GUIDE TO TRAFFIC MANAGEMENT

Part 12: Traffic Impacts of Development

Austroads

promoting improved road transport outcomes

Guide to Traffic Management
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Summary

The Austroads *Guide to Traffic Management* has 13 parts and provides a comprehensive coverage of traffic management guidance for practitioners involved in traffic engineering, road design, town planning and road safety.

Part 12 – Traffic Impacts of Developments is concerned with identifying and managing the impacts on the road system arising from land use developments. It provides guidance for planners and engineers associated with the design, development and management of a variety of land use developments. The aim is to ensure consistency in the assessment and treatment of traffic impacts, including addressing the needs of all road users and the effect upon the broader community.

Part 12 presents the land use and transport planning context for traffic impact assessment, including travel demand, safety, parking and access management issues. It provides guidance on the need and criteria for impact assessments, and a detailed procedure for identifying and assessing the traffic impacts, and mitigating their effects. Assessment of safety, infrastructure and environmental effects is also covered. Examples are given of checklists, report structures, traffic generation rates and case study projects.

Keywords

Traffic management, developments, traffic impacts, transport planning, town planning, planning schemes, travel demand management, sustainable development, traffic planning, road network planning, access, traffic impact assessment

First Published August 2009

ISBN 978-1-921551-61-1

Austroads Project No. NP1157
Austroads Publication No. AGTM12/09

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Guide to Traffic Management
Part 12: Traffic Impacts of Development

Austroads

Sydney 2009

Austroads profile

Austroads purpose is to contribute to improved Australian and New Zealand transport outcomes by:

- providing expert advice to SCOT and ATC on road and road transport issues
- facilitating collaboration between road agencies
- promoting harmonisation, consistency and uniformity in road and related operations
- undertaking strategic research on behalf of road agencies and communicating outcomes
- promoting improved and consistent practice by road agencies.

Austroads membership

Austroads membership comprises the six state and two territory road transport and traffic authorities, the Commonwealth Department of Infrastructure, Transport, Regional Development and Local Government in Australia, the Australian Local Government Association, and New Zealand Transport Agency. Austroads is governed by a council consisting of the chief executive officer (or an alternative senior executive officer) of each of its 11 member organisations:

- Roads and Traffic Authority New South Wales
- Roads Corporation Victoria
- Department of Transport and Main Roads Queensland
- Main Roads Western Australia
- Department for Transport, Energy and Infrastructure South Australia
- Department of Infrastructure, Energy and Resources Tasmania
- Department of Planning and Infrastructure Northern Territory
- Department of Territory and Municipal Services Australian Capital Territory
- Department of Infrastructure, Transport, Regional Development and Local Government
- Australian Local Government Association
- New Zealand Transport Agency.

The success of Austroads is derived from the collaboration of member organisations and others in the road industry. It aims to be the Australasian leader in providing high quality information, advice and fostering research in the road sector.

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1 INTRODUCTION

1.1 Purpose and Scope

This guide is designed to help traffic and transport practitioners identify and manage the impacts on the road system arising from land use developments. Specifically, guidance is given on how to:

- identify the types of traffic impacts and interactions which will result from a specific land use development proposal
- assess the size of those impacts
- determine how those impacts need to be managed, either within existing infrastructure or through the provision of additional infrastructure
- report on these matters in a way that provides the road authority, town planning authority and others with an adequate understanding of the issues and the actions which need to be taken for the development to proceed; such a report is typically called a Traffic Impact Assessment report.

It will also help road authorities and others to check and respond to reports on traffic impact assessments, for projects as varied as in the following examples:

- small single site commercial developments which generate customer traffic and goods vehicle movements
- large single site or single use commercial developments (including mines, tourism facilities) which generate customer traffic and goods vehicle movements
- multi-use commercial or retail developments, including small and large shopping centres, which require significant on-site traffic facilities
- residential subdivisions, whether for a limited number of lots or for a major expansion of an urban area
- industrial subdivisions.

Within the context of the matters outlined above, the aim of the guide is to ensure that:

- traffic impact assessment of developments is undertaken in a uniform manner leading to consistent treatment of similar developments
- the level of impact assessment is appropriate for the level of potential impacts
- a road or a road network continues to operate at an agreed level of service following the opening of a development
- both ‘soft’ solutions (e.g. road use management such as alternative routes) and ‘hard’ solutions (e.g. changes to infrastructure) are considered when mitigating impacts
- the needs of all road users are considered and appropriate facilities (e.g. bicycle lanes, footpaths, bus lanes, intersection widenings or upgraded intersection controls) are provided
- a development is considered within its physical context and not in isolation from nearby features such as intersections, footpaths and other driveways
- cumulative impacts on networks of other developments in an area or region are considered
- road safety and environmental impacts (both natural and built) are given due consideration.

1.2 Context

The structure and content of the Guide to Traffic Management is presented in Part 1 – *Introduction to Traffic Management*. Table 1.1 summarises the 13 parts of the Guide to Traffic Management, several of which may need to be referred to in assessing a particular development. For example, in assessing larger developments practitioners may have to:

- consider network management implications (Guide to Traffic Management Part 4) (Austroads 2009e)
- consider road management (mid-block) issues such as road space allocation on the surrounding network (Guide to Traffic Management Part 5) (Austroads 2008c)
- develop traffic management arrangements for intersections and crossings (Guide to Traffic Management Part 6) (Austroads 2007c)
- analyse the traffic performance of options (Guide to Traffic Management Parts 2, 3 and 9) (Austroads 2008b, 2009d, 2009g)
- develop traffic control, signs and marking schemes (Guide to Traffic Management Part 10) (Austroads 2009h)
- consider parking requirements (Guide to Traffic Management Part 11) (Austroads 2008e)
- manage the interface between the development and adjacent local areas (Guide to Traffic Management Parts 7 and Part 8) (Austroads 2008d, 2009f).

Table 1.1: Parts of the Guide to Traffic Management

Part	Title	Content
Part 1	Introduction to Traffic Management	Introduction to the discipline of traffic management. Breadth of the subject and the relationship between the various parts of the guide.
Part 2	Traffic Theory	An introduction to the characteristics of traffic flow and the theories, models and statistical distributions used to describe many traffic phenomena. Processes that practitioners should consider.
Part 3	Traffic Studies and Analysis	Traffic and transport data collection surveys and studies Traffic analysis for mid-block situations (including freeways/motorways) Analysis of signalised and unsignalised intersections, including roundabouts.
Part 4	Network Management	Broader issues and aspects of managing networks of roads to provide effective traffic management for all road users. Network needs of freight, public transport, pedestrians, cyclists and private motor vehicles. Network management objectives, operational objectives, network performance measures.
Part 5	Road Management	Focus on managing mid-block traffic conditions. Good practice for access management, allocation of space to various road users, lane management. Application of speed limits.
Part 6	Intersections, Interchanges and Crossings	Types of intersection. Selection of intersection type and appropriate use. Traffic considerations in traffic management for intersections, interchanges and other crossings.
Part 7	Traffic Management in Activity Centres	Planning and traffic management of activity centres and associated transport nodes. Principles for various types of centre.
Part 8	Local Area Traffic Management	Principles and processes. Issues and resources. Selection of schemes and treatments. Design and implementation of schemes and devices.
Part 9	Traffic Operations	Applications used in traffic operations. Current practice for common systems including: traffic signals, congestion management, incident management, traveller information. Manual systems used in these application areas. Event management. Information management issues and principles. Related systems integration and interoperability issues.
Part 10	Traffic Control and Communication Devices	Signing and marking schemes. Traffic signs, static and electronic. Pavement markings and delineation. Traffic signals and islands.
Part 11	Parking	Parking policy. Demand and supply. Data and surveys. On-street and off-street. Types of parking and parking control.
Part 12	**Traffic Impacts of Developments**	Relationship to road level of service and access management. Development profile and trigger points for treatment. Traffic impact assessment.
Part 13	Road Environment Safety	Principles and management of the safety of road environments within a traffic management context. Links to relevant sections of the GRD (Guide to Road Design) and GRS (Guide to Road Safety).

Part 12 deals specifically with traffic management advice related to assessing the traffic impacts of individual developments. It is assumed that matters such as parking policy (e.g. meeting demand or constraining demand) have already been determined and the traffic impact assessment will take place within an established policy framework. See Section 1.3.3 for further discussion of the broader context.

Part 12 is intended to be used when examining a specific development. Where there is a need to consider the impact of a development as part of a larger area, practitioners are referred to Part 7 – *Traffic Management in Activity Centres*. Examples of activity centres include city and town centres, major commercial and transport hubs that are often situated around railway stations, traditional universities, hospitals, airports and sea ports.

Where issues are more appropriately addressed in other Austroads guides references are given to those guides. In some cases a brief discussion is included in the present document, for example to provide a summary of the planning context in which traffic assessments are undertaken.

While it is difficult to discuss many aspects of traffic management without consideration of road design and/or safety issues, the practice adopted in the Guide to Traffic Management is that discussion of such topics should be brief, with references given to the Guide to Road Design and/or the Guide to Road Safety where more details can be obtained.

1.3 Traffic Impacts and Developments

1.3.1 Why Assess the Traffic Impacts of Developments?

Road authorities are responsible for the safe and efficient management of road networks. Land use developments (henceforth referred to simply as 'developments') generate traffic movements as people move to, from and even within the development. Without a clear picture of the type of traffic movements (e.g. cars, pedestrians, cyclists, trucks, etc.) or their scale, timing and location, there is a risk that this traffic movement may contribute to safety problems, unforeseen congestion or other problems where the development connects to the road system or elsewhere on the road network.

Potential impacts are not only the direct and obvious ones such as congestion or crashes at an entrance driveway. They may include:

- amenity impacts on local communities (e.g. through excessive traffic on minor streets)
- road safety impacts some distance from the development
- greater demands placed on existing and future transport networks (including on-road public transport and pedestrian and bicycle facilities)
- reducing the operational efficiency of roads near to and approaching the proposed development
- the degree to which the development or its traffic and transport impacts align with government objectives.

All potentially affected modes of transport need to be considered.

1.3.2 Considering the Type and Scale of a Development

Developments vary from small establishments that generate relatively little traffic to large retail, commercial, industrial or residential developments that generate large volumes of traffic. Consequently, access requirements can vary from minor alterations to an existing driveway to substantial roadworks or new road links.

The extent of a traffic impact assessment will vary according to the scale of the development. Some developments require major traffic assessments, while others may require only a brief traffic impact statement (Section 4.1and 4.2 for details). Similarly, it is important to recognise that developments occur in a variety of situations that require different types of analysis and treatment, for example:

- greenfield sites in rural or outer urban areas can require a different assessment from 'brownfield' ('recycled' and often constrained) sites
- inner urban sites can be different from middle suburb sites
- residential developments typically have different issues from commercial developments or industrial developments – and the latter ones are different again.

1.3.3 Traffic Impact Assessments in Context

For many developments, the traffic impacts and the options for accommodating the generated movement of people and goods cannot be considered in isolation from government planning and transport policies and strategies. These policies and strategies provide a framework within which the matters in this Part should be applied.

In the broadest context, transport planning involves the setting of objectives, the development of policy, system planning and the identification of infrastructure and non-infrastructure initiatives. Community objectives or whole of government objectives are an important part of the process as they recognise the relationship between transport, environmental issues and health (refer to the Austroads Guide to Road Transport Planning, (Austroads 2009c)). These objectives may include reducing dependence on cars, reducing greenhouse emissions and improving air quality.

Transport planning takes place at several levels that may be described as:

- multi-modal network/regional planning
- area or corridor planning
- route or link planning.

Planning in general and transport planning in particular sets the scene for traffic impact assessment through land use policy, parking policy and various strategies and plans which determine the accessibility within and through an area – and the transport modes which will provide that accessibility. It is not the purpose of this part of the Guide to Traffic Management to provide guidance on transport planning.

2 SETTING THE SCENE FOR TRAFFIC IMPACT ASSESSMENTS

This section provides some background information on town planning (otherwise referred to as land use planning), transport planning, traffic planning, planning for on-road public transport and thinking ahead about road safety. Transport efficiency and safety should be basic considerations for town planning and transport planning.

2.1 Transport and Town Planning

2.1.1 Planning Schemes and Transport

Management of the use of land occurs through planning schemes. A planning scheme is a legal document established under town planning legislation (typically state legislation in Australia and national legislation in New Zealand). Planning schemes set out policies and provisions for the use, development and protection of land. Each municipality in Australia is covered by a planning scheme. Whilst planning schemes are prepared individually by each municipality (or in some cases by a regional planning authority) they usually have provisions mandated by state governments to ensure that issues of state significance are dealt with in a consistent manner.

Planning schemes typically include:

- maps showing how all public and private land is zoned
- map-based information about where specific protection requirements apply
- written requirements of the scheme, such as policies, standards and codes of practice.

The zones reflect the primary character of land, such as residential, industrial or rural. Each zone is described, indicating the type of use that is appropriate in that zone. Arterial roads or other traffic routes are often included in planning schemes as specific zones. In some cases local streets are also described as a specific zone.

Because of the impacts that adjacent land uses and proposed developments can have on the efficiency and safety of arterial roads, state governments generally have legislation or policies that require local government to refer to the state road authority any development application abutting or impacting on these roads.

The fundamental interaction between land-use development and transport is typically recognised in local and regional planning strategies by adoption of objectives such as local self-containment, which seek to inhibit intra-regional or inter-centre travel in the interests of sustainable development.

2.1.2 Planning Processes

Planning processes typically consist of:

- preparing a planning scheme, which sets out on maps and in written descriptions and requirements how land may be used and developed
- adoption of the planning scheme as a legal document
- amendments to the planning scheme from time to time
- application by a developer to the planning authority for a new or changed use of an area of land, or a new or changed access to a road
- consideration of the application by the planning authority, taking account of the details in the planning scheme, applicable policies, submissions by experts and other information

- referral of the application to a potentially affected road authority and/or other potentially affected authorities for comment and setting conditions of approval including any infrastructure charges if approved
- consultation involving parties affected by the proposal in the application
- a decision by the planning authority that the development application be agreed to, modified or refused
- the opportunity for appeal to a centralised state planning review body by the developer or a third party if the planning decision is not agreed with.

2.1.3 Transport Considerations

During consideration of both an application and any appeal, access to arterial roads or traffic impacts on local areas are often contested issues. Issues typically focus on the impact on the adjacent road, the road network, or other modes (including modal split) created by:

- the type of development
- the scale, form or layout of the development
- the location and type of access onto the adjacent roads.

Transport issues considered during these processes typically include:

- the suitability of the development for its location, considering the transport options available for potential users
- compatibility of the development and its access requirements with the traffic function of the adjacent road
- the impact on the wider road network, both arterial and local
- the likely use of public transport, cycling and walking instead of using motor vehicles for access (modal split)
- trip generation (both people and goods), especially peak generation periods (development and background traffic)
- traffic volume generation and its distribution and accommodation, including traffic capacity issues
- impact on pavements where development involves significant haulage during the construction or operation phases
- the access and site layout needs of delivery and service vehicles, and public transport vehicles
- parking demands and where they are to be provided for
- traffic safety within the site, at the access points and on the approach roads for all likely groups of road users
- the accommodation of pedestrians and cyclists, including access to and location of pedestrian and cycling facilities
- noise assessment and mitigation
- air quality (transport emissions), for example, for a proposed childcare centre adjacent to a major road with high traffic volumes.

These are examples of 'traffic impacts' or 'transport impacts,' which will need to be assessed during the consideration of a development application. In addition, these and broader traffic and transport impacts need to be considered when a major rezoning of land is proposed or when large areas of land are planned for future urban development. A comparison of traffic impact assessment and the broader transport assessment is given in Commentary 1.

2.1.4 Road Safety Considerations

Road safety is one of the most important aspects of managing the road system. Planning decisions can strongly affect later road safety outcomes. In order for road safety to be given due consideration in both strategic plans and in individual development proposals, it needs to be incorporated into town planning processes. Legislation establishing the town planning framework needs to define road safety as one of the primary objectives of a planning scheme. Experience suggests that where this does not happen, road safety is often viewed as a matter that can be addressed later through good design.

Road safety cannot always be resolved through design; it needs to be given prominence from the earliest stages of strategic planning. For example, if safety is not a primary consideration when the locations of land use zones are decided, intractable safety problems can arise. There are examples of shops and schools being located on opposite sides of a major road – or expanded retail zones being approved on the opposite sides of arterial roads. The relative positioning of these land uses leads to new pedestrian movements across the major roads and increases the risk of pedestrian crashes. Redesign or traffic management initiatives would not necessarily be as effective as planning initiatives in addressing the fundamental land use issues giving rise to that risk.

The incorporation of road safety assessments into the town planning approvals process (whether through formal road safety audits or some other assessment procedure) needs to be coordinated and controlled by the planning authority. Clear procedures need to be established for deciding these questions:

- Which types of projects require a road safety audit and which require a less formal assessment process (see Section 5.3 for examples)?
- When, during the development and design of a project does a road safety audit or assessment need to be done?
- Who is responsible for obtaining the road safety report (the developer or the planning authority)? Whoever it is, the report should be addressed to the planning authority as an independent report.
- Who is accredited or accepted as suitably experienced and qualified to provide the road safety report
- How will the road safety report's recommendations be dealt with and what mediation, arbitration or third party assessment arrangements are needed if there is disagreement
- Will any further road safety assessment of a redesign be required?

To reduce the likelihood of crashes occurring once a development is operating, road safety needs to be given specific consideration at the project planning and design stages. This requires that road safety engineering skills are applied to the project, through an audit or some other approved and effective procedure. The Austroads Guide to Road Safety Part 6 (Austroads 2006-2009c) recommends that an audit of a development be done separately from any 'traffic impact assessment', as those assessments are usually part of the design process and are not independent.

Strategic plans involve considerable negotiation and consultation. Experience in Australia is that the most effective way to include road safety engineering expertise into strategic plans is to directly involve an independent road safety engineer in the negotiations and consultation, rather than subject the finally negotiated plan to an independent audit. Understandably, other parties involved in developing a strategic plan will be very reluctant to accept significant changes to the negotiated plan when they have already put so much effort into it – even if road safety is the issue.

2.1.5 Travel Demand Management and Sustainable Development

Historically, road transport system management in Australia and New Zealand has predominantly been focussed on attempting to meet the demand for motor vehicle travel by supplying new roads or increasing the capacity of existing roads. However, it has been recognised that increases in road capacity are quickly taken up by latent demand and that communities do not have the economic capacity to remove road traffic congestion through the continual provision of additional road capacity. Observations in large cities show that many urban dwellers have a high tolerance for the daily delays created by the traffic congestion to which they add. How can urban transport, travel and accessibility be better managed to reduce travel delays and reduce the negative impacts of motor vehicle use on urban communities?

Travel demand management (TDM) seeks to answer this question. TDM involves interventions to modify travel decisions so that more desirable transport, social, economic and/or environmental objectives can be achieved, and the adverse impacts of travel can be reduced. It involves managing the transport and traffic task through:

- reducing dependence on the private car for many trips
- encouraging people to better organise their travel so they make fewer trips, make shorter trips, use one vehicle to carry more people and combine journey purposes
- reducing the distance of trips via self-containment objectives
- encouraging walking, cycling and the use of public transport
- supporting alternative commuting arrangements such as teleworking, car-pooling.

Travel plans

One approach to reducing the impact of travel associated with land use developments involves the preparation of travels plans for those developments. There is a case for encouraging, if not requiring, developers of new land use developments, or a major expansion of an existing development, to prepare a travel plan to mitigate traffic generated by the development. The travel plan may influence decisions on the appropriate traffic facilities to be provided.

Workplaces generate large amounts of travel, and often-large amounts of car traffic – by staff, deliveries, and visitors. Workplace travel plans aim to reduce vehicle use, especially private car use, associated with the workplace. In Australia, workplace travel plan initiatives are being encouraged in government agencies, in business and in community institutions such as universities and hospitals (TravelSmart Australia 2008).

While reduction of car travel to work is voluntary in Australia, in some countries (e.g. UK and US) it is mandatory for organisations over a certain size. Such organisations are required to prepare a travel plan, which outlines the initiatives that will be taken to reduce car use. Evidence cited by Giblin et al. (2007) indicates that workplace travel plans can reduce work trips by private car use by between 10 and 20 percent.

Travel plans typically involve encouragement for employees to change their work travel from private car use to walking, cycling, public transport, or car-pooling, by means such as financial incentives, provision of special facilities (showers, lockers), or subsidies for public transport use. Organisations typically also revise policies – for example, on fleet composition and management, or on flexible working arrangements – in order to facilitate a reduction in the impact of car use associated with the workplace. There are potential benefits for the organisation and employees, as well as for the community.

Sustainable development

Sustainable development can be described as attempting to reduce resource depletion and environmental impacts of a development activity. It has also taken on meanings that refer to economic vitality and quality of life. These three objectives may not always be compatible even though policy statements attempt to accommodate them all.

The interest in sustainable development reflects a growing awareness and concern in urban communities about the problems created by growth in traffic, particularly car use and the resultant congestion. There is a realisation that it is neither feasible nor desirable to provide improved road capacity at a rate that would satisfy the ever-increasing demand. Apart from the quality of life for citizens who are dependent on cars for daily travel, the issues of poor air quality, greenhouse gas emissions and reliance on non-renewable energy resources are of major concern.

For additional discussion of this topic, refer to Commentary 2, to the Guide to Traffic Management Parts 4 and 7 (Austroads 2009e, 2009f) and the Guide to Road Transport Planning (Austroads 2009c).

2.1.6 Parking Supply and Parking Restraint

One type of intervention to limit the amount of car travel is to limit the amount of parking space in developments where public transport can play a significant role. For example:

- In central business districts of cities frequent, reliable public transport is available and suitable for a large number of trips. In these situations it is common for individual developments to be required to have little or no on-site parking, as part of a parking restraint policy.
- In high-density residential areas where frequent, reliable public transport is available, the permitted provision of parking spaces is often lower than rates stated in ‘parking demand’ tables. Also, some residents choose to have no car or fewer cars per household.

However, practitioners should be aware that unless it is properly managed across a region, the adoption of a ‘parking restraint’ policy will not automatically lead to more trips by public transport, a reduction in car trips or a reduction in parking demand. For example:

- Because there is no restriction on the number of cars an individual or a family is allowed to possess, a reduction in the number of on-site parking spaces in a residential development poorly served by public transport will inevitably lead to on-street parking and continued use of cars for all or most trips. The public transport needs to be frequent, reliable and provided in the desired directions of travel.
- At the other end of a regular work journey, the lack of parking at or close to a place of employment will lead to some workers parking as close as they can and walking the last section (or making a short public transport trip). For a parking restraint policy to be effective (e.g. in a central business district), restrictions to on-street parking need to be implemented over a wide buffer area around the restraint area.

- Some types of trips are sometimes not amenable to travel by public transport, such as a weekly family shopping trip. Therefore a parking restraint policy is not appropriate for land uses at each end of this type of trip.

Therefore, when considering the adoption of a parking restraint scheme, these types of potential problems need to be acknowledged and 'plans' prepared to avoid them. These plans may include improved public transport services, restrictions to on-street parking (near homes or near work locations) and the provision of local commercial facilities, which are accessible by bicycle or on foot and which reduce the need for car travel.

Refer to Guide to Traffic Management Part 11 (Austroads 2008e) for further information about the parking and stopping of vehicles.

2.1.7 Planning for Public Transport

While public transport use in some urban areas is presently limited, this may not always be the case. Equally, it is a worthwhile objective to provide people with travel options that allow them to use motor vehicles less. For these reasons, it is important that urban areas are planned in ways that assist in providing road-based public transport, notably by buses. Non road-based public transport options such as rail also play an important role, although the opportunities are more limited for extending or modifying routes to accommodate urban growth.

