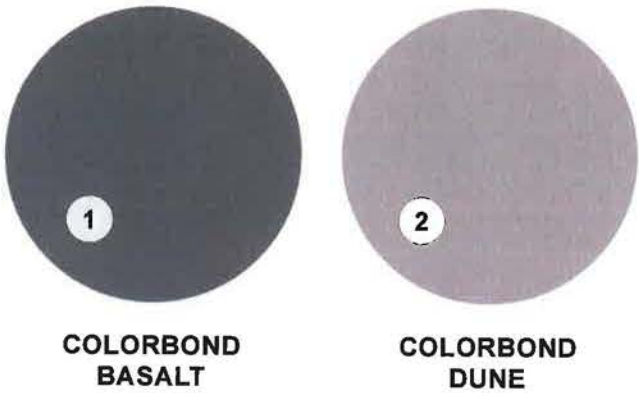


COLORBOND
BASALT



COLORBOND
DUNE

7.3.1 BRIDGES AND PARAPETS: DETAIL



TYPICAL BRIDGE BARRIER PROFILE SECTION

PART ELEVATION.



8.0 OPERATIONS AND MAINTENANCE

Operations and maintenance activities minimisation has been addressed within the design as follows:

- Hydromulching using a 'flexible growth medium' FGM Flexterra, which enables slopes of up to 1:1 to be stabilised, minimising soil loss over all other products available in this market
- The FGM hydromulch has high moisture absorbency and retention properties, minimising watering. Most watering is required within the first 8 weeks to establish the cover crop, with regular watering required for the first year
- A sterile cover crop is proposed, which dies back leaving the native seed to grow without the competition and maintenance requirements of a typical imported species grass cover crop
- The native grass mix negates the need for slashing typical of most infrastructure grass treatments
- Pit planting of shrub and tree species augment the native grasses in the hydromulch to establish a naturally sustaining vegetation cover over time.

Urban design treatments have minimised operations and maintenance requirements through:

- The use of natural unpainted off-form concrete to minimise repainting requirements and associated road closures
- The use of no maintenance materials such as Cor-Ten steel
- Treatment to parapet profiles to eliminate visible staining marks from water run off
- The light transition portal shell to the western exit portal reduces the need for transition lighting within the tunnel and associated ongoing costs.



Toowoomba grassland species



TSRC
PART 2 - CLARIFICATION QUESTION
A.1 - Design

Question ID	Report Reference	Question	Proponent Response
T157a	A.1	Further to T149 the State requires additional information with respect to Postman's ridge road for the following : Please advise what impacts there are to cost and program to provide a fixed barrier (not vegetation) that is capable of blocking headlights between the Toowoomba Second Range Crossing and the Postmans Creek Road extension to Murphys Creek Road. The barrier must be located such that no eastbound motorists including truck drivers would be able to see the headlights of any vehicle including trucks travelling along the service road.	In order to block headlights between the Tollroad and the Postmans Ridge Road / Murphy's Creek Road connection, Nexus proposes to place a screen on top of the standard 1.1m high concrete barrier (between chainages 3,190 and 4,180) to extend the effective height to approximately 2.5m. The screen will be perforated metal supported by vertical posts on top of the concrete barrier. The D+C cost impact of this inclusion will be \$577,426. We confirm the O+M cost will be zero.
T185	A.1	Further to your response for T173, can Nexus provide an indicative sketch for the works associated with the Accommodation works for the Bach's bore including the location, lengths and extents of enveloper pipe, and the price of each of these works? The sketch should also indicate Nexus' understanding of the location of the bore and the Tollroad. During discussions at the meeting on 14 July, the State noted that Nexus may have incorrectly assumed the location of the Bach's bore. Please find attached a drawing (T185) that provides an indicative location of the bore. Nexus is required to undertake its own due diligence of the exact location. It is possible that the extent of access tracks previously priced by Nexus may not be required as a result of the true location of the bore. Nexus should take account of this fact when providing a price in response to this question. Nexus is also requested to ensure that the final price for these works does not include the duplication of effort in relation to enveloper pipes that the State has identified was included in Nexus's earlier Accommodation Works pricing.	Please see attached sketch showing the scope of works required to relocate and protect the pipe. The additional scope from the one included as part of the Accommodation Works schedule as of 25th February is: • 105m of enveloper pipe protection @ 563.4\$/m = 59,157 \$ • 140m of relocated pipe @ 680.0\$/m = 95,200 \$ • TOTAL= 154,357 \$
T186	A.1	Further to our discussions on 20th July, can Nexus please include an appropriate emergency access onto the TSRC at the junction with proposed Postmans Ridge Road cul-de-sac?	The works required at Postmans Ridge Road to provide emergency access will be minimal as follows: - A maintenance access track is already proposed which will need a gate. - The embankment height is less than 1m. - The existing road can be retained to connect from the cul-de-sac to the Tollroad. We can offer the State to undertake these works at no additional cost. However, also in regard to Postmans Ridge Road, we note T157 Q1 identifies an additional cost to provide a headlight blocking barrier that wasn't included in the last financial model submitted to the State on the 2nd July 2015.

