Department of Transport

Context Sensitive Design (CSD) for Road Projects

RDN 01-01

April 2021

Abstract

This Road Design Note (RDN) will assist designers develop context-sensitive road designs to meet a project's objectives, even when guidelines cannot always be followed particularly in constrained environments.

Key Information

This RDN is considered part of the DoT *Supplement to AGRD Part 1: Design objectives*.

Context-sensitive design is essential to the development, assessment, justification and the selection of a preferred design solution within a constrained environment.

Where information contained in this RDN cannot be followed, the designer, engineer or team should seek technical advice (from the Department of Transport or delegated Technical Advisor) and gain acceptance (where necessary) for a departure from the content in this guideline.

1. Purpose

The purpose of this Road Design Note (RDN) is to outline the Department of Transport's (DoT) commitment and approach to "context sensitive" road design. It provides a framework, information and tools to help road designers develop, assess, decide and justify the selection of a design solution within each unique and/or constrained environment.

A "context sensitive" road design must incorporate the following components;

- Set 'Performance-Based Criteria' where relevant
- Apply 'DoT Design Decision Making Principles'
- Explore 'Flexible Design Solutions' where appropriate and ensure that the outcome responds to the network problem or deficiency being addressed
- Support and respond to 'Road-user Requirements and Stakeholder Engagement'

This RDN will outline how these components can be applied to the road design process through information, tools and examples.

This RDN should be read in conjunction with the *DoT Supplement to AGRD Part 1* and *RDN 01-02 Design Exception Reports (DER)*.

2. What is Context Sensitive Design (CSD)?

Austroads Guide to Road Design has been developed adopting using the principle of Context Sensitive Design to provide designers with the guidance needed to respond to the variety of problems and issues that typically need to be addressed in developing and managing a road network. All road designs should therefore be "context sensitive" by applying design guidance to best suit the context and constraints encountered across the road network (such as property boundaries, trees, existing utility services and structures like bridges and retaining walls). Road design guides and standards outline an approach to road design, as well as values for road design elements, that cover a broad range of contexts and applications. However, the guidelines often focus on what should be done for new roads, substantial infrastructure upgrades and largely unconstrained environments (sometimes referred to as "greenfield" sites).

In constrained environments (such as built-up established road corridors or CBDs in urban environments or upgrading existing rural road corridors) it can be difficult to meet all criteria in road design guidelines and standards and provide the infrastructure that is needed without significant costs and/or impacts to the community or environment.

In these constrained environments, it is necessary that there be a consistent approach (or design philosophy) to ensure that risk is managed when developing a design to meet network, corridor or project objectives.

The DoT considers this approach to be the “Context Sensitive Design” approach.

2.1 The components of the CSD approach

The DoT’s CSD approach is comprised of 4 components;

SET	• 'Performance Based Criteria' where relevant
APPLY	• 'DoT Design Decision Making Principles'
EXPLORE	• 'Flexible Design Solutions' where appropriate
SUPPORT	• 'Road-user and Stakeholder Engagement'

These 4 components and how to apply them in the road design process are discussed in detail in Section 4.

2.2 Definitions

The following terms will be used throughout the RDN;

Context Sensitive Design (CSD)	The required approach to design which engages road-users and stakeholders to develop site-specific designs that best meet the objectives of the project while minimising the impact on constraints.
Design Criteria	The specified standards and values (or range of values) for design elements which the design must adopt. These are usually obtained from guides and further detailed in the project scope, works agreement or in a client requirements document. For example; reaction time of 2.5 seconds, 19m semi-trailer design vehicle for intersection swept paths, a design speed of 100km/h. The adopted Design Criteria (values, or range of values for design elements) should be stated by the designer in the design report.
Design Objectives	The intended outcomes (expected level of performance or level of service) for adopting certain design criteria, including definition of any problems that the design is required to address.
Design Elements	Design elements are individual components that make up a design. For example, a design element may be; a horizontal curve, a vertical crest or sag, the crossfall of a road, lane widths, offsets between one feature and another, sight distances for stopping or responding
Design Values	The numerical value selected for an individual design element. The design value is selected from a specific design domain.
Design Domain	The range of ‘design values’ for a ‘design element’ contained in road design guides and standards
Normal Design Domain (NDD)	A range of values for ‘design elements’ contained in road design guides and standards which demonstrate “best practice” and produce acceptable performance in all contexts. The NDD range is published in the body of publications such as Austroads Guide to Road Design (AGRD).
Extended Design Domain (EDD)	A range of values below the NDD range for ‘design elements’ contained in road design guides and standards which produce acceptable performance in some constrained contexts. The EDD range does not exist for all design elements, only for those where there has been evidence of acceptable performance outcomes if used appropriately (i.e. risk has been managed appropriately). The EDD range is published in the appendices of publications such as Austroads Guide to Road Design (AGRD). The use of these values may require acceptance for their use by authorized DoT representatives.
Design Exceptions	The values outside the NDD and EDD (where they exist) ranges for ‘design elements’. These values should only be used where it can be demonstrated that the design produces an acceptable level of performance in the context of the network and/or project. These values may or may not be published in road design guidelines. The use of these values will require acceptance for their use by authorized DoT representatives.

For more information about the Design Domain, Normal Design Domain, Extended Design Domain and Design Exceptions, refer to *DoT Supplement to AGRD Part 1*.

3. The Road Design Process

The road design process begins with a high-level consideration of the strategic network requirements and is completed with a design that is able to be constructed. This process can be divided into clear phases as shown in Figure 1.

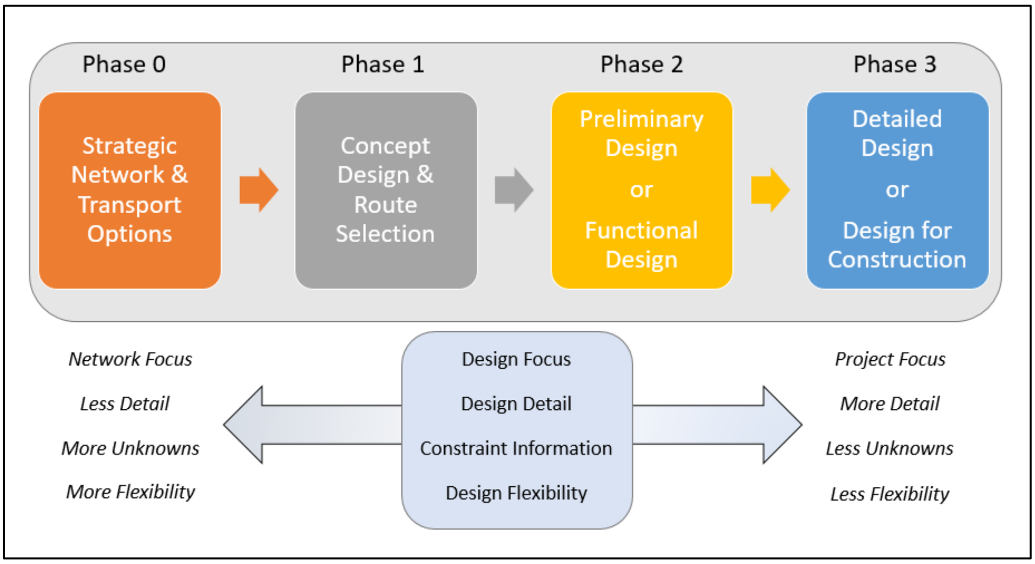

Figure 1: The Road Design Process (Project Phases)

These phases have been developed from *Austroads Guide to Road Design Part 8 Section 1.5*. However, these phases may be referred to with slightly different titles in published documents and across state jurisdictions.

Each phase should have clear and distinct objectives, tasks and outputs (refer to *DoT Supplement to AGRD Part 1 Section V2.1.1.2*). These objectives, tasks and outputs should be clearly stated in a project scope or works agreement document.

Typically, a designer will be working within one particular phase of the project (such as Concept Design or Detailed Design). However, design development within each phase is an iterative process as indicated in Figure 2 with the level of development required often dependent on understanding of risk.

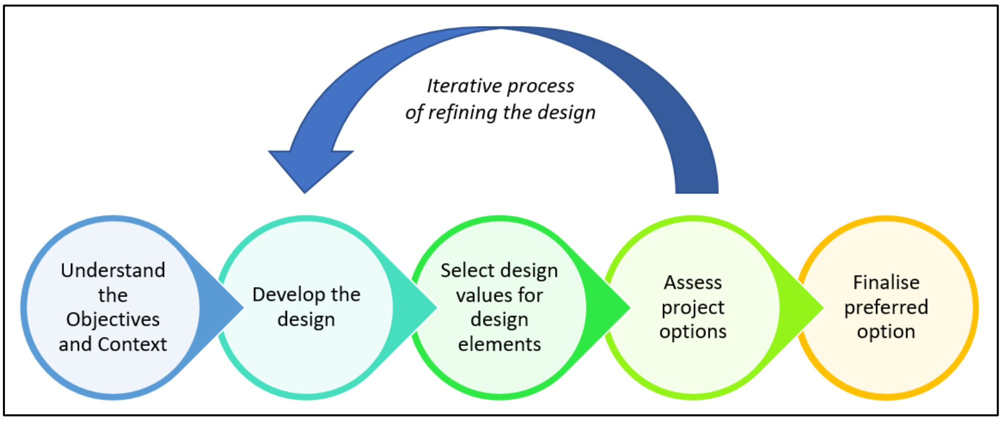

Figure 2: Design development and the iterative design process

The process of developing a design, selecting design values and assessing project options (where there are multiple feasible alternatives) requires the use of judgement and decisions at appropriate stages. These decisions should involve the appropriate stakeholders and relevant authorized DoT representatives. Decisions about design elements and the selection of design options, including reasoning and justification, should be included in the project's Design Report (See Section 5).

4. Applying a CSD framework in the Road Design Process

DoT considers a design to be context sensitive when it incorporates 4 key components. This section will demonstrate how to apply these 4 components in the road design process. The level of application of 4 components of CSD will vary within each phase.

The appendices at the end of this document provide more information, tools and examples for each of the 4 components to assist designers apply CSD to their project.

4.1 Set 'Performance-Based Criteria'

Performance-based design is an approach by which designs are developed and assessed using agreed and established performance-based criteria. This ensures that project options are consistently and methodically assessed and that the preferred design option is selected based on how it addresses the performance-based criteria considered appropriate for the design.

The DoT has divided "Performance-based Criteria" for road design into 4 categories as shown in Table 1. Setting criteria for these 4 criteria encourages designers to develop designs which are:

- consistent across the network ('Network-wide Design' & 'Road Design Objectives')
- tailored to site-specific constraints and requirements ('Project Objectives' & 'Impact on constraints').

Table 1: Performance-based criteria

Criteria	Key Concepts
Network-wide Design	**How well does the option align with the ultimate vision for the route/corridor and the transportation network?** The vision for the network may be generic or detailed in nature, based on the current network plan and/or corridor plan.
Project Objectives	**How well does the option meet the project objectives?** Project objectives are typically defined in the scope, from the investment logic map or are the primary reasons for a project being initiated. e.g. to address a safety issue.
Road Design Objectives	**How well does the option meet the road design objectives (best practice) for safety, mobility, access, economy and environment?** Road Design Objectives are discussed in *Austroads Guide to Road Design Part 1* and are defined within relevant standards and guidelines. Road design objectives are set to achieve 'best practice', each having varying levels of importance for each project. Road design objectives can be set for an overall design solution (macro) or a specific design element (micro).
Impact on constraints	**What constraints does the option impact; to what extent are they impacted; what is the cost and consequence of the impact?** Every project will have constraints and controls, whether they are physical, cost or time, and the importance of these constraints will vary by project and site.

Relevant criteria should be clearly stated and include the minimum acceptable targets and the methodology for measuring. Methodology and targets may include both quantitative or qualitative measures.

Some performance-based criteria, such as the project objectives, may be set by the client and stated in the Design Brief, Works Agreement or Client Requirements Document. Others, such as 'Road Design Objectives' and 'Impacts on constraints' require the designer to undertake tasks to determine how these criteria relate to the project.

Mapping and documenting the impact on constraints is fundamental to the development of a context-sensitive design. It ensures that decisions regarding impacting constraints are informed and justifiable and are based on the best and most appropriate available information. Refer to Appendix A.4 for more information about mapping project constraints.

Key performance-based criteria that may be used (and quantified) relate to operational and road safety outcomes.

The Performance-based Criteria should be documented in the Design Report (See Section 5), along with the assessment of project options and decisions against these criteria.

Additional information and tools to help with assessing project options against Performance-Based Criteria are included in Appendix A.

4.2 Apply 'DoT Design Decision Making Principles'

The Department of Transport (DoT) recommends a consistent and transparent principles-based approach to decision-making. This encourages tailored solutions in compliance or that address reasonable engineering principles. While road design standards and guidelines encourage consistent road and transport infrastructure based on the project context, the aim of DoT Decision Making Principles is to produce consistent decisions for similar contexts during the development of designs, even when guidance is lacking or insufficient.

The following DoT Design Decision Making Principles, shown in Table 2, should be used in the development of designs and used to justify and support engineering decisions that are made.

Table 2: DoT Design Decision Making Principles

DoT Principle	Principle Description
Safe System	The road and road environment must support a vision of zero deaths and serious injury for all road users.
Road Network Efficiency	The efficiency of the transport network will be maintained or enhanced in line with performance objectives including the Movement and Place framework
Community Wellbeing	The wellbeing of the community is not adversely affected
Environmental Sustainability	The environment – both natural and cultural – is not harmed
Utility Services	Access to roadside utilities is preserved
Investment Benefit	The project net benefits outweigh the costs

Many DoT and Austroads standards and guidelines provide details/information to help designers deal with a specific decision or exception. Project officers should adopt a holistic approach when applying guidance for design details, seeking technical advice from designers where appropriate.

Designers should use these principles through the development, selection and assessment of design elements and options and they should be documented in the project's Design Report (See Section 5).

Documentation is of particular importance when decisions have been made to use values for design elements which are less than the Normal Design Domain (NDD) range. Justification and decision-making reasoning should refer to these principles within the documentation (See Section 5 and *RDN 01-02 Design Exception Reports (DER)*).

Additional information about 'DoT Design Decision Making Principles' is included in Appendix B.

4.3 Explore 'Flexible Design Solutions'

Road design guidelines and standards often include a range of values for each design element. This allows designers to select values that best address the project objectives and fit the context by managing the impact on constraints. Guidelines often specify the contexts (such as rural or metro, low-speed or high-speed environments) and describe where these values (or range of values) should be applied.

These ranges of values are categorised into three domains;

Table 3: Design Domains

Domain	Description
Normal Design Domain (NDD)	These values represent current road design standards which should be used wherever possible. These values should produce acceptable levels of performance in all contexts
Extended Design Domain (EDD)	These values are below Normal Design Domain but were developed for certain design elements where it was identified that adopting lower values would still produce an acceptable level of performance in some contexts. EDD criteria does not exist for all design elements
Design Exceptions (DE)	These values are below the Normal Design Domain and fall outside the Extended Design Domain (where they exist). They should only be used in very limited application and where it can be demonstrated that the design produces an acceptable level of performance and level of safety for road users.

The Context Sensitive Design approach encourages designers to explore flexible design solutions using a range of values for design elements, whether within the Normal Design Domain range or outside this range.

While it is desirable to use values from the Normal Design Domain (NDD) range wherever possible, this may not always be feasible. In constrained and existing built-up environments (i.e brownfield projects), implementing NDD values for every design element may significantly impact constraints such as existing buildings and property, utilities or the environment. These impacts may produce unfavourable and unacceptable outcomes for stakeholders and road-users.

This may require the designer to explore 'flexible design solutions' which use a range of design values to achieve the outcomes that have been set in the Performance-based Criteria. Often, the adoption of values below the NDD range for one or two design elements may still produce acceptable performance against the project criteria (See Section 4.1). A number of design iterations are often required to inform an appropriate response, particularly when adoption of values below NDD is proposed.

The Context Sensitive Design approach ensures that designs are developed through a risk assessment and management process. This approach may mean that in some contexts it may be acceptable to reduce lane widths to less than 3.5m and in other contexts it may not be acceptable, in fact lane widths may need to be widened in some cases.

The Context Sensitive Design approach also encourages the development and exploration of innovative designs and emerging treatments. Refer to Appendix C.5. for more information about exploring flexible design solutions and innovative designs and emerging treatments.

Designers are required to document all key design values (especially where EDD and DE values have been used) which are included in the preferred design option in the project's Design Report (See Section 5). Designs which include Design Exceptions are required to be documented in a Design Exception Report (DER) and be assessed and accepted through the appropriate processes and by delegated DoT representatives (See Section 5 and *RDN 01-02 Design Exception Reports (DER)).*

Additional information about factors and considerations that influence the exploration of 'Flexible Design Solutions' are included in Appendix C.

4.4 Support 'Road-user and Stakeholder Engagement'

Understanding how road-users and stakeholders intend on using the road space and infrastructure is critical to developing a design which is context-sensitive. The project team should document which road users should be prioritised on how their needs will be addressed in the development of options, including the level of service that is required to meet the minimum performance targets (as developed through a Movement and Place Assessment; *Austroads Guide to Road Design Part 1 Section 1.2*.).

The development of the project should occur in parallel with a stakeholder engagement plan (which usually proposes representatives from road-user groups). The development of a stakeholder engagement plan generally involves four components:

1. Identifying stakeholders
2. Consulting and engaging stakeholders at key stages

3. Selecting appropriate engagement techniques
4. Planning for implementation to ensure stakeholders are adequately consulted and support the project

A typical list of stakeholders may include all or some of:

- Adjacent property owners (residential, commercial, industrial, institutional—education, religious, government)
- Adjacent property renters (residential, commercial, industrial, institutional)
- Facility users (commuters, heavy vehicle operators, business customers, major regional employers)
- Local jurisdiction elected and appointed officials (city council officers)
- Local jurisdiction transportation or technical professionals (public works directors, traffic engineers, council planners)
- DoT Regional officers
- State transportation professionals (DoT highway designers, traffic engineers, environmental planners)
- Federal transportation professionals
- Transportation service providers
- Emergency Services
- Neighbourhood organizations
- Business organizations (local and regional Chambers of Commerce, economic development agencies, industry associations)
- Transportation interest groups (public transport, bicycle, pedestrian, motorcycle, heavy vehicles)
- Environmental interest groups
- Historic preservation and scenic conservation groups
- Growth management interest groups

A key component of supporting road-user and stakeholders needs and requirements is to assess whether the design adequately (safely and efficiently) supports important movements (access and mobility) of road-users and their varying characteristics. A way of assessing this is through a risk assessment called a 'road-user capability assessment'. Addressing certain road-user requirements and project objectives may be only possible through development of flexible design solutions which do not meet all of the current guidelines and standards requirements for all design elements. A 'road-user capability assessment' ensures that the designer considers the risks associated with the design and assesses whether these risks are acceptable to the road-user.

Road-user and stakeholder needs and requirements, including an assessment of how the preferred design addresses these items, should be documented in the Design Report (See Section 5).

Additional information about supporting 'Road-user and Stakeholder Engagement' is included in Appendix D.

5. Documenting the design and design process

The information provided in this RDN and also in *RDN 01-02 Design Exception Reports (DER)* is to assist designers document the development and reasons for the preferred design (and other options which are considered). This should be captured in the Design Report which provides the narrative and justification of the preferred design as presented in the final design drawings (for the particular design phase being addressed).

The purpose of documenting this information in the Design Report is to provide a complete record of assessments and decisions that made throughout the development of the project. Wherever possible, the designer should refer to the 4 components of context sensitive design (Section 2.1).

All design drawing packages forwarded for review should include an appropriate design report for the stage of development the design is at so that the status of the design is clearly understood by reviewers.

A comprehensive list of items which should be considered in the Design Report are covered in *Austroads Guide to Road Design Part 1 Section 5.2 Design Report*. In addition to this, further considerations are documented in the *DoT Supplement to Austroads Guide to Road Design Part 1 Section 5.2 Design Report*.

Some of the goals of documenting in the Design Report are:

- To record information that might be of use to others or to future projects.

  - The documentation should provide a clear understanding of the design criteria and the context of the site, describe the alternative solutions considered, and justify any decision to deviate from NDD criteria.
  - It can also inform an interested party who might not be familiar with the project or the design exceptions proposed.
- To assist in reviewing, verifying and justifying the design.
  - In particular, the documentation must describe the strategies considered, and adopted, to mitigate the potential risk of any proposed EDD element or design exception.
  - It can be referenced to defend or justify a design decision in the event that the decision is challenged following an incident on the network.
- To record the evolution of the project.
  - The documentation must record the process and reasoning – engineering and otherwise – leading to each decision. It should provide a complete explanation of each decision, noting its relation to the particular context of the site. It should also explain what alternatives were considered and why they were rejected.
  - The documentation can also be used to monitor and assess the performance of the project.
- To provide an asset maintenance record.

Solutions which contain Design Exceptions must complete a Design Exception Report as indicated in *RDN 01-02 Design Exception Reports (DER)*. All Design Exception Reports (DER) for the project should be attached as an Appendix to the Design Report.

References

AASHTO 2018, *A Policy on Geometric Design of Highways and Streets*, 7th edn.

Austroads 2019, *Guide to Road Design*.

NCHRP 2002, *A Guide to Best Practices for Achieving Context Sensitive Solutions*, Transport Research Board, Washington DC, NCHRP Report 480.

NCHRP 2014, *Performance-Based Analysis of Geometric Design of Highways and Streets*, Transport Research Board, Washington DC, NCHRP Report 785.

Appendices

APPENDIX A	Commentary for Setting 'Performance-based Criteria'
APPENDIX B	Commentary for Applying 'DoT Design Decision Making Principles'
APPENDIX C	Commentary for Exploring 'Flexible Design Solutions'
APPENDIX D	Commentary for Supporting 'Road-user and Stakeholder Engagement'

Revision History

Version	Date	Description of Change
0.1	Dec 2019	Working Release
1.0	April 2021	First Version

Additional notes on current version

Restructured RDN to focus on DoT's four components of CSD

Content and editorial changes to align with the latest version of *Austroads Guide to Road Design Part 1 Objectives of Road Design (2021)* and DoT's Supplement

Moved Legal Considerations for Using *Design Exceptions to RDN 01-02 Design Exception Reports (DER)*

Examples have been added to the document to help designers understand the content

Contact Details

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Appendix A: Commentary for Setting 'Performance-based Criteria'

A.1 Network-wide Design (Strategic Corridor or Ultimate Design)

Although a project may originate from a specific problem or need, it is very important to understand the context of the transport network. This will have a significantly influence project objectives and what the project should or shouldn't facilitate (project scope).

Understanding the vision for the project area within the network may include;

- the ultimate cross section, corridor plans or road stereotype
- the future operational classification for the road corridor and project area (movement and place)
- the future traffic demand (traffic volumes and composition)
- changes in land-use and access
- the strategic importance of the route (Does it serve an important function such as a flood or fire evacuation route? Are there limited viable or comparable alternative routes for road-users to use if it were to be temporarily closed? Does the route for an important strategic function for the economy?)

Example A.1.1 – Ultimate Corridor Strategy and the project option A route on which the project is located may have an ultimate corridor strategy for a duplicated carriageway. The project objectives could include upgrading the section to provide the ultimate carriageway. Alternatively, as a minimum requirement, improvement works as proposed by the project should not prevent the ultimate strategy from being implemented.
Example A.1.2 – Scope limits of Project Option due to ultimate vision for project area A problem has identified that a route is heavily congested and operating at a low level of service. However, the ultimate strategy for the corridor may be to transform the project area to cater for high pedestrian movements and activity, including improved cycling infrastructure. The future network strategy could be that the existing traffic will be moved to an upgraded or new alternative route with the residual demand being met by other modes of transport such as trams, buses, trains, walking and cycling. The project objectives could include making minor general traffic improvements to address short-term critical problems without over investing in the existing infrastructure that is planned to be transformed.

The assessment of project options should include how various options address the ultimate vision for the project area.

A.2 Establishing Project Objectives

A.2.1 Problem Definition

A project often originates when a problem or need is identified. A problem can be identified through a planning study, a concern raised by the community, or from a technical review (such as safety or asset program). The problem or need for the project may cover one or more main issues that fit into the following categories;

- Safety Problem
- Current and Future Transport Demand
- Mobility and Access Problem
- Infrastructure replacement or rehabilitation
- Economic Development

It is important that the problem or need is clearly defined and validated by technical tools and analysis. The problem definition should be at the centre of the project. The project objectives should directly address the problem or need that has been identified.

It is not necessarily the responsibility of the designers to define or validate the problem although at times they may assist with this task. However, it should be clear to the designer what the major drivers of the project are so that appropriate decisions about priorities and requirements during the design development process can be made (See Section 3).

A.2.2 Existing Infrastructure Performance

The problem definition may raise items such as a safety problem without stating what deficiencies may be contributing to this. An assessment of the existing geometry and layout against the current guidelines and standards will help identify how the existing infrastructure may be contributing to this problem. This should occur early in the project lifecycle during Phase 1 or 2 (See Figure 1).

Although some design elements of an existing road may not meet current road design standards, this does not mean that they do not produce an acceptable level of performance given the context.

> **Example A.2.2.1 – Existing Infrastructure does not meet current standards**
>
> An existing alignment may include horizontal curves (radii and length) that do not meet current standards for the design speed of the road. This scenario is actually quite common in rural areas where a road may not have been thoroughly planned and over time the road has been progressively upgraded to meet road-user requirements, or demand has changed. The existing road design elements may not have resulted in poor safety or traffic mobility and access performance. However, if the project anticipates that future conditions will result in significant changes to the existing conditions (such as increased traffic volumes), then it is reasonable to consider aspects of existing geometry and layout that may be affected by these changes, even those which historically have not produced poor performance under a lower demand scenario than projected.

Existing design elements (irrespective of whether they do or do not meet current standards) that are identified as contributing to poor performance should be noted and included in the problem definition as items which the project should address.

An analysis of the existing infrastructure will inform the project scope (including 'project type', see Table C.1.1) as the project progresses from the early project phases through to preliminary and detail design.

A.2.3 Ranking Project Objectives

Ranking objectives assists designers and decision-makers assess design options where trade-offs are required. It is useful to rank objectives in order of importance and classified as either Primary (P) Objectives, Secondary (S) Objectives, or Other (O) Objectives.

- Primary Objectives are those that are integral to the success of the project.
- Secondary Objectives are those that are important and desirable but not integral to the success of the project.
- Other Objectives are those that are optional and could be included in the project if they result in minimal impact to constraints (such as time, budget and physical constraints).

Table A.2.3 is an example of how project objectives may be listed and ranked and included in a Design Brief, Works Agreement or Design Report.

Table A.2.3: Ranking Project Objectives

What are we trying to achieve?		
Primary Objectives	**Secondary Objectives**	**Other Objectives**
{List the primary project objectives} P1 –	*{List the secondary project objectives}* S1 –	*{List the other project objectives}* O1 –
P2 –	S2 –	O2 –
P(n) –	S(n) –	O(n) –
* List Objectives in order of importance		

A.3 Setting Road Design Objectives

A.3.1 The Performance of Road Design Objectives

The principles and objectives of road design are general and should be considered and adopted (where applicable) to provide a safe, efficient, economic and environmentally sensitive transport network.

The Austroads Guide to Road Design (AGRD) and Austroads Guide to Traffic Management (AGTM) outline "best practice" for these general principles and objectives. It is helpful for project teams and designers to identify objectives that are relevant to the project and establish targets for the purpose of assessing options.

Below is an example of road design and traffic engineering objectives and how targets can be set so that options can be assessed consistently against these targets.

Example A.3.1 - Examples of Measuring Performance of Road Design Objectives

Objective	Tool	Minimum/Target Performance
Reduce the likelihood of run-off road and head-on crashes (safety)	Predictive Road Safety Risk models such as ANRAM, iRAP	This could be a star rating or predictive FSI reductions
Traffic Intersection Capacity and Efficiency	Traffic simulation models (microscopic simulation)	This could be that capacity and demand volumes are met through LoS targets for various scenarios
Effective Flood immunity for the route	Appropriate hydraulic design software	1 in 50 year flood modelling for culverts

Modelling tools and targets are specific to the requirements of the project and context. Effective tools for assessing the performance are always being refined and improved. However, the tools used should be accepted within the industry as appropriate for the task and, where applicable, accepted by DoT for use.

A.3.2 Summary of Road Design Objectives

The following sources have been used to summarise the principles and objectives of Road Design:

- Austroads Report AP-R548-17 Fundamental Objectives of Road Design
- Austroads Guide to Road Design Part 3 Austroads 2016
- Victorian Transport Integration Act 2010
- Austroads Guide to Road Design Part 1 (2020)

These general objectives and principles can be organised into the following categories:

Safety; Mobility and Access; Economy; Environment and Community.

Table A.3.2: Summary of Road Design Objectives into four categories

<table>
<tr><th colspan="2">Safety Objectives</th></tr>
<tr><td>
Principles of Road Design

3. A design must be fit-for-purpose, whilst trying to achieve the highest possible standard of design, operational efficiency and safety within the context of the site, the project scope and budget.

6. A design cannot be considered fit-for-purpose and/or conforming if it simply adopts design minima, particularly in combination, for most or all elements of the design.

8. A design should consider and cater for the interaction between all road users and the roadway.

11. A design should maintain or improve the performance of an existing road. The improvement of one or more elements should not adversely affect the performance of another.

Objectives of Geometric Design

Maximise safety by providing a road and roadside that is designed to minimise fatalities and serious injuries for all road users.

DoT Design Decision Making Principles

Safe System Principle & Utility Services Principle

Objectives of Road Design
</td><td>
Transport Integration Act 2010 – Transport Objectives

<u>Social and economic inclusion</u>

The transport system should provide a means by which persons can access social and economic opportunities to support individual and community wellbeing including by—

(a) minimising barriers to access so that so far as is possible the transport system is available to as many persons as wish to use it;

(b) providing tailored infrastructure, services and support for persons who find it difficult to use the transport system.

<u>Safety and health and wellbeing</u>

(1) The transport system should be safe and support health and wellbeing.

(2) Without limiting the generality of subsection (1), the transport system should—

(a) seek to continually improve the safety performance of the transport system through—

(i) safe transport infrastructure; (ii) safe forms of transport;

(iii) safe transport system user behaviour;
</td></tr>
</table>

3. Safety 8. Provision for Cyclists and Pedestrians	(b) **avoid and minimise the risk of harm** to persons arising from the transport system; (c) promote forms of transport and the use of forms of energy which have the greatest benefit for, and least negative impact on, health and wellbeing.
Mobility and Access Objectives	
Principles of Road Design 3. A design must be fit-for-purpose, whilst trying to achieve the highest possible standard of design, operational efficiency and safety within the context of the site, the project scope and budget. 9. A design should meet current needs whilst also providing for future needs. 11. A design should maintain or improve the performance of an existing road. The improvement of one or more elements should not adversely affect the performance of another. Objectives of Road Design 1. Strategic Fit 2. Nature and Magnitude of Transport Demand 5. Reduced Travel Time and Costs 7. Improved Public Transport 8. Provision for Cyclists and Pedestrians Objectives of Geometric Design Maximise operational efficiency by providing a road that can carry the required volume of traffic at a speed that is consistent with the functional class of the road and road safety objectives. Maintain uniformity of design parameters along a route and/or within a network, particularly across administrative boundaries, to provide a consistent and operationally effective driving experience relative to the functional class of the road. Adequately provide for the future requirements of the road network by considering the ultimate road layout required to serve general traffic growth and adjacent development in the vicinity of the works. Also ensure that future expansion of the road can be accommodated with minimum reconstruction. Transport Integration Act 2010 – Transport Objectives Social and economic inclusion The transport system should provide a means by which persons **can access social and economic opportunities** to support individual and community wellbeing including by— (a) **minimising barriers to access** so that so far as is possible the transport system is available to as many persons as wish to use it; (b) providing tailored infrastructure, services and support for persons who find it difficult to use the transport system. Economic prosperity The transport system should facilitate economic prosperity by— (a) **enabling efficient and effective access for persons and goods to places of employment, markets and services;** (b) increasing efficiency through reducing costs and improving timeliness; (c) fostering competition by **providing access to markets**; (d) facilitating investment in Victoria; (e) supporting financial sustainability.	Transport Integration Act 2010 – Transport Objectives Integration of transport and land use (1) The transport system should provide for the **effective integration of transport and land use and facilitate access** to social and economic opportunities. (2) Without limiting the generality of subsection (1), transport and land use should be effectively integrated so as to **improve accessibility and transport efficiency with a focus on**— (a) **maximising access to residences, employment, markets, services and recreation;** (b) planning and developing the transport system more effectively; (c) reducing the need for private motor vehicle transport and the extent of travel; (d) **facilitating better access to, and greater mobility within, local communities**. (3) Without limiting the generality of subsection (1), the transport system and land use should be aligned, complementary and supportive and ensure that— (a) transport decisions are made having regard to the current and future impact on land use; (b) land use decisions are made having regard for the current and future development and operation of the transport system; (c) transport infrastructure and services are provided in a timely manner to support changing land use and associated transport demand. (4) Without limiting the generality of subsection (1), the transport system should improve the amenity of communities and minimise impacts of the transport system on adjacent land uses. Efficiency, coordination and reliability (1) The transport system should facilitate network- wide efficient, coordinated and reliable movements of persons and goods at all times. (2) Without limiting the generality of subsection (1), the transport system should— (a) balance efficiency across the network so as to optimise the network capacity of all modes of transport and reduce journey times; (b) maximise the efficient use of resources including infrastructure, land, services and energy; (c) facilitate integrated and seamless travel within and between different modes of transport; (d) provide predictable and reliable services and journey times and minimise any inconvenience caused by disruptions to the transport system. DoT Design Decision Making Principles Road Network Efficiency Principle Utility Services Principle

Economic Objectives

Principles of Road Design

3. A design must be fit-for-purpose, whilst trying to achieve the highest possible standard of design, operational efficiency and safety within the context of the site, the project scope and **budget**.

5. A design should demonstrate **cost-effectiveness** through value engineering processes, cost benefit analysis and consideration of **whole-of-life costs**.

Objectives of Road Design

5. Reduced Travel Time and Costs

6. Reduced Freight Costs

DoT Design Decision Making Principles

Investment Benefit Principle

Transport Integration Act 2010 - Decision making principles

<u>Principle of triple bottom line assessment</u>

The principle of triple bottom-line assessment means an assessment of all the **economic**, social and environmental costs and benefits taking into account externalities and **value for money**.

Objectives of Geometric Design

Development of economically efficient designs to maximise the benefit of limited funds available for road construction and maintenance. Therefore, for a particular design, minimise costs associated with construction, maintenance, and operation of the road whilst meeting all other objectives.

Transport Integration Act 2010 – Transport Objectives

<u>Social and economic inclusion</u>

The transport system should provide a means by which persons can access social and **economic opportunities** to support individual and community wellbeing including by—

(a) minimising barriers to access so that so far as is possible the transport system is available to as many persons as wish to use it;

(b) providing tailored infrastructure, services and support for persons who find it difficult to use the transport system.

Transport Integration Act 2010 – Transport Objectives

<u>Economic prosperity</u>

The transport system should **facilitate economic prosperity** by—

(a) enabling efficient and effective access for persons and goods to places of **employment, markets and services**;

(b) increasing efficiency through **reducing costs** and improving timeliness;

(c) fostering competition by providing access to markets;

(d) **facilitating investment** in Victoria;

(e) **supporting financial sustainability**.

<u>Integration of transport and land use</u>

(1) The transport system should provide for the effective integration of transport and land use and facilitate access to social and **economic opportunities**.

(2) Without limiting the generality of subsection (1), transport and land use should be effectively integrated so as to improve accessibility and transport efficiency with a focus on—

(a) maximising access to residences, **employment, markets, services** and recreation;

(b) planning and developing the transport system more effectively;

(c) reducing the need for private motor vehicle transport and the extent of travel;

(d) facilitating better access to, and greater mobility within, local communities.

(3) Without limiting the generality of subsection (1), the transport system and land use should be aligned, complementary and supportive and ensure that—

(a) transport decisions are made having regard to the current and future impact on land use;

(b) land use decisions are made having regard for the current and future development and operation of the transport system;

(c) transport infrastructure and services are provided in a timely manner to support changing land use and associated transport demand.

(4) Without limiting the generality of subsection (1), the transport system should improve the amenity of communities and minimise impacts of the transport system on adjacent land uses.

Environmental and Community Objectives

Principles of Road Design

3. A design must be fit-for-purpose, whilst trying to achieve the highest possible standard of design, operational efficiency and safety within the **context of the site**, the project scope and budget.

4. **A design must be context sensitive** and consider and incorporate input of all appropriate disciplines and stakeholders to ensure the objectives of road design and a balance of often competing and contradictory factors are achieved.

7. A design must be considerate of **environmental, cultural heritage and social requirements**.

Objectives of Geometric Design

Minimise adverse environmental impacts (during construction and operation) and enhance the environment where possible both in the immediate vicinity of the road and over a wider area. This includes integration of the road design into the surrounding environment to achieve a visually pleasing outcome.

Transport Integration Act 2010 – Transport Objectives

<u>Social and economic inclusion</u>

The transport system should provide a means by which persons can access social and economic opportunities to support individual and community wellbeing including by—

(a) minimising barriers to access so that so far as is possible the transport system is available to as many persons as wish to use it;

(b) providing tailored infrastructure, services and support for persons who find it difficult to use the transport system.

<u>Environmental sustainability</u>

The transport system should actively contribute to environmental sustainability by—

(a) protecting, conserving and improving the natural environment;

Transport Integration Act 2010 – Transport Objectives

Objectives of Geometric Design	Transport Integration Act 2010 – Transport Objectives
Maximise opportunities to cater for the needs of all road user groups including all types of vehicles expected to use the road. Where practicable, provide a design that takes account of the views of the community including local residents, businesses, community groups and road users. **Transport Integration Act 2010 - Decision making principles** Principle of triple bottom line assessment The principle of triple bottom-line assessment means an assessment of all the economic, social and environmental costs and benefits taking into account externalities and value for money. Principle of equity The principle of equity means— (a) equity between persons irrespective of their— (i) personal attributes, including age, physical ability, ethnicity, culture, gender and financial situation; or (ii) location, including whether in a growth, urban, regional, rural or remote area; (b) equity between generations by not compromising the ability of future generations to meet their needs. Principle of the transport system user perspective The transport system user perspective means— (a) understanding the requirements of transport system users, including their information needs; (b) enhancing the useability of the transport system and the quality of experiences of the transport system. Precautionary principle (1) The precautionary principle means that if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. (2) The precautionary principle includes— (a) a careful evaluation to avoid serious or irreversible damage to the environment wherever practicable; and (b) an assessment of the risk-weighted consequences of various options. Principle of stakeholder engagement and community participation The principle of stakeholder engagement and community participation means— (a) taking into account the interests of stakeholders, including transport system users and members of the local community; (b) adopting appropriate processes for stakeholder engagement.	(b) avoiding, minimising and offsetting harm to the local and global environment, including through transport-related emissions and pollutants and the loss of biodiversity; (c) promoting forms of transport and the use of forms of energy and transport technologies which have the least impact on the natural environment; (d) improving the environmental performance of all forms of transport and the forms of energy used in transport. Integration of transport and land use (1) The transport system should provide for the effective integration of transport and land use and facilitate access to social and economic opportunities. (2) Without limiting the generality of subsection (1), transport and land use should be effectively integrated so as to improve accessibility and transport efficiency with a focus on— (a) maximising access to residences, employment, markets, services and recreation; (b) planning and developing the transport system more effectively; (c) reducing the need for private motor vehicle transport and the extent of travel; (d) facilitating better access to, and greater mobility within, local communities. (3) Without limiting the generality of subsection (1), the transport system and land use should be aligned, complementary and supportive and ensure that— (a) transport decisions are made having regard to the current and future impact on land use; (b) land use decisions are made having regard for the current and future development and operation of the transport system; (c) transport infrastructure and services are provided in a timely manner to support changing land use and associated transport demand. (4) Without limiting the generality of subsection (1), the transport system should **improve the amenity of communities** and minimise impacts of the transport system on adjacent land uses. **Objectives of Road Design** 4. Community Expectations **DoT Design Decision Making Principles** Community Wellbeing Principle Environmental Sustainability Principle

A.4 Constraints mapping and impact assessment

Constraints Mapping is an important task to understand the project context. Constraints may be assets, infrastructure, areas, items or conditions which if impacted have an effect on time, cost, reputation, community and political support, and environmental sustainability. Constraints need to be mapped and assessed so that during the development of options, the designer is informed about the impacts the design may have on constraints.

A.4.1 Project Phase

Typically, a project starts with high-level information about the general characteristics of constraints (See Figure 1). This may be adequate in understanding the major risks for the project and whether certain options are feasible. High-level information may not be very accurate but may be adequate for the purpose of developing and assessing multiple strategic options.

However, as the project develops, more detail may be needed and require specialist studies (such as environmental studies, cultural heritage studies) to understand the significance of constraints and consequences if a constraint is impacted.

. As more information is received about constraints, previous decisions may need to be revisited in light of the new knowledge to assess which option best meets the project objectives while minimising the impact on constraints.

. This may require changes to the designs, including previously accepted options. It is important to assess how the proposed changes to design elements align with achieving the project objectives.

At later phases of the project lifecycle, there is often a focus on minimising the impact on constraints, reducing construction costs and avoiding delays to delivery. All of these aspects are important to the success of the project but the design should always be measured against the project objectives. Decisions about the impacts on constraints should not be at the compromise of adequately addressing the objectives of the project and the objectives of road design.

The project team should understand what information is required about constraints for each phase of the project. This will ensure that decisions are being made about constraints with adequate knowledge about them and the consequences of impacting them. The project team should be aware that gathering information about some constraints may require significant lead times. This should be factored into the project program.

A.4.2 Constraints Mapping

Mapping constraints involves two tasks;

- Identify and catalogue constraints in a CAD file or files
- Create a register of constraints with details

Constraints mapping is the exercise of identifying constraints, locating them in relation to the project area of interest, understanding the level of detail of the information that is available, noting the importance of the constraint and documenting the consequences if the constraint is impacted.

Mapping constraints should be undertaken at the beginning of the project and be continually updated as the project is developed.

A.4.2.1 Typical Project Constraints

Below is a list of typical project constraints. The project team should consult experts to understand the constraints that may exist in the project area or area of interest. Many of these constraints will be picked up through detailed survey at later phases of the project. However, some information (such as existing reports, GIS databases or desktop studies) about some of these constraints may be available and be documented earlier in the project lifecycle.

Table A.4.2.1: Typical Project Constraints

Environment	Time	Budget	Right-of-Way (ROW)	Property Boundaries
Utility Locations	Heritage Properties	Structures	Geotechnical Conditions	Hydrology Requirements

A.4.2.2 Constraint Location

The designers should develop a CAD file with the location of constraints so that they can easily be overlayed or referenced into the proposed designs or options. Constraints can be either points (such as the location of a power pole) or areas (such as an environmentally sensitive or protected area, or property boundary).

A.4.2.3 Level of Detail

The level of detail known about the constraint should be documented and contained within the metadata of the CAD file. During the early phases of a project, information about constraints may have been extracted from aerial photography or high-level information with a low degree of accuracy. It is vital that the project reference the source of the constraint information and note the level of accuracy. As a project develops, more accurate information about constraints may become available through specialist studies or detailed survey.

Constraints that are critical to decision making require precise information about the size and location of the constraint. If this is not available, the project should include contingencies to allow for the variability of accuracy of data.

The designer should also be aware of how up-to-date the constraints mapping data is.

> **Example 4.2.3.1 – Context Data is out-dated or has been superseded**
>
> A detailed survey for a project may have been undertaken some time ago, but pipeline priorities changed, and the project was put on hold. Significant changes have occurred within the surveyed project area and information may become superseded. Changes include, utilities and utility relocations, property accesses and developments, additional roadside furniture.
>
> If the design was to be developed based on the survey that was done 5 years earlier, the project may discover that it is not scoped properly, assumptions about constraints are not correct and there is a risk that this will result in significant extra costs, delays to delivery timelines and a significant amount of design rework.

It should not be assumed that because the information containing constraints has a high level of detail that the information is current and relevant. Designers should always check the accuracy (reflective of current site conditions) of information. This may require verifying information on site.

A.4.2.4 Constraint Importance

Once all known constraints have been mapped, the project together with experts and specialists can rank the importance of constraints.

> **Example A.4.2.4.1 – The varying importance of project constraints within the project area**
>
> There may be commercial and residential properties that can be impacted to a greater extent than others (such as vacant land, or lower value buildings). Conversely, there may be commercial and residential properties that cannot be impacted (such as new buildings, heritage listed buildings). Similarly, there may be some vegetation that can be impacted more than others and other vegetation which should be avoided because they contain endangered or protected species.

The constraint importance gives designers and decision makers information about which constraints can be impacted and which constraints should be avoided.

A.4.2.5 Constraints Mapping Table

Table A.4.2.5 is an example of a constraints mapping table which can be used as a reference for designers when developing a design and assessing project options. This table could also be included in the Design Report.

Table A.4.2.5: Constraints Mapping Table

Constraints Mapping						
	Type of Constraint	**Constraint Details**	**Constraint Location**	**Level of Detail**	**Constraint Importance**	**Consequence of Impact**
1	*{Environmental, Time, Budget, RoW, Property Boundaries, Utilities, Heritage, Structures}*	*{Description of constraint}*	*{Location of constraint if it is physical}*	*{The level of detail known about the constraint}*	*{Very High, High, Moderate, Low, Very Low}*	*{for example, physical actions such as relocation or acquisition, costs involved}*
2						
n						

When documenting the constraints, the importance of the constraint should be noted so that it is clear to designers what constraints should be avoided and which may be impacted if necessary. Below is an example of how to categorise the importance of constraints.

Very High:	Constraint cannot be impacted (or must be met for constraints such as time and budget) and there are very significant consequences (such as time, money, impact on community) if impacted
High:	Impacting constraint should be avoided and only be impacted under very limited circumstances resulting in significant consequences
Moderate:	Constraint may be impacted if it can be demonstrated provides reasonable benefit to meeting project objectives
Low:	Impacting the constraint has consequences that are acceptable to the stakeholders and community
Very Low:	Impacting the constraint has little to no adverse consequences

A.5 Assessing the performance of Project and Road Design Objectives

The Performance-based Criteria identifies the project and road design objectives that are critical to the success of the project. A performance-based assessment documents the expected performance of each project option against each of the objectives.

Key aspects of the Performance Based Assessment for each option are;

- State the objective that is being measured
- State the measured performance against the objective
- State the tool or tools that were used to measure the performance with any relevant assumptions
- State why the option may have performed as measured and how the option compares with other options

A.5.1 Presenting the results of an options assessment performance

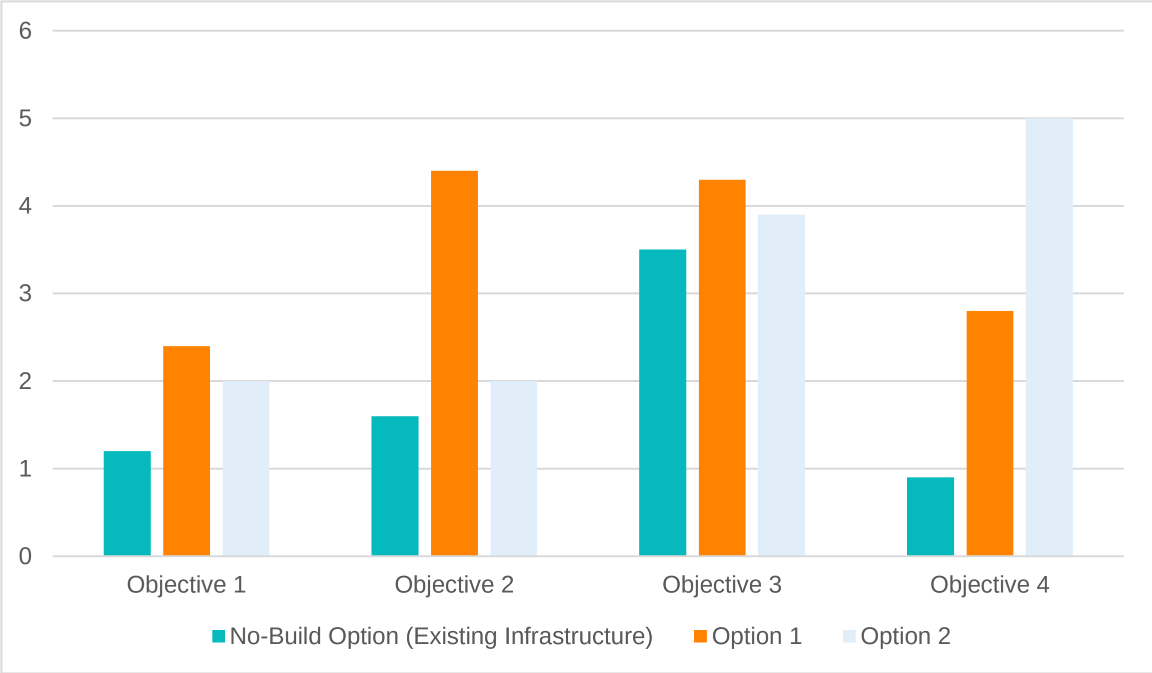
Table A.5.1 is an example of how to document the results of a performance-based assessment in the design report. Providing a summary table such as this demonstrates clearly how each option performs against the criteria.

Table A.5.1: Ranking Project Options

Performance Based Assessment			
Objective	**Performance**	**Tool**	**Comment**
{Objective 1}	*{state the performance}*	*{how was the performance measured and what are the assumptions (if any) used in measuring the performance}*	*{Comment about why it performed as measured, how does it compare with other options}*
{Objective 2}			
{Objective n}			

It may be helpful to present the results of the options assessment performance in a comparison table as shown in Chart A.5.2.

Chart A.5.2: Option Comparison Against Objectives



A.2.5 Assessing the performance against a base case 'No Build' option

If the project is in an early phase of the project lifecycle, it may be helpful to compare projects against a 'no build' project option. This is an analysis of the project area (or existing road corridor) if no options are built. The 'no build' option should be assessed for the future design year. Tools such as traffic simulation and modelling, or crash prediction tools, existing asset performance can be used to predict the future for the existing infrastructure.

For new routes, the 'no build' performance may consider the current and future impacts on the existing network if the project is not built. As existing infrastructure does not exist, the 'no build' scenario highlights the poor performance of areas of the network if the transport demand is not met.

If the project is in later phases of the project lifecycle, assessing project options against a 'no build' project option may not be effective.

Appendix B: Commentary for Applying 'DoT Design Decision Making Principles'

The Department of Transport has principles which should be applied during the development, selection and assessment of design elements and options. These principles ensure that there is a consistent approach, even when design guidance does not include a certain context or combination of constraints.

Designers and decision-makers should adopt a holistic approach in applying these principles, seeking technical advice from designers where appropriate. Safety performance must always be considered, especially the Safe System Principle (discussed in Section B.1).

Each core principle should have quantitative support where appropriate. For example, the project benefits of a design element should be quantified, as should the risks. Quantification provides a measure for later monitoring and evaluating the success of the design.

B.1 Safe System Principle

The risk of death or serious injury is directly related to the likelihood of a crash and the severity of the forces vehicle occupants are subjected to during a crash. This level of risk needs to be carefully considered when proposing a design that adopts minimum design criteria. Such consideration must take into account the speed environment, the road environment (such as the existing substantive safety, traffic composition, road facility type, geometry, roadside characteristics, etc.) and the likely success of various mitigation options.

The Safe System Principle aims to provide a safe transport network for all users by:

- minimising the likelihood and severity of conflict between vehicles through a forgiving road and roadside
- providing mitigation to reduce the forces on occupants when their vehicles collide with roadside objects
- minimising the likelihood and severity of conflict between vulnerable users and other users of roads
- meeting driver expectation (including reasonable road-user capability) and
- providing consistency of character along the road corridor.

Road-user capability is an important consideration for many reasons. Consider the case where an existing cross-section is to be upgraded. Care must be taken here to ensure that the upgraded road is not made less safe by giving drivers an exaggerated sense of capability.

Designers must thoroughly investigate the substantive safety of brownfield sites, noting the number and types of crashes at those sites and their relationship to the design of the site. (They might also consider the substantive safety of similar sites.) The substantive safety must be documented, along with any existing substandard design elements and elements designed to minimum criteria.

B.2 Road Network Efficiency Principle

In line with the Department of Transports' Movement and Place decision-making framework, designs should have no adverse effects on the efficiency of vehicle movement on roads designated as significant traffic or freight routes. Transport network decisions should be aligned with land-use decisions so that transport infrastructure will meet the accessibility and operational needs of all transport modes in both the present and the future.

Consideration should be given to vulnerable road users and also those who may not directly use the road but whose transportation needs may be influenced by the proposed works.

B.3 Community Wellbeing Principle

The goal of this principle is to ensure that transport infrastructure supports healthy liveable communities, provides high-quality roadside amenity and accommodates active travel (that is, travel that involves physical activity, such as walking and cycling). It is necessary to gain broad stakeholder and community acceptance of road designs.

B.4 Environmental Sustainability Principle

The goal of this principle is to minimise the transport system's adverse effects on the environment, and to improve the environment where appropriate. This can be achieved by protecting the natural environment – in particular the flora and fauna – and by enhancing the aesthetics of roadside amenities.

This principle extends to respecting and preserving cultural heritage values and assets, both Indigenous and non-Indigenous.

B.5 Utility Services Principle

This principle ensures that road reserves can accommodate other appropriate uses – such as utility services – without adversely affecting road safety. Works should not make the roadside environment any less safe than it currently is (and provide appropriate mitigation if necessary). Consideration should also be given to providing easy access and a safe workplace for utility maintenance work.

B.6 Investment Benefit Principle

This principle prescribes that each proposed design element, and its alternatives, be objectively reviewed to establish whether the associated capital expenditure for the project represents the best use of community resources across the road network. Not only must the initial development costs and costs of mitigation be considered, but also the whole-of-life costs (such as maintenance costs).

Project planners must also ensure that current proposals align with long-term network plans to avoid redundant works in the future and not impact on future project viability.

Appendix C: Commentary for Exploring 'Flexible Design Solutions'

Road design guidelines and standards continue to evolve and change to reflect best practice. Guidelines and standards should be followed by designers wherever possible. However, in certain circumstances, it may be difficult to follow guidelines and standards and achieve the project objectives without significant impacts to cost, constraints and the environment. In these constrained, designers may be required to explore design solutions which are

C.1 The Project Type and Design Criteria

Road design projects can be categorised into four categories as shown in Table C.1.1. Projects may not always fall neatly into one of these four categories. However, these project types provide guidance about the typical criteria that can be considered when exploring flexible design solutions.

Table C.1.1: Project Type and Design Criteria

Project Type	Changes to Existing Road	Design Criteria
New Road or Duplication	A new road or duplication involving a new alignment or significant changes to existing geometry and intersections.	Normal Design Domain (NDD), Extended Design Domain (EDD) if context warrants, Design Exceptions (DE) should be avoided
Restoration (Major)	A project on an existing road involving major changes to the cross section, intersection layouts and targeted geometric improvements	Normal Design Domain (NDD), Extended Design Domain (EDD) if context warrants, Design Exceptions where it is prohibitively expensive to justify NDD criteria
Restoration (Minor)	A project on an existing road involving minor changes to the cross section and intersection layouts while retaining existing geometry	Retain existing design criteria and adopt flexible design criteria to upgrade areas of poor performing design elements
Maintenance & Improvement Works	A project involving maintenance and minor upgrades to seal width, barriers, signs and linemarking	Retain existing design criteria and adopt flexible design criteria to upgrade areas of poor performing design elements

The project type relates to the Performance-based Criteria (See Section 4.1) and informs what new infrastructure and changes to existing infrastructure should be included as part of the project scope. In addition to this, it also informs the designer what design criteria can be used to develop the design.

Table C.1.1 is a guide only and design criteria (Design Domains and values for design element) should be agreed through a collaboration between the client and designer as the project develops through the design phases (See Figure 1). It may not be possible to refine all the design criteria at the early phases of a project (Phase 1 & 2) as all the available information about context and constraints may not be available. *DoT Supplement to AGRD Part 1* highlights the criteria for elements which should be accepted at the various phases of a project.

Example C.1.2 - Pedestrian crossing in a highly constrained environment

A project objective may be to provide a new pedestrian crossing ('Improvement Works' focused on a raised platform, additional signs and linemarking) within an existing highly constrained urban environment. It may not be appropriate to upgrade the horizontal and vertical geometry just because they do not meet current standards. However, if existing geometry will significantly impact the performance (particularly safety) of the new crossing, then it may be appropriate to include some geometric improvements as part of the project scope.

Example C.1.3 – Design Criteria for new major motorway

If the project is a new major motorway ('New Road') involving significant infrastructure, then there is an expectation that current road design standards (NDD range) be applied wherever possible. It is not appropriate to be adopting lesser values for design elements on major infrastructure projects purely on the basis of reduced capital costs or budget constraints. The new motorway should be scoped such that it adopts 'best practice' for geometry, layout and infrastructure to produce the highest level of performance in all areas (safety, access and mobility, economy, environment and community). The results of adopting reduced project standards or scope decisions on network performance outcomes need to be clearly documented and discussed as part of decision making.

C.2 Project Phase

Figure 1 demonstrates that as the design is developed there is less flexibility to explore design solutions as project timeframes and budgets are refined and locked in.

It is important that the design criteria be established in an early project phase (Phase 1 and 2) where there is the greatest flexibility to determine the scope (including project type) of work that will be undertaken to satisfy network objectives.

It may not be feasible to explore flexible design solutions that include major changes to the scope in later project phases (Phase 3 & 4).

However, if key assumptions that were used to determine the project scope in earlier phases of the project (Phase 1 and 2) prove to be incorrect (such as the location, significance or ability to impact key constraints), then the project may be required to explore alternative options. The assessment of options that significantly change the scope of the project should be thorough and consistent with the content sensitive components referred to in this document (See Section 2.1), irrespective of whether the project is at a later phase of design. All alternative options considered should address impacts on broader network and maintenance operations and outcomes.

C.3 Constrained Locations vs Typical Cross Section

The decision to adopt reduced values for certain design elements should always be considered in the context of the corridor. Is the decision to reduce values for design elements at a constrained location on a project, or for a significant section of a project, or to be applied to the typical cross section (i.e. whole project)?

Example C.3.1 - Reduced barrier offset at a project constraint vs for a typical cross section

Reduced Barrier offset at a constrained location

Reduced Barrier offsets for the typical cross section for median and verge barriers on a constrained site

A designer is working on the preliminary design to upgrade to an existing high-speed rural highway to incorporate a verge barrier. The concept design showed a 4m offset from the travel lane to the verge barrier.

In Scenario 1, a designer may be required to reduce the sealed shoulder and verge barrier offset from 4m to 1m where there is a localised constraint (such as existing structure like a culvert, major utility service, significant tree) to avoid or reduce the impact on that constraint. The total length of reduced shoulder and barrier offset may be 60m. The shoulder and barrier offset for the remainder of the project is 4m and is shown as 4m on the typical cross section of the drawings.

In Scenario 2, there may be a longitudinal constraint along the project (such as a significant retaining wall, existing earthworks batter, RoW boundary, constant offset of significant trees, environmentally sensitive area adjacent to the road corridor) which results in the selection of a 1m shoulder for the majority of the project. The typical cross section is updated to show a 1m offset to the verge barrier.

Although both Scenario 1 and Scenario 2 contain reduced shoulder and barrier offset to 1m, the risk associated with each scenario is significantly different. Scenario 1 is a decision to adopt a reduced barrier offset (i.e. Design Exception) at a constrained location. Scenario 2 is a decision to adopt a Design Exception as well as a reduction in project scope.

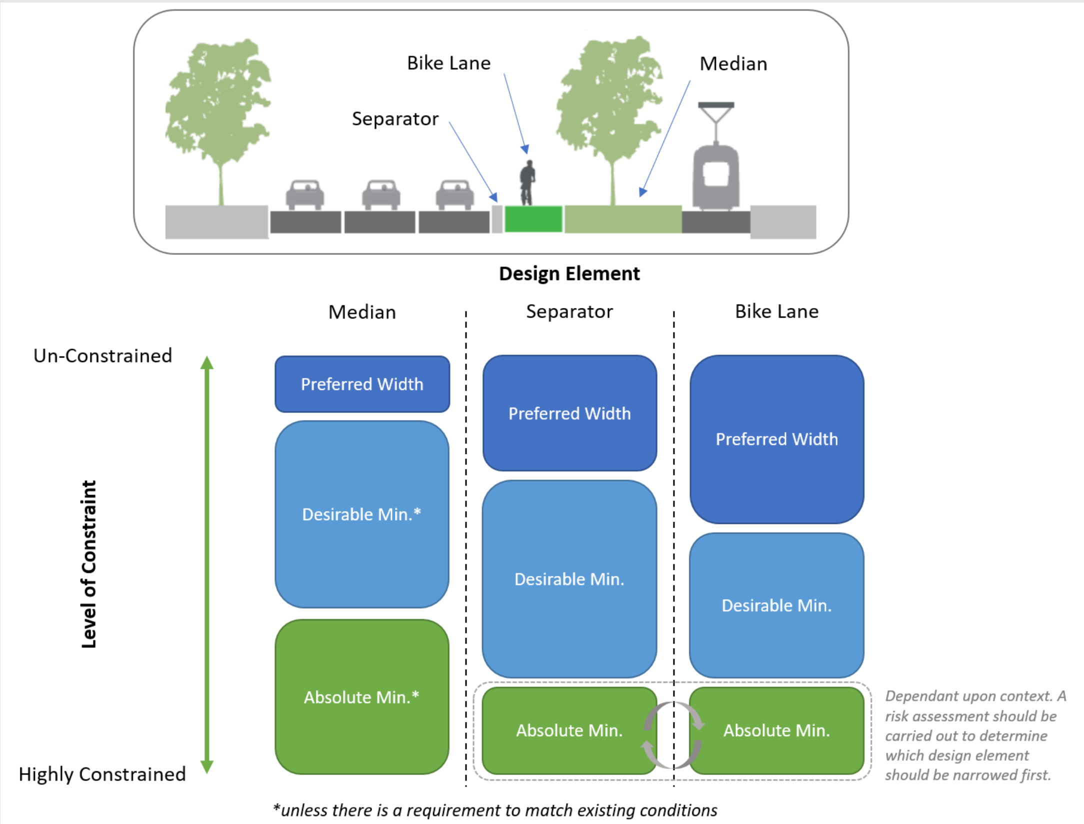
Technical advice is required for both a reduction of a design element(s) at a constrained location on a project, as well as to be adopted for a typical cross section for a project. However, the decision to change a typical cross section (project scope) is likely to be deemed greater risk and may trigger a separate DoT governance processes to finalise a decision.

C.4 Finding the optimum balance when combining values for design elements

When designing in constrained environments, it is inevitable that not all road design standards and guidelines (NDD values for design elements) can be met. This will require the designer to decide which values are reduced, how much they are reduced by.

Example C.4.1 - Process for reducing design elements for a cycle facility in constrained environments

Below is an example of a process that was developed for the provision of a bicycle lane in a central median. There are varying constraints along sections of the project which require the reduction of widths for median, bicycle lane and physical separator between the bicycle lane and general traffic lanes. The process shows that the first element to be reduced is the median, followed by the separator and then finally the bicycle lane as the level of constraint becomes higher.



Example C.4.2 – Providing an additional turning lane at a constrained intersection

The designer is investigating the proposal to upgrade an intersection in an urban environment to accommodate an additional turning lane to improve capacity. The adjacent land use (property boundaries and buildings) restrict the upgrade works to within the road corridor (existing RoW). To provide an additional turning lane, this will require the designer to reduce some design elements. Some questions that the designer may have to address when exploring flexible design solutions may be;

- Which elements are reduced first, how much can they be reduced by? Should the lane widths be reduced first, or should the existing shoulders, or should the median? How much can this design element be reduced before considering reducing another element? Should the lane widths be reduced from 3.5m lanes to 3.3m lanes before considering reducing the median width? Could the lane widths be reduced to 3.1m or 2.9m? Should the turning lane widths be reduced before reducing the through lane widths?
- Which elements are reduced next, and how much can they be reduced by?
- What is the absolute minimum lane width that can be adopted before the anticipated performance is unacceptable? Is 2.9m the absolute minimum that can be accepted?
- What combination of reduced lane widths, reduced shoulder widths and reduced median widths produce the optimum balance between meeting the project objectives while still producing an acceptable level of performance?

Developing the design, selecting values for design elements and assessing project options (See Figure 2) requires engineering judgment and experience. Often the decision to accept the combination of values for design elements will require technical advice and approval by authorised DoT delegates.

Road design guidance provides some direction for acceptable range of values for some design elements and what values can be combined with other values and still produce an acceptable level of performance. However, the contexts and scenarios are so varied and often site/project specific that it is not practical for guidance to be produced to cover these variations in published material. It is often left to the designer to develop a logical process for reducing design elements that best address the project objectives and are tailed to the site conditions.

Below are some typical questions that a designer will have to answer in constrained environments when exploring flexible design solutions;

- Which elements are reduced first, how much can they be reduced by?
- Which elements are reduced next, and how much can they be reduced by?
- What is the absolute minimum value for a design element before the risk becomes unacceptable?
- What combination of values will produce the optimum balance?
- What type of vehicle and associated demand is being catered for as the critical design vehicle or road user (i.e. vehicle size, performance characteristics etc.), and how does that impact on the geometric solution being considered?

Designs which include Design Exception values should be assessment through a risk assessment process (See *RDN 01-02 Design Exception Reports (DER)*).

Where some design elements have been reduced (for example, reduced sight distance over a vertical crest), designers should consider increasing the values of other design elements (for example, wider sealed shoulders where vertical sight distance is reduced).

For more information about the selection of design values, refer to *DoT Supplement to AGRD Part 1 Section V2.1.1*.

C.5 Design approach and values for innovative and emerging treatments

Innovative and emerging design treatments may require designers to select values, or combinations of values for design elements which are either not addressed or not supported by existing and current guidelines and standards.

New and emerging treatments managing may focus on a wholistic approach to risk rather than the individual risks associated with the reduction of values of some design elements. For example, a compact roundabout intersection form manages the wholistic risk associated with impact speeds and angles better than a T-intersection. Therefore, risks associated with the reduction of some design values (such as reduced roundabout radii) need to be assessed in the context of the wholistic management of risk for the intersection form and context.

When developing designs for innovative and emerging treatments, the designer should;

1. Determine a logical approach based on the components of Context Sensitive Design (See Section 2.1) with a focus on the principles and objectives of road design
2. Select values for design elements for innovative and emerging treatments based on these principles
3. Assess designs where the operation of the treatment is somewhat unknown through a risk-based approach (such as Safe System Assessment, road-user capability assessment,)
4. Document what design values were used and why they were used in a Design Report. This information can be used for monitoring and evaluating the effectiveness of the treatment and how the combination of values contributed to the operational performance. The values used for developing the design may also contribute to the development of Design Domain (NDD, EDD and DE) values for the new and emerging treatments in new design guidelines and standards based on how these values and combinations of values performed in trial sites.

Example C.5.1 – Compact Roundabout design approach

An example of this is a compact roundabout. A compact roundabout can be defined as a small roundabout (smaller than those specified in *Austroads Guide to Road Design Part 4B*) in a rural environment with raised safety platforms on the approaches to reduce the speed on the approach of the roundabout.

This treatment may be applicable in some rural locations where the cost and impact to constraints prohibit the implementation of a larger roundabout. Although there is guidance about roundabout and raised safety platform (RSP) design, there may be gaps in this guidance or even guidance which discourages the use of values such as reduced roundabout radii. However, the net safety benefit of providing a compact roundabout at some locations may be far greater than retaining the existing traditional (and sometimes conforming to all the current guidelines) intersection forms such as a T-intersection.

Figure C.5.2: Example of a Compact Roundabout at Lance Creek, Victoria

Approach	Example
1. Determine a logical approach based on the components of Context Sensitive Design (See Section 2.1) with a focus on the principles and objectives of road design	Understand learnings and design methodology from trial sites Liaise with technical experts to determine a design philosophy and approach for the design of a compact roundabout Adopt the principles of conventional roundabout designs as documented in *AGRD Part 4B Section 2.2 Design Principles* As much as possible, examine the crash history at the site and assess possible causes or influencing factors

	Utilise the design parameters for raised safety platforms in RDN 03-07. Develop a slowing logic to slow vehicles from the approach speed to the desired turn speed at the roundabout
2. Select values for design elements for innovative and emerging treatments based on these principles	Select values for entry curve radius, roundabout radii (outside and inside circulating carriageway and concrete annulus), gradients for RSP profiles and RSP spacings
3. Assess designs where the operation of the treatment is somewhat unknown through a risk-based approach	Assess the designs using the first principles for roundabout design such as entry path speed, angle of impact, turning speed and through path speed. Assess heavy vehicle stability using simulations (where applicable)
4. Document what design values were used and why they were used in a Design Report.	Document the design development, assessment and justification of options and the design criteria used for the preferred option in the Design Report. Document any use of Design Exceptions in a Design Exception Report (DER) and have the application accepted by authorised DoT representatives

As more compact roundabouts are built and evaluated, design guidance, including values which make up the various design domains, will be developed and refined.

Appendix D: Commentary for Supporting 'Road-user and Stakeholder Engagement'

D.1 Documenting Road-user and Stakeholder requirements

At the beginning of the project lifecycle (Phase 0 of Figure 1), the project will determine what road-users will be catered for and how they will be prioritised. This is done through a Movement and Place (M&P) assessment. However, as the design develops, the requirements of road-users will be more specific and detailed as feasible options are developed and assessed. Stakeholders needs and requirements should be documented. Stakeholders include not only those who may benefit or be impacted by the project, but also those who will be required to construct, operate and maintain the project.

It is important that at the start of each project phase the road-user and stakeholder requirements are clearly documented so that the designer can clearly understand how to develop a design that addresses these needs and requirements.

Table D.1.1 is an example of how the designer might document the requirements of stakeholders and road-users.

Table D.1.1: Stakeholder and Road-user requirements

Whom are we serving?
Stakeholders
{List stakeholders and their requirements. *Stakeholders include; community representatives, state agencies, property owners (residential and businesses), utility companies, local government.* *In addition to these categories, the project should consider the requirements of those who those who construct, operate and maintain the network.}*
Road-Users
{List specific road-users and road-user groups that will be impacted or benefited from this project. *This may include; Heavy Vehicles, OSOM vehicles, bicycle user groups, pedestrians (school children, elderly), motorcyclists, cyclists.* *State any specific requirements that are known for each road-user group}*

A wholistic approach should be taken to ensure that road-users and stakeholder's requirements are balanced and prioritised based on the Performance-based Criteria and that one group does not disproportionately (requirements vs priorities) influence the project direction or decisions. In constrained environments, the designer may be required to make decisions about how road-users and stakeholders needs and requirements may or may not be met by the design. It is critical that there is a consistent approach to these decisions based on the 4 components of Context Sensitive Design (Section 2.1).

D.2 Road-user and Stakeholder Engagement Plan

The development of the project should occur in parallel with a road-user and stakeholder engagement plan as developed between the project team and community communication and consultation team.

The intent of this section is to highlight important aspects of engaging road-users and stakeholders and how it may influence the design development and decisions where there are multiple viable options. It is not the intent of this RDN to inform designers, communication and engagement officers of the specific DoT processes of engagement road-users and stakeholders in the design development phases. The designer should always work within their organisation's methodology and processes for engagement with road-users and stakeholders.

It is likely that road-user and stakeholder engagement will have significant impacts on the development of the design. Below are four points which the designer should be aware of when working with an engagement and communications team;

1. How to manage road-users and stakeholders' expectations - making it clear as to what can and cannot be achieved within the scope of the project
2. When to best engage road-users and stakeholders for their input and feedback

3. How to provide information about the design in a format that road-users and stakeholders can easily understand. Many stakeholders and road-users may not come from a technical background (such as engineering) and therefore design drawings may not be the best way of communicating the intent of the design. Designers should consider utilising tools such as 3D visualisations to engage stakeholders and road-users
4. How to communicate decisions about the designs that make it clear as to why something has been designed as presented and why it meets the needs and requirements of road-users and stakeholders

D.3. Road-user Capability Assessment

(a) What is the road-user capability?

A Road-User Capability Assessment is a Risk Assessment that views the design from the road-users' perspective and takes into account their needs, requirements, characteristics and abilities. It is a risk analysis tool aimed at understanding the risks (exposure, likelihood and severity) associated with performing a certain action for various road-users. Road-user capability assesses;

- What the design is requiring road-users to do?
- How easy or difficult (risk) it is for road-users to do this?

It also may consider movements which road-users may perform unintentionally (possible or feasible manoeuvres) but are not the intention of the design.

Road-user capability should be assessed on movements which are identified as higher risk. Geometry and layout which include Design Exceptions should have road-user capability assessments on all movements that interact with design exception elements.

(b) What are the road-user categories?

Road-user categories include; general traffic, pedestrians, cyclists, motorcyclists, freight, public transport, those who conduct business on the road network.

Identifying the road-users will help the development of options that meet the specific road-user requirements and identify those who will be most impacted or benefited by the project option.

Road-users may have specific characteristics that require particular consideration when assessing project options.

(c) Road-user capability considerations

In documenting the road-user capability it is important to consider;

Table D.3.1: Road-user capability considerations for an assessment

Consideration	Example
What road-users will be using the infrastructure?	Pedestrians, wheelchairs, cyclists, motorcyclists, car drivers, freight, maintenance workers, emergency response (i.e. ambulance, police, fire etc.)
Understanding the specific characteristics of road-users based on the project context	If the project is located near a school it is important to consider the specific requirements and characteristics of school children. If the project is located near an aged-care facility located near a shopping centre, community centre or club, specific road-user characteristics should be considered.
What is the design requiring road-users to do?	Pedestrian crossing an arterial road at an uncontrolled crossing point.
What tasks is the design asking specific road-users to undertake?	See the hazard on the road ahead and react appropriately *(What is the sight distance that is available?)* Select a gap for turning across through traffic *(What gaps in the traffic are available for road-users to select for undertaking a turning manoeuvre across traffic?)* Brake to avoid a hazard or crash *(What is the stopping distance required to brake and what is the deceleration rate required to brake adequately to avoid a crash?)*

Consideration	Example
What skills or abilities are required to undertake the task?	If the design is requiring road-users to react in a short period of time (i.e. 1.5 sec), will road-users have the skills or ability to do this?
Assessing exposure of the specific task	Is this task something which is going to happen frequently? What is the volume of road-users that will be undertaking this task?
What risks is the road-user exposed to?	Interactions with other road-users such as a vehicle exiting or entering an access or intersection Hitting roadside hazards or furniture
What action or reaction does a road-user need to undertake to avoid or minimise a crash?	State the deceleration rate or Stopping Sight Distance required to avoid or minimise an impact. Include calculations, assumptions and state the reasonableness of such information
Are there any site-specific situations that may contribute to risk?	Do certain times of the day create sight distance issues such as sun glare or fog? Does queuing of vehicles create sight distance restrictions?

Table D.3.2 is an example of how to document a summary of a road-user capability assessment. It may also be helpful to include more details about the analysis (including drawings and calculations) to support the information in the summary table.

Designers and the project team should;

- State the outcome or consequence of the risk
- Rate the risk according to a qualitative or quantitative risk tool

Decisions about whether this risk is acceptable or not acceptable should be documented in the Design Report.

Table D.3.2: Road-User Capability Assessment

Road-User Capability Assessment							
Road-User	**Characteristics**	**Road-User Capability**				**Exposure**	**Risk Rating[1]**
		Task	**Risk**	**Action or Reaction to Avoid Risk**	**Consequence or Outcome if Risk is Not Avoided**		
{State the type of road-user *For example: pedestrian}*	*{State the specific characteristics of the road-user.* *For example: school child}*	*{State what task the design is asking the road-user to do.* *For example: cross 3 lanes of traffic at an uncontrolled crossing, turn right out of a driveway or access}*	*{State the risks that the road-user is exposed to while undertaking the task.}*	*{State the action or reaction required to avoid the risks and whether it is reasonable for the road-user to perform this}*	*{State the consequence or outcome if the action or reaction to avoid the risk is not performed}*	*{State the number of road-users in this category that will be undertaking the task and the frequency of the task}*	

[1] See *RDN 01-02 Design Exception Reports (DER) Appendix I – Risk Assessment Tools* for information and tools about rating Road-User risk