The following planning checklist, based on material in Department of Transport Victoria (2008), indicates ways public transport can be assisted and promoted and not hindered when planning new urban areas:

- consult public transport operators when preparing or revising structure plans
- when planning or proposing new urban areas ensure that public transport service provision 'performance requirements' can be met and development densities enable cost-effective public transport service provision
- avoid mixed-function collector roads (i.e. through traffic and property access functions) as these will ultimately require restrictions on traffic, to the detriment of buses
- create a comprehensive network of traffic routes/arterial roads such that 90% of homes are within 400 metres of a bus route
- assume all traffic routes/arterial roads are potentially a bus route
- consider where bus priority will be needed to allow buses to 'jump' traffic queues on arterial roads
- allow enough space for the appropriate design vehicle and checking vehicle to be accommodated at bus stops and intersections
- plan higher residential densities to be near major public transport services
- plan for, and assess the impact of, bus routes through residential subdivisions or serving industrial subdivisions
- locate residential development both sides for the full length of all bus routes. Provide bus routes directly between activity centres and locate all facilities on bus routes
- provide employment areas with through bus routes, minimum route deviation and lay them out so that all areas fall within 400 metres of a bus route
- provide direct pedestrian access to bus routes at 300 metre intervals for bus stops

- Ensure pedestrian routes to bus stops are located where they are attractive and convenient to use, with safe access across roads (e.g. plan for refuge islands), especially for arterial and collector routes.

2.2 Road Network Planning

2.2.1 Road Classification

When considering the potential impact of a development on particular roads in the network, it is important to establish the agreed traffic function of each of the roads potentially affected. Is it primarily a traffic route or a local street? This then enables an objective assessment of whether the development, and its access and traffic needs, is compatible with the road's function.

In these guidelines 'road classification' means a road's 'functional classification' – its traffic function.

For further advice and information on road hierarchy and functional classification, refer to Commentary 3 and the Guide to Traffic Management Parts 1, 4 and 5 (Austroads 2007b, 2008c, 2009e).

For effective traffic management of the road network, a clear distinction needs to be made between those roads that are to function principally as 'arterial roads' (or 'traffic routes') and those that are to function principally as 'local streets'. Within each of these two primary categories of traffic function, finer distinctions can be made.

2.2.2 Arterial Roads and Local Streets

In urban areas, the principal classification of each road as either a ***traffic route*** (arterial road) or a ***local street*** should result in an interconnecting network of traffic routes at a sufficiently close spacing, considering the intensity of traffic generating development. Each area bounded by traffic routes is a ***local traffic area***, which should be small enough that no road within it has excessively high traffic volumes.

Town planning schemes may include objectives for road networks such as 'to provide a network of streets with clear physical distinctions between traffic routes and residential streets based on function, legibility, convenience, traffic volumes, vehicle speeds, public safety and amenity'. The distinction between arterial roads and local streets supports such objectives.

The single most important step in achieving the clear 'two class' arterial road/local street classification in areas of new development is to prevent frequent direct – frontage driveway access off roads which will need to function primarily as 'traffic routes'. These routes need to be provided at 0.8 to 1.5 km spacings and may be on existing road alignments or newly created alignments.

2.3 Traffic Planning

2.3.1 Road Access Management

Access management is an important part of managing roads in a way that is consistent with their primary traffic function. There is often pressure to permit direct driveway access onto the majority of roads in a developing area, to reduce development costs per site. But if this occurs on roads that, through their location in the network, will need to function as traffic routes, the lower site development cost is inevitably offset by higher transport, amenity and safety costs later, to the detriment of future residents and road users.

There is a general right of access between a road and abutting property, unless action is taken to restrict that access. Access management is the process of controlling where and how that access may take place. The mobility, safety and amenity of road users and occupiers of abutting land are influenced by the provisions for access to and from roads. Given this, the objective of access management is to achieve a level of interaction between the road and abutting land that is consistent with the function of the particular road. Access needs to be designed and managed in a way that allows the road to perform its traffic functions safely and efficiently.

Access to and from roads is generally controlled in two ways:

- Access control by laws, statutory regulations or planning regulations that apply to a particular road, a class of road or a type of development for the abutting land.
- Access control by geometric design. One example is the provision of service roads, where the driveway, side street and parking interactions take place clear of the main carriageway.

Access management is an integral part of managing a road so that it can perform its primary traffic function safely. Because providing arterial roads is a basic part of the town planning system, access management is an essential part of the larger planning framework. Broad planning policies and objectives need to incorporate access management.

The need for access planning and management arises because vehicle movements generated by a development site can potentially create interruptions to traffic on a road. On many roads these interruptions are of little or no concern, because they are infrequent and traffic volumes are low. However, on roads carrying high traffic volumes or fast moving traffic these interruptions can create inefficiencies and other costs to the community, such as:

- increased crash rates, due to incompatible traffic activity or unexpected traffic movements
- increased delay and interruptions, including to public transport
- reduced arterial road capacity
- deterioration in the driver’s perception of the safety and ease of use of an access point
- increased vehicle emissions and reduced air quality
- increased fuel consumption
- functional obsolescence of the roadway (i.e. the ability of the road to perform its primary traffic function is slowly degraded)
- diminished value of the public investment.

A framework for arterial road access management (Austroads 2000c) provides basic steps and factors for the consideration of access during new road planning, the preparation of development applications and when assessing proposals. Table 2.1, from that report, sets out crash experience with various levels of access management.

Table 2.1: Compilation of experience; access related to crashes

On Rural Roads	▪ As a rule of thumb, there are 10 crashes per 100mvkm* of travel per access point. ▪ Typically, the comparative crash rates for no access control: partial control: high level of control will be roughly in the ratios 100: 60: 40. That is, there could be 2-3 times the number of crashes if there is no access control. ▪ On 4-lane rural roads, each private access adds 2-3 percent to the crash rate, and much more at higher degrees of road curvature. ▪ Each commercial access point per kilometre can add 5-10 percent to the crash rate at low access frequencies (perhaps 10-15 acc/100mvkm for each access point). ▪ An access point on a 4-lane rural highway can be up to 10 times more hazardous without a median than with one.
On Urban Arterials	▪ Allowing direct access and frequent minor junctions can increase the casualty crash rate by 30 percent on divided roads and 70 percent on undivided roads. ▪ Each non-commercial access point adds 1-2 percent to the crash rate on low-access 4-lane roads, and 2-3 percent on 2-lane roads. ▪ Going from zero to 10 commercial access points per km on 2-lane urban roads can add about 80 percent to the crash rate. Going from zero to 20 access points per km can double or treble the rate. ▪ On 4-lane roads, each extra commercial access point can add 5-10 acc/100mvkm above 10 access points per km. ▪ Urban arterials without medians have a 30-40 percent higher crash rate than divided sections.

Note: mvkm denotes million vehicle kilometres.
Source: Austroads (2000c)

For more details about access management, see Austroads (2000c) and the Guide to Traffic Management Part 5 (Austroads 2008c).

2.3.2 Parking Issues

Parking needs

When planning a development and assessing its impacts, the need for vehicles to be parked or to stop for picking up or setting down passengers or goods needs to be assessed, taking into account the following:

- types of vehicles
- types of vehicle users
- duration of stay for the parked or stopped vehicle
- times of the day, week or season when required
- locations to be used for stopping and parking and their feasibility, practicability and impact on moving vehicles and pedestrians
- demand for (i.e. numbers of) parking and stopping spaces
- order of priority in allocating spaces when demands at particular places or times exceeds supply
- use of each mode of travel
- vehicular access to and from the parking or stopping spaces
- pedestrian or goods delivery access to and from the parking or stopping spaces
- dimensions and layout of spaces and access routes so that the likely types of vehicles can be accommodated.

Types of vehicles and their needs

Every trip involving an on-road vehicle creates a demand for parking or stopping:

- cars need to be garaged or parked at residences and parked at shops, businesses and other attractions, for a short or longer time. Passengers often need to be dropped off or picked up, creating a demand for places to stop briefly
- motorcycles have similar parking demands
- cars with caravans need to stop at toilets, rest areas and tourist attractions
- buses need to stop to pick up or set down passengers. They also need a place to stop or lay over at the end of the scheduled route
- taxis need places to store and queue (taxi ranks), places to wait for passengers and places to set down passengers and collect a fare
- cyclists need somewhere to park their bicycle. Security from theft is a particular issue
- trucks need space to stop for loading and unloading. On longer journeys truck drivers need space to park their vehicles when they rest.

Factors affecting parking demand

Car parking demand is related to the land use that is served. Different land uses generate different demands for parking, in terms of the time when they are used and the duration of stay, as well as the numbers of parking spaces for a set size of development. The parking demand at a specific land use will be influenced by factors such as the:

- extent to which the need for that particular land use is satisfied in the locality or region (undersupply or oversupply of the land use)
- availability and suitability of public transport and the ease with which it provides access to the land use, compared with access by motor vehicle
- cost of parking for different durations of stay
- where trips are local, the ease with which people can access the site by bicycle or on foot.

Typical parking 'rates' (i.e. number of spaces required per unit of development such as sq.m. of floor area or number of seats) for different types of land uses have been surveyed. They appear as tables of information in most town planning schemes and they form the basis on which the actual parking demands at a particular site will be assessed (Section 3.4.3). But these rates are only a surrogate measure as, for example, creation of an area of floor or a seat does not create a demand for parking spaces; the actual demand is created by the people who need, to or wish to, come to the property. Also, a category in these tables may group a number of differing land uses. A more accurate assessment of likely parking demands can often be achieved by demand surveys of more applicable examples of existing activities, or by calculating the maximum demand (parking accumulation) from known information about durations of stay and rates of arrival.

Details of parking requirements and management approaches are given in the Guide to Traffic Management Part 11 (Austroads 2008e).

3 TRAFFIC MANAGEMENT FOR DEVELOPMENTS

3.1 Elements

This section provides advice on the elements that contribute to a land-use development working well from a traffic perspective – whether that traffic is pedestrian, bicycle, car, truck or bus or other motor vehicle.

Table 3.1 provides an initial checklist for use in ensuring that traffic management arrangements assist in achieving the basic function of the development efficiently and safely. All expected users of the development should experience site access and internal movement, which is both efficient and safe. Traffic operations on adjacent roads should not be adversely affected. Practitioners are encouraged to apply these principles in traffic management for developments and to gauge the traffic impacts of a development with these requirements in mind.

Table 3.1: Elements to consider in traffic management of developments

Issue	Considerations	Prompt questions
Access and traffic movements	Origins	From where will the likely users come? At what typical times of day? What are the prime approach directions and modes of travel? What parts of the development are the prime access points?
	Road user types	Who are the likely users of the development? Will they come by vehicle? If so, in private vehicles or by public transport? Where within the development will they need to go?
	Vehicle types	What vehicle types will be accessing the site? Does this vary for different sections of the development? Are all relevant vehicle types catered for?
	Non-motorised users	Will pedestrian movements, adjacent to and within the site, be prime factors? Are special facilities needed?
	Disabled users	What is the extent of disabled access requirements? What are the relevant statutory requirements or design rules?
	External areas	What traffic controls and parking arrangements are there on roads adjacent to the site? Do these need to be modified?
Safety	Vehicle speeds	What are the likely traffic speeds – for approaching, adjacent and circulating traffic? Does the site design help to contain speeds? Is additional control needed?
	Conflicts	How are potential vehicle-vehicle and vehicle-pedestrian conflicts to be controlled or managed? Is there a need to separate vehicles and pedestrians?
	Sight distance	At all potential conflict points, is there adequate sight distance? Is additional traffic control needed?
Environmental effects	Adjoining developments	Will the traffic movements be compatible with those from adjoining developments?
	Noise, pollution	Will the types of vehicles accessing the site give rise to noticeably increased noise or atmospheric pollution?

3.2 Road User Considerations

3.2.1 General Traffic

Effective operation of traffic around and within land-use developments is assisted by applying the guidance given in other relevant Parts of the Guide to Traffic Management, particularly Part 5, Part 6 and Part 9 (Austroads 2007c, 2008c, 2009g).

The safety of general traffic is assisted by incorporating road safety into town planning processes (see Section 2.1.4) and by the adoption of such safety processes as road safety audit during the design and development of a project (see Guide to Road Safety Part 6 (Austroads 2006-2009c)).

Different groups of road users have different design and safety needs. The first step in successfully designing for vehicle users and pedestrians is to establish who will be the users of the development and how will they arrive. The users may include:

- pedestrians, walking to and within a development
- pedestrians who are accessing the development from public transport
- road based public transport vehicles: buses, trams, taxis
- heavy vehicles, making deliveries and collecting rubbish
- couriers and smaller delivery vehicles
- emergency vehicles, notably fire engines and ambulances
- cars carrying residents, shoppers, workers, etc.
- motorcycles
- bicycles.

Some of these user groups will have common access needs, yet may need to reach different parts of the development and have different parking or stopping requirements. Some user groups, such as large delivery vehicles, will have quite specific needs when access layout is being considered.

Consideration also needs to be given to the level of access demand likely to be required by the development. Over–provision or under-provision of traffic facilities can result in inefficiencies, excessive costs, unnecessary traffic movements, environmental impacts and adverse safety effects.

3.2.2 Vehicle Types

Access roads and circulation areas need to accommodate the right vehicle classes. Except within those parts of car parks used exclusively by cars, this will always include larger vehicles. Each access route needs to account for all likely types of road users (and their likely volumes), whether they are on foot or using a vehicle. For vehicles, this is done by specifying the ‘design vehicle’ and ‘checking vehicle’ appropriate for each category (traffic function) of access road and designing for it (Austroads 2006a). See also Guide to Road Design Part 4 (Austroads 2009b) for advice on large vehicle turning requirements.

Within new residential subdivisions, most traffic will be cars and vans. But garbage trucks, delivery trucks and fire engines also need access. In general, the right design vehicles will be:

- design vehicle: design service truck, 8.8 m
- checking vehicle: design single unit truck/bus, 12.5 m.

Within a subdivided area any roads which function as bus routes or access routes to offices, shopping centres or emergency facilities will need to be designed using larger design and checking vehicles. Within a large shopping centre, some access roads will be used by delivery vehicles as well as customers’ cars.

To design for the right vehicle:

- On public roads, the traffic function needs to be determined and adopted, based on effective road hierarchy principles (Section 2.3.1); then the correct design vehicle and checking vehicle needs to be assigned to each road category and to intersections along them. For example, arterial roads may be sub-categorised into major arterial and other arterial, with different design and checking vehicles. Non-arterial roads which regularly accommodate larger vehicles (e.g. bus routes) need to be assigned suitable design and checking vehicles
- Within developments and at their access driveways, the access routes and circulation routes for the different road user groups need to be identified (who are the likely users and where within the site will they need to travel?); then for each group the appropriate design vehicle and checking vehicle needs to be selected.

3.2.3 Heavy Vehicles

It is important to identify the type and size of heavy vehicles that will need to gain access to the development. This will help in determining the appropriate design vehicle and checking vehicle to be used in the development's design.

Most planning schemes require that in new areas, as well as with large developments in existing areas, loading and unloading must take place on-site rather than from a vehicle stopped on a public road. Most developments that have significant loading or unloading have a loading dock where vehicles are required to reverse into position. Developments in new areas should be designed so that all reversing and other maneuvering takes place on-site and away from conflicts with pedestrians and other vehicles. Reversing of trucks off public roads creates a potential hazard for other road users, including pedestrians and cyclists. While it often cannot be avoided in existing areas, it should not be permitted for new developments on an existing traffic route/arterial road, due to the degree of conflict.

The types of heavy vehicles requiring regular access to developments may include:

- Local shops — Food delivery trucks (design service truck, 8.8 m long)
- Shopping centres — Large delivery trucks (design prime mover and semi-trailer, 19.0 m overall length)
- Offices — Furniture removal trucks (design single unit truck/bus, 12.5 m long)
- Factories — Large delivery vehicles (design prime mover and semi-trailer, 19.0 m overall length; or long extendable semi-trailers for indivisible loads, up to 25 m long; or B – Doubles, up to 26 m long)
- Warehouses — Similar to factories
- Hospitals — Food delivery vehicles, including large ones (design single unit truck/bus, 12.5 m long)
- Rubbish tips — Garbage trucks and large waste transfer trucks (design single unit truck/bus, 12.5 m long; design prime mover and semi-trailer, 19.0 m overall length)
- Mines — Truck-trailer combinations, B-Doubles, B-triples or other configurations.

3.2.4 Buses

Buses run to schedules. Delays (i.e. greater travel time variability) for buses make the choice of this travel mode option less desirable. Whether a development includes roadways traversed by buses or it simply generates a demand for on-road bus stops, the layout of the bus route and the number and location of the bus stops should take account of bus scheduling needs, as well as the convenience of bus passengers.

Bus passengers need to be provided with safe and convenient pedestrian access to and from bus stops. Where several bus routes service the one location, convenient and safe interchanging between bus routes should also be provided in the design.

Developments of a recreational or entertainment nature will often require on-site parking for coaches. This needs to be located so that passengers can safely alight and reach the front door. Where will they be able to safely stand if they are waiting for a coach to arrive or return? Can the coaches travel without reversing in areas used by pedestrians or other motor vehicles? Matters such as these should be considered at the planning stage so that adequate space is provided in the layout for the safe operation of buses and coaches.

3.2.5 Emergency Vehicles

Emergency vehicles need to be considered in the layout of approach roads, access driveways or intersections and with any internal roads or driveways. Development plans also need to take account of any nearby facility frequently used by emergency vehicles (e.g. a hospital, ambulance station, fire station or police station) to ensure the plans do not result in delays to emergency vehicles or do not involve placement of traffic restrictive devices on trunk access routes required on a regular basis by emergency services.

Every property must be readily accessible by emergency vehicles. In some commercial or industrial areas large and heavy fire appliances need direct access. The level of accessibility and the extent of speed restriction needs to be determined in consultation with emergency service operators, taking into account accepted criteria of response times and bearing in mind that vehicles may not always be available from the nearest emergency services station. Some emergency service authorities have their own planning guidelines for emergency vehicle access, which should be consulted when planning the layout of a development.

3.2.6 Pedestrians

Where a development is designed to be used by people in nearby residential areas, direct convenient and attractive pedestrian access should be provided between the two locations. This will assist in reducing the number of short car trips. Pedestrian facilities should also address the needs of people with vision impairment and other disabilities.

Within a development site, issues of pedestrian safety and amenity are discussed in Section 3.3.3.

3.2.7 Cyclists

Depending on the nature and scale of a development, cyclists will access it via the adjacent road system from more distant locations, from nearby residential areas or from nearby bicycle routes. Where there are nearby bicycle facilities (off-road bicycle paths or on-road bicycle lanes) bicycle links into the development need to be considered. Convenient, safe and attractive cycle access should be provided.

Secure bicycle parking is an essential part of a network of bicycle facilities. Bicycle parking needs to be provided in a location that is convenient, and visible to the public for security reasons. In some planning schemes there are specific requirements for bicycle parking at developments in particular land use zones. Australian/New Zealand Standard *AS 2890 Part 3 Bicycle Parking Facilities* (1993) outlines the requirements for bicycle parking.

3.3 Access to Developments

3.3.1 Approach Roads

Depending on the type, scale and location of a development, the traffic impacts may need to be assessed for a considerable distance on the approach route(s) along an arterial road and geometric elements of that road may need to be expanded, modified or redesigned at mid block locations and at intersections. Consider the following examples:

- A large development involving signalisation of an access point is likely to require assessment of existing nearby major intersections for capacity and safety. Also, the intervening sections of approach road must carry the total predicted traffic volume (through traffic plus development traffic), and the traffic approaching the development must be in the correct lane (left or right); auxiliary lanes may be required. Successive and closely spaced access points and/or side streets are each likely to need a dedicated turning lane.
- A rural development (e.g. involving an extractive industry) may produce a significant increase in the proportion of heavy vehicles using the access road(s), as well as a significant increase in total traffic volume. In this situation any haul route needs to be identified and then assessed for traffic operation on road sections and at intersections, and for pavement impact and safety. There may be trigger values, typically 5% or 10%, for traffic volume increases which prompt an assessment (Section 4.2.2).

For advice on the traffic management of approach roads see **Guide to Traffic Management Parts 5** and **6**.

3.3.2 Driveways or Intersections into the Development

Vehicle access to most developed land is via one or more driveways. At larger developments driveways are usually replaced by intersections, where the trafficked areas remain at road level rather than rising across the footpath along the public road.

Driveways

Driveways have the following characteristics:

- The speed of traffic can be better controlled by the rise in level, thereby assisting the safety of pedestrians walking along the intersecting footpath.
- The lower speed of turning vehicles may mean that a left turn deceleration lane, clear of the through-traffic lane, is required to avoid rear end collisions with faster moving through traffic
- Some aspects of the road rules apply differently at driveways to private land, compared with intersections of roads.

In all cases each driveway needs to be wide enough to accommodate the swept paths of the types of vehicles that will need to use that access point. At commercial developments, driveways need to be wide enough to accommodate entering and exiting vehicles at the same time. Where larger vehicles are infrequent and not regular, and where car use is intermittent, it may be acceptable to design a driveway for two-way car use and accept that a larger vehicle will need to occupy both lanes. The kerb radius at a driveway must be able to accommodate the likely classes of vehicles (i.e. the design vehicle) without the need to mount a kerb. Where the kerb radius is large, care is required to ensure the safety of pedestrians using the footpath. A wide two-way driveway may need to be divided so pedestrians can negotiate one half at a time. Any driveway needs to provide adequate sight lines to pedestrians using the footpath: structures near the property line need to be set back or splayed.

Petrol stations and associated convenience stores should desirably be designed with separate entry and exit driveways, so that internal circulation past the petrol pumps is one way. These developments are typically on corner blocks at intersections; entry driveways should be far enough away from a major intersection that a following driver who is concentrating on activity at the intersection has time to be aware of any slowing and turning vehicles ahead. This applies for left and right turns. Right turns after major intersections should only be considered where a separate right-turn lane with adequate deceleration and storage length can be provided, otherwise rear end crashes may become common. On typical undivided urban roads, the safety implications of allowing right turns from a through lane into a development within 100 m of a major intersection should be carefully considered.

In cities with trams, the implications of allowing right turns from or across tram tracks should be carefully considered.

Intersections

Intersections into developments have the following characteristics:

- they may be controlled by lines, control signs, a roundabout or traffic signals
- they can be combined with an existing intersection, where appropriate
- they permit faster turning movements, which are better for safety on higher speed roads, but it does require that the safety of pedestrians and their ease of access across the intersection are carefully considered during planning and design.

A decision to control an intersection into a development site by give-way signs should be made using the same decision criteria as for any other intersection. If sight distance is so poor that safe intersection sight distance is not achieved, or worse still, stop signs are warranted (see Australian Standard AS 1742.2, 2009), the intersection should be redesigned and/or relocated so that adequate sight distance is provided. Refer to Guide to Traffic Management Part 6 (Austroads 2007c) for details of intersection traffic management.

If the traffic volume accessing a development is only a small proportion of the total traffic along a road, roundabout control of the access intersection is usually not appropriate due to the disruptive impact it has on all vehicles travelling along the road. At any location on the road network, roundabouts where the side road volumes are significantly lower than the main road volumes (say a one seventh or less) are also known to experience increased crashes due to the low expectation of conflicting traffic. If, for example, a development experiences peaks of traffic, which warrant a greater level of control than give-way signs can safely provide, then traffic signals are a more suitable option. This may be the case with sporting or concert facilities. If the access point forms a fourth leg off an otherwise major T intersection, either traffic signals or a roundabout may be appropriate.

3.3.3 Internal Roads, Circulation Areas and Parking

Site access

It is particularly important, when planning the layout of trafficked areas within a site, to consider who are the likely road user groups, how they will arrive, where they need to go and what they need (in terms of layout) for their safety. For example, people arriving by car need:

- a convenient and obvious way to approach the entrance to the car parking
- a safe way to get from the access road to the parking area
- a convenient way of circulating within the car park and advice about the location of pedestrian access to entrance doors
- a safe route to walk amongst or past the parked cars to reach the entrance doors.

The safety of these users of the development is enhanced by the following layout characteristics – or diminished where they are not present:

- a safe form of intersection control coming off the access road, considering volumes and site layout
- separation of the internal access road or driveway from any parking spaces (with their parking manoeuvres, stopped vehicles, restrictions on sight lines, etc.)
- separation of the internal access road or driveway which leads to parking, from the manoeuvring area for loading and unloading of goods
- a car park layout and design which physically limits vehicle speeds and which provides safe space for pedestrians, including adequate sight lines at intersection points and conflict points
- a pedestrian link between the car park and entrance doors which does not require pedestrians to cross a trafficked roadway, driveway or circulation route within the site.