TSRC
PART 2 - CLARIFICATION QUESTION
A.1 - Design
Attachment for T185

Basches Bore

Toowoomba Second Range Crossing

65. Provide envelopers and new pipe under new road (thick yellow line).

Length of enveloper and new pipe

- Cecil Plains Road - 45m
- exit ramp - 35m
- Tollroad + entry ramp - 70m

Provide new pipe (not in enveloper) thin yellow line

Length of relocated pipe (not in enveloper) north of Cecil Plains Rd is 140m.

Realignment of water pipe to relocate away from intersection.

Baches Bore and windmill

Revised wording in accommodation works schedule:

Item 60. ...Enveloper Pipe: Refer Item 65.

Item 65. ...Construct: Replace sections of pipe impacted by the the new works with a new pipe and enveloper. The existing water pipe connects the tank on the eastern severance of Lot 198 on SP190232 to bore on Lot 2 SP190232 and the to the water supply on Lot 15 on SP195574. Where the existing pipe conflicts with the proposed interchange intersection, relocate the pipe away from the intersection. The relocated pipe is not required to be in an enveloper (except where it is under any road, new or existing).

Existing pipe (blue). Suggest that this section is abandoned and relocated outside the intersection. The new alignments will be the red and yellow

Water Tank

July 10, 2013

**PARSONS
BRINCKERHOFF**

1:4,514

0 0.05 0.1 0.2 mi
0 0.075 0.15 0.3 km

DRAFT

Printed from: <https://maps.pb.com.au/SITEMAP/Default.aspx?p=tsrc>

Value Add Options

Warrego Highway (West) Grade Separated Intersection

Overview

The grade separated interchange at Warrego Highway (west) includes the Tollroad passing over the Warrego Highway with ramps connecting the Tollroad to the Warrego Highway. The proposed arrangement will also accommodate the future construction of grade separated loop ramps from the Tollroad to the Warrego Highway.

The Tollroad posted speed on the overpass bridge and approaches could be changed to 100 km/h, which is an increase from the 80 km/h (posted) for the approaches to the at-grade signalised intersection.

Design Principles

The grade separated intersection will improve traffic circulation and connection between the Tollroad and Warrego Highway (west), increase capacity of turning movements using the ramps onto Warrego Highway (west) from Tollroad, provide opportunity for future connections from the Tollroad to Warrego Highway (west) and allow for future upgrade of the Warrego Highway, if required by the State.

Pavement Element

The design of the mainline pavement is in accordance with the principles set out in the Conforming Tender.

Drainage Element

The drainage design for this option is in accordance with the principles set out in the Conforming Tender.

Below is a summary of the difference between the Conforming Proposal and the Warrego Highway (west) Grade Separated Option design:

- The drainage design between Chainages 26000 and 27000 for the Warrego Highway (west) Grade Separated Option is the same as the Reference Design
- The culvert at Chainage 27250 is lengthened to accommodate the proposed ramp
- Additional culverts are required to drain the trapped areas between the ramps and the main alignment
- Additional culverts are required to drain the trapped areas between the proposed on ramps and the Warrego Highway
- Additional culverts are required to drain the median on the Warrego Highway
- The culverts under Willet Road are not required for this option
- The longitudinal drainage on the main alignment at the Warrego Highway is not required for this option
- Longitudinal drainage is required at the four ramp merges/diverges with the main alignment to drain the gore areas
- Additional of open drain is required for this option.

The proposed drainage design maintains the same hydraulic and water quality performance as the Reference Design.

Grade Separated Intersection: Cecil Plains Road

Overview

The grade separated intersection at Cecil Plains Road includes the Tollroad passing over Cecil Plains Road with ramps connecting to the Tollroad.

The provision of a Tollroad bridge passing over Cecil Plains Road means traffic does not need to stop at the intersection for north and south bound travel along the Tollroad.

The Tollroad posted speed on the overpass bridge and approaches could be changed to 100 km/h, which is an increase from the 80 km/h (posted) for the approaches to the at-grade signalised intersection.

Design Principles

Pavement Element

The design of the mainline pavement is in accordance with the Conforming Proposal..

Grade Separated Intersection: Gore Highway

Overview

The grade separated system interchange at the Gore Highway intersects as a T-Junction with the Tollroad and provides free flowing traffic movements from the Tollroad to and from the Gore Highway (west).

This interchange arrangement eliminates the at grade intersection conflicts by providing grade separated ramps. The benefits of this arrangement are predominantly associated with the road operating speed and road environment where drivers may not be expecting to negotiate the at grade intersection as detailed in the Conforming Proposal. The proposed ramps will allow vehicles to maintain speed on both the Gore Highway and the Tollroad through the interchange.

The provision of the Tollroad bridge enables north to south Tollroad traffic to pass over the Gore Highway Road. This overpass combined with the reconfiguration of the Gore Highway to Tollroad link (for northbound traffic) removes the at grade, signalised intersection. This enables the Tollroad and Gore Highway traffic streams to be free flowing. The removal of the at grade intersection increases safety, reduces Tollroad travel times and improves overall Tollroad capacity.

The posted speed through the grade separated interchange could increase to 100 km/h (posted), an increase from 80 km/h (posted) for the approaches to the at-grade signalised intersections.

Design Principles

Drainage Element

The design of the drainage for this option is in accordance with the principles set out in the Conforming Proposal.

Below is a summary of the difference between the Conforming Proposal and the Gore Highway grade separated intersection design:

- The culverts at Chainage 40580 and Chainage 41090 have been lengthened to accommodate the wider embankments for this option
- An additional culvert has been provided upstream of the culvert at Chainage 40580 at the proposed eastbound ramp
- An additional culvert has been provided downstream of the culvert at Chainage 41090 at the proposed eastbound ramp
- Additional culverts have been provided under the westbound ramp to drain the existing drains in this area
- Two culverts under the Gore Highway are not required for this option and have been removed
- The longitudinal drainage at the intersection of the Gore Highway with the main alignment in the Conforming Proposal design is not required for this option
- Additional sediment/spill capture basins are required to treat the runoff from the proposed ramps
- Additional open drain is required for this option.

The proposed drainage design maintains the same hydraulic and water quality performance as the Tender Design - Conforming Proposal.

Four Lanes from Gowrie Junction to Warrego Highway (West)

Design Principles

Roads and Safety Element

This option retains the Conforming Tender Design road geometry, however instead of two traffic lanes, an additional traffic lane is added for each way between the following locations:

- Westbound from Chainage 24250 to Chainage 27950
- Eastbound from Chainage 23100 to Chainage 27950.

This results in the cross-section width of the road to increase to 4 lanes in total with eastbound and westbound carriageways separated by a median barrier.

To provide separation between opposing traffic lanes and maintain consistency through the TSRC network, the Tender Design – Conforming Offer road cross-section east of Ganzer Morris Road is extended through to the Warrego Highway (west) intersection. As a result, this option design adopts an approximate 20 m cross-sectional width, with a 2.7 m wide central median (including inside shoulders) and two 3.5 m wide traffic lanes including a 2 m wide outside shoulder each way.

Pavement Element

The design of the mainline pavement is in accordance with the Conforming Proposal.

Drainage Element

The design of the drainage for this option is in accordance with the principles set out in the Conforming Proposal.

Below is a summary of the difference between the Conforming Proposal and the Four Lanes from Gowrie Junction to Warrego Highway (west) Value Added Option design:

- Culverts on the main alignment between Chainages 24000 and 28000 have been lengthened to accommodate the wider main line road embankment
- Additional longitudinal drainage is required on the median barrier between Chainages 23300 and 24100
- Additional longitudinal drainage is required on the median barrier between Chainages 25500 and 26700
- The culvert and longitudinal drainage at the intersection of the main alignment and the Warrego Highway is the same for the Tender Design - Conforming Proposal and for the Four Lanes from Gowrie Junction to Warrego Highway (west) Option.
- Bio-retention/sediment/spill capture basins have been made larger to accommodate the additional road runoff from the extra lane.

Agreed Exceptions

Agreed Exceptions

Item	Reference	Agreed Wording
1	Performance Specification Refers to: Design criteria for bridges and other structures 4.7.5.6	Nexus Infrastructure's Tender Design is based on adopting the alternative requirement that PSC T Girders shall be designed with concrete strength at transfer greater than or equal to 35 MPa, and less than or equal to 50 MPa. The maximum 28 compressive strength shall be 65 MPa
2	MRTS04 General	Nexus Infrastructure's Tender Design is based on adopting the following supplementary drainage layer grading specification based on RMS R44 Section 3.2.5: The drainage layer strength and durability requirements will need to meet the requirements for Rockfill (Clause 14.2.3 and Clause 19.2.13) noted in the item MRTS04.
3	Performance Specification Refers to: Geotechnical Design Standard – Minimum Requirements Section 2.1 (a)	Nexus Infrastructure's Tender Design is based on amending Section 2.1 by adding 2.1 a) iii, as follows: Notwithstanding the requirements stipulated in TMR Technical Specification MRTS04, the following also shall apply: iii. 1 (vertical) to 1.5 (horizontal) for a zoned embankment (earth-fill core and rock-fill shell) that is subject to geotechnical design and takes into consideration the following minimum requirements: - Applicable for embankment height greater than 6m - Batter slopes achieve a global factor of safety for slope stability not less than 1.5, - A minimum rock shell (outer zone) thickness of 3.0 m, and - Rock shell is of sufficient thickness to ensure embankment core materials are protected from erosion and seasonal moisture changes
4	Performance Specification Refers to: Geotechnical Design Standard – Minimum Requirements Section 2.3 (b)	Nexus Infrastructure's Tender Design is based on amending Section 2.3 b) by adding the following FOS requirements: • Seismic stability – 1.15 for OBE • Sudden drawdown – 1.3 • Worst case drawdown (Q2000) event – 1.0
5	MRTS04 Clause 14.3.1	Nexus Infrastructure's Tender Design is based on amending Table 14.3.1 as follows: For H(m) Greater than 6 and less than or equal to 10; change the second column "Batter Slope" to "to be determined by engineering assessment"
6	MRTS04 CI18.3.3	Nexus Infrastructure's Tender Design is based on amending Clause 18.3.3 by adding the following text: Treatment Type I - Special: will be proposed using a 300 mm thick geotextile wrapped drainage blanket. The drainage blanket material will be in accordance with grading in accordance with RMS R44 Section 3.4.2.
7	MRTS04 CI 14	Nexus Infrastructure's Tender Design is based on adopting the Clause 14.2.4 specification for the top 300 mm subgrade and a 700 mm thick Class A/B upper zone layer with a minimum CBR = Subgrade CBR.
8	MRTS04 Clause 14.2.2	Nexus Infrastructure's Tender Design is based on adopting the following replacement of the Table 14.2.2: Class A WPI <1200 (plus other requirements) Class B WPI 1200 < WPI < 2200 Class B* WPI <2200 (for use in embankment cores)
9	Performance Specification Refers to: Design criteria for bridges and other structures 8.5.1(l)	l) Any new property acquisition and areas required for easements, including those to mobilise the soil block for ground anchors, soil nails, rock bolts, and so on, for permanent and temporary works shall be determined.