Bruce Highway Scope Management and Design Guidelines

Program Management and Delivery

Version 2

Queensland Government

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Revision register and amendment notes:

- No amendments, corrections and updates will be directly recorded within the Scope Management and Design Guidelines document until the release of the next version.
- These guidelines will be reviewed annually.
- Cumulative details of all amendment notes will be recorded in the Amendment Record section of the Scope Management and Design Guidelines.
- All amendments relating to scope management will be issued for use by Director (Program Delivery), Program Management and Delivery.
- All amendments relating to technical standard or practice will be issued for use by the Chief Engineer (Engineering and Technology) or relevant Deputy Chief Engineer.
- All amendments relating to safety will be issued for use by the Director, Safer Roads (Land Transport and Safety)
- All amendment notices will be approved for use by Director (Program Delivery), Program Management and Delivery prior to publishing.

Notice:

- This guideline is the Department of Transport and Main Roads technical reference for people engaged in the planning and delivery of works associated with the Bruce Highway Program (the Program). However it is acknowledged that this guideline will not cover all situations and additional reference materials may need to be examined and/or relevant experts consulted, as required.
- This guideline is not a substitute for professional expertise and skills of qualified practitioners for the planning and delivery of Program works.
- This plan to manage the delivery of the Bruce Highway Program was prepared in consultation with the following key stakeholders (and/or their representatives):
  - General Manager (Portfolio Investment & Programming) – Portfolio Investment and Program
  - Program Leader, Safe System Program (under the PDO Leadership Programs).

Contents

Acronyms		**i**
1.	**Preamble**	**1**
1.1	Document purpose	1
1.2	Structure and content	1
1.3	Rationale	2
1.4	Application	2
1.5	Principles	2
1.6	Vision standards	2
1.7	Fit-for-purpose – use of Extended Design Domain and Design Exception	3
1.8	Interaction with other programs and guidelines	3
1.9	Responsibilities	4
1.9.1	District Director or delegate	4
1.9.2	Registered professional engineers in Queensland	4
1.10	Key documents	5
1.10.1	Program documents	5
1.10.2	Other corporate documents	5
2.	**Management of scope**	**6**
2.1	Safety package	6
2.2	Overtaking lanes	7
2.3	Capacity and flooding projects	7
2.4	Safe Systems approach	7
2.5	Road safety audit	7
3.	**General design guidance**	**8**
3.1	Hierarchy of documents	8
3.2	Cross section	8
3.2.1	Safety widening	9
3.2.2	Wide Centre Line Treatment	9
3.2.3	Seal width	9
3.2.4	Lane width	10
3.2.5	Shoulder and verge width	10
3.3	Roadsides	10
3.3.1	Embankments	10
3.3.2	Cuttings	10
3.3.3	Roadside hazards and clear zones	10
3.3.4	Roadside barriers	11
3.3.5	Median road safety barrier	12
3.3.6	Existing safety barriers and end terminals	12
3.3.7	Connection to bridge structures	13
3.4	Targeted treatments	13
3.4.1	Special channelised left turn treatment (offset CHL)	13
3.4.2	‘2+1’ road design	13
3.4.3	Minor safety works treatments	13
3.5	Pavements	15

3.5.1 Consideration of future rehabilitation/overlay options 15
3.5.2 Pavement structural design life for rehabilitation 15
3.5.3 Part-width formation/pavement widening 15
3.6 Drainage infrastructure 16
3.6.1 Culverts 16

4. Traffic management 17

4.1 Preventing end of queue crashes 17

5. Evaluation and monitoring 18

Table of Figures

Figure 1 Typical road cross section with cut-and-fill 8
Figure 2 Wide Centre Line Treatment with Audio Tactile Line Marking 9

Table of Tables

Table 1 National Land Transport Network seal widths 9
Table 2 Minimum structural pavement design life 15

Acronyms

AADT	Annual Average Daily Traffic
AGRD	Austroads Guide to Road Design
ATLM	Audio Tactile Line Marking
AUL	Auxiliary Left Turn
BCR	Benefit Cost Ratio
BDM	Bridge Design Manual
BHAP	Bruce Highway Action Plan
BHSP	Bruce Highway Safety Package
BHUP	Bruce Highway Upgrade Program
CHL	Channelised Left Turn
DDPSM	Drafting and Design Presentation Standards Manual
DE	Design Exception
E&T	Engineering and Technology
EDD	Extended Design Domain
GRDBS	Guidelines for Road Design on Brownfield Sites
LTS	Land Transport Safety Division
MRTS	Main Roads Technical Specifications
MUTCD	Manual of Uniform Traffic Control Devices
NPA	National Partnership Agreement
PDO	Program Delivery and Operations
PDI	Planner & Designer Instructions
PDM	Pavement Design Manual
PPR	Project Proposal Report
PRM	Pavement Rehabilitation Manual
PRN	Priority Road Network Investment Guide
QTRIP	Queensland Transport & Roads Investment Program
RCBC	Reinforced Concrete Box Culvert
RCP	Reinforced Concrete Pipe
RDM	Road Drainage Manual
RISC	Road Impact Severity Calculator
RMPC	Road Maintenance Performance Contract
RPDM	Road Planning & Design Manual
RPEQ	Registered Professional Engineers in Queensland
RSAPD	Road Safety Audit Policy and Guide Lines

RSS	Reinforced Soil Structure
RUL	Remaining Useful Life
SD	Standard Drawings
TET	Township Entry Treatment
TMR	Transport and Main Roads
TN	Technical Note
TOR	Terms of Reference
TRUM	Traffic and Road Use Management Manual
WCLT	Wide Centre Line Treatment

1. Preamble

1.1 Document purpose

The purpose of the Bruce Highway Upgrade Program (the Program) Scope Management and Design Guidelines is to provide:

- guidance on project scope development to ensure Transport and Main Roads (TMR) accountabilities are met, e.g. the Australian Government National Partnership Agreement on Land Transport Infrastructure Projects (NPA)
- engineering criteria and guidance (supplement to the Road Planning and Design Manual) for the planning, design and delivery of works associated with the Program, in particular for:
  - ensuring that maximising the overall benefits of the program is the primary consideration, when defining, designing, managing and delivering intended scope of all capacity, flood improvement and safety projects
  - ensuring safety benefits in delivery of the Bruce Highway Upgrade Program (BHUP)
  - providing guidance on highly effective road treatments
  - promoting consistency in applying road treatments
  - designing for resilience.

BHUP includes numerous sub-programs and packages with various funding sources, including:

- capacity projects
- flood resilience projects
- safety package
- overtaking lane projects.

While funding sources and individual project objectives may differ, all projects must deliver a consistent vision for the Bruce Highway using this guideline.

1.2 Structure and content

These guidelines are presented in the following sections:

- Section 1: Preamble is a ‘big-picture’ overview of these supplementary guidelines
- Section 2: Management of scope describes the scope management procedure
- Section 3: General design guidance provides additional guidance and criteria for all work types which may be undertaken under the Program
- Section 4: Traffic management
- Section 5: Monitoring and evaluation
- Appendices: provides information to supplement Section 2.

1.3 Rationale

These guidelines have been developed with the intention to:

- supplement current departmental design documents, e.g. *Road Planning and Design Manual 2nd Edition (RPDM), Pavement Design Manual* (PDM) and *Guidelines for Road Design on Brownfield Sites* (GRDBS)
- clarify what is appropriate in the circumstances of the Program
- deliver the department's vision standards for the Bruce Highway
- provide affordable, value-for-money and fit-for-purpose solutions at brownfield sites
- include new design criteria where appropriate that have not yet been released into the various departmental design documents.

Where particular situations are not covered by these guidelines or other departmental design documents, relevant Austroads documents should be used.

1.4 Application

These guidelines apply to all Bruce Highway projects and are intended to specifically address the Program's priority objectives of delivering safety, flooding and capacity improvements along the Bruce Highway.

Consistency in the application of departmental technical guidelines is extremely important to ensure consistent program outcomes. However, it is recognised that there will be subtly different solutions developed across the state due to specific site circumstances.

1.5 Principles

The guiding principles include:

- Maximising benefits – deliver the intended scope and optimise Program outcomes. In particular to realise expected safety benefits through reduced fatal and serious injury crashes.
- Ensuring value for money – prioritise low cost/high value innovative, (e.g. Wide Centre Line Treatment) and recognised road engineering treatments to deliver the Program's objectives.
- Consistent customer experience – consistent application of engineering standards and treatments consistently along the Bruce Highway to assist road users in managing risk.
- Collaboration – all internal and external stakeholders are committed to working closely throughout the development and delivery phases to ensure the best outcome.
- Latest design, traffic, procurement and construction research is applied to ensure best practice approaches are employed throughout the life of the Program.

1.6 Vision standards

The Bruce Highway Action Plan (BHAP) defines its 10 year vision to fix the Bruce Highway and bring it up to an acceptable engineering standard by employing:

- standards which are realistic in terms of community and industry needs and expectations
- solutions which address the most critical deficiencies and adopt cost-effective and innovative techniques.

These are addressed within each of the following three improvement areas:

(1) **Safety improvements** – implementing appropriate safety standards and specific treatments of sections with poor safety ratings and undertaking critical maintenance.

(2) **Flooding improvements** – reducing flood impacts for highway sections and connections to cities.

(3) **Capacity improvements** – enhancing or making better use of infrastructure to overcome persistent congestion problems.

1.7 Fit-for-purpose – use of Extended Design Domain and Design Exception

Generally, there is sufficient flexibility in published guidelines for the scoping and design of fit-for-purpose, context sensitive infrastructure solutions. Like most design guidelines however, these guidelines do not explicitly cover every situation that will be encountered. All design is a compromise between the ideal and what is fit for purpose and affordable. Relevant engineering experience, professional judgement, and an understanding of the technical fundamentals, principles and safety aspects of scoping projects, and design criteria and practices is necessary when making trade-offs between competing priorities. Importantly, solutions must provide a consistent road user experience and not reduce the intended safety benefits or create any increase in safety risk.

In reality, with constrained budgets, application of these guidelines to an aged network will require compromises and some residual performance risks will remain. It is expected that experienced practitioners working with regional staff will apply the guidelines to deliver fit for purpose outcomes within available budgets. Where it is not possible to achieve the requirements of the guidelines, the following may be required:

- Adoption of Extended Design Domain (EDD) criteria in accordance with TN155 *Wide Centre Line Treatment – Interim Advice* prior to Design Exception (DE) criteria e.g. *A report to support the approval of the design exception for the Bruce Highway Wide Centre Line Treatment*.
- Adoption of a lesser work type that does not compromise safety, e.g. a basic maintenance solution in lieu of reconstruction.
- Identification of treatments to be implemented as part of a future capital works project.

All such decisions must be agreed with the Region, Engineering and Technology (E&T) (design standards) and Land Transport Safety (LTS) (safety benefits) and may be justified by the suitability of the residual risks and/or by whole-of-life cost considerations.

1.8 Interaction with other programs and guidelines

When undertaking any works on the Bruce Highway, check to determine what other departmental Investment Group projects and business programs are current or proposed. For example: maintenance, preservation and operations works, Transport System Planning Program projects, freight requirements, and legacy programs such as Safer Roads Sooner and Black Spot works. Where projects from one or more of these other programs overlap or are in close proximity, greater project efficiency will usually result if the works are integrated and coordinated, rather than undertaken as separate projects.

1.9 Responsibilities

Various responsibilities are detailed throughout the guidelines and are summarised below. Please note that this is not an exhaustive list and additional responsibilities are likely to apply.

1.9.1 District Director or delegate

The responsibilities of the District Director or delegate include the following:

- Approval of variations (except major variations as defined in *Bruce Highway Upgrade Program Major Scope Variation Procedure* in Appendix A) within the delegated authority of the District Director or recommendations for change of scope to the appropriate authority from the scope and design intent of this guideline (e.g. changed scope, reduced design life for structural design of pavements, reduced cover over expansive clay subgrades, staged works).
- Sign-off acceptance of documentation justifying where EDD or design exceptions are to be used or retained.
- Secure funding and approvals to undertake complementary works.
- Sign-off responses to risks identified in new or existing road safety audits.
- Approve the use of relevant supplementary requirements in contract documents.

1.9.2 Registered professional engineers in Queensland

The responsibilities of registered professional engineers in Queensland (RPEQ) involved in the design and delivery of the Program's works include but are not limited to certifying:

- use of Extended Design Domain
- design exceptions
- pavement designs and rehabilitation designs
- roadside safety barrier designs
- engineering drawings
- sprayed bituminous surfacing treatments and notification of deviation from the requirements of the Austroads guidelines
- structural assessment and design
- structural works
- level 3 structural inspections
- for BHSP projects where variations are proposed, demonstrating that the safety benefits (expected reductions in future fatal and serious injury crashes) of the proposed scope will deliver the same or better road safety benefits as the original project scope (defined in the BHSP project proposal report, including indicative outputs in the program schedule).
- design report and calculations for global stability of Reinforced Soil Structures (RSS) and boulder retaining walls including all relevant engineering drawings
- built retaining structures by the Contractor's RPEQ Geotechnical Engineer who carried out the design and supervised the construction (i.e. works constructed as per the specifications and design requirements, including the foundation bearing requirements).

1.10 Key documents

Key documents of relevance to these guidelines are listed below.

1.10.1 Program documents

Specific Program documents of relevance to these guidelines include:

- Bruce Highway Program Management Plan
- Bruce Highway Benefits Realisation Plan
- Bruce Highway Risk and Opportunities Plan
- Steering and Coordination Group Terms of Reference (TOR).

1.10.2 Other corporate documents

Key corporate documents referenced in these guidelines include:

- *Bridge Drafting Manual* (BDM)
- *Design Criteria for Bridge and Other Structures*
- *Drafting and Design Presentation Standards Manual* (DDPSM)
- *Guidelines for Road Design on Brownfield Sites* (GRDBS)
- Technical Specifications (MRTS)
- Queensland *Manual of Uniform Traffic Control Devices* (MUTCD)
- *Pavement Design Manual* (PDM)
- *Pavement Rehabilitation Manual* (PRM)
- Planners and Designers Instructions (PDI)
- *Queensland Transport and Main Roads Investment Program* (QTRIP)
- *Road Drainage Manual* (RDM)
- *Road Maintenance Performance Contract* (RMPC) Manual
- *Road Planning and Design Manual* 2nd edition (RPDM) (Note RPDM 2nd edition still refers to 1st edition where necessary)
- *Austroads Guide to Road Design* (AGRD)
- *Road Safety Audit Policy and Guidelines* (RSAPD)
- Standard Drawings (SD)
- TMR Technical Specifications
- *State-controlled Priority Road Network Investment Guidelines* (PRN)
- *Traffic and Road Use Management – Manual* (TRUM)
- TN155 *Wide Centre Line Treatment – Interim Advice*.

More specific technical policies, standards and guidelines are referenced in the relevant sections of this guideline.

2. Management of scope

Scope of the projects are described in relevant PPR's, PPR attachments and schedules.

If approved scope in the PPR cannot be delivered, Districts must provide a Scope Variation following the process. The BHUP Major Scope Variation Procedure document and request form are available on PDOConnect at: https://inside.tmr.qld.gov.au/sites/pdoconnect/teamspace/pdo-and-regional-sites/spo-teamsite/Pages/pmd-bruce-highway-program.aspx.

Any project with major scope change shall not proceed to construction without endorsement from Bruce Highway Coordination Group.

While delivering approved scope additional works that are essentially required to implement in conjunction with the project, (within the defined project limits and available budget) may be considered as part of project development including:

- pavement shape correction
- pavement rehabilitation where the remaining useful life (RUL) is less than 5 years
- for new pavements adjacent to existing pavements, the minimum design life should be 5 years and the maximum design life should be equivalent to RUL of the existing pavement
- repair or "like for like" replacement of existing culverts in poor condition
- reinstatement of longitude drainage including diversion blocks
- resealing where the remaining seal life is less than 3 years
- correction of existing geometric deficiencies, e.g. inadequate site distance, stopping distances, aquaplaning etc.(if budget permit)
- coordination of work with adjacent/nearby maintenance and repair activities.

2.1 Safety package

Bruce Highway safety improvements are aimed to significantly reduce head-on, run-off road and intersection crashes that result in fatal and serious injury outcomes.

The priority for the Safety Package program is safety improvements. For all other capital projects and programs, a consistent approach to safety along the Bruce Highway corridor is critical.

For the Safety Package program, a series of safety projects have been identified based on their safety benefits and grouped into tranches. The program has been approved based primarily on delivering these safety benefits.

Any works that deliver safety outcomes as secondary benefits (primary benefits are non-safety outcomes) are to be generally considered out of scope from Safety Package funding, including:

- capacity enhancement
- upgrading drainage capacity to address significant flooding issues
- realignment of horizontal and vertical geometry (unless the geometry is causing the safety issue, e.g. sight distance, concealed driveways etc.)
- modification of bridge structures
- treatment of slope stability issues unless new work directly affects the unstable area.

2.2 Overtaking lanes

Overtaking lane projects are required to deliver the consistent vision for the Bruce Highway set out in these guidelines, including consistent application of Wide Centre Line Treatments (WCLT) and safer roadsides. Intersections within overtaking lanes should be consistent with RPDM.

2.3 Capacity and flooding projects

Capital projects, including capacity and flooding projects are expected to deliver the consistent vision for the Bruce Highway set out in these guidelines, including consistent application of Wide Centre Line Treatments on undivided sections and safer roadsides on all road sections.

2.4 Safe Systems approach

Queensland has adopted a safe system approach to addressing road safety. The safe system approach provides a framework for a safe road transport system that is forgiving of human error, minimises the impact of crashes to survivable levels and reduces the contribution of road user behaviour to road crashes. These principles and approach underpins BHUP and should be followed in the development of designs and management of scope on all projects.

2.5 Road safety audit

Road safety audits of BHUP projects shall be in accordance with the department's Road Safety Audit Policy and Supporting Guidelines. For clarity, the policy was suspended with regard to road safety auditing of existing roads (not required). The provisions for auditing projects remains unchanged and must be complied with on all BHUP projects. This policy and guide can be access through links below.

https://inside.tmr.qld.gov.au/sites/lts/Road%20Safety%20Docs/RSA%20Policy%20Approved%20by%20GM(Engineering%20and%20Technology).pdf

https://inside.tmr.qld.gov.au/sites/lts/Road%20Safety%20Docs/Road%20Safety%20Audit%20Policy%20Supporting%20Guidelines.pdf#search=road%20safety%20audit

3. General design guidance

3.1 Hierarchy of documents

The hierarchy of BHUP documents will be on following order:

(1) Project Proposal Report

(2) Business Case

(3) Bruce Highway Scope Management and Design Guidelines

(4) TMR Road Planning and Design Manual

(5) Austroads Guides to Road Design.

The order of precedence above does not remove the requirement for a documented design exception to be produced if required.

3.2 Cross section

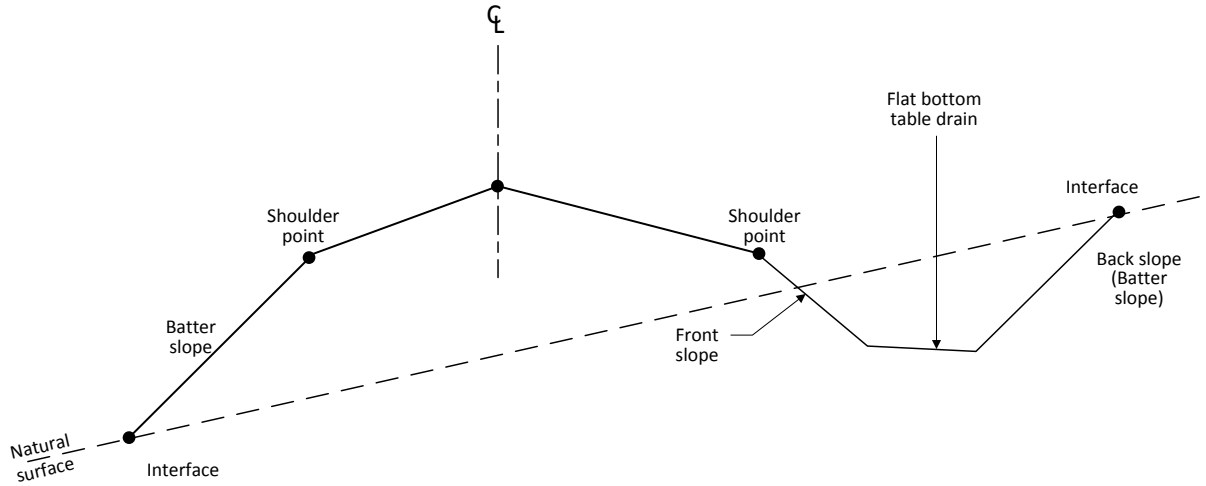
In line with Sections 1.1 and 1.5, the primary purpose of design is to improve the safety capability of the road and roadside in order to help achieve the safety objective of reduced death and serious injury along the Bruce Highway.

Requirements and guidance contained in the RPDM and GRDBS are generally sufficient to achieve the project objective. Designers must assess the site fully to determine current safety capability and understand any safety (potential or otherwise) issues. The design is then undertaken to improve roadside safety as much as possible within the context of the site and constraints of the project in line with the Safe System approach and by providing improvement to achieve consistent road user experience. This will require intelligent application of the current guidelines and engineering judgement and does not mean that every element along the highway, for example; culverts, requires improvement.

Designers must also observe the requirement to deliver project outputs particularly where stated in PPR schedules. Where projects can be designed to deliver better value for money (achieving the same or better project outcomes for the same or less cost) the variation process described above must be followed.

Figure 1 provides clarification of terminology.

Figure 1 Typical road cross section with cut-and-fill



3.2.1 Safety widening

Safety widening treatments, such as shoulder sealing and formation widening, are intended to provide sufficient seal width for WCLT.

3.2.2 Wide Centre Line Treatment

3.2.2.1 Vision standard

The target is to have WCLT (See **Figure 2**) installed along the full length of all undivided (including overtaking lane) rural sections of the Bruce Highway.

3.2.2.2 Technical references

The department's technical note TN155 *Wide Centreline Treatment – Interim Advice* (including WCLT at overtaking lanes, bridges and sections of highway with narrow bridges close together).

Figure 2 Wide Centre Line Treatment with Audio Tactile Line Marking

3.2.3 Seal width

The seal width information from the Appendix 4, Section 3 of *State Controlled Priority Road Network Investment Guidelines* shows the vision and interim seal widths (for 2 lane 2 way roads) for the National Land Transport Network as below. See **Table 1**.

Table 1 National Land Transport Network seal widths

Link	Vision seal width (m)[1]	Interim seal width (m)[2] [3]
Bruce Highway, Brisbane to Cairns	11	10

The *State Controlled Priority Road Network Investment Guidelines* are available at http://intranet.mainroads.qld.gov.au/junction/depdocs.nsf/main.html?Open&link=f1/16559C176D8862684A2578E70008392E?OpenDocument

[1] Vision for dual carriageways not included. Refer to RPDM.

[2] Technical Note TN155 *Wide Centre Line Treatment – Interim Advice* provide latest information on seal width requirements for WCLT applications.

[3] As the Bruce Highway forms part of the Principal Cycle Network, for rural road sections without WCLT, adopt a vision seal width that matches the AGRD Part 3: Geometric Design Widths from Section 4.2.6, Table 4.5, and an interim seal width that matches the 'Minimum shoulder seal' row in Table 4.5. Cycling treatments in urban areas should comply with Section 4.8 of the same guide.

3.2.4 Lane width

For 2 lane 2 way roads where WCLT is constructed the widths of traffic lanes are to be in accordance with the TN155 *Wide Centre Line Treatment – Interim Advice*.

For other traffic lanes (including multi-lane roads) the widths are to be in accordance with Volume 3 Part 3 of the RPDM.

3.2.5 Shoulder and verge width

TN155 *Wide Centre Line Treatment – Interim Advice* provides shoulder width requirements for straight road segments.

For all other scenarios, shoulder and verge width can be designed in accordance with RPDM. In case of continuous barrier installation, please also refer to Section 3.3.4 of this document.

3.3 Roadsides

3.3.1 Embankments

Design must use the flattest possible roadside slopes to improve roadside safety. The minimum batter slope is 1V:6H which is considered traversable by both cars and trucks (1V:4H is not considered traversable by trucks).

Where site constraints prohibit use of these batter slopes, steeper slopes can be used. However an appropriate barrier system should be used where this provides better safety outcomes. Refer to scope of PPR for additional guidance on use/location/required length of barrier systems.

3.3.2 Cuttings

Where table drains are required, flat bottom table drains are preferred with the front slope being 1V:6H and the back slope no steeper than 1V:4H. The intention here is to ‘dish’ the table drain more than usual to improve traversability.

Where site constraints prohibit use of flat bottom drains and/or prescribed slopes, steeper slopes can be used. Refer Section 4.6 of AGRD Part 3 for guidance on table drain slopes however use of an appropriate barrier system should be considered. Refer to scope of PPR for additional guidance on use/location/required length of barrier systems.

Where table drains would normally be required, but the subgrade is greater than 50 mm above natural surface and the natural surface slopes away from the road, apply a batter slope 1V:6H (or flatter) with no table drain. This situation highlights natural conditions where flood water will not pond against the embankment, but possibly somewhere away from the embankment.

3.3.3 Roadside hazards and clear zones

A key objective of the Safe System approach is to ensure that when driver errors do occur, they do not result in high severity outcomes.

Hazard protection treatments include:

- providing Clear Zone by roadside hazard removal (trees, poles, flattening batters and so on), and/or
- installation of safety barriers.

This area must be both traversable and clear of hazards. However, errant vehicles can still travel beyond this ‘zone’ and potentially crash, resulting in a fatality or serious injury. Therefore, in line with project objectives,

designers need to review and design the area between the clear zone limit and road boundary, making it as clear and as traversable as possible (minimise hazards).

Where site constraints prohibit sufficient improvement the use of an appropriate safety barrier system must be considered in accordance with the safety barrier section of this guideline.

Refer to scope of PPR for additional guidance on use/location/required length of barrier systems.

3.3.3.1 Technical references

Clear zone requirements must be considered in accordance with Part 6 Supplements to RPDM Volume 3, AGRD Part 6 and to AGRD Part 9

3.3.4 Roadside barriers

The key feature of safety barriers is not to reduce the likelihood of vehicles leaving the roadway but to prevent errant vehicles from striking roadside hazards such as trees or rolling on batters. This generically produces a less severe injury to motorists. There are three common types of barriers: wire rope barriers (flexible), steel W-beam guardrails (semi-rigid), and concrete barriers (rigid).

The wire rope barriers' ability to reduce the severe impacts associated with striking non-frangible objects could have a major impact on reduction of fatalities on Bruce Highway. Wire rope barriers are designed to absorb energy more gradually than other barrier types (guardrail and concrete) and so have the potential to result in fewer high severity crashes. Guardrail and concrete barriers may be preferred in locations where high traffic volumes would need significant traffic management to carry out repairs and/or high volumes of heavy vehicles mean the safety risk of barrier encroachment outweighs the benefits of using a flexible barrier.

Wire rope barrier in painted medians may be specified where head-on crash risk is high. This should be justified on a project by project basis. Guidance can be found in the RPDM.

3.3.4.1 General

Roadside safety barrier shall be constructed to current standards in accordance with the provisions of the RPDM Volume 3 Part 6. Practitioners, especially the RPEQ endorsing design solutions, must have understanding of the principles described in that document.

3.3.4.2 Warrants

For the Bruce Highway Safety Package, BCR of the barriers/safer roadsides treatments has already been calculated at a project and program level which has resulted in a prioritised series of safer roadsides treatments. Funding has been secured and a specific quantity of treatments has to be delivered.

For all other projects it is prudent to use the RISC calculator and ensure BCR > 0 so we know we are reducing risk in all cases. Warrants based on roadside hazard risk of objects or batter slopes are discussed under those headings.

3.3.4.3 Design criteria

Current practice for the design of road safety barriers typically results in relatively short lengths of barrier, located approximately along the shoulder edge. Vehicles that need to pull-over for whatever reason, generally will try to stop beyond the barrier ends where they can clear the traffic lane.

However, longer or continuous lengths of barrier may need to be installed. If vehicles are unable to clear the traffic lane due to shoulder width and installed barrier, the risk of incident to the stopped vehicle and its occupants increases.

The following guidance does not currently represent departmental practice. While guidance is based on accepted practice in Victoria, further investigation and guidance development is required, therefore this advice may change in the future.

- A continuous length of barrier is defined as any barrier system installed along the outside shoulder and with a length greater than 500m.
- Absolute minimum offset for continuous barrier (distance between the traffic lane edge line and face of barrier system) is 3m plus required width at similar crossfall to road to support barrier system (refer manufacturers specifications).
- Desirable minimum offset for continuous barrier is 4m plus required width at similar crossfall to road to support barrier system (refer manufacturers specifications). This results in a greater safety benefit over the 3m absolute offset.
- Where site/project constraints prohibit the absolute minimum offset, suitable pull-over areas may need to be provided at approximately 500m intervals.
- Where consecutive lengths of longitudinal barrier systems are installed along the road and where the minimum offset cannot be provided, the minimum distance between the two systems needs to be approximately the same length as a pull-over bay and batter slopes as flat as possible.
- Batter slope outside of installed barrier should be as flat and as clear as possible (as barrier systems can be breached) if a value-for-money outcome can be achieved.

3.3.5 Median road safety barrier

3.3.5.1 Description

Median barriers, and especially the wire rope barrier type, have been used extensively overseas to address head-on crashes. They have also been installed at a number of sites in Australia and New Zealand for the same purpose. Wire rope barrier is used on medians between opposing carriageways, predominantly as a barrier to the roadside environment within painted medians although also as a separator between opposing traffic flows to prevent head-on collisions.

3.3.5.2 Other considerations

The location of median road safety barrier needs to consider heavy vehicle (e.g. Over Size Over Mass) access along the Bruce Highway.

3.3.5.2.1 Technical references

The RPDM Volume 3: Part 6 and GRDBS should be referred for more detail.

3.3.6 Existing safety barriers and end terminals

In addition to new safety barriers; repairing, replacing, upgrading or extending existing safety barriers (including approach barriers at structures) or end terminals should be considered if the existing barrier is unable to reasonably protect the adjacent hazard. While compliance with current standards is desirable, many existing safety barriers and/or end terminals that may not comply with current standards may still provide reasonable performance. Replacing these safety barriers and/or end terminals typically comes at a full cost of new installation, however often only a marginal benefit.

Engineering judgement should be used to ensure only those safety barriers or end terminals that are unlikely to perform adequately are replaced. This will ensure that the program budget is used efficiently and benefits are maximised. The intent is that existing assets that will likely perform to a reasonable level, even if not compliant with current standards, are not replaced unnecessarily at significant cost to the program. This contrasts with currently untreated sections that can be treated for the same cost but will provide much greater benefit, thus producing much greater crash reduction benefits per dollar spent.

3.3.7 Connection to bridge structures

Bridge traffic barriers and roadside safety barriers are to be reinstated to current standards, as documented in the *Design Criteria for Bridges and Other Structures* and the RPDM Volume 3 Part 6.

Approach barrier must be connected to the bridge structure to provide continuity. Where there is no existing bridge rail or parapet on the bridge structure, review whether there is a warrant for barrier on the approaches. If approach barrier is required and full conformance with the bridge connection options in the department's Standard Drawings (e.g. Standard Drawing Numbers 1509 and 1510) cannot be achieved, seek specialist advice from Structures Section of the department whenever proposing to connect to structural installations.

When specifying approach barrier, investigate the need to extend the length beyond the minimum requirement so that roadside risk is adequately managed. Existing approach barrier lengths should also be checked and extended if required.

3.4 Targeted treatments

3.4.1 Special channelised left turn treatment (offset CHL)

3.4.1.1 Description

Significant numbers of vehicles, particularly heavy vehicles making a left turn from the major road at an intersection with an Auxiliary Left Turn lane (AUL), have been identified as restricting the sight lines for vehicles turning out of the minor road, resulting in serious crashes in many cases.

Offsetting the left turn lane from the adjacent through lane on the minor road improves the sight lines for vehicles turning out of the minor road.

3.4.1.2 Technical References

RPDM Volume 3 Part 4A Section 8.2.7

3.4.2 '2+1' road design

3.4.2.1 Description

Districts are advised to seek assistance from Engineering and Technology (E&T) for project specific advice.

3.4.3 Minor safety works treatments

Examples of Minor Safety Works treatments listed below.

3.4.3.1 Audio Tactile Line Marking

3.4.3.1.1 Vision standard

ATLM should be consistently applied with a view to obtaining complete coverage of the Bruce Highway.

3.4.3.1.2 Technical references

Departmental Specification MRTS45 *Road Surface Delineation*, and TRUM Volume 2 *Guide to Road Safety* Part 5 Section 4 provide guidance on the installation for ATLM.

Refer also TN155 *Wide Centre Line Treatment – Interim Advice* which details placement of ATLM with the construction of WCLT.

3.4.3.2 Township Entry Treatment

3.4.3.2.1 Description

A Township Entry Treatment (TET) is a speed management measure that involves providing physical measures at the transition from a high speed rural environment to a lower speed environment that coincides with entering a township.

3.4.3.2.2 Technical references

For guidance on this treatment refer to the department's Technical Note TN170 *Township Entry Treatment*.

3.4.3.3 Move limit lines forward

3.4.3.3.1 Description

Limit lines, also known as Yield line or Hold Lines are technically named Give way and Stop lines. They should be placed in prolongation of the kerb line or edge line using painted markings or kerb extension, such that lines maximise the sight distance available between turning and through vehicles.

3.4.3.3.2 Vision standard

It is recommended that all Stop and Give way lines on intersections with Bruce Highway be moved forward (if not already) unless there is a sound reason not to do so. Possible reasons may include, frequent turning of large vehicles that require additional space to turn into a side road or at some locations with sight line problems. If necessary, the side road can be widened to accommodate moving the limit line on the side road closer to the highway.

3.4.3.3.3 Technical references

Technical guidance related to the positioning of lines at Stop and Give way signs should be referred to MUTCD Part 2 Section 5.4.4 *Traffic Control Devices for General Use*.

3.4.3.4 Traffic signals with controlled right turns

3.4.3.4.1 Description

Traffic signals with controlled or fully protected right turn service consists of a separate signal phase for right-turning vehicles, which allows them to make their turn undisturbed by opposing through traffic. Filtering is prohibited by the presence of a red arrow.

3.4.3.4.2 Vision standard

All traffic signal sites on Bruce Highway should be reviewed, with a view to providing controlled right turns at any site with recorded through-right crashes, or where filtering is a concern for example, where sight distances are limited or traffic volumes are high.

This treatment should be provided both reactively and proactively, before crashes occur, at potentially risky sites.

3.4.3.4.3 Other considerations

A number of studies have found that the installation of partially controlled right turn phases have no beneficial effect on right through collisions.

Fully controlled right turns will reduce the efficiency of the intersection operation. Subject to the turning volumes and other site characteristics, this could have a small or significant impact.

3.4.3.4.4 Technical references

Austroads *Guide to Traffic Management* Part 12 provides clear guidelines on when a protected right-turn phase is required.

Also refer to Austroads *Guide to Traffic Management* Part 10: *Traffic control and communication devices* and MUTCD Part 14.

3.5 Pavements

3.5.1 Consideration of future rehabilitation/overlay options

One of the most important principles of undertaking reconstruction and formation widening projects along the Bruce Highway is to consider future rehabilitation/overlay options. Designers should not provide a solution initially that either:

- makes it difficult to undertake future works, or
- will require major interventions/rehabilitation before the end of the pavement's minimum structural design life.

This applies even when undertaking patching repairs to the pavement where the wrong choice of materials will make it difficult to rehabilitate in the future.

3.5.2 Pavement structural design life for rehabilitation

For guidance on the design life please refer the department's Pavement Design Supplement.

This section applies to both part-width and full-width pavement rehabilitation pavement works under the Program.

For rehabilitation associated with safety package work, this section should be used in conjunction with Section 2 and Section 3.5.3 of this document.

Bruce Highway pavements rehabilitation are to be constructed with a structural design life according to the values in **below.**

Table 2 below.

Table 2 Minimum structural pavement design life

AADT	Pavement Design Life
AADT < 1000	10 years
AADT > 1000	20 years

Adoption of a structural design life below the general minimum values given in Table 2 must be documented and approved by the District Director or delegate.

3.5.3 Part-width formation/pavement widening

For part width pavement widening, existing pavements with a Remaining Useful Life (RUL) of less than 5 years should be considered for rehabilitation, depending on available funding. To determine the residual (remaining) life it is important an adequate pavement investigation is done. This will often include, at the project level, maintenance history, test pits/trenches, testing of materials, testing of the pavement (e.g. deflection testing) and back analysis. Economies of scale may be realised if project investigations are bundled.

For new pavements adjacent to existing pavements, the minimum design life should be 5 years and the maximum design life should be equivalent to the RUL of the existing pavement. A minimum life of five years is reasonable where the new pavement is entirely in the shoulder, and the new pavement does not create a 'boxed' in (overall) pavement. Pavement drainage, including at the interface between existing and new pavements, will need to be carefully considered in all cases. Where the pavement is not entirely in the shoulder, a minimum of a 10 year design life should be adopted.

If the existing pavement needs to be rehabilitated, the 'new' pavement is to have the same design life as the rehabilitated pavement (e.g. 10-20 years dependant on available funding). There is potential to optimise/rationalise the pavement layers/design full width in this case

Stabilised pavement and pavement in boxed-out areas, constructed under a part-width pavement widening or rehabilitation treatment, are to be in accordance with the above criteria and Chapter 4 of the PRM.

3.6 Drainage infrastructure

3.6.1 Culverts

Drainage infrastructure such as culverts, headwalls and table drains can contribute to the severity of run-off-road crashes. The design needs to ensure that potential road safety risks from drainage infrastructure are mitigated if possible or minimised within the context of the site and constraints of the project. For all multi-barrel culverts or culverts over 600 mm in height, safety risk needs to be fully assessed and roadside safety barriers should be considered.

Generally, culverts should be extended where existing headwalls are either within the shoulder or located outside the shoulder but within 0.5m of the shoulder point. Localised widening/shaping of formation will typically be required to provide cover over the extended culvert barrel(s). Not all culverts need to be improved, but expectation is that higher risk culverts are improved. The widening/shaping work should be smooth and permit an errant vehicle to safely traverse.

Slope faced ends are not required on culverts of any size (excluding existing steel culverts with slope faced ends) perpendicular (or skewed) to the highway centre line, however culverts should be provided with ends that have wings so that the flatter embankment slopes can be brought as close as possible to the culvert inlet/outlet.

Small Reinforced Concrete Pipe (RCP) culverts (600 mm or less) under turnouts/accesses, (culvert barrel is laid generally parallel to the highway centreline) must be installed with a precast slope faced end unit (a type that doesn't include bars). Use of Reinforced Concrete Box Culvert (RCBC) type culverts in these situations is not encouraged as slope faced ends are not available for these culvert types.

3.6.1.1 Culvert pre-cast end walls

If pre-cast end/head walls are being used, then consideration should be given to the provision of adequate anchoring (off back of wall into embankment) to improve stability.

Precast, slope-faced end units are not to be used on culverts under the Bruce Highway. Slope-faced units without bars are to be used on culverts under turnouts and accesses (where culvert is laid generally parallel to the highway centreline.

4. Traffic management

4.1 Preventing end of queue crashes

Construction work on Bruce highway has increased extensively under BHUP. This high volume of work means safety around roadworks and traffic controllers continue to be a major issue for Transport and Main Roads and its contractors.

In an environment with multiple road work sites, motorists often required to stop. In some cases, there may be multiple sites within short distances of each other. As motorists approach roadwork sites, drivers are often unable to anticipate queued traffic due to sight distance issues, driver distraction or fatigue conditions and resulting in rear end crashes.

New end of queue risk control measures have been introduced and guidance about supplementary devices to reduce speed and prevent end of queue crashes is now provided in the Supplement, MUTCD Part 3 Works on Roads. Please also refer to Clause 6.5.7 of MRTS02, the department's TC drawings TC2232_1 toTC2232_4 and Clause 4.7.8 of the Supplement to MUTCD Part 3 for guidance on the sign layout.

Mandatory control measures can be nominated in Clause 5.6 of Annexure MRTS02.1.

5. Evaluation and monitoring

For BHUP monitoring and evaluation, the Program Management and Delivery branch collects project details listed below:

- business case documentation
- tender drawings (Hard Copies and AutoCAD Drawings if available)
- ‘As Constructed’ drawings.

Districts are advised to provide above project details to Program Manager (BHUP).

Business Case documents and tender drawings must be provided before tenders are released to the market.