For advice on car park layouts and the design of car park accesses, see Guide to Traffic Management Part 11 (Austroads 2008e).

Conflicting traffic activities

As far as is practicable, incompatible traffic activities should be segregated from each other. In most situations, mixing of trucks and cars while they travel along a section of internal road or driveway is no more of a safety problem than it may be on the external road network. But when manoeuvring of trucks is required, the potential for conflicts and unexpected manoeuvres (by either group of road users) increases significantly. Truck manoeuvring areas (i.e. for turning and reversing) should be kept separate from areas trafficked by the car drivers or used by pedestrians.

Pedestrian safety and amenity

Within car parks there is an expectation that pedestrians will be walking along parking aisles, but this means that the design of parking aisles needs to include measures to keep car speeds low. Where there are significant numbers of pedestrians, separate footpaths should be provided. Provision should also be made for ensuring that pedestrians with disabilities have adequate access to all areas (including car parks) within a development. Where a footpath meets a trafficked area, consideration should be given to whether drivers or pedestrians will expect arrival of the other, and whether they can see each other in sufficient time.

Pedestrian/traffic conflict can be addressed by:

- avoiding the conflict altogether (put the trafficked route somewhere else)
- having the conflict point at a location with low traffic speeds;
- reducing traffic speeds;
- having the conflict point at a location where traffic movements are simple, so pedestrians do not need to make complex decisions about when to proceed;
- providing good sight distance in combination with low speeds (avoiding pedestrians walking out from between parked cars or near walls or stopped trucks or buses);
- having the conflict point where it is expected, rather than where it might not be expected;
- ensuring that the priority for drivers and pedestrians is correctly indicated to both groups and is compatible with the traffic speeds;
- ensuring that any pavement markings are in accordance with the relevant standard and correctly installed.

3.4 Subdivision Developments

A development which consists of the subdivision of land and the creation of new urban areas requires consideration of some broad design issues, as well as the application of good design and management practices in the local details.

3.4.1 Residential Subdivisions

Residential subdivisions need to be planned within the context of an agreed network of arterial roads.

It is important for both local amenity and efficiency of the arterial roads that, at the network planning and subdivision approval stages, arterial road networks are developed having satisfactory spacing, adequate capacity and interconnection without missing links. The spacing and size of arterial roads depend on the intensity of development. In areas of more intense development, more arterial links are likely to be needed.

If, for example, a subdivision is a further extension of the urban area on the edge of a town or city, then the future arterial road network needs to be established first. Otherwise, intractable traffic problems will occur once the new area is fully developed: the local area will be too large and high traffic volumes will occur on some local streets.

Having established the arterial network, each section of the residential subdivision within the local area needs to be part of an overall plan, which has low traffic impacts. For example, residential development should not occur as a series of isolated cul-de-sac off an arterial road, as each block of land is developed.

Traffic impacts of residential subdivisions can occur at connections with the arterial network, in adjacent residential areas or within the new area itself. Adverse impacts can include:

- excessive volumes of traffic at connections with the arterial road network (e.g. at certain times of day or in other particular circumstances)
- too many conflict points at connections (e.g. when cul-de-sac directly connect to arterials)
- poorly managed traffic conflicts at connection points (e.g. due to the wrong number, location or types of intersection controls)

- excessive volumes on local streets leading to the connection points
- excessive trip lengths to exit the subdivision
- excessive speeds on streets within a new or existing local area
- crashes involving motor vehicles on local streets.

Factors influencing the efficiency, safety and amenity of local streets include:

- under-provision of arterial roads
- arterial road congestion and delay
- external connectivity of the local street system
- internal connectivity of the local street system
- location of traffic generating developments.

The relationship between local areas and arterial roads is discussed further in the Guide to Traffic Management Part 8 (Austroads 2008d). A summary of the major issues as they relate to assessing traffic impacts of developments is given in Commentary 4.

3.4.2 Industrial Subdivisions

Industrial subdivisions need to have their own street access to the arterial road network, so that heavy vehicle traffic does not interact with residential traffic on residential streets or with other non-industrial traffic on streets that provide access to offices, shopping centres or community facilities. As well as avoiding safety-related conflicts between heavy vehicles and local manoeuvring traffic, the separation of industrial subdivisions avoids amenity conflicts as well.

Equally, industrial subdivision roads should not provide connectivity between two arterial roads as this will lead to higher traffic volumes on the industrial road, with conflicts between turning trucks and the shortcutting traffic. Nor should industrial driveways be permitted directly onto arterial roads and other traffic routes, as the conflict between the through traffic function and property access function can be severe with large, slow-turning vehicles.

Heavy vehicles accessing industrial areas include long vehicles. The design vehicle and checking vehicle for these areas will be larger than for residential subdivisions (Section 3.2.2). To cater for turns and manoeuvres to, from and within these areas, larger intersections and wider roads will be needed. This in turn will result in higher speeds by drivers of cars, which can be difficult to address in designs. Therefore the design and layout of approach roads and internal streets needs to recognise this and provide elements such as clear sight lines, which are consistent with likely speeds. The parking of cars on local industrial streets may need to be banned to maintain adequate sight lines at driveways and car parks. Consider the common contributors to problems in residential streets (in Section 3.4.1) when designing industrial subdivisions; the issues are often similar.

Heavy vehicles have lower acceleration performance than motor cars; they therefore take longer to turn or proceed at an intersection. This will influence the location of intersections onto the adjacent arterial roads as well as the types of control. While give-way control may be suitable in some locations (e.g. where sight lines are long, the proportion of left turns is high, exiting volumes are low or arterial volumes are low, etc.) the design of an industrial subdivision may need to include a signalised intersection for access onto an arterial road. A roundabout will rarely be a suitable intersection treatment, due to the difficulty for trucks to turn right at roundabouts.

4 TRAFFIC IMPACT ASSESSMENT

This chapter describes a traffic impact assessment (TIA) and why TIAs are needed; it sets out the steps involved in carrying out a TIA and discusses some of the issues to consider during these steps.

4.1 What is Traffic Impact Assessment?

A traffic impact assessment is a process of compiling and analysing information on the impacts that a specific development proposal is likely to have on the operation of roads and transport networks.

The assessment will not only include general impacts relating to traffic management (road efficiency and safety), but should consider specific impacts on all road users, including on-road public transport, pedestrians, cyclists and heavy vehicles.

The scope of a traffic impact assessment will depend on the location, type and size of the development and the ability of the road network to handle traffic generated by the development. The assessment may have to address broader transport planning and environmental considerations discussed in Section 5 and will need to take into account any traffic management strategy, strategic plan or local development plan.

A traffic impact assessment is undertaken by competent experts on behalf of the proponent of a development and is documented in a traffic impact assessment report. The report is typically prepared for a planning authority or road authority to consider.

4.1.1 Traffic Impact Assessment Report

The steps in carrying out a TIA are outlined in Section 4.3, with details given in Section 4.4. Checklists are provided in Appendix A and Appendix B. A TIA report should be structured as suggested in Appendix C and practitioners should consider the need to include information on all the subjects and issues listed.

4.1.2 Traffic Impact Statement

A traffic impact statement (TIS) serves the same purpose as a TIA report but is not as comprehensive. It should be noted, however, that:

- a lower threshold, in terms of additional traffic generated, may be appropriate in more densely populated areas
- a TIA report or a TIS may be required for reasons other than the volume of peak hour traffic to be generated by the development.

A TIS should include:

- a brief description of the development in terms of proposed land use and trips generated
- a brief description of the existing operational conditions of the road network in the immediate vicinity of the development
- analysis of the operation of the accesses to the development
- analysis of the operation of the first intersection, as a minimum, on either side of the accesses
- a conceptual geometric layout of the access arrangements, including any nearby driveways and intersections

- professional opinion on the expected traffic impact based on a site observation during the expected critical peak hour and the analysis conducted.

4.2 The Need for Traffic Impact Assessment

4.2.1 General

The traffic attracted to a new land use development or a major expansion of an existing development, such as an industrial project or a major shopping centre, can have significant impacts on the performance of the current or future arterial road network. These need to be properly assessed and addressed so that a satisfactory level of road safety and transport efficiency is maintained.

In many cases, criteria are already established for requesting a traffic impact assessment to be carried out. For example, legislation may require developments on state controlled roads to be referred to the relevant road authority for assessment. Or planning authorities and road authorities may have the power to seek a traffic impact assessment where it is considered a development is likely to have a significant impact on the safety or efficiency of one or more roads (e.g. impacting general traffic or pedestrians, cyclists or public transport).

But whether or not such powers exist, judgment is required to decide whether a project requires a full traffic impact assessment or some lesser analysis of traffic issues. For example, small urban developments may only require alterations to driveways and off-street parking spaces, whereas a similar development on a rural road may require turn lanes because of the high speed environment, the level of traffic generated and/or site geometry that restricts visibility. The following section provides a guide for deciding on the level of traffic assessment required.

4.2.2 Criteria for Traffic Impact Assessment

Criteria for traffic impact assessment for developments may be based on the size of the development, or on the expected level of (or increase in) traffic to be generated. Triggers for requiring traffic impact assessment may relate to the amount of additional traffic likely to be generated (typically 5% to 10% of existing volumes) or the likely increase in the proportion of heavy vehicle traffic (typically 5% to 10% increase).

In Victoria, for example, a traffic impact assessment is required where the proposal constitutes a 'major development' as defined by certain numerical trigger points, as illustrated in Table 4.1 (VicRoads 2006). A road authority may also request an impact assessment where those criteria are not met but the proposed development is considered to have an impact on safety and operational efficiency of the adjacent roads.

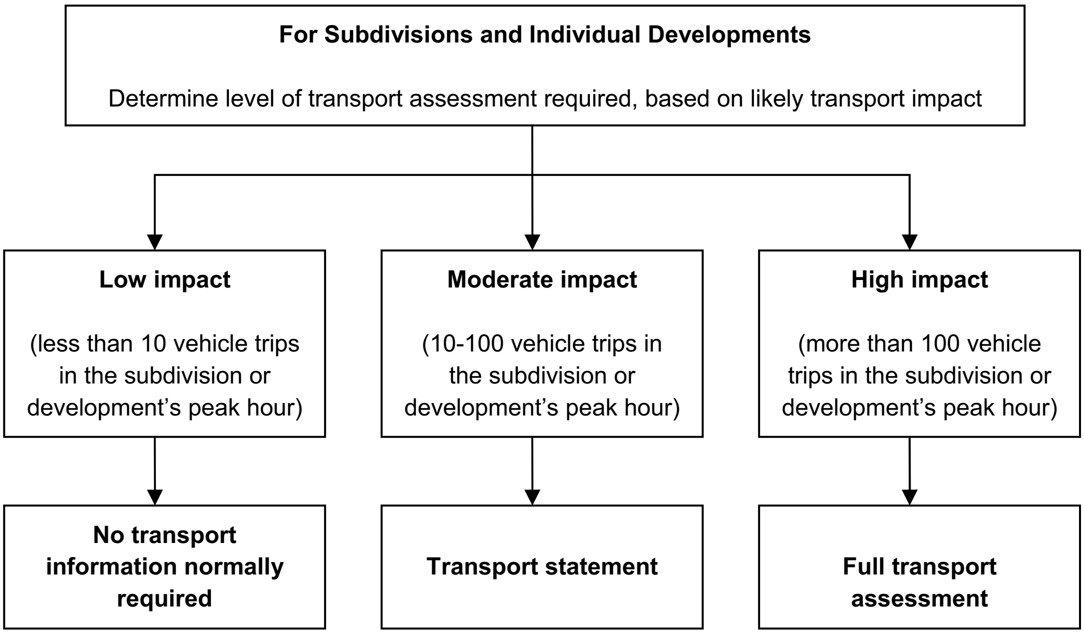
As a further example, in Western Australia, the threshold values for impact assessments are in terms of the level of likely transport impact and are related to the type and size of development, as illustrated in Figure 4.1 and Table 4.2 (WA Planning Commission 2006).

Table 4.1: Thresholds for a 'major development'

Item	Type of Development	Scale of Development (trigger points)
1	Residential flat – building	75 dwellings
2	Retail	500 m^2 GFA
3	Retail and commercial	1000 m^2 GFA
4	Commercial	5000 m^2 GFA
5	Commercial and industry	4000 m^2 GFA
6	Industry	5000 m^2 GFA
7	Residential subdivision	50 allotments
8	Tourist facilities Recreational facilities Showgrounds Sportsgrounds	50 car parking spaces
9	Clubs Hotels	50 car parking spaces
10	Places of assembly Places of public worship	50 car parking spaces
11	Refreshment rooms Restaurants	300 m^2 GFA
12	Drive-in take-away food outlets	50 car parking spaces
13	Service stations	Any scale
14	Motor showrooms	50 car parking spaces
15	Hospitals	100 car parking spaces
16	Roadside stalls	Any scale
17	Educational establishments	50 students
18	Drive-in theatres	Any scale
19	Transport terminals Bulk stores Liquid fuel depots	Any scale
20	Junk yards Waste disposal depot	Any scale
21	Heliports Airports Aerodromes	Any scale (heliports: only commercial ports require a TIAR)
22	Extractive industry Mining	Any scale
23	Parking area	50 car parking spaces

Note: GFA is Gross Floor Area

Source: VicRoads (2006)



Source: WA Planning Commission (2006)

Figure 4.1: Level of transport assessment required for developments

Table 4.2: Level of transport assessment required by land use and size

Land Use	Moderate impact	High impact
	Transport statement required	**Transport assessment required**
	10-100 vehicle trips in the peak hour	**> 100 vehicle trips in the peak hour**
Residential	10-100 dwellings	>100 dwellings
Schools	10-100 students	>100 students
Entertainment venues, restaurants	100-1 000 persons (seats) or 200-2 000 m^2 gross floor area	>1 000 persons (seats) or >2 000 m^2 gross floor area
Fast food restaurants	50-500 m^2 gross floor area	>500 m^2 gross floor area
Food retail / shopping centres with significant food retail outlet	100-1 000 m^2 gross floor area	>1 000 m^2 gross floor area
Non-food retail	250-2 500 m^2 gross floor area	>2 500 m^2 gross floor area
Offices	500-5 000 m^2 gross floor area	>5 000 m^2 gross floor area
Industrial	1 000–10 000 m^2 gross floor area	>10 000 m^2 gross floor area
Other uses	Discuss with approving authority	Discuss with approving authority

Source: WA Planning Commission (2006)

Discretion of the road authority

The need for a traffic impact assessment can be influenced by many factors apart from traffic generation. Where other criteria are significant, the discretion of the road authority can be exercised. For example, a development may be located in a particularly sensitive area and a TIA report may be deemed necessary, even though fewer than 50 peak hour trips are generated. Conversely, there may be cases where the development is in an isolated and insensitive area and a TIS is considered to be sufficient even though the development generates more than 150 peak hour trips.

Factors other than total generated traffic, which may determine a need for a TIA report or a TIS, include:

- accessibility for local communities, cyclists, pedestrians, vision and physically impaired people and public transport users
- existing or potential safety or traffic problems on the roads serving the proposed development, such as a crash issue, complex intersection geometry, roads operating at or close to capacity
- the generated traffic applies to one turning movement
- significant impact to the current or projected level of service or the operational characteristics of roads that have high traffic growth adjacent to the development
- situations where there may be an adverse impact on public transport services
- situations where traffic from other existing or proposed abutting developments is likely to compound traffic impacts (e.g. by increasing or complicating traffic demands due to the locations of existing and proposed driveways/intersections)
- areas that will have their environmental capacity adversely affected (e.g. traffic volume, speed or noise in residential areas; sensitive natural environment near the development)
- developments that will generate a different type of traffic that may require geometric improvements or cause damage to an existing pavement (e.g. heavy vehicles, buses, road trains).

4.2.3 Assessing Site Suitability for Development

At the time a major development is first proposed it should not be assumed, simply because the use fits the general use criteria in the planning scheme, that the proposed site is automatically acceptable or can be made so by measures to mitigate impacts on the surrounding road network or transport system.

The site proposed by the developer may not be appropriate because of complications or hazards it will create when its access requirements are established. Poorly located developments can result in access arrangements that create intractable traffic operational issues or road safety problems.

If there are concerns of this nature, a TIA report can be requested, to highlight the extent of the problems and indicate the cost of the necessary mitigating works – or perhaps indicate that the problems cannot be realistically solved. In such cases it may be necessary for the planning or road authority to demonstrate through the use of reliable analytical techniques or prediction models that the proposed development will result in an unacceptable crash or traffic operational outcome for the community. This may require the authority, rather than the developer, engaging independent expertise.

4.2.4 Other Assessments

A TIA may be just one of several assessments which are needed, to examine the impacts a development may have on a road network. Other assessments for consideration (discussed in Section 5) relate to:

- road infrastructure (including pavement) impacts
- road safety effects (potential for crashes and injuries)
- the utility for expected users (walkability, cycleability, availability of public transport)
- environment impacts and cultural or heritage issues.

4.3 Steps in a Traffic Impact Assessment

The steps in carrying out a traffic impact assessment are summarised in Figure 4.2 with detailed guidance given in Section 4.4.

Refer to Section	THE TRAFFIC IMPACT ASSESSMENT	OTHER ASSESSMENTS
4.4.1	Document proposed development ↓	
4.4.2	Resolve any initial problems with designers ↓	Audit development plans
4.4.3	Identify area and stakeholders affected ↓	
4.4.4	Describe existing and design year conditions ↓	
4.4.5	Determine generated traffic and modal split ↓	
4.4.6	Determine approach and departure directions ↓	
4.4.7	Assign traffic to roads ↓	
4.4.8	Determine where non-car traffic will go ↓	
4.4.9	Review limits of area affected ↓	
4.4.10	Assess traffic operation on roads ↓	
4.4.11	Assess traffic operation on-site ↓	Pavement impact Road safety impact Environmental impact
4.4.12	Determine required impact-mitigating treatments ↓	
4.4.13	Obtain independent road safety engineering assessment ↓	
4.4.14	Document findings and recommendations	

Figure 4.2: The steps in a traffic impact assessment

4.4 Conducting a Traffic Impact Assessment

This section explains how to conduct a TIA, using the steps shown in Figure 4.2. For each sub-heading there is a list of tasks to be carried out. These are shown in the highlighted box. To conduct a TIA, go through each of these tasks and each of these steps.

Appendix A provides a checklist based on these steps.

Appendix B provides similar checklists based on the ITE procedure (ITE 2006) and the process used in Queensland (QDMR 2006).

Appendix C contains a suggested structure for a TIA Report, based on ITE (2006).

The steps detailed in this section apply generally to all types of development, whether urban or rural, residential or commercial or industrial, large or small. It is possible with a small development that some tasks are not required. Detailed requirements should be determined in consultation with the planning authority.

4.4.1 Document Proposed Development

THE TASKS …

- Provide a plan, or plans, which show the layout of all the traffic and pedestrian areas on the site, plus the locations of vehicle and pedestrian accesses onto roads, plus the position and layout of all nearby driveways and intersections.
- Check that each type of internal access (e.g. cars, pedestrians, trucks, etc.) is direct, connected, continuous and makes sense.
- Check that the approach roads and paths are clearly understood and are practical.
- Check that the correct design vehicle and checking vehicle has been used in the various sections of the development (refer Austroads 2006a).
- Check that basic design requirements have been applied.
- Document the land use planning zonings in the vicinity, for use when assessing impacts later.
- Summarise/list the traffic-related features of the development, including those to be taken from the plans (e.g. total number of parking spaces, access points to roads, internal access to different sections for pedestrians, cars, trucks, bicycles, etc.).
- Describe the timing and any phasing of the development and note any connection with external events (e.g. calendar events, community events, development nearby, etc.)

On-site layout for large developments

Large developments may have internal roads to which the Road Rules apply (e.g. major shopping centres). It is desirable that the internal layout:

- minimises conflict between pedestrians and motor vehicles (e.g. design to eliminate the need for pedestrians to cross internal roads at grade, as much as possible)
- provides delineated, direct, safe and well-signed paths for pedestrians (e.g. moving from local areas, public transport stops, interchanges or stations to the development)
- provides efficient, safe, and well-signed and delineated lanes or paths for cyclists accessing the development from roads and the shared path network

- encourages and reinforces low traffic speeds
- segregates the movement of trucks servicing the development from all other traffic within the site
- enables all deliveries by truck to be made on-site (i.e. no loading or unloading from the external road network) and all trucks to enter and leave the site in a forward direction (i.e. not reverse out onto any road)
- supports the efficient movement of public transport within the site and between the site and the external road network
- incorporates bus interchange facilities, which are safe and readily accessible for users.

Parking-related layout issues

The amount of on-site parking, its location and its layout, the position and control of accesses and the layout of access routes within the site – for motor vehicles and bicycles – should ensure that:

- Traffic is able to flow freely into and out of the development and is not hindered by drivers queuing for parking, exiting a space or waiting for a particular space to become vacant.
- Parking aisle intersections with access driveways are far enough away from access points onto the external road that queuing or turning vehicles do not inhibit access to the site or inhibit exiting from parking aisles.
- There is a sufficient amount of parking in desired locations to avoid a spillover of parking onto adjacent traffic routes or local streets. Be aware that while planning ordinances specify amounts of parking to be provided for particular land uses, these may not reflect the actual parking demands likely to occur at any particular site.
- The objectives, intent and requirements of AS/NZS 2890 Parking Facilities (2004) are achieved; refer also to the Guide to Traffic Management Part 11 (Austroads 2008e).

The mix of business types in larger developments may affect the total amount of parking required, because peak parking demands for different land uses may occur at different times. This also affects traffic generation at different times of the day or week.

Relationship to surrounding development

It is desirable that developments along arterial roads should be complementary to each other and to the function of the road. For example, internal connections between car parks and access via service roads will improve circulation and reduce conflicts.

Development characteristics

Any structure plan that describes the context in which the development will operate (e.g. the land use transport relationship) should be referred to.

All relevant characteristics of the development should be established, collated and documented. Important details include:

- site location and boundaries
- current and intended use of the land
- current and intended use of adjacent parcels of land and their relationship to the development

- other proposed developments that may not be adjacent to the site but which could have a substantial impact on the transport or road system
- size of the development and proposed activities (e.g. floor area for different commercial purposes, number of dwellings)
- timing of the development, at opening and any subsequent stages
- proposed access locations to the road network for cars, public transport, cyclists, pedestrians and delivery vehicles (including heavy vehicles)
- proposed layout of internal roads and parking areas
- proposed arrangements for pedestrian, bicycle, public transport and heavy vehicles within the site.

For non-residential uses additional details should be provided, such as:

- proposed hours of operation
- peak traffic periods
- numbers of employees and visitors, where appropriate, for both construction and operational phases
- the volume and origins/destinations of major product inputs and outputs, where haulage is involved.

4.4.2 Resolve Any Initial Problems with Designers

THE TASKS …

- Identify any initial problems or issues needing resolution by designers.
- Advise the designers of the need to resolve any problems before proceeding with the impact assessment.
- Re-document the amended proposal.

If any of the documentation in the previous step highlights a traffic-related problem (e.g. parking requirements not applied, driveway conflicts with nearby intersections, layout resulting in high pedestrian / traffic conflicts which are avoidable or should be controlled, etc.) do not proceed with the traffic impact assessment without referring these to the designers.

Reports on design audits or road safety audits may be available.

4.4.3 Identify Area and Stakeholders Affected

THE TASKS …

- Document the agreed functional road hierarchy in the area, identifying those roads that are principally traffic routes and those which are principally local streets.
- Document the non-car transport networks or services affected or of relevance.
- Make an initial assessment of the area affected by the changed traffic conditions.
- List the sites that are potentially impacted and will need to be included in the later analysis.
- Identify all the affected stakeholders and provide them with the opportunity to provide input.

Defining the network

For small developments the area affected may be quite localised. Where a major development such as a regional shopping centre is involved, the impacts may be experienced several kilometres away at critical intersections.

In general terms the affected area is determined from the magnitude and distribution of generated traffic volumes in relation to existing and future volumes on the surrounding road network. Preliminary traffic analysis may be necessary to define the area.

Is the area just the frontage section of road? Are more distant intersections affected? If so, how far away and in which directions? What area of footpaths and bicycle routes needs to be examined? Over what area of roads will there be an impact on public transport?

Stakeholders

Where a development in one road authority's area is likely to impact on the transport network and roads in another area, the appropriate organisations in the neighbouring area need to be adequately consulted and have the opportunity to provide input into the process. In some instances a rail authority could be a relevant stakeholder or developer. Key aspects include the scope of the study, the extent of the network to be analysed, staging, critical analysis periods, traffic generation rates, traffic distribution, etc.

4.4.4 Describe Existing and Design Year Conditions

THE TASKS …

- Document the existing conditions on the site.
- Document the existing traffic conditions. Do this for critical periods of the day or week, etc.
- Select the design year (or years, for a staged development) and document the same types of traffic conditions for that time. Exclude the traffic generated by the development. Show the traffic volumes on a plan.
- Describe the parking conditions to the extent this will be relevant, e.g. parking controls, parking locations, parking occupancy, existing parking spill-over or problems, etc.
- Document the traffic crashes at the potentially impacted locations.
- Document any known traffic safety or operational problems and any proposals to address them.
- Document any traffic, transport or parking policies that affect the proposed development.

Existing conditions

Conditions on-site should include the traffic and parking conditions, as these may need to be accounted for when calculating traffic generation and new parking demands.

The surrounding transport networks (including public transport, freight, bicycle, and pedestrian networks as well as roads) should be identified. The sections that are likely to be affected by the development should be identified in consultation with the transport facility owners and operators.

Documentation of existing conditions – for the external sites, road lengths and/or areas identified as potentially impacted – should include items such as number of lanes, through volumes, turning volumes, percentage or numbers of commercial vehicles, bus frequencies, pedestrian volumes, types of traffic controls, speed limits, etc.

Design volumes

In considering the design year conditions, sources of traffic growth information, e.g. forecasts by the planning or road authority, should be identified.

The process used to determine design volumes will vary depending on the nature and size of the proposed development. Small proposals may simply involve adding generated traffic volumes to existing traffic volumes and undertaking a traffic capacity analysis of the access to the external roads. Major developments such as residential suburbs or sub-divisions, or regional shopping centres will normally require a more comprehensive approach. Details of the process, including data collection and projection considerations, are given in Commentary 5.

Items for consideration

The items to be described (with maps or diagrams as appropriate) may include:

- road condition, width, alignment and cross-section detail
- public transport routes and facilities (including bus, tram and train)
- current public transport patronage information, if available, and land use/access arrangements

- pedestrian and bicycle routes generally and specific links between the development and public transport facilities (e.g. nearby railway stations and tram stops)
- access facilities for pedestrians, particularly the elderly and those with disabilities
- existence and details of on-street parking
- intersection configurations including median breaks and traffic control devices
- existing daily traffic volumes by vehicle type
- existing peak periods and associated traffic volumes by vehicle type
- traffic growth trends and assumptions relied upon to produce the 'without development' traffic volume forecasts at the time of each stage of the development
- details of any planned changes to public transport services or significant road improvements
- identification and inventory of routes through local street networks in the vicinity of the development that may be subjected to increased traffic flow if capacity issues arise on the surrounding arterial network
- any limits on the types of vehicles permitted on the surrounding roads (e.g. type, length, height, mass limit)
- for development involving significant numbers of heavy vehicles or haulage of production outputs (e.g. from mines, industrial use, distribution centres), the routes that can or may be used and their associated issues (e.g. suitability of the route, current and development related pavement loadings)
- other proposed developments or road network changes that may affect assessment of the proposed development.

In some cases additional traffic, patronage, pedestrian, parking or other types of survey will need to be carried out.

4.4.5 Determine Generated Traffic and Modal Split

THE TASKS …

- Determine the number of trips that will be generated (daily, peak period, etc.). Do this for the design year or years.
- Determine the generated volumes of general traffic, commercial vehicles, public transport vehicles (including taxis), bicycles, pedestrians, etc. and their proportions of the total number of trips.

Traffic generation

The trips likely to be generated by the development will need to be forecast for each stage of development. This should include vehicle trips by type of vehicle, public transport trips and pedestrian activity and cyclist activity. When available and applicable, results from a transport model of the city, region or town should be used to estimate the trip demands for each mode of transport for each stage of development.

Peak period traffic volume generation may need to be forecast for the assessment of mid-block and intersection capacity. Traffic generation is normally considered for the peak periods of the surrounding road system, and for other normal weekly peak periods associated with the development and the surrounding area (e.g. evening or Saturday shopping).

For some developments the peak traffic generated by the development may coincide with peak recreational flows on the surrounding road network. In these cases data will be required for the normal weekday situation as well as recreational periods.

Traffic generation can be estimated using trip generation rates established in previous surveys. Locally derived rates are preferred to those applying elsewhere. This information may be available in consultant reports (copyright provisions permitting) including those reported in town planning appeals, local government files and collated ‘traffic generation’ reports (e.g. Roads and Traffic Authority 2002). In New Zealand, a database has been established (Clark 2007), to capture traffic and parking generation rates for developments in New Zealand and Australia.

Some examples of traffic generation rates that apply to the more common land uses and activities are provided in Appendix D.

Commentary 6 provides further discussion and advice on the availability and quality of traffic generation data.

Further advice on the computation of traffic generated by land use developments is given in Commentary 7.

Transport modal split

Different urban locations can have different transport services, which can affect modal split (the proportion of trips by different modes). Inner areas of cities are likely to have a higher density of existing development and a mature public transport system. Consequently a higher percentage of the overall trips generated by a development are likely to be made by public transport or involve walking and cycling. Conversely, developments in outer areas may not be well served by public transport, resulting in a lower usage of transport modes other than cars.

The data for determining realistic modal splits can come from census information, transport surveys and transport studies. More directly, mode use and parking surveys for similar developments in areas with similar characteristics can be a good way to obtain reliable information.

Modal split estimation should take into account transport strategies such as parking restraint or travel demand management initiatives (refer to the Guide to Traffic Management, Parts 4 and 7 (Austroads forthcoming 2009e, forthcoming 2009f).

Trips potentially generated by the development can be mitigated by initiatives for walking, cycling, public transport use, car-pooling and teleworking. There may be a need for large companies to actively implement such initiatives in their corporate travel plans (Section 2.1.5).

4.4.6 Determine Approach and Departure Directions

THE TASKS …

- Determine the approach and departure directions for the traffic.
- Take account of traffic that returns to its point of origin and traffic that stops while passing by.

Factors

The directions from which traffic will access the site can vary depending on many factors (ITE 2006), including:

- the type of proposed development and the area from which it will attract traffic (its catchment area)
- competing developments (if applicable)
- size of the proposed development
- surrounding land uses and population centroids, and their locations with respect to the development location
- traffic conditions on and the layout of the surrounding road network and the mode of travel.

Some journeys will involve a return trip to the same point of origin, while others will involve the trip continuing in a forward or other direction (see 'Linked trips' on the following page).

These factors are relevant to all transport modes that may serve the development.

Methods

Various methods can be used to estimate site traffic distribution. Note that distribution refers to establishing directions of travel, while assignment refers to allocating those trips onto specific routes. The three most commonly acceptable methods of traffic distribution (ITE 2006) are:

- An analogy method that is based on data collected from a similar development (if one exists) located near the proposed development.
- A gravity model or other locally acceptable trip distribution model that may be available and is capable of being applied to a specific site by experienced practitioners.
- A surrogate data method that involves the development of origins and destinations from data when an adequate socio-economic, demographic database of usable detail by zones and sub-areas is available for the population or employment distribution representative of the study target year. For example, population can be used as the basis for estimating office, retail and entertainment trips whereas employment is a reasonable surrogate for residential trips.

Marketing studies and strategies may provide an insight into traffic distribution.

In the absence of more rigorous data, and where the development is relatively small, the access directions can be estimated by splitting the compass point into four and allocating proportions of trips to each of the four quadrants, taking account of the population or catchment in each direction.

The method used should be specified in the report. Where there is a degree of uncertainty, this should be acknowledged and the use of ranges of direction estimates should be considered. Sensitivity analysis is particularly important where a development will have a significant impact on the transport network and/or where the network has limited capacity.

Microsimulation models may also be used to assist with the distribution and assignment of generated trips. See the Guide to Traffic Management Part 3 (Austroads 2009d) for further advice.

Linked trips

The concept of linked trips is based on the fact that traffic generated by (or attracted to) a development will be composed of:

- new trips that will not be made on the network if the development does not proceed
- existing trips between an origin and destination that divert a significant distance to visit the development
- existing trips that use the roads immediately abutting the development and break the journey to use the development.

For a given development, proportions are assumed for each type of trip based on studies of similar land uses.

Further discussion of linked trips in the context of traffic impact assessment is given in Commentary 8.

4.4.7 Assign Traffic to Roads

THE TASKS …

- Assign the generated traffic to the road network in the potentially affected area for the design year(s).
- Show this development-generated traffic on plans.
- Add the background traffic (i.e. existing volumes factored to the design year) and development-generated traffic together.
- Show the total traffic on plans for critical times of the day or week, etc.

In determining the assignment of traffic, take account of the approach and departure directions, the road network layout and road features such as one-way streets, medians, etc.

Sensitivity analysis

Where there is uncertainty about the magnitude of estimated traffic movements it may be beneficial to test the ability of the existing or proposed road layout to carry a range of volumes (e.g. + or – 20%). This is important for key links and key intersections, such as those where priority measures for public transport exist or are planned. Sensitivity analysis should also be undertaken for locations that are approaching traffic capacity, as an underestimation of design volume could result in inadequate impact mitigation measures.

4.4.8 Determine Where Non-car Traffic Will Go

THE TASKS …

- Determine what paths, lanes, etc. will be required for pedestrians, cyclists, buses, delivery vehicles, etc.

Examine continuous lengths of routes and identify any missing links, significant conflict points or other potentially difficult locations.

4.4.9 Review Limits of Area Affected

THE TASKS …

- Check to see whether the limits of the area affected need to be altered.
- If so, make the changes and carry out further analysis.

Additional intersections may need to be analysed.

Pedestrian issues may need to be assessed over a greater area.

4.4.10 Assess Traffic Operation on Roads

THE TASKS …

- Analyse the traffic operations (traffic volumes, capacity, level of service, delays) and assess any likely consequences such as diversion to other roads or streets. Do this for the access points at the development as well as intersections and mid-block sections, as required, within the affected area on the road network.
- Consider the circulation of traffic near the site.
- Establish whether the development will result in on-street parking, and if so, whether this will occur on suitable streets or will impact on arterial roads/traffic routes/residential streets.
- Assess the impact on public transport services, arising from any use of public transport to access the development, and from increased vehicular traffic on public transport routes (buses and trams).

Performance criteria

Traffic operation and safety analysis is generally required:

- on affected arterial and local road links
- at affected intersections on the surrounding road network
- at site entry/exit points.

The performance of the surrounding road network concerns both mid-block links and intersections. Intersections are often considered the critical locations in relation to network capacity because the time available has to be shared between a number of competing traffic movements. However, mid-block sections or road links can be critical if they are not adequately managed. For example, if parking is permitted in the left lane between major intersections it can have a dramatic and critical impact on the movement of traffic along a route.

The traffic impact assessment produces design hour volumes for use in analysing the performance of roads and intersections that serve a development. Common practice is to design for the peak 15-minute rate of flow – commonly accepted as the shortest interval during which stable flow exists – to allow for fluctuations that are likely to occur within the design hour. This is done by dividing the design hour volume by an appropriate 'peak hour factor' (see the Guide to Traffic Management Part 3 (Austroads 2009d)). In Australia a period of 30 minutes is often used. This should be agreed upon between the road authority and the person conducting the traffic impact assessment.

Road link performance criteria

The performance of mid-block road links is based on the concept of *level of service*. Level of service (LOS) is defined as a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and passengers. Six levels of service are defined for each type of facility, from A to F, with LOS A representing the best operating conditions and LOS F the worst. LOS A is a condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream whereas LOS F is a condition of forced flow, usually involving flow breakdowns, extensive queuing and delays. Further information and advice on level of service considerations is given in Commentary 9 and the Guide to Traffic Management Part 3 (Austroads 2009d).

Rural roads

Aspects that may require consideration include the effect of additional traffic and access treatments on:

- overtaking opportunities
- dust nuisance and visibility impediment from unsealed shoulders
- speed differentials and reduction in LOS where significant heavy vehicle movement occurs
- noise for adjoining properties.

Urban Roads

Aspects that may require consideration include the effect of the development on:

- public transport generally
- changes to bus routes
- the need for and location of bus stops and tram stops
- amenity including traffic infiltration to local streets, traffic noise, dust and speeding issues
- the effect on community accessibility (e.g. severance, areas inaccessible by other modes)
- existing on-street parking.

The level of service estimated to apply to the road system surrounding the development may indicate the need to provide or protect the integrity of public transport priority measures, allocated road space (e.g. bus lanes) and other treatments to improve or maintain public transport running times at key congestion points. A general guide may be adopted that average travel speeds for buses need to be maintained at 20–25 km/h, but this value will vary between jurisdictions depending on the road system available and traffic demand.

Pedestrians and cyclists

Pedestrian and cyclist flows associated with some developments can be significant. It is important that pedestrian level of service is also considered in a traffic impact assessment report. A development should be planned and designed to guide pedestrians and cyclists to safe and efficient road crossings. Excessive pedestrian delays can lead to higher levels of non-compliance with traffic signals; delays should be kept to a minimum in relation to the competing traffic demands at various times of the day.

Intersection performance criteria

The performance of intersections is established through the use of analytical methods that determine the intersection congestion levels. It is the developer's responsibility to arrange and provide estimates of the performance of all existing intersections that are affected by the development and new intersections provided specifically for access to the development. Analytical methods are available for signalised intersections, roundabouts and major/minor intersections (i.e. where the minor road is controlled by signs or the T-junction rule). Design software packages are normally used because of their efficiency in examining the performance of alternative treatments and design options. Various packages are available for analysing intersections and modelling networks. Some of those commonly used in Australia are described in the Guide to Traffic Management Part 3 (Austroads 2009d).

The performance of intersections is commonly described by the degree of saturation (DOS) of the critical traffic movements, a measure of the volume/ capacity ratio or degree to which available intersection capacity is utilised. The performance of intersections may also be described in terms of a level of service based on the average stopped delay (TRB 2000) and this approach may be preferred by some jurisdictions or for some purposes.

The design for a new or upgraded development-related intersection should also be assessed for safety (i.e. as part of the TIA and quite separately from any independent road safety audit), other operational considerations and convenience for road users other than cars. For example, check that:

- adequate sight distances are achieved (refer to the Guide to Road Design Parts 3 and 4 (Austroads 2006-2009b))
- pedestrians do not experience excessive delays (e.g. by having a long signal cycle time)
- the intersections provide for the safe movement of cyclists through all turning manoeuvres
- priority for on-road public transport is considered
- any co-ordinated traffic signal system is not adversely affected; these systems can be rendered totally ineffective if too many intersections are signalised along a section of road
- access to other properties is not unduly impeded or made more hazardous
- heavy vehicle stability is not compromised during turning movements
- are consistent with pedestrian safety where pedestrians and turning vehicles interact
- pedestrians, including those who have mobility problems are catered for.

The intersection analysis should consider operation during the normal peak periods on affected arterial roads and, for larger developments, during peak generation of the development, or during a combined peak. With signalised intersections computer-aided analysis is recommended to enable consideration of factors such as:

- pedestrian crossing times
- public transport priority measures
- the effect of shared lanes
- the effect of short lanes
- constraints imposed on cycle time, phase sequence and green splits if the intersection is coordinated with other intersections.

For signalised intersections, the key indicator of operational performance used is the DOS. For unsignalised intersections, it is the utilisation ratio (volume/capacity or service volume/service rate) for entering movements that must give way. This is also a measure of LOS.

The limits of operation for the different types of intersection are generally accepted as being:

- **Signalised intersections** – the intersection **DOS**, which represents the proportion of available green time capacity taken up for the critical movement(s), should generally not exceed **0.90**. This represents 90% of theoretical capacity and is considered a 'practical capacity' beyond which delays increase substantially for modest increases in volume.
- **Roundabouts** – the **DOS** for any movement should not exceed **0.85.**
- **Priority junctions** – the **DOS** for any movement should not exceed **0.80.**

A key parameter in the analysis of signalised intersections is the saturation flow (capacity of a lane during the time it is serviced by a signal phase). However, saturation flow that can be achieved depends on the general environment and traffic environment at the intersection (e.g. type of abutting land use, lane widths, road gradient, presence of public transport services) so the choice of values requires careful consideration. The planning authority or road authority and consultant to the developer should agree on the appropriate saturation flows to be used in the analysis of intersections, accesses and crossings that serve the development. The appropriateness of a particular value can be confirmed by field measurements at comparable sites.

Traffic queuing and the implications of queue lengths (refer to the Guide to Traffic Management Part 6 (Austroads 2007c)) should also be assessed. For arterial roads, a 95% confidence limit should generally be used for queue lengths. This is referred to as the 95th percentile queue length, meaning that the queue will be exceeded on 5% of occasions in the design hour. A greater confidence limit may be appropriate where excessive queue lengths are likely to cause significant problems.

4.4.11 Assess Traffic Operation On-site

THE TASKS …

- Analyse the traffic operation of roads, aisles, access ways, etc. on the site.
- Determine whether the expected traffic volumes and the expected vehicle types can be safely and efficiently accommodated within the traffic and parking areas on-site.
- Establish whether the on-site parking provision is adequate and is suitably located.

Consider the circulation of traffic within the site.

Some on-road effects may also arise. For example, there should be sufficient storage for queues of vehicles departing the site so they can discharge onto the road network without interacting with pedestrian activity or parking/un-parking movements. Similarly, sufficient storage should be available for incoming vehicles prior to the first conflict point, which might generate queues tailing back to the external road network.

4.4.12 Determine Required Impact-mitigating Treatments

THE TASKS …

- From the traffic analysis, determine what changes, improvements, upgrades and/or modifications are required to road and intersection layouts, traffic lanes, intersection controls, access driveways, etc.
- From the parking assessment, determine what changes are required on-site and on nearby roads and streets to manage parking and to assist efficient and safe traffic operations.
- From the assessment of non-car traffic issues, determine what works and traffic management arrangements are required to accommodate pedestrians, cyclists, public transport and delivery vehicles on-site and in the nearby area.
- From the assessment of the other issues listed in Section 5, determine what other treatments are required.
- Co-ordinate consideration of all the above items so that they complement each other and do not work against each other.

Timing and co-ordination

An important consideration is the timing of the development and the road authority investment program. A road authority requires time to incorporate new infrastructure investment into a program. It is desirable that proposed developments are brought to the attention of the authority as early as possible. On the particular road(s) involved, the road authority may have works planned. In other cases there may be no intention of improving the road for the foreseeable future.

The authority and developer need to work through a process to determine how best to fund and deliver the necessary works. Cost sharing and other responsibilities for works may be detailed in an agreement between the proponent and affected agencies.

It is also essential that the developer determines whether utility authorities have any existing services or planned works that would be affected by the development and its access roads and intersections.

A road use management plan may also be used to set out what is to be delivered, by whom and how. Such a plan could be attached to conditions of approval for the development to ensure completion of requirements before commencement of works or use of the development.

Co-ordinate the response to all issues

Impact-mitigating treatments are the treatments that are required in response to operational, safety and other issues. These may relate to:

- traffic capacity or operational issues
- parking management or operational issues
- non-car-related traffic operational issues (including pedestrians as well as vehicles)
- other issues including infrastructure, road pavement, road safety, and environmental problems.

It is important that consideration of solutions to these different types of problems is co-ordinated and that each area is not considered in isolation.

The mitigation measures should not simply focus on providing a satisfactory level of service for the surrounding transport (including the road network) system at opening and shortly thereafter, but should have due regard to any long term plans and strategies that the planning authority and road authority have for the system (e.g. 10-year road design horizon, traffic growth, future public transport demand). Selection of an appropriate design year is the basis for this happening.

Traffic operation

The traffic operation assessment will highlight the areas of each network (road, bicycle, etc.) that require improvements to remedy any adverse effects likely to result from the development. It is generally the responsibility of the developer to investigate and design the mitigation measures for their developments in consultation with the relevant road authority.

Depending on the size of the development, the required road improvements may include:

- additional through traffic lanes
- additional arterial roads, service roads or local roads
- new intersections
- new medians, closed median breaks, new turning lanes
- modified driveways
- provision, relocation or upgrading of bus/tram stops and services
- modifications to parking arrangements (e.g. removal of parking near the new driveway(s) or more extensively to provide better capacity, safety or operating conditions on approach roads)
- new, relocated or upgraded footpaths, bicycle paths and shared paths
- pedestrian and cyclist crossing facilities (e.g. signals, refuges, etc.)
- pedestrian and cyclist grade separations
- pedestrian fencing.

Remedial work at existing intersections may require items like:

- additional turn lanes
- new signalisation or changes to the phasing of signals
- signal co-ordination where new intersections are implemented

- new, relocated or upgraded bus stops, bus bays and bus priority measures
- cycle lanes.

Economic considerations

Where they contribute jointly to works on the surrounding network, the developer and road authority may wish to evaluate the economic benefits of alternative options for the treatment of mid-block sections and intersections. Reference should be made to the Guide to Project Evaluation (Austroads 2005-2008a), which is designed to assist transport agencies and practitioners charged with the task of evaluating projects in the road sector. It is a dynamic system of evaluation methods that provides:

- guidance on good practice
- a consistent approach to key data used in analysis
- state-of-the-art tools.

Reference should also be made to the *New Zealand Economic Evaluation Manual* (New Zealand Transport Agency 2008).

4.4.13 Obtain Independent Road Safety Engineering Assessment

THE TASKS …

- Obtain an independent assessment of the road safety aspects of the development by a qualified road safety engineer or road safety audit team.

Depending on the size, type and location of the development, specialist expertise may be required in undertaking the road safety assessment. Details on the requirements for road safety assessment and auditing activities are given in Section 5.3 and in Guide to Road Safety Part 6 (Austroads 2006-2009c).

4.4.14 Document Findings and Recommendations

THE TASKS …

- Document the above steps and their outcomes.

Checklists

To assist developers and road authorities in the preparation and consideration of traffic impact assessment reports, checklists of matters that may have to be considered are contained in the appendices.

Appendix A provides a checklist based on these steps set out in Figure **4.2**.

Appendix B provides example checklists based on the ITE procedure (ITE 2006) and the process used in Queensland (QDMR 2006).

Reports

It is desirable that reports for traffic impact assessments are set out in a reasonably uniform way.

Appendix C contains a suggested structure for a TIA Report, based on ITE (2006), the headings providing a guide to a logical presentation off information.

It is important that a TIA report clearly and separately:

- describes the proposed development and the traffic it will generate
- establishes the potential impacts of the development on the road and transport network
- outlines the appropriate mitigation measures.

Appendix E provides an example of a TIA study for a rural quarry development.

Appendix F provides an example of a TIA study for an urban commercial/industrial development.

5 ASSESSMENT OF OTHER IMPACTS

5.1 Introduction

The full assessment of the impact of a development will in many cases require consideration of other issues. These include:

- road infrastructure and pavement impacts
- road safety impacts
- environmental and other issues.

A TIA report should thus not be viewed as the only traffic-related development assessment report which should be considered. In particular, for developments of a size, scope or location as described in Section 5.3.2 a road safety audit report will be an essential part of any effective development assessment.

5.2 Infrastructure and Pavement Impact Assessment

Some projects, because of their size, location and/or the types of vehicles involved, will have a direct impact on the road pavement – and possibly bridges and culverts – in the vicinity of the development. Examples include quarries (where the vehicles accessing the development are large and heavy) and developments that generate volumes of traffic, which exceed the earlier design volume for the road pavement, in terms of the number of equivalent standard axles (ESAs). In these types of cases an assessment of the development's impacts on the road pavement will be required.

Where existing roads will be exposed to increased heavy vehicle traffic or new vehicle types, e.g. buses resulting from subdivision development, pavement impact can be a significant consideration, especially where old road pavements are involved.

Issues to be considered with any large road project may also include drainage, utility service relocation and effects on structures and water courses.

Further discussion and advice on pavement impact issues is given in the Austroads Guide to Pavement Technology (Austroads 2005-2009b).

5.3 Road Safety Assessment

5.3.1 Types of Road Safety Assessments

The following types of road safety assessments can be applied to developments. A road authority or planning authority should consider the level of road safety assessment required for a particular development. Some developments will require both types of assessment.

An assessment of road safety as part of the TIA report

The types of development projects that should include this type of assessment are described in Section 5.3.2. This assessment:

- may involve reviewing the known crash pattern at or near the site, so that development works can either address the problem, not make it worse or be designed to accommodate future road authority works to address the problem
- should assess the safety of the development's access points in relation to nearby access points, intersections, traffic control devices, etc.

- should assess the safety of the internal traffic layout, access point layouts, pedestrian and cycle path layouts, commercial vehicle area layouts, etc.

An independent road safety audit of the design

A road safety audit forms part of the development impact assessment process, described in Figure 4.1. The types of development projects that should be audited are described in Section 5.3.2. The types of practitioners suitable for conducting road safety audits are discussed in Section 5.3.3.

5.3.2 Types of Developments to be Assessed or Audited

To consistently consider road safety aspects of developments, it is desirable that planning authorities and road authorities have policies and guidelines regarding the types and size of developments that require either a road safety assessment (as part of a TIA report) and/or an independent road safety audit report.

Generally, any development can benefit from a road safety assessment. It is suggested that the road safety assessments or audits be applied as follows:

A road safety assessment as part of a TIA report

This should be undertaken for any project where:

- the internal traffic layout consists of more than a short driveway leading to a single parking area of, say, ten spaces, or
- the dot points for road safety audits (below) apply.

An independent road safety audit

This should be undertaken where the risks to the public are significant, specifically where:

- roads surrounding the development have existing road safety issues
- the development is large and complex with high levels of activity by all road users (e.g. residential subdivisions and industrial subdivisions of more than 20 lots; shopping centres (new and expanding) with more than 50 car parking spaces)
- there is significant use by pedestrians and/or cyclists
- the development directly abuts an arterial road/traffic route (i.e. the volumes of traffic and traffic speeds are higher).

Examples include petrol stations, convenience stores, offices, medical consulting rooms, other commercial developments and increased density developments on a single site.

5.3.3 Who Should Undertake an Assessment or Audit

Designers should consider road safety issues as they design a development. However, to be consistently effective, a road safety assessment requires the input of a road safety engineer. This is someone with experience in the diagnosis and treatment of crash locations and the design of effective remedial treatments. This experience is gained from the investigation of hazardous locations (see the Guide to Road Safety Part 8 (Austroads 2006-2009c)) and is an essential ingredient in road safety auditing (see the Guide to Road Safety Part 6 (Austroads 2006-2009c)).

- For a road safety assessment of a development as part of a TIA report, the road safety engineer(s) need not be independent of the developer or the developer's advisers.

- For a separate road safety audit report, the road safety engineer(s) will need to be independent of both the development's proponents and advisors, and the authors of the TIA report. If the development is large, an audit may be required at more than one design phase.

In addition to the above requirements, road safety engineering input into a design can also be sought through less formal consultation with a road safety engineer during the design process.

Experience is a vital part of road safety engineering. Most state road authorities have lists of accredited road safety auditors and senior road safety auditors. These lists are a good starting point when considering whom to engage to conduct an audit, but they do not include information on experience levels. It is important that the auditor has:

- experience with the types of issues and types of developments being assessed
- an adequate length of professional experience.

5.3.4 Typical Road Safety Issues

The purpose of an assessment or audit is to ensure that all potential road safety issues on-site and on existing and proposed roads near a development have been identified and addressed. Depending on the type, size and location of the development it is suggested that the following types of issues be considered:

- vehicular and pedestrian site access, including driveway locations and shape, new turn lanes, swept paths of large vehicles, footpath locations near traffic
- pedestrian-vehicle conflicts on-site and adjacent to the site
- adequacy of parking provision and the need to avoid parking overflow onto nearby roads (especially into traffic lanes on traffic routes)
- speeds within the site and at access/conflict points
- visibility at conflict points
- safe provision for public transport and its patrons
- generation of pedestrian and cyclist movements across existing arterial roads
- safety impact of congestion in peak periods, including changes to turning movements and the use of nearby streets
- type, layout and operation of adjacent intersections.

5.4 Environmental and Other Impacts

Where necessary an assessment of environmental and other issues should be undertaken, including those associated with the natural, social, economic and built environments. The assessment may need to include the effects upon environmentally sensitive, conservation and heritage areas. Issues may include:

- adverse effects on waterways, wetlands, flora and fauna
- hydrological impacts on waterways and abutting private land, including changes to surface and subsurface drainage, and water quality
- storm water control
- geotechnical stability
- treatment of surface run-off during construction

- traffic noise at opening and in the design year
- dust, noise and inconvenience to the public associated with construction of the development and access roads
- air pollution
- contribution to greenhouse gas emissions
- spillage of road lighting
- distracting lighting from the site
- general visual impact or aesthetic appearance of the development or abutting roads; this could include buildings, kerbing, road surfacing, street lighting, road furniture, fences and walls, large signs, etc.
- visual impacts associated with the scale of development
- landscaping
- heritage issues.

There are several Austroads publications (search www.austroads.com.au) covering environmental matters that are relevant to issues that may arise in the planning, design, construction and ongoing management and maintenance of developments, such as:

- road investment profiles and potential environmental consequences
- guidelines on environmental reporting
- environmental considerations for planning and design of roads
- environmental risk management guidelines and tools for road projects
- the description and measurement of environmental noise
- road run-off and drainage – environmental impacts and management
- maintenance techniques to reduce social and environmental impacts.

When considering environmental impacts relating to traffic using local areas adjacent to the development (traffic volume, speed, safety) refer to the Guide to Traffic Management Part 8 (Austroads 2008d).

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APPENDIX A CHECKLIST FOR TRAFFIC IMPACT ASSESSMENTS

Table A 1: Technical completeness checklist – Austroads guide to traffic management – Part 12

TECHNICAL COMPLETENESS CHECKLIST

Austroads Guide to Traffic Management Part 12

Project Name: ____

Reference ____

GTM section	Steps in traffic impact assessment	Done (✓)
4.4.1	**Document proposed development**	
	Obtained plans showing layout of all traffic and pedestrian areas on site, locations of vehicle and pedestrian accesses, position and layout of nearby driveways and intersections.	
	Each type of internal access (cars, pedestrians, trucks, etc.) is direct, connected, continuous and makes sense.	
	Approach roads and paths are clearly understood and practical.	
	The correct design vehicle and checking vehicle have been used in various sections of the development.	
	Basic design requirements have been applied.	
	Land use planning zonings in the vicinity are documented.	
	Traffic-related features of the development have been summarised.	
	Timing and staged phasing (if any) has been described, including any connections with external timings.	
4.4.2	**Resolve any initial problems with designers**	
	Any initial problems or issues needing resolution by designers have been identified.	
	Designers notified.	
	Issues have been checked and re-worked by designers.	
	Amended proposal has been re-documented.	
4.4.3	**Identify area and stakeholders affected**	
	Agreed functional road hierarchy in area has been documented.	
	Relevant or affected non-car transport networks or services have been documented.	
	Initial assessment of area affected by changed traffic conditions has been made.	
	Sites potentially impacted have been listed.	
	All affected stakeholders have been identified and a note made about when each needs to be consulted.	

GTM section	Steps in traffic impact assessment	Done (✓)
4.4.4	**Describe existing and design year conditions**	
	Existing on-site conditions, including traffic and parking, have been documented.	
	Existing traffic conditions for external sites, road lengths and/or areas identified as potentially impacted have been documented for critical periods.	
	Design year has been selected, and traffic conditions, excluding traffic generated by the development, have been documented. Volumes shown on plan.	
	Parking conditions, as relevant, have been described.	
	Traffic crashes at potentially impacted locations have been documented.	
	Other known traffic safety or operational problems, and any proposals to address them, have been documented.	
	Any traffic, transport or parking policies which affect the proposed development have been documented.	
4.4.5	**Determine generated traffic and modal split**	
	Number of trips which will be generated by the development (daily, peak period, etc.) has been determined for the design year or years.	
	The split of general traffic, commercial vehicles, public transport vehicles (including taxis), bicycles, pedestrians, etc. has been determined.	
4.4.6	**Determine approach and departure directions**	
	Approach and departure directions for the traffic have been determined.	
	Nature of attracted traffic (same origin and return destination, linked trips, etc.) has been considered and described.	
4.4.7	**Assign traffic to roads**	
	Traffic generated by the development has been assigned to the road network in the potentially affected area for the design year or years.	
	Development-generated traffic has been shown on plans.	
	Background traffic (existing volumes factored to the design year) and development-generated traffic have been added together.	
	Total traffic has been shown on plans for critical times of day or week, etc.	
4.4.8	**Determine where non-car traffic will go**	
	Paths, lanes, etc. required for pedestrians, cyclists, buses, delivery vehicles, etc. have been determined.	
4.4.9	**Review limits of area affected**	
	Limits of area impacted by the development have been checked, and necessary alterations noted.	
	If assessment over a greater area is needed, further analysis has been done.	
4.4.10	**Assess traffic operation on roads**	
	Traffic operations (traffic volumes, capacity, level of service, delays) for access points, mid-blocks and intersections have been assessed; consequences noted.	
	Circulation of traffic near the site has been considered.	
	Need for on-street parking, and potential impact on arterial roads / traffic routes, has been determined.	
	Impact on public transport services, from development generated use and from increased traffic on public transport routes (buses and trams) has been assessed.	

GTM Section	Steps in traffic impact assessment	Done (✓)
4.4.11	**Assess traffic operation on-site**	
	Traffic operation of roads, aisles, access ways on-site, including traffic circulation within the site, has been analysed.	
	Expected traffic volumes and vehicle types can be safely and efficiently accommodated within the traffic and parking areas on-site.	
	On-site parking provision is adequate and is suitably located.	
4.4.12	**Determine required impact-mitigating treatments**	
	Required changes, improvements, upgrades and/or modifications to roads, intersections, traffic lanes, controls, access driveways, have been determined.	
	Required changes on-site and on nearby roads/streets to manage parking have been determined.	
	Required works and traffic management to accommodate pedestrians, cyclists, public transport, delivery vehicles, on-site and in the nearby area, have been determined.	
	Required treatments relating to pavements, safety and environmental issues have been determined.	
	Coordination of all required treatments has been considered.	
4.4.13	**Obtain road safety engineering assessment**	
	Need for an independent assessment of the road safety aspects of the development has been considered.	
	If necessary, independent road safety engineering assessment has been arranged.	
4.4.14	**Document findings and recommendations**	
	The above steps and their outcomes have been documented in a suitable report.	

APPENDIX B EXAMPLE CHECKLISTS

Table B 1: Technical completeness checklist 1 - Institute of Transportation Engineers

Example Checklist 1:

Institute of Transportation Engineers (ITE 2006)

TRAFFIC IMPACT STUDY

TECHNICAL COMPLETENESS CHECKLIST

Project Name: ______________________________

Reference Code: ______________________________

		TRAFFIC REQUIREMENT
❑Yes	❑No	Traffic generated greater than vehicles per day
❑Yes	❑No	Study required comment: ____________ Date: ________
		BACKGROUND AND INFORMATION
❑Yes	❑No	
❑Yes	❑No	**INTRODUCTION AND SUMMARY**
		EXISTING CONDITIONS
❑Yes	❑No	Roadway network – summary of roadway classifications and description of study areas
❑Yes	❑No	Analysis period correct (AM, mid-day, PM and/or Saturday, recreational traffic
❑Yes	❑No	Existing Traffic Operations (Existing Level of Services, traffic volumes, speeds, crash data, etc)
		IMPACTS
❑Yes	❑No	Trip generation – daily, peak hour trips generated by site development.
❑Yes	❑No	Trip distribution
❑Yes	❑No	Level of service analysis – projected LOS with site build out, existing traffic and background traffic growth (Identify existing and projected LOS deficiencies)
❑Yes	❑No	Signal warrant analysis
❑Yes	❑No	Turn lane warrant analysis
❑Yes	❑No	Analysis of sight distance at frontage road access point(s)
❑Yes	❑No	Identify safe route to school or school bus stops (contact with school district)
❑Yes	❑No	Analysis of safe pedestrian/bicycle access to nearest transit stop (if within 500 m of project site)
❑Yes	❑No	Identify accessibility to public transport

		TRAFFIC REQUIREMENT
		MITIGATION
❑Yes	❑No	Identify need for right/left turn lanes, storage capacity and length
❑Yes	❑No	Identify possible corrections of any LOS deficiencies
❑Yes	❑No	Identify any access deficiencies (including pedestrian/bicycle connections)
		FIGURES
❑Yes	❑No	Vicinity map
❑Yes	❑No	Site plan
❑Yes	❑No	Existing peak hour turn movement volumes (counts conducted within previous 12 months)
❑Yes	❑No	Trip distribution (%) including added project peak hour traffic volumes (see sample)
❑Yes	❑No	Project completion year peak hour traffic volumes (see sample)
❑Yes	❑No	Comprehensive plan future year turn movement volumes
❑Yes	❑No	Programmed transportation improvements and transportation mitigation outlined in study
		TABLES
❑Yes	❑No	Intersection performance existing conditions
❑Yes	❑No	Project trip generation
❑Yes	❑No	Intersection level of service
		OTHER
❑Yes	❑No	Technical appendix – sufficient material to convey complete understanding of traffic issues (e.g. HCM analyses, trip generation calculations, signal warrant analyses, turn lane warrant analyses, etc)
		LOCAL AREA TRAFFIC MANAGEMENT MITIGATION
❑Yes	❑No	Meets requirements for mitigation of NTM. Provide data, and preliminary design and locations
Completed by: ______________________________ Date: ______________		

Example Checklist 2:

Checklists for Road Impact Assessment
[Source: Queensland Department of Main Roads (2006)]

The following tables provide checklists for road impact assessment and therefore include items related to areas other than traffic (e.g. flooding, drainage, pavements, visual amenity). However, many of the items are directly related to a traffic impact assessment.

Note that Table B 2, copied verbatim from the source document *Guidelines for Assessment of Road Impacts of Developments,* makes reference to the previous Austroads *Guide to Traffic Engineering Practice (GTEP)*. The referenced material previously in GTEP may be found in Austroads Guides as follows:

Table B 2: Checklist for road impact assessment

GTEP reference	Topic	Primary Austroads Guide reference
Part 2	Roadway capacity	Guide to Traffic Management Part 3
Part 4	Treatment of crash locations	Guide to Road Safety Part 8
Part 5	Intersections at grade	Guide to Road Design Parts 4 and 4A Guide to Traffic Management Part 6
Part 12	Roadway lighting	Guide to Road Design Part 6B
Part 13	Pedestrians	Integrated into all relevant Parts of the Guide to Road Design and the Guide to Traffic Management
Part 14	Bicycles	
Part 15	Motorcycle safety	

The extract also makes reference to other Main Roads Queensland documents and programs as follows:

- RIP: Roads Implementation Program
- RPDM: Roads Planning and Design Manual
- MUTCD: Manual of Uniform Traffic Control Devices.

Table B 3: Issues checklist for intensive road use, such as feedlots or mining/extractive industries

	Generally required	MR discretion
Development context		
site locality	X	
site access (existing use, location and layout)	X	
preferred land use	X	
adjacent land uses/approvals		X
description of road network (function, alignment, grade, lanes, intersections, median breaks, etc)	X	
existing traffic volumes (daily & peak)	X	
traffic growth trends	X	
speed environment/speed surveys		X
existing parking provision	X	
current MR planning and Roads Implementation Program (RIP)	X	
road hierarchy	X	
public transport network and services (existing and planned)	X	
pedestrian/bicycle facilities		X
crash history		X
flood immunity of access route		X
existing pavement standard/condition	X	
Development proposal		
proposed uses and scale (dwellings, rooms, floor area)	X	
operating hours, peaks	X	
number of employees/visitors	X	
travel demand management policies		X
site layout (including adjoining connections to properties and other roads)	X	
access form and location	X	
development staging	X	
traffic demand (vehicle/pedestrian/bicycle/public transport)	X	
stormwater and drainage works (internal)		X
stormwater and drainage works (external)	X	
construction traffic	X	
service vehicle arrangements (access and on-site manoeuvring areas etc)	X	
proposed parking provision	X	
trip distribution/assignment	X	
haulage routes (including vehicle type and operating times)	X	
Impact assessment and remedial works treatments		
traffic operation (including pedestrian, cycle and public transport)	X	
road safety issues	X	
pavement and bridge impacts	X	
changes to the road network or planning	X	
noise/hydraulic impacts on state-controlled roads		X
visual amenity and other environmental impacts		X

*Depending upon the size / location of the development proposal, Main Roads may reduce the number of issues to be considered in an RIA.

Table B 4: Issues checklist for other developments

	Generally required *	MR discretion
Development context		
site locality	X	
site access (existing use, location and layout)	X	
preferred land use	X	
adjacent land uses/approvals		X
description of road network (function, alignment, grade, lanes, intersections, median breaks, etc)	X	
existing traffic volumes (daily & peak)	X	
traffic growth trends	X	
speed environment/speed surveys		X
existing parking provision	X	
current Main Roads planning and RIP	X	
road hierarchy	X	
public transport network and services (existing and planned)	X	
pedestrian/bicycle facilities	X	
crash history		X
flood immunity of access route		X
existing pavement standard/condition		X
Development proposal		
proposed uses and scale (dwellings, rooms, floor area)	X	
operating hours, peaks	X	
number of employees/visitors	X	
travel demand management policies		X
site layout (including adjoining connections to properties and other roads)	X	
access form and location (queuing and storage)	X	
development staging	X	
traffic demand (vehicle/pedestrian/bicycle/public transport)	X	
stormwater and drainage works (internal)		X
stormwater and drainage works (external)	X	
construction traffic	X	
service vehicle arrangements (access and on-site manoeuvring areas etc)	X	
proposed parking provision	X	
trip distribution/assignment	X	
haulage routes (including vehicle type and operating times)		X
Impact assessment and remedial works treatments		
traffic operation (including pedestrian, cycle and public transport)	X	
road safety issues	X	
pavement and bridge impacts		X
changes to the road network or planning	X	
noise/hydraulic impacts on state-controlled roads		X
visual amenity and other environmental impacts	X	

Table B 5: Safety issues checklist for all developments

Safety aspect	Reference *
Intersections and access	
#on and off-site queuing	AS 2890
#access location and layout/sight distance	GTEP Part 5/ RPDM Ch 4 – Applications of Design Principles and Standards RPDM Ch 13 – Intersections at Grade RPDM Chap 14 – Roundabouts
bus stops	AMCORD / Qld Streets RPDM Ch 4 – Application of Design Principles and Standards RPDM Ch 5 – Traffic Parameters and Human Factors RPDM Ch 20 – Road Side Amenities
lighting	GTEP Part 12/ RPDM Ch 17 – Lighting RPDM Ch 18 – Traffic Signals
pavement marking & signage	MUTCD Guide to Pavement Markings Traffic & Road Use Management Manual
speed environment	GTEP Part 4/ RPDM Ch 6 – Speed Parameters
#intersection operation & acceleration/deceleration lanes	GTEP Part 5/ RPDM Ch 13 – Intersections at Grade RPDM Ch 14 – Roundabouts
#auxiliary turn lanes/lengths/weaving	GTEP Part 5/ RPDM Ch 13 – Intersections at Grade RPDM Ch 16 – Interchanges (for weaving and auxiliary lanes on freeways)
#heavy vehicle and bus turnpaths	AS 2890/ RPDM Ch 5 – Traffic Parameters and Human Factors
utilities (hardware/services)	MR Policy
location of poles/traffic signal	RPDM Ch 17 – Lighting RPDM Ch 18 – Traffic Signals RPDM Ch 7 – Cross Section RPDM Ch 8 – Safety Barriers and Road Side Furniture

Table B 5: Safety issues checklist for all developments (Continued)

Safety aspect	Reference *
Road links	
#road width	RPDM Ch 7 – Cross Sections
#shoulder seals	Design Manuals
#vertical/horizontal alignment	RPDM Ch 11 – Horizontal Alignment RPDM Ch 12 – Vertical Alignment
#bridges and approaches	RPDM Ch 22
#clearance to obstructions	RPDM Ch 7 – Cross Sections
#overtaking opportunities	RPDM Ch 15 – Auxiliary Lanes/ GTEP Part 2
Pedestrians	
road crossing facilities	GTEP Part 13/ RPDM Ch 5 – Traffic Parameters and Human Factors
footpaths	GTEP Part 13/ RPDM Ch 5 – Traffic Parameters and Human Factors
disabled provision	RPDM Ch 5 – Traffic Parameters and Human Factors/ GTEP Part 13
Cyclists	
cycle lanes/paths	GTEP Part 14/ RPDM Ch 7 – Cross Section RPDM Ch 5 – Traffic Parameters and Human Factors
road crossing facilities	RPDM Ch 5 – Traffic Parameters and Human Factors/ GTEP Part 14
intersection provision	GTEP Part 14/ RPDM Ch 5 – Traffic Parameters and Human Factors
Motorcyclists	
road surface	Ch 5 – Traffic Parameters and Human Factors/ GTEP Part 15
warning of hazards	Ch 5 – Traffic Parameters and Human Factors/ GTEP Part 15
barrier kerbs	GTEP Part 15/ RPDM Ch 5 – Traffic Parameters and Human Factors
visibility at intersections	GTEP Part 15/ RPDM Ch 13 and 14
drainage pits and culverts	GTEP Part 15/ RPDM Ch 5 – Traffic Parameters and Human Factors

Notes:

* Where Austroads guidelines and relevant Main Roads manuals cover the same safety aspect then the Main Roads manual will take precedence.

Safety issues that are likely to have been addressed through other parts of the RIA.

APPENDIX C TRAFFIC IMPACT ASSESSMENT REPORT STRUCTURE

C.1 Report Outline

As a guide for the organisation of a traffic impact assessment report, Table C 1provides an outline of the sample table of contents for a TIA and Table C 2 provides a list of suggested figures and tables for the report.

Table C 1: Traffic Impact Assessment Report

I. Introduction and Summary
- A. Purpose of Report and Study Objectives
- B. Executive Summary
  1. Site location and study area
  2. Development description
  3. Types of studies undertaken (impacts, signal warrant, site access, etc.)
  4. Principal findings
  5. Conclusions
  6. Recommendations

II. Proposed Development (Site and Nearby)
- A. Off-Site (or Background) Development
- B. Description of On-Site Development
  1. Land use and intensity
  2. Location
  3. Site plan
  4. Zoning
  5. Phasing and timing

III. Existing Area Conditions
- A. Study Area
  1. Area of influence
  2. Area of significant transportation impact (may also be part of Chapter IV)
- B. Study Area Land Use
  1. Existing land uses
  2. Existing zoning
  3. Anticipated future development
- C. Site Accessibility
  1. Area roadway system
     - a. existing
     - b. future
  2. Traffic volumes and conditions
  3. Transit service
  4. Pedestrians and bicyclists
  5. Existing relevant transportation system management programs
  6. Other as applicable

IV. Projected Traffic
- A. Site Traffic (each horizon year)
  1. Trip generation
  2. Trip distribution
  3. Modal split
  4. Trip assignment
- B. Through Traffic (each horizon year)
  1. Method projection
  2. Non-site traffic for anticipated development in study area
     - a. method of projections
     - b. trip generation

- c. trip distribution
- d. modal split
- e. trip assignment

3. Through traffic
4. Estimated volumes

C. Total Traffic (each horizon year)

V. Transportation Analysis

A. Site Access

B. Capacity and Level of Service

1. Existing conditions
2. Background conditions (existing plus growth) for each horizon year
3. Total traffic (existing, background and site) for each horizon year

C. Transportation Safety

D. Traffic Signals

E. Site Circulation and Parking

VI. Improvement Analysis

A. Improvements to Accommodate Existing Traffic

B. Improvements to Accommodate Background Traffic

C. Additional Improvements to Accommodate Site Traffic

D. Alternative Improvements

E. Status of Improvements Already Funded, Programmed, or Planned

F. Evaluation

VII. Findings

A. Site Accessibility

B. Transportation Impacts

C. Need for Any Improvements

D. Compliance with Applicable Local Codes

VIII. Recommendations

A. Site Access/Circulation Plan

B. Roadway Improvements

1. On-site
2. Off-site
3. Phasing, if appropriate

C. Transit, Pedestrians and Bicycles

D. Transportation System Management /Transportation Demand Management Actions

1. Off-site
2. On-site operational
3. On-site

E. Other

Conclusions

Source: ITE (2006)

Table C 2: Suggested figures and tables to be included in a traffic impact assessment report

Figure A	**Site location**	**Area map showing site location**	
Figure B	Study area	Map showing area of influence.	
Figure C	Existing transportation system	Existing roadway system serving site. Should show all major streets, minor streets adjacent to site and site boundaries. Show also transit, bicycle and major pedestrian routes, if applicable, along with right-of-way widths and signal locations. In some cases, may be combined with Figure A.	
Figure D	Existing and anticipated area development	Map at some scale as Figure H showing existing and anticipated land uses/developments in study area.	
Figure E	Current daily traffic volumes	Recent or existing daily volumes on roads in study area. May be combined with Figure C or F. Include existing moving lanes if not show in Figure C.	
Figure F	Existing peak-hour turning volumes	Current peak hour turning volumes at each location critical to site volumes access or serving major traffic volumes through study area. May be combined with Figure E. Also existing moving lanes if not shown in Figure C.	
Figure G	Anticipated transportation system	Area transportation system map showing programmed and applicable planned roadway, transit, bikeway and pedestrian-way improvements affecting site access or traffic flow through the study area. May be combined with Figure C.	
Table A or Figure H	Directional distribution of traffic	Map or table showing (by percentages) the portion of site traffic approaching and departing the area on each roadway; may differ by land use within multi-use development.	
Table B	Estimated site traffic generation	Estimated peak hour (and daily if required) trips to be generated by each major component of the proposed development; must be shown separately for inbound and outbound directions.	
Figure I	Site traffic	Map of anticipated study area roadway network showing peak hour turning volumes generated by site development.	
Table C	Estimated trip generation for non-site development	Trips generated by off-site development within study area. Similar to Table B.	
Figure J	Estimated non-site traffic	Map similar to Figure H showing peak hour turning volumes generated by off-site development within study area plus through horizon year traffic.	
Figure K	Estimated total future traffic	Map similar to Figure H showing sum of traffic from Figures I and J.	
Figure L or Table D	Projected levels of service	Levels of service computed for critical intersections in study area. Include existing, horizon year non-site and total horizon year (with site development) conditions.	
Figure M or Table E	Recommended improvements	Map showing recommended off-site transportation improvements, site access points and on-site circulation and parking features, as appropriate. May require more than one figure. Table will describe improvements by location and type. If phasing of improvements is to be stipulated, this should also be shown on these or a separate figure or table.	
Figure N or Table F	Study checklist	Checklist showing the required/optional elements of a transportation impact analysis report, whether or not they have been incorporated, and their locations in the report.	

Note: Additional figures and tables may be needed for studies and additional complexities, issues, or study years.

Source: ITE (2006)

APPENDIX D EXAMPLE OF TRAFFIC GENERATION RATES

The traffic generation rates in Table D 1 are taken from RTA (2002). The table is extracted verbatim from that publication, and contains some references to sections elsewhere in that guide. It is provided as a typical example only.

The NSW guide is currently the most comprehensive Australian reference on the subject. However, it is noted that the base data included in that publication were collected many years ago and need to be updated with more recent data.

Table D 1: Example summary table of land use traffic generation rates

Land Use	Traffic generation rates	
	Daily Vehicle Trips	Peak Hour Vehicle Trips
Residential		
Dwelling houses	9.0 / dwelling	0.85 per dwelling
Medium density residential flat building	*Up to 2 bedrooms*	
	4-5 / dwelling	0.4-0.5 / dwelling
	3 bedrooms or more	
	5-6.5 / dwelling	0.5-0.65 / dwelling
High density residential flat building	*metropolitan regional centres*	
	-	0.24 / unit
	metropolitan sub-regional centre	
	-	0.29 / unit
Housing for aged and disabled persons	1-2 / dwelling	0.1-0.2 / dwelling
Casual accommodation		
Motels	3 / unit	0.4 / unit
Hotels - traditional Hotels - tourist	See section 3.4.2 See Section 3.4.3	-
Office and commercial		
Commercial premises	10 / 100m^2 GFA	2 / 100m^2 GFA
Retail		
Shopping centres	see section 3.6.1	-
Service stations and convenience stores	see section 3.6.2	-
Motor showrooms	-	0.7 / 100m^2 Site Area
Car tyre retail	10 / 100m^2 Site Area	1 /100m^2 Site Area
Road side stalls	-	-
Drive-in liquor	-	-
Markets	18 / stall	4 / stall
Bulky goods retail	see section 3.6.8	-
Video stores	see section 3.6.9	-

Land Use	Traffic generation rates	
	Daily Vehicle Trips	Peak Hour Vehicle Trips
Drive-in take-away food outlets	See section 3.7.1	-
Restaurants	60 / 100m^2 GFA	5 / 100m^2 GFA
Clubs	see section 3.7.3	-
Recreation and Tourist facilities		
Squash courts	-	3 / Court
Tennis courts	4-5 / Court	4 / Court
Bowling greens	-	-
Gymnasiums	*metropolitan regional centre*	
	20 / 100m^2 GFA	3 / 100m^{2}GFA
	metropolitan sub-regional areas	
	45 / 100m^2 GFA	9 / 100m^2 GFA
Caravan parks	-	-
Marinas	see section3 .8.2	-
Road transport facilities		
Road transport terminals	5 / 100m^2 GFA	1 / 100m^2 GFA
Container depots	-	-
Truck stops	-	-
Industry		
Factories	5 / 100m^2 GFA	1 / 100m^2 GFA
Warehouses	4 / 100m^2 GFA	0.5 / 100m^2 GFA
Plant nurseries	See section 3.10.3	-
Business parks	See section 3.10.4	-
Health and community services		
Professional consulting rooms	-	-
Extended hours medical centres	see section 3.11.2	-
Child care centres	see section 3.11.3	
Private hospitals	see section 3.11.4	-
Public car parks		
Public car parks	see section 3.12	-

Source: RTA (2002)

APPENDIX E SAMPLE RURAL PROJECT – QUARRY

This appendix presents an example drawn from Queensland Department of Main Roads (2006).

It is intended to provide an understanding of those issues requiring consideration for rural developments. It is not intended to provide an exhaustive example of traffic analysis, although some analysis is provided for illustrative purposes.

The process steps are as follows:

Step 1: Development profile

Step 2: Pavement impact assessment

Step 3: Traffic operation assessment

Step 4: Safety review

Step 5: Environmental and other issues

Step 6: Impact mitigation.

Note that in presenting this example in the primary context of traffic management guidance, Step 2 has not been included in this appendix. Note also that cross-references to other sections within the source document have been removed where possible for clarity.

E.1 Step 1: Development Profile

E.1.1 Development Details

The proposal is a new quarry to be located outside a large rural town as shown in Figure E 1. An existing processing plant, which will receive the extracted material, is located 2.5 km to the east on the same State-Controlled Road (Desert Crossing Road).

- The quarry has an estimated output of 200 000 t/year.
- The development application was referred to Main Roads by the local government, as the quarry would have direct access to a SCR. The planned size of the quarry exceeds identified referral thresholds. (Referral triggers are documented in Department of Infrastructure & Planning Queensland, 2007)
- Currently, the site is vacant and there are agricultural land uses adjacent.
- The development is proposed to have a single access onto Desert Crossing Road. The processing plant has an existing access direct to Desert Crossing Road.

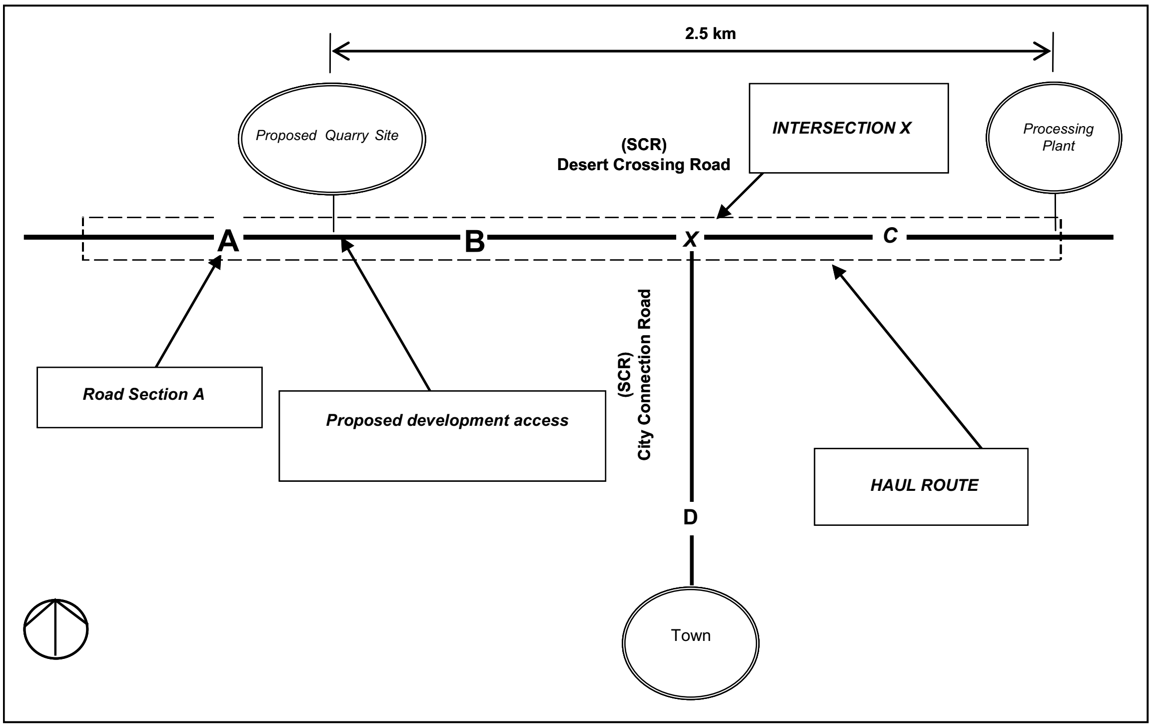

Figure E 1: Locality map

- The quarry is proposed to operate in a single 6am to 5pm shift, six days per week, throughout the year (i.e. 312 days/year). Up to 25 staff will be present during a shift.
- Haulage vehicles will be 42.5 t GVM tri-axle semi-tippers with a tare (vehicle) mass of 16 t and net (payload) weight of 26.5 t.
- The proposed development will employ a local workforce, residing primarily in the town.
- The quarry is expected to become fully operational in the year 2007 and has an estimated extraction life of 20 years.

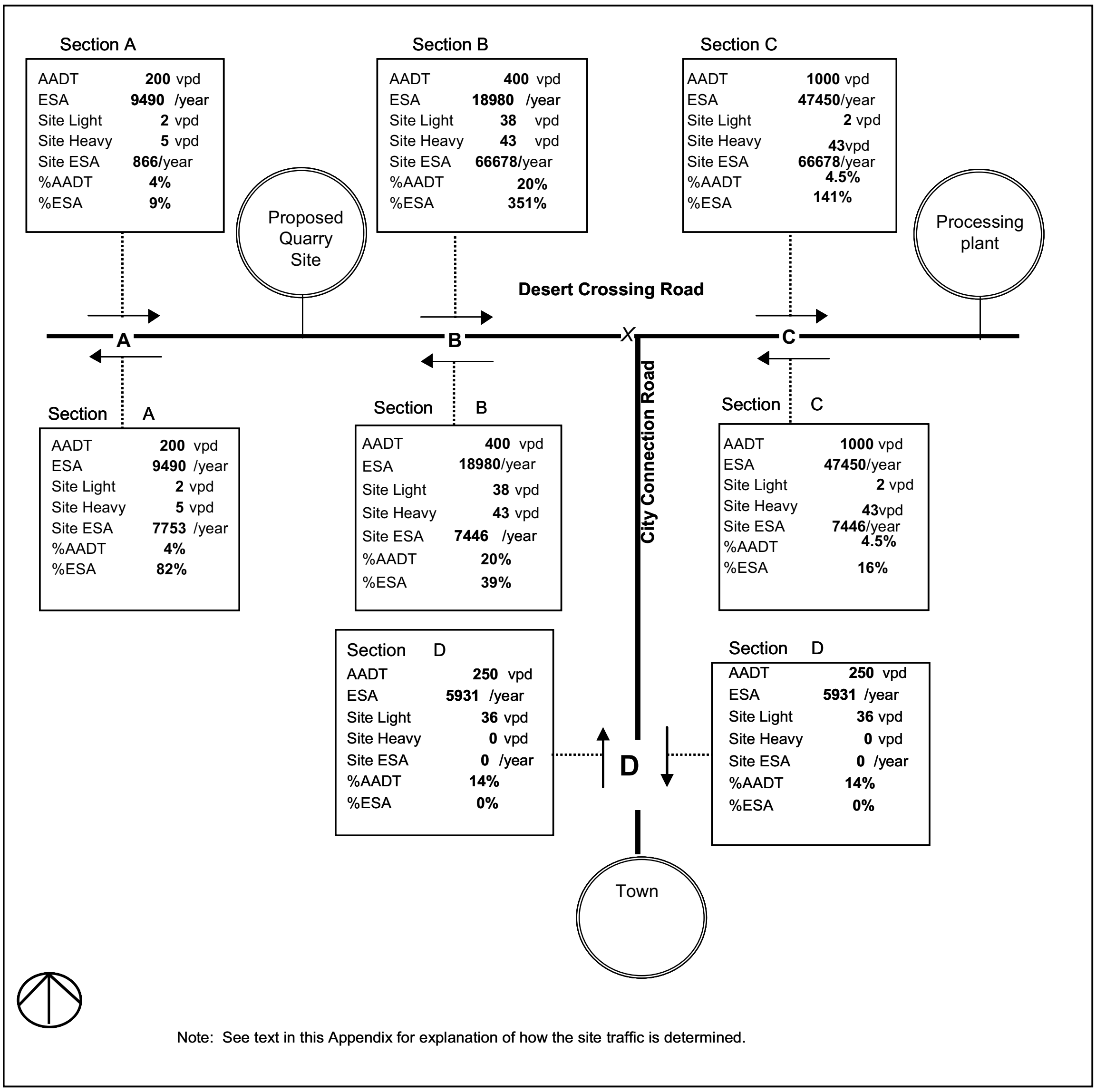

Figure E 2: Traffic volumes

E.1.2 Surrounding Road Network Details

- Desert Crossing Road is aN SCR as is City Connection Road to the town. Both are low volume rural roads.
- Both roads have a 10 m pavement, comprising two 3.5 m lanes and 1.5 m sealed shoulders (the road forms were confirmed by site inspection).
- Existing AADTs provided by the MR district office are shown in Figure E 2. Road sections A, B and C have 10% commercial vehicles while road section D has 5% commercial vehicles.
- The MR district office has advised that the traffic growth rate in the area is of the order of 2% linear per annum.

E.1.3 Development Traffic Generation

- The likely traffic profile generated by the proposal was based upon consideration of the operation and its traffic generation characteristics.

E.1.4 Traffic Generation – Light Vehicles

- In this particular example, peak employee traffic has been estimated for a period of one hour. However, this may not be sufficient in some situations and estimates for periods of 15 minutes might be necessary where arrival or departure rates are more pronounced. Visitor movements have also been estimated.
- No reduction in trip making due to potential ride-sharing has been made. Options for operating a shuttle bus have been examined but found to be unviable. Some ride-sharing may occur and would be encouraged by the plant operator.
- A survey of a similar development was conducted by means of an automatic traffic counter to identify the traffic profile. Previous surveys of similar developments also support the assumptions adopted.

Traffic generation – light vehicles

Employees 25 staff per day x 2 trips/staff/day (1 in/1 out)

=	50 light vehicle trips/day	(A)
or	25 light vehicle trips/hour (peak) (trips during shifts are unlikely)	

Visitors average of 15 visitors per day x 2 trips/visitor/day (1 in/1 out)

=	30 light vehicle trips/day (it is unlikely that any of these trips would occur during the peak period)	(B)

E.1.5 Traffic Generation – Heavy Commercial Vehicles

- The anticipated annual profile of quarry extraction was examined and the design case identified. For the purposes of traffic operation, the peak operation (‘worst case scenario’) should be considered, whereas for pavement impacts, the average case should be used. For the purposes of this example, it has been assumed that the peak demand is the same as the average demand.
- The quarry operator has forecast that March will be the peak month. Extraction is expected to be in the order of twice the average.

E.1.6 Development Traffic Distribution

- The anticipated distribution of development traffic has been based upon the locations of potential product destinations and staff accommodation. This is shown in Table E 1.

Table E 1: Traffic distribution

Component	Percentage	Road section	Volume
Light vehicles	90%	D	72
	5%	C	4
	5%	A	4
	100%		**80**
Heavy commercial vehicles	90%	B and C	86
	10%	A	10
	100%		**96**

- In accordance with this distribution, the daily site traffic volume is as shown in Figure E 2.

E.1.7 Study Network Definition

- All haul routes associated with the development will need to be assessed in accordance with Criterion 4 (in Chapter 3.2 of source document).
- To identify the spatial extent of investigation, information on existing traffic volumes and ESAs was obtained. In most cases, AADT and percentage commercial traffic will be available from the MR district office. Supplementary traffic counts may be required.

Traffic operation

- For traffic operation, assessment is required where the development traffic exceeds the thresholds set by Criteria 3 and 4.
- This is the case for road section A (Criterion 4), road section B (Criterion 3), road section C (Criterion 4) and road section D (Criterion 4).
- Intersection X also requires assessment (Criteria 3 and 4).

Pavement impacts

- Assessment of pavement impacts is required where development traffic generates an increase in ESAs equal to or greater than 5% (Criterion 2).
- As shown in Figure E 2, the development will generate an increase in ESAs equal to or greater than 5% on road sections A, B and C. Road section A extends for the full distance of the haul route to the west.

Traffic generation – heavy commercial vehicles

Average Demand

200 000 t/year ÷ (26.5 t/truck x 312 days/year)

= 24 loaded truck trips/day

(24 unloaded trips/day to the site/24 loaded trips/day from the site)

= 48 heavy commercial vehicle trips/day

Peak demand (twice the average extraction)

= 48 loaded truck trips/day
(48 unloaded trips/day to the site/48 loaded trips/day from the site)

= 96 heavy commercial vehicle trips/day (C)

Traffic generation – all vehicles

= 80 light vehicle trips/day + 96 heavy commercial vehicle trips/day (A+B+C)

= 176 total vehicle trips/day.

Existing ESAs for each road section should be calculated, as shown below, by weighting the AADT in accordance with the proportion of existing commercial traffic.

ESA calculation (road section B)

AADT	=	400 vpd eastbound
Commercial vehicle (CV) %	=	10%
ESA:CV ratio	=	1.3 (derived from MR's Pavement Design Manual)
Existing ESA (Section B)	=	400 vpd x 10% CV x 365 days/year x 1.3 ESA/CV
	=	18 980 ESA/year

E.1.8 Design Horizon

- The design horizon for this project was identified as 2027, as the quarry has an estimated operating life based upon identified yield of 20 years beyond initial opening in 2007.
- For the purposes of traffic operation, it is appropriate to limit the impact assessment to ten years and therefore 2011 has been adopted for traffic operation assessment.

E.1.9 On-site Aspects

- All servicing and parking will take place on-site, as there is ample space.

E.2 Step 2: Pavement Impact Assessment

(Excluded from this appendix).

E.3 Step 3: Traffic Operation Assessment

Following identification of the traffic profile of the development, discussions with the Main Roads District Office were convened to resolve what traffic operation assessment was required along the haul route on road section A. In this instance, the District Office limited the assessment to road sections B, C and D and intersection X. The analysis process for each is outlined below.

E.3.1 Road Link Analysis

- Volumes on all sections of roads are within acceptable limits for the present road forms.
- Existing AADT volumes (2006 base year) were factored by the 2% linear annual growth rate for the 2017 analysis. The forecast link volumes without and with development are shown in Table E 2.
- Volumes on all road sections will continue to be acceptable with the existing road forms at 2017 with the development operational.
- No overtaking lane provision or four lane upgrading will be required within the 2011 design horizon.

Table E 2: Forecast link volumes

Link	Existing AADT (2000)	2007		2017	
		No dev	With dev	No dev	With dev
Section A	400	408	422	488	502
Section B	800	816	978	976	1 038
Section C	2 000	2 040	2 130	2 440	2 530
Section D	500	510	582	610	682

E.3.2 Intersection Analysis

- To determine the adequacy of intersection X, the site access and the processing plant access, the following have been considered:
  - intersection capacity
  - criteria for auxiliary turn lanes
- Peak hour turning movement volumes with and without the development at the opening year (2007) and design year (2017) were forecast.
- SIDRA analysis for operation of unsignalised intersection X is summarised in Table E 3. Degree of saturation and 95 percentile queue lengths are as shown. The critical degree of saturation for an unsignalised intersection of this form is 80%.

Table E 3: SIDRA Analysis for Intersection X

Design case	DOS (%)		95%ile queue (m)
		Right turn in	Right turn out
2000 No development	42	10	5
2000 With development	40	12	8
2010 No development	75	15	8
2010 With development	79	19	12

- Intersection X will continue to operate adequately in its existing unsignalised form to 2017 with the development operational.
- Rural turn lane warrants were checked under projected traffic volumes to determine whether any upgrading to the existing form of intersection X is required. In this instance, the existing Austroads Type B right turn configuration will need to be upgraded to a Type C form on site opening. With no development of the quarry, upgrading would not be required within the 2017 design horizon.
- Traffic operation at the proposed quarry access and the existing processing plant access was also examined using SIDRA. The degrees of saturation at 2017 with the development operational were calculated to be 40 % and 50 % respectively, which in both cases is acceptable. Rural turn lane warrants were checked for both accesses and Austroads Type A layouts found to be required. The existing processing plant access has already been built to this standard and requires no further work.

E.4 Step 4: Safety Review

- Actual crash rates for road sections B, C and D and critical crash rates for the district were obtained from Main Roads. As the actual crash rates were well below the critical crash rates, no amelioration is necessary.
- The safety issues checklist provided in Appendix B was used to check the safety aspects of the intersections and accesses associated with the proposed development. Pedestrian and cycle facilities are not present or needed on the low volume rural roads assessed.
- Discussions with Main Roads indicated that no safety audit is required.
- No development works are required to ameliorate any existing safety deficiencies.

E.5 Step 5: Environmental and Other Issues

- No new transport corridors are planned in the vicinity. The existing reserve for Desert Crossing Road is adequate to accommodate four lanes on the southern side if and when necessary.
- The development will not generate significant night traffic and the adjacent agricultural land uses are not sensitive to the noise and vibration created by heavy commercial vehicle traffic that will be generated by day.
- There is no adjacent development that could be affected by headlight glare. On-site lighting will be oriented so as to avoid illuminating Desert Crossing Road.
- Detailed design of the proposed quarry access will need to include landscaping to present well to passing motorists and to replace existing vegetation removed and avoid erosion on Desert Crossing Road.

- Approval for the quarry access onto Desert Crossing Road is being sought as part of this application. The spacing between the proposed access and the nearest adjacent access is approximately 1.25 km. There are few access points along this section of road and it is not anticipated that the proposed access would interfere with others.
- The detailed design of the proposed quarry access and upgrading of Intersection X to Austroads Type C configuration will need to allow for drainage continuity with the existing swale drains along each side of Desert Crossing Road.
- The quarry access will need to be sealed so as not to generate dust across Desert Crossing Road. The on-site design and operational procedures will need to minimise dust generation so as not to impact Desert Crossing Road.
- There is one structure over a creek along the haul route between the site and the processing plant on road section C. Its design has been verified to accommodate the proposed haulage vehicle fleet.
- An Environmental Impact Statement (EIS) is being prepared as part of the development application. This EIS will examine the overall impact of the development.

E.6 Step 6: Impact Mitigation

E.6.1 Impacts

The RIA has identified that the following improvements are required as a result of the development:

- contribution toward increased routine maintenance on section A
- rehabilitation of the pavement on section B
- rehabilitation of the pavement on section C is brought forward from 2010 to 2008
- upgrading of intersection X to Austroads Type C at opening of the development
- construction of an Austroads Type A site access intersection to the development.

E.6.2 Costing/Contributions

Main Roads identified that section A has an annual routine maintenance allowance of \$50 000 (2006 \$). With development, ESAs will increase by 9%and 82% eastbound and westbound respectively. The development therefore creates a need for a further \$22 750 per year (9% x \$50 000 / 2 + 82% x \$50 000/2) for routine maintenance during its operational life. In this case, Main Roads and the developer agreed that the requirement for additional routine maintenance would be limited to the first 10 years of operation of the quarry.

After discussions with Main Roads, the developer agreed to pay half of the cost of pavement rehabilitation on section B. This section had no remaining pavement life but would have continued to operate effectively with minimal maintenance in the absence of the development. Using Main Roads unit rates, the full cost of rehabilitating the pavement on section B was estimated at \$1.25M (in 2006 \$). The developer therefore accepted responsibility for paying \$625 000.

Main Roads advised that \$1.25M (in 2010 \$) was expected to be allocated through the RIP for rehabilitating the pavement on road section C in 2010. Using an outturn factor of 1.00/1.12 extracted from the RIP Guidelines, this is converted to \$1.12M (in 2006 \$). The cost of bringing this improvement forward from 2006 to 2008 is the responsibility of the developer. Main Roads will need to ensure that the capital cost for the rehabilitation is available in 2008.

The developer paid for the whole cost of upgrading Intersection X to an Austroads Type C form at year 2007 ($475 000 in 2006 $).

The developer paid for the cost of construction of the Type A access intersection to the quarry ($150 000 in 2006 $).

APPENDIX F SAMPLE URBAN PROJECT – COMMERCIAL /INDUSTRIAL DEVELOPMENT

The following example is drawn from Queensland Department of Main Roads (2006).

It is intended to provide an understanding of those aspects requiring consideration for urban development types. It is not intended to provide an exhaustive example of traffic analysis, although some analysis is provided for illustrative purposes.

The process steps are as follows:

Step 1: Development profile

Step 2: Pavement impact assessment

Step 3: Traffic operation assessment

Step 4: Safety review

Step 5: Environmental and other issues

Step 6: Impact mitigation.

Note that Step 2 is not required in this example. Note also that cross-references to other sections within the source document have been removed where possible for clarity.

F.1 Step 1: Development Profile

F.1.1 Development Details

- The proposal is for a light industry/office development within an urban environment on the fringe of a major city. A locality map is shown in Figure F 1.
- The proposed development is to have a gross floor area of 6 000 m^2.
- It is anticipated that staff will work a single shift between 6.30am and 4.00pm daily. The typical attendance will be 50 employees.
- The application was referred to Main Roads by the local government, as the planned development would access a local government road that intersects with aN SCR within 200 metres.
- Currently, the site is vacant and is used by adjacent industry uses for parking.
- The development proposal is planned to be opened in 2007.

Access to the development will be obtained via an all-movements access to Industrial Road.

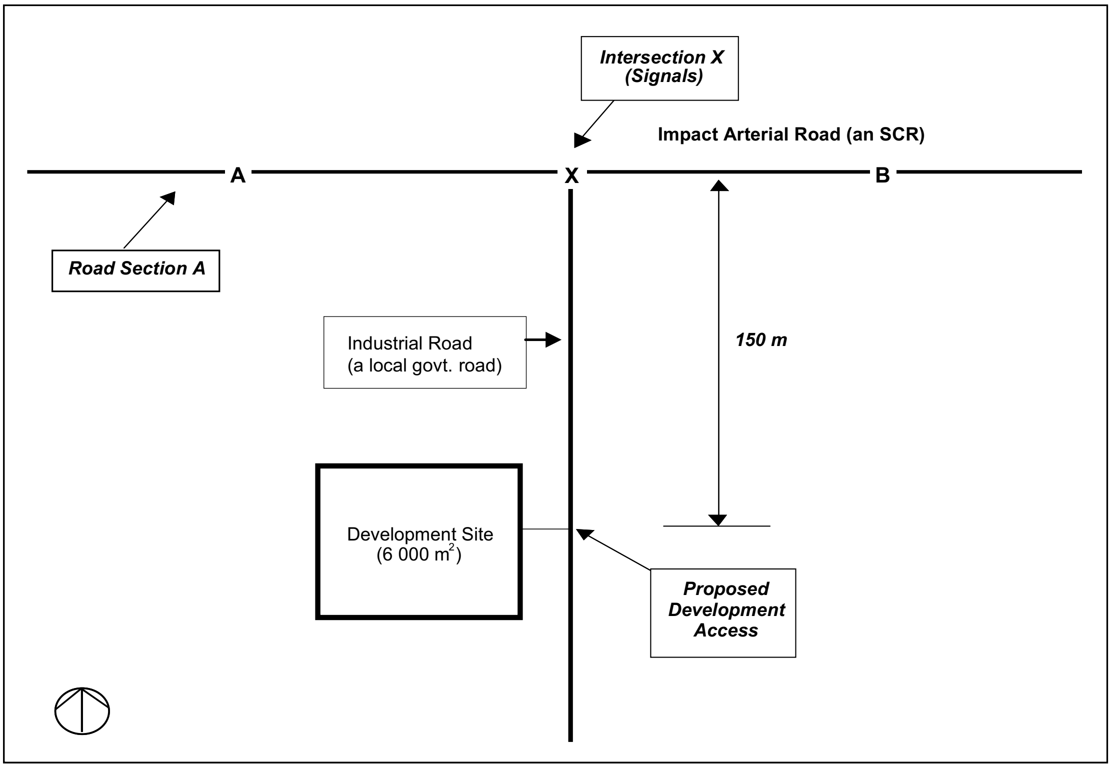

Figure F 1: Locality map

F.1.2 Surrounding Road Network Details

- the site is located adjacent to a major local government road (Industrial Road) that intersects a SCR (Impact Arterial Road) approximately 150 m away.
- the intersection of Industrial Road and Impact Arterial Road is currently signalised.
- traffic counts were conducted at the intersection to ascertain the existing peak hour and daily demand. The surveyed turning movements at the intersection are shown in Figure F 2.
- historic traffic counts were reviewed to determine the profile of traffic growth. Growth assumptions were confirmed and agreed with Main Roads District officers prior to usage.

Base year and 10-year horizon traffic volumes at the intersection were generated for the scenario without the proposed development.

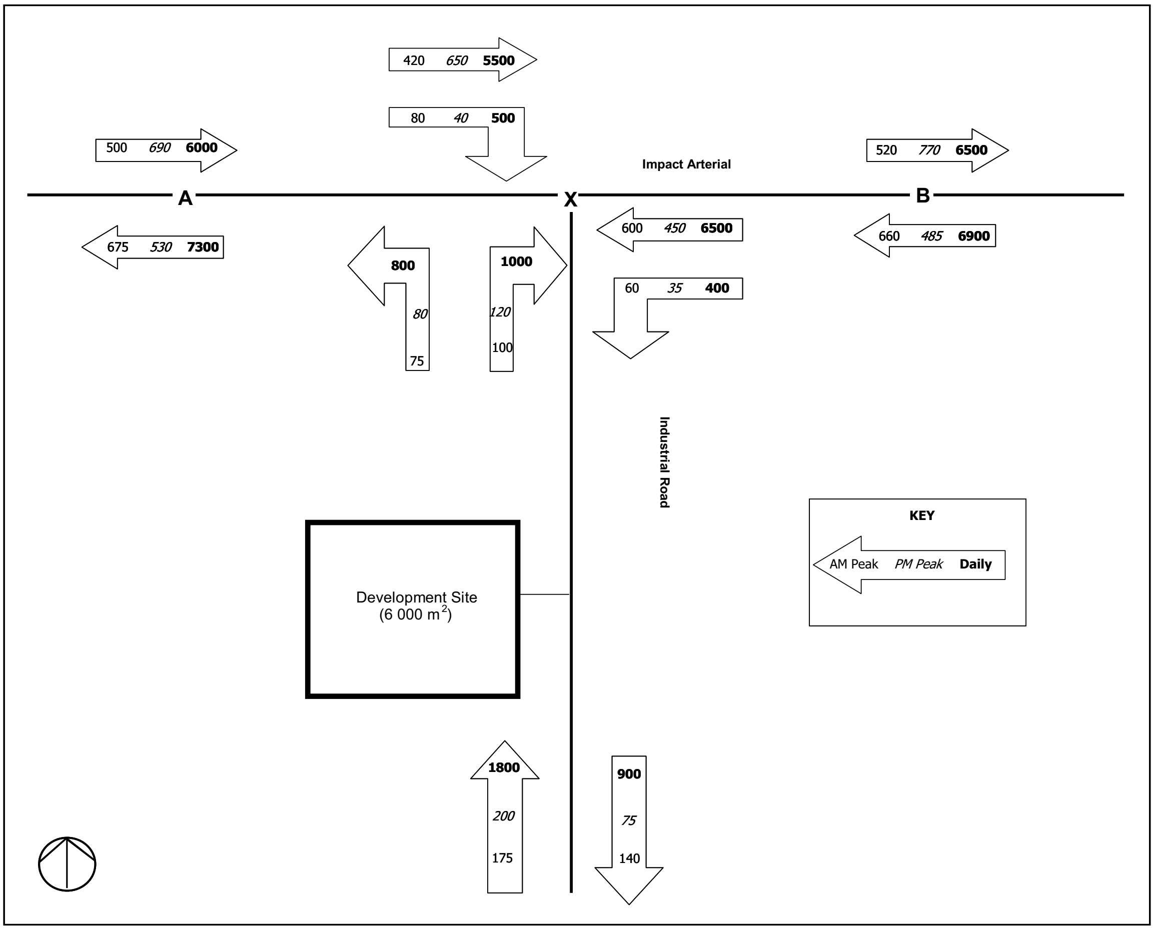

Figure F 2: Existing traffic volumes

F.1.3 Development Traffic Generation

- Likely traffic volumes generated by the proposal were estimated using unit traffic generation rates extracted from surveys of similar developments. The source of any such traffic generation information utilised should be documented.
- Table F 1 shows the traffic generation based upon a peak rate of one trip end per 100 m^2 and a daily rate of 10 trip ends per 100 m^2.
- In this case, trip generation estimates based upon gross floor area provide a reasonable estimate of development traffic.

Table F 1: Traffic generation (light industrial – 6 000 m^2)

Traffic generation characteristic	In	Out	Total
Daily trip ends	300	300	600
AM peak hour trip ends	45	15	60
PM peak hour trip ends	15	45	60

Traffic generation calculation

Daily trips = 6 000 m^2 x 10 trip ends/100 m^2

= 600 trip ends per day

Peak hour trips = 6 000 m^2 x 1 trip end/100 m^2

= 60 trip ends per hour

(A direction distribution of 50% in/50% out was assumed for daily trips on the basis of similar surveys. For the peak hour generation, a directional distribution of 75% in/25% out was utilised for the AM peak and reverse for the PM peak.)

F.1.4 Development Traffic Distribution

- Traffic generated by the proposed development was distributed in accordance with existing turning movement patterns at the intersection and residential development within the anticipated catchment (Table F 2)

Table F 2: Traffic Distribution

Direction (to/from)	Percentage	Daily		AM peak		PM peak	
		In	Out	In	Out	In	Out
South	20%	60	60	9	3	3	9
East	35%	105	105	16	5	5	16
West	45%	135	135	20	7	7	20
TOTAL	**100%**	**300**	**300**	**45**	**15**	**15**	**45**

Development-generated traffic is shown in Figure F 3.

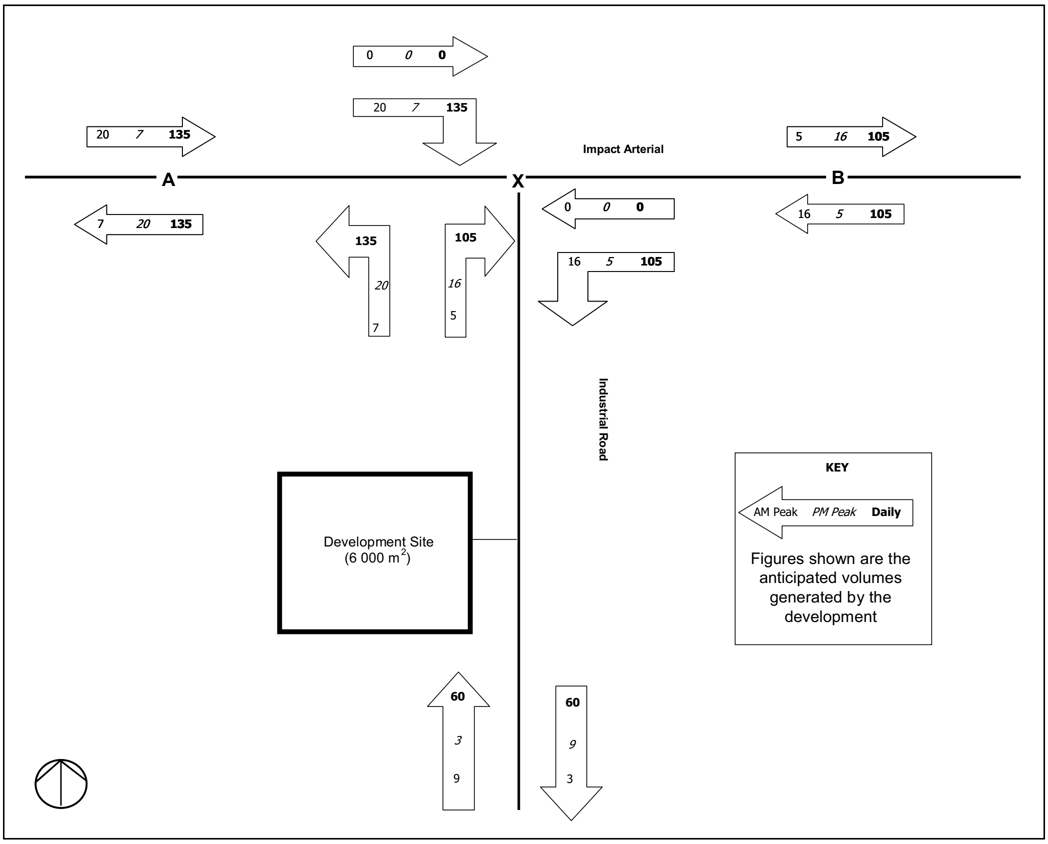

Figure F 3: Development generated traffic

F.1.5 Study Network Definition

Traffic Operation

- The scope of investigation in this instance was limited to the intersection of the local government road and the SCR (Impact Arterial Road / Industrial Road).
- Figure F 4 shows the development traffic as percentages of existing turning movements. In all cases, the percentage is greater than 5 per cent and assessment of the intersection is therefore required (see Criterion 3 in Section 3.2 of source document).
- With respect to road link volumes, development traffic on Impact Arterial Road east and west of Industrial Road is less than 5% of the existing flows and therefore assessment is not necessary.

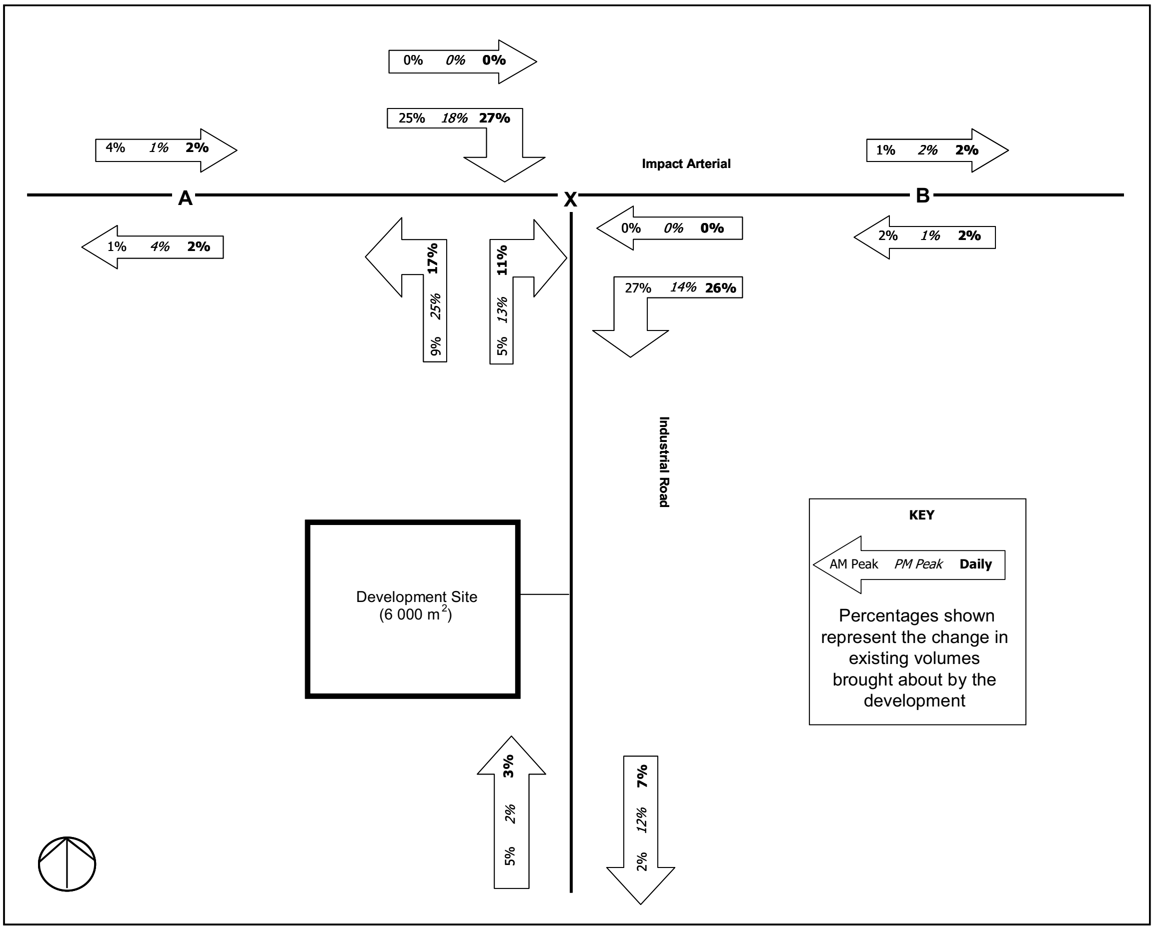

Figure F 4: Percentage change generated by development

F.1.6 Pavement Impacts

- Site-generated ESAs associated with heavy commercial vehicles were calculated to be less than 5% of the existing use on the SCR and therefore no assessment of pavement impacts was required.

F.1.7 Design Horizon

- The development is anticipated to be completed and open by 2007. The horizon year is therefore 2017, 10 years following opening).

F.1.8 On-site Aspects

- In this case Main Roads is not interested in on-site aspects, as they are not expected to affect operation of the remote intersection.
- On-site aspects will need to be covered for the local government assessment.

F.2 Step 2: Pavement Impact Assessment

(Not required in this example)

F.3 Step 3: Traffic Operation Assessment

- The traffic operation assessment prepared as part of the RIA needs to address the operation of the intersection of the local government road with the SCR (Impact Arterial Road/Industrial Road). The local government would also require an assessment of the operation of the points of access from the development to its road. This would generally be covered in the one assessment.
- No assessment of road link operation was required for this project, as the threshold set by Criterion 3 (in Section 3.2 of source document) was not exceeded for Impact Arterial Road.

F.3.1 Intersection Analysis

- Development traffic volumes at the Impact Arterial Road / Industrial Road intersection were produced by considering increases generated by the development using the assumptions regarding traffic generation and distribution discussed above.
- Intersection operation was tested using SIDRA.
- Analysis revealed that the intersection is currently operating at levels outside desirable limits of capacity during peak periods. With development, operation is marginally worse.

F.4 Step 4: Safety Review

- A review of safety issues was undertaken including crash history at the intersection. No concerns were identified.
- Safety was not considered to be a major concern given that the types of vehicles generated by the proposal were not inconsistent with those currently using the intersection.

F.5 Step 5: Environmental and Other Issues

- No other issues were determined to be relevant to the affected SCR or intersection.

F.6 Step 6: Impact Mitigation

- It was identified that RIP funding has been committed for some minor intersection improvements.
- The development, in this instance, brought forward the timing for the intersection improvements by less than one year. As a result, capacity impacts were viewed as insignificant and no contribution sought.

COMMENTARY 1 TRANSPORT ASSESSMENTS

The following commentary is extracted from the following sources:

- West Australian Planning Commission (2006)
- Department of Transport NSW (undated)
- Department for Transport UK (2007)
- Scottish Executive (2003).

Note: The practitioner should be aware of statutory obligations and guidance on transport assessment that may apply in a given jurisdiction.

C1.1 Transport Assessment and Traffic Impact Assessment

Section 2 of this guide describes traffic impact assessment (TIA) procedures and makes reference to wider transport considerations required in the case of larger or more complex developments. Table C1 1 compares the general features of the two forms of appraisal.

Table C1 1: TIAs and transport assessment compared

	Traffic impact assessment	Transport assessment
Modes considered	Focus on car but others may be included.	All modes considered but initial emphasis on walk, cycle and public transport.
Transport implications covered	Comparison to similar developments.	Accessibility and mode split analysis.
Impacts considered	Road safety and traffic.	Wide criteria based on transport appraisal guidance.
How are negative impacts addressed?	Increase road capacity and add safety features.	Wider assessment. Travel plans. Financial incentives. Additional transport capacity if required.

Source: Scottish Executive (2003)

Transport Assessment is defined in the United Kingdom as follows:

> A TA [Transport Assessment] is a comprehensive and systematic process that sets out transport issues relating to a proposed development. It identifies what measures will be taken to deal with the anticipated transport impacts of the scheme and to improve accessibility and safety for all modes of travel, particularly for alternatives to the car such as walking, cycling and public transport.
> (Department for Transport (UK) 2007)

The transport assessment (TA) processes that are followed as part of development control of major projects include (but are not limited to):

- Road capacity issues and impacts, at the macro (system) level. Note that a traffic impact study would be a component of the assessment as well.
- Accessibility (ability to be reached) by car, public transport, foot, bicycle etc.
- Ease of access: A more local examination of the ability of site approaches and entrances (location and design) to accommodate/provide adequately for various modes.
- Capacity issues for non-road modes (can the public transportation system handle the demand, what works would be required, etc.).

- Related to the foregoing: For major public facilities that are located on the basis of other policy decisions or criteria (airport, hospital, stadium, etc.), what infrastructure is required to service the development?

A transport assessment requires consideration of all modes of transport and the full range of transport tasks – not just person movements, but also freight movements, local distribution and delivery of goods and services, and emergency services operations. A typical set of considerations and features would include:

- Applicable to all forms of development, from individual developments to subdivisions and even structure plans, although the level of detail will be different.
- Assessment to consider all parts of the transport network where the development movement would be likely to have a material impact.
- Impacts to be assessed for year of (full) opening and 10 years after opening, (to identify whether the development would use up any spare capacity in the surrounding transport network, bringing forward the need for improvements).
- Assessment of the likely parking demand compared with parking provision advised or required under the relevant regulations.
- Consideration of any nearby committed (but not yet built) developments and of any proposed or possible changes (by others) to the surrounding transport network.
- Assessment of the potential for development traffic to intrude into the surrounding area, particularly residential areas, and its likely impact on amenity.
- Thresholds for remedial measures at intersections based on acceptable delays and include delay to pedestrians at intersections and crossing roads mid-block.
- The adequacy of the site location, layout and access points to accommodate the level of expected movements (car, truck and public transport).
- Assessment of impact of the development traffic on existing pedestrians, cyclists and public transport users.
- Assessment of the impact of the development on (or compatibility with) existing or proposed plans for public transport to or within the study area.
- Assessment of the accessibility of the site by non-car modes including links to bus stops, train stations, any new or improved services and detailed description of any proposed pedestrian/cycle facilities.
- Estimation of internal and external movement by all modes is an integral part of the planning process – not just to estimate impacts to be compensated beyond the development site, but rather as part of the cyclic process of development planning to reach an optimal land use transport outcome.
- The tools for analysing the movement implications and needs of the development involve a comprehensive travel demand forecasting process and a means by which various levels of diversion from car to other modes can be tested. This transport assessment clearly goes beyond a localised traffic impact assessment.

C1.2 Contents of a Full Transport Assessment

Transport assessment involves three elements:

- Analysis of the level of demand for movement to and within the site, by all modes. In the iterative process, this may involve re-analysis with different input assumptions about land use type and intensity, layouts, and policy requirements.
- The feasibility and effects of different strategies for the management of movement to and within the site.
- Impact assessment, including impacts in the full range of policy areas that are of concern to the government.

The level of detail needing to be addressed in a transport assessment may be influenced by the scale of the development; the significance of the development at a local, regional and state level; the relevance of any statutory planning requirements e.g. local environmental plan; the development control plan; design guidelines.

In more detail, common features of the transport assessment process are:

Stage 1 – Assessing the travel characteristics of a development

- the site and general characteristics
- measurement of accessibility to and from the site by all modes – present and future (under various internal and external land use scenarios)
- estimating the travel generated and likely modal split
- assessing effects on local transport.

Stage 2 – Influencing travel to the development

- choosing an accessible location
- scale of the development
- intensity of use
- effects of mixed-use developments
- the layout and design of the development
- promoting access on foot and bicycle
- pedestrian or bicycle access audits
- promoting public transport access
- access to rail services
- traffic impact assessment
- travel plans
- awareness raising and marketing
- behavioural change initiatives
- changing working practices to support the travel objectives.

Stage 3 – Appraising and mitigating impacts

- accessibility and integration impacts with the local community
- safety and security impacts
- environmental impacts
- highway and traffic impacts
- strategies for enhancing public transport.

The allocation of responsibility (funding and implementation) for mitigation works carries the same problems as in the simpler case of traffic impact studies. While transport assessments can be of considerable assistance in assessing and dealing with the transport impacts of new developments, it can be hard to identify and provide any off-site infrastructure or services required of the development and to ensure sustainable transport provision including integrated walking and cycling networks because:

- New development is usually incremental, with several individual developments taking place in an area over a period of years.
- Transport to a new development adds only one more layer to already complex movement patterns. Though additional demands are created, they are hard to identify, and in particular to identify specific infrastructure or services related to particular developments.

COMMENTARY 2 SUSTAINABLE DEVELOPMENT AND TRAVEL DEMAND MANAGEMENT

Many governments have recognised that policies and strategies for urban development need to be based on sustainable development principles for improving the environment, the economy and communities. In Australia, the National Strategy for Ecologically Sustainable Development, released in 1992, provides a foundation for sustainable development theory and practice. Austroads has also published a number of documents dealing with sustainability including:

- Strategy for Ecologically Sustainable Development (Austroads 1995)
- Ecologically Sustainable Development Toolbox (Austroads 2000a)
- Strategy for Ecologically Sustainable Development: progress and directions (Austroads 2000b).

Much has been written on the subjects of integrated planning and sustainable development. Brindle (1999) points out that 'Integrated planning does not mean only putting a development with the movement system it needs, or vice versa. It implies the expansion of land use and transport planning into the wider context of community needs, inter-dependencies and sustainable urban areas. It is thus essentially holistic'.

Brindle also describes the meaning of 'sustainability', suggesting that in practical terms it attempts to reduce resource depletion and environmental impacts of an activity, and has taken on meanings that refer to economic vitality and quality of life. The author considers that these three objectives are not always compatible even though policy statements attempt to progress all three, and concludes that integrated land use/transport planning, even if fully implemented, would not fully satisfy the needs of sustainable development.

The interest in sustainable development reflects a growing awareness and concern in urban communities about the problems created by growth in car use and the resultant congestion. There is a realisation that it is neither feasible nor desirable to provide improved road capacity at a rate that would satisfy the ever-increasing demand. Demand need not only be managed by meeting that demand; it can be managed by managing expectations. Apart from the quality of life for citizens who are dependent on cars for daily travel, the issues of poor air quality, greenhouse gas emissions, and reliance on non-renewable energy resources are of major concern. For example, transport accounts for about 14% of Australia's greenhouse gas emissions and is the most rapidly growing source. This growth must be slowed if Australia is to meet its international commitments to help prevent interference with global climate systems.

In response to these issues governments are introducing planning policies and strategies aimed at reducing dependence on private car travel. Planning for sustainable development may focus on key aspects such as:

- managing urban growth through integrated land use, transport and environmental planning, including the definition of urban growth boundaries
- location and provision of affordable housing providing transport choice options
- activity centres as important transport nodes, closely integrated with public transport services
- provision of real choices for use of sustainable modes of transport including a substantial increase in public transport usage and encouragement of walking and cycling

- development and management of an arterial road system so that it meets stated transport and community objectives (e.g. safety and accessibility), in a way that considers the needs of all road users (e.g. freight, public transport, pedestrians and cyclists as well as motor vehicle users) as well as the communities through which the roads pass
- conservation of green wedges between corridors of urban growth
- coordination of transport modes to improve accessibility.

Sustainable development policies and travel demand management initiatives may have a significant impact on traffic management, particularly in inner areas of cities, and they need to be considered in the development of transport and traffic strategies.

Communities or suburbs which are planned and laid out in the following ways can lead to reductions in private car use and to improvements in the health of the local community and road users:

- encouragement of walking and cycling
- replacement of longer trips by shorter trips (by more local facilities)
- public transport that links residences with work, recreation and other attractions.

However, achievement of these benefits requires planning, policy implementation and the provision of alternative infrastructure and services. It is not sufficient to merely leave sections of road infrastructure off a plan, or not provide sufficient car parking on-site, with the expectation or wish that people will walk, cycle or perhaps not travel so much. People need to travel to work, school, shops, friends, etc. Realistic assessments of trip generation are required. Unless consistent and positive action is taken to manage travel demand and provide non-car options, missing road links or insufficient vehicle access points (for example) will simply result in needless congestion, which also affects road-based public transport. In other words, the achievement of sustainable development objectives and travel demand management objectives requires the consistent application of stated policy and positive action to provide travel options; it cannot occur through a lack of investment in appropriate infrastructure.

COMMENTARY 3 ROAD HIERARCHY AND ROAD CLASSIFICATION

C3.1 Functional Classification

In considering road classifications it is necessary to differentiate between legal or administrative classifications, and functional classifications. Legal or administrative classifications are usually determined by national or state governments as a means of allocating funds and identifying the authority responsible for the care and management of various parts of the road network.

Functional classification describes the road's ‘traffic function’; it involves the relative balance of:

- the traffic mobility function (or ‘through traffic' function)
- the amenity or access function.

A map showing the traffic functions of roads across a network is often referred to as a ‘road hierarchy plan’. A ‘road hierarchy’ may be defined as the ‘grading of roads according to increasing or decreasing importance of their traffic-carrying or other function’ (Austroads 2008). For the safety of road users a grading of roads, with many different mixes of movement function and access function should actually be avoided. Particularly in urban areas, unless these two functions are clearly separated by space they conflict with each other and the mixture results in higher crash rates. While this separation of functions cannot always be achieved on existing roads, the more closely it is achieved the safer a road will be.

C3.2 Networks for Specific Road User Groups

The majority of all urban roads and streets are accessible by all types of vehicles and road users, except that:

- Urban freeways are typically restricted to motor vehicles which are capable of traveling at higher speeds
- Local streets are typically not designed to accommodate the largest freight vehicles and the largest buses.

Within local areas and along strategic routes, networks of off-road cycling and walking paths are provided in many cities. Again within local areas, streets can be laid out in highly connective networks for pedestrians and cyclists, while having some sections or ‘road’ closed off to motor vehicles. For example a rectangular grid of local streets can be created where motor vehicles encounter only T-intersections; the fourth leg of all ‘crossroads’ is a section of park accessible only by pedestrians and cyclists.

A further way to assist particular road user groups is to allocate road space or give preference to them on the general road network. This commences by planning a user group-specific network superimposed onto existing roads. The aim of these networks is to assist the movement of these specific road user groups. Examples include:

- Networks of bicycle lanes, so that cyclists have their own space. Routes within the network may be on arterial roads or higher order local streets, such as collector roads. Although typically full time, they may be part time during clearway hours on arterial roads.
- Bus and tram lanes, either full time or part time, to let these vehicles move past queues of traffic and thereby reduce their travel time variability as well as their total journey time. These lanes need not be provided as interconnecting networks.

More broadly across an urban area, the arterial road network can be split into sub-categories, with the more major or strategic routes designated as the principal freight network or other type of preferential network. This network of roads is then managed to increase the priority of the identified user group (e.g. with traffic signal timing assisting truck movement) and the features along the road are designed to accommodate larger vehicles.

COMMENTARY 4 LOCAL AREAS, STREETS AND ARTERIAL ROADS

Effective planning, development and management of an interconnected network of urban arterial roads can assist in protecting the amenity of local areas. For example, a local street might be carrying an unacceptable volume of traffic, or an undesirable proportion of heavy vehicles, or simply 'intruding' extraneous traffic. These outcomes all result from a deficiency in the nature of the local street and arterial road network, and the location of traffic generators in relation to the network.

The Guide to Traffic Management - Part 8: *Local Area Traffic Management* lists common contributors to higher traffic volumes and intruding traffic in local areas as:

- Under-provision of traffic routes. This results in larger local areas and the greater number of trips generated results in higher volumes on some local streets.
- Arterial road congestion. Especially in networks with grids of local streets, congestion does not have to be severe for the alternative routes via local streets to become attractive.
- External connectivity. If two local street connections to the arterial road network, on opposite or adjacent sides of a local traffic area, provide an easy travel path through the local area, these connections will lead to higher volumes on the connecting local streets.
- Internal connectivity. Local street networks with numerous alternative internal routes will spread traffic across many local streets. This tends to increase the average exposure to traffic per household.
- Excessive development density and inappropriate location of traffic generators. The greater the development of a block of land (even with units instead of a detached house and garden), the greater the traffic generation. Community facilities and employment locations generate more traffic. Where these are desirable, they need to be located where roads of suitable traffic function can take the traffic.

The under-provision of arterial roads in developing urban areas (e.g. on the urban fringe or in growth corridors) can come in several forms:

- arterial roads spaced too far apart; that is, too few arterials within a given area
- missing links in the arterial road network, typically where freeways, railways, rivers and other constraints are relatively expensive to bridge
- inadequate road width and an insufficient number of traffic lanes
- inadequate control of vehicular access.

The first two deficiencies lead to:

- larger local areas, so that even where all traffic within the local area is locally generated, some local streets will have excessive traffic volumes and experience poor amenity
- larger volumes of turning traffic at those arterial/arterial intersections which do exist, leading to severe delays for turning traffic and through traffic
- short cutting by through traffic on local streets where the local street network is at all susceptible to this
- difficulty in providing bus services within reasonable walking distance of all properties, or if internal links are suitable for bus routes they risk becoming through traffic short cuts

- some local streets (e.g. those described as collector roads) acting as de facto arterial roads through necessity. This is not a satisfactory option as these streets typically have direct frontage driveway access, with its lower levels of safety under heavy traffic volumes.
- longer trips on the arterial roads to get around gaps in the network.

It is therefore most important for both local amenity and efficiency of the arterial roads that, at the network planning and subdivision approval stages, arterial road networks are developed having satisfactory spacing, adequate capacity and interconnection without missing links. The spacing and size of arterial roads depends on the intensity of development. In areas of more intense development, more arterial links are likely to be needed. Brindle (2001) points out that in order to provide bus routes all households can reach easily, the grid should be at 800 m spacings. Some state guidelines recommend the spacing of arterial roads to be no more than 1 km to 1.5 km.

Arterial road congestion can be the prompt for external through traffic to use local streets. In areas with grid local street systems, this congestion does not have to be severe for the alternative short cut paths through the local area to become attractive as a way of avoiding delays. Local streets intersecting with arterials near traffic signals are especially vulnerable to through traffic.

External connectivity describes the extent to which a vehicle path through a network provides a connection between any given points, compared with alternative paths. When vehicle paths through the local street network have equal or higher connectivity than the alternative routes using the major road system, they will attract through (non-local) traffic. These paths through a connective local street system may be attractive to through traffic because they are shorter or faster than the alternative arterial routes, or they may simply be preferred because they involve fewer stops ('dodging the lights') or provide opportunities to 'jump the queue' at congestion points on the major road system.

Some local street systems have been planned deliberately to create low connectivity paths that are not attractive to through traffic, e.g. with hierarchical street networks including loops and culs-de-sac. More recent planning philosophies have sought to create 'permeable' local networks, e.g. with a return to a grid network of local streets with frequent connections to arterial roads. This results in high levels of *internal connectivity*. This in turn can lead to short cutting through traffic along connective vehicle paths and a greater exposure to higher levels of traffic for more households. Such problems should preferably be anticipated and dealt with at the network planning stage rather than left to be dealt with by LATM. Networks that are permeable for pedestrian and cycle movement, and which provide adequately for local traffic circulation, do not need to have high external connectivity for motor traffic.

In planning and designing arterial roads and local traffic areas, there should be:

- high levels of connectivity for vehicles at the arterial road scale, through the provision of an interconnected arterial road network at sufficiently close spacing in two perpendicular directions in plan, with no missing links
- low levels of connectivity for motor vehicles at the local street scale. Within a local traffic area, there should be adequate links for vehicle circulation without high levels of connectivity which encourage short trips to be made by car and expose more households to more traffic
- high levels of connectivity for pedestrians and cyclists at the local street scale. Local traffic areas should be easy to walk and cycle through.

The *location of traffic generating developments* that often generate substantial volumes of traffic is critical to the operation and amenity of local street systems and arterial roads alike. The impact of such developments must be assessed at the planning stage to ensure that arterial roads serving the development (e.g. a regional shopping centre) can cope with the increased demand and that local streets are not used as access routes to the development.

COMMENTARY 5 DESIGN VOLUMES

C5.1 Process

Major developments such as residential suburbs or sub-divisions, or regional shopping centres will normally require the following or a similar process to be used:

- Collect all available traffic data for the affected area of the network and plot existing AADT volumes onto a map including turning volumes at all major intersections. This may require conversion of shorter-term traffic counts to AADT estimates using factors derived from existing data (refer to the Guide to Traffic Management Part 3 (Austroads 2009d)).
- Determine a traffic growth rate for roads in the area from historical data for rural areas or population growth estimates and traffic modelling for urban areas. If sufficient data is not available rates from similar roads in the region might be used.
- Use growth rates to establish estimated AADTs (without the development) for the year of initial opening, the years in which subsequent stages may open, and an appropriate design year. Adjust the AADTs for each stage accounting for any major transport infrastructure improvements and any other major developments that will occur in the area during the assessment period.
- Estimate the traffic generated by the development for the various stages, adjusting for linked trips, those trips that are new to the network and those that are undiverted drop-in trips (see below).
- Assume a distribution of development traffic to the network and plot these volumes onto a map as a record of the likely impact of the development as a basis for allocating responsibilities between the developer and the road authority.
- Add the estimates of traffic generated by the development to the estimates of traffic (without development) to obtain plots of design AADT volumes for each stage of the development.
- Convert the AADT estimates for the affected network into peak hour design volumes for each direction of flow using appropriate peak hour factors and directional splits.

It will also be necessary to establish the numbers of heavy commercial vehicles for all links and turning movements so that the effect of these vehicles can be included in traffic analysis.

C5.2 Existing Traffic Data

The satisfactory assessment of the impact of developments requires detailed data relating to existing traffic on the network. It is usual to acquire the following data for all roads in the study area that are likely to be affected by the generated traffic:

- daily traffic volumes
- profile of daily traffic volumes to establish variations throughout the week
- profile of hourly volumes of traffic for the days when development traffic generation is expected to peak
- traffic growth rates
- the daily and peak hour volumes of heavy vehicles
- anticipated pedestrian and cyclist traffic flows.

It is important to ensure that the existing data collected is adequate to determine the various times at which development traffic is expected to peak. This is necessary so that critical combined peak periods for normal road traffic plus growth plus development traffic can be established. For some developments the peak traffic generated by the development may coincide with peak recreational flows on the surrounding road network. In these cases data will be required for the normal weekday situation as well as recreational periods.

C5.3 Design Year

The selection of a design year is a key decision in the design of roads and the same applies to developments. It is common for important roads to assume a design year some 20 years beyond the opening date for a road. Whilst this may be practicable for rural roads it is often not feasible in urban areas where existing arterial roads operate close to capacity or have limited potential to accommodate traffic growth, and new roads may attract trips from other parts of the network or attract new trips.

The design year is particularly important for traffic operation assessment and any road safety review, particularly for large developments where the design year should desirably be 10 years after opening. For a large staged development this may be in the range of 10 to 20 years after opening of the final stage. Where assessment of individual stages is undertaken, base flows for successive stages should include the previous stages' traffic generation. Where staging is over a period exceeding five years it is preferable to reassess traffic impact closer to the time of implementation when other influences can be considered with greater certainty.

C5.4 Traffic Growth and Future Traffic

For existing roads in rural areas and roads on the fringes of cities historical traffic data can be used to determine and underlying growth rate, and this can be used to estimate future traffic volumes for key times in the development (e.g. at opening, in the design year or at any intermediate stage). This approach may also be applied to urban roads in that are not likely to have their traffic flows influenced by changes in land use and/or road network changes (e.g. new roads or capacity improvements).

Traffic growth and future traffic volume estimates for roads that are likely to be influenced by changes to land use or the road network should be determined through the use of appropriate traffic modeling techniques (refer to the Guide to Traffic Management Part 3 (Austroads 2009d)). The outputs from these models cannot be taken at face value and need to be calibrated against existing traffic flows.

Because modelling techniques have limitations on their accuracy to predict future volume it is often necessary to provide a range of traffic volume that could be expected to use roads surrounding a development. These volumes can be used for a sensitivity analysis of design volumes where a range of peak hour design volumes are analysed. The peak hour design volumes would be based on various assumptions as to the peak hour volume/24 hour volume ratio, and the directional slit of traffic using the road.

COMMENTARY 6 TRIP GENERATION DATA

It is recognised that rates may change between jurisdictions and locations within jurisdictions and for this reason practitioners should obtain information from local sources wherever practicable. Generation rates may also vary within each development category and therefore practitioners should not assume that a single rate 'fits all' for any particular type of land use but should justify rates based on information from other sources, for example, the development industry.

Developments also generate public transport trips and depending on the location of the development (e.g. congested inner city area) public transport may be required to accommodate a large proportion of the transport demand. This in turn will affect the traffic generation rates used for other modes, especially the private car, and will influence the extent of parking required.

Trip generation data for a variety of land uses is available from a number of sources including:

- the Roads and Traffic Authority of New South Wales (RTA 2002)
- the Institute of Transportation Engineers (ITE 2008) – comprehensive data collation, from USA, which may need to be modified to suit Australian conditions
- state and local government databases
- databases and/or reports from traffic and transportation consultants and surveyors.

The NSW guide is currently the most comprehensive Australian reference on the subject. However, it is noted that the base data included in that publication were collected many years ago and need to be updated with more recent data. In Australia, some jurisdictions are embarking upon surveys and analysis to derive more recent traffic generation rates for an extended range of land uses.

In New Zealand, a database has been established (Clark 2007), to capture traffic and parking generation rates for developments in New Zealand and Australia. The Trips and Parking Database (TPD) is intended to act as a repository for data on surveyed trips, parking and travel related to all land uses, collated from a variety of public and private sources, and available for sharing amongst professional engineers and planners.

In the UK, the main source of trip rate information is the TRICS database (cited in Clark 2007), which provides a wide variety of data across many land uses, and contains some multi-modal trip rate information. Research is under way in New Zealand to correlate the UK and NZ data on trips and parking (Milne 2008).

The level of detail provided in the sources listed above varies from raw data, relationships between amount of traffic generated and the type and size of land use, to rates only. Some references contain other information such as parking demand data and or rates, data collection methods and guidance on use of data.

The most reliable source of trip generation data is likely to be survey data from the actual development (only possible where an existing development is being changed or enlarged) or a similar one in a similar location – preferably in close proximity. However, it may be appropriate to collect data from similar developments and to modify it to allow for differences in attributes between the surveyed and proposed developments, such as size, location, and minor differences in the mix of uses (e.g. business types).

Alternatively, a survey of a similar existing development may be conducted, so long as the comparison is appropriate. Note that when comparing a commercial development in a city with a similar development in a regional town, the traffic generation rates will typically be lower in the latter case, as the business is likely to be operating at a lower activity level per unit of floor area.

Table C6 1 is an example of the format for traffic generation data that can be collected to obtain rates for a proposed development. Raw data are provided together with a description to allow appropriate use of the information.

Table C6 1: Development traffic generation data

Use:	*Shopping Centre*	
Location:	*Shopping Central*	
Description of Development:	*GFA*	65 000 m^2
	GLA	60 000 m^2
Description of Surrounds:	*CBD*	
Day of Survey:	*Friday, 3 October 1998*	

CENTRAL SHOPPING CENTRE - TRAFFIC GENERATION

TIME (1/4hr commencing	15 MINUTE GENERATION		TOTAL	HOURLY GENERATION	PARKED VEHICLES	OCCUPANCY
	IN	OUT				
700	35	37	72		30	2%
715	41	29	70		42	2%
730	61	10	71		93	5%
745	102	32	134	347	163	8%
800	94	39	133	408	218	11%
815	118	36	154	492	300	15%
830	156	47	203	624	409	20%
845	206	41	247	737	574	29%
900	175	59	234	838	690	35%
915	198	62	260	944	826	41%
930	231	78	309	1050	979	49%
945	225	101	326	1129	1103	55%
1000	215	127	342	1237	1191	60%
1015	174	105	279	1256	1260	63%
1030	201	134	335	1282	1327	66%
1045	176	136	312	1268	1367	68%
1100	122	125	247	1173	1364	68%
1115	229	171	400	1294	1422	71%
1130	175	153	328	1287	1444	72%
1145	225	172	397	1372	1497	75%
1200	241	261	502	1627	1477	74%
1215	166	167	333	1560	1476	74%
1230	180	178	358	1590	1478	74%
1245	197	214	411	1604	1461	73%
1300	176	224	400	1502	1413	71%
1315	128	174	302	1471	1367	68%
1330	176	198	374	1487	1345	67%
1345	174	185	359	1435	1334	67%
1400	153	250	403	1438	1237	62%
1415	169	209	378	1514	1197	60%
1430	169	204	373	1513	1162	58%
1445	154	162	316	1470	1154	58%
1500	153	232	385	1452	1075	54%
1515	106	185	291	1365	996	50%
1530	131	160	291	1283	967	48%
1545	131	165	296	1263	933	47%
1600	131	148	279	1157	916	46%
1615	159	200	359	1225	875	44%
1630	125	204	329	1263	796	40%
1645	110	196	306	1273	710	36%
1700	118	187	305	1299	641	32%
1715	102	199	301	1241	544	27%
1730	126	175	301	1213	495	25%
1745	116	180	296	1203	431	22%
TOTAL	**6750**	**6351**	**13101**			
PEAK PARKING ACCUMULATION					**1497**	**75%**
PEAK HOUR TRAFFIC GENERATION				**162**		
TOTAL SPACES AVAILABLE						**2000**
AVERAGE OCCUPANCY						**47%**

Source: Queensland Department of Main Roads (2006)

COMMENTARY 7 TRAFFIC GENERATED BY DEVELOPMENT

The computation of traffic generation is based on unit rates that are applied to a particular class of development on the basis of the number of units, the gross floor area or in some cases the site area.

Appendix D of this guide provides an example of typical traffic generation rates for various types of development that can be used to estimate daily and peak hourly traffic flows generated by such developments. It is emphasised that these rates are average rates and that:

- variations from the average may occur for particular sites
- they are adequate to enable comparisons between the traffic generation potential of various land use types enabling a rough assessment of the traffic implications of land use zoning
- departures from these rates for individual development proposals may be adopted in which case such departure should be justified.

Traffic generation rates provide an estimate of the magnitude of the traffic volume generated by developments. However, it is also important to gain an understanding through data of the composition (classes of vehicles) and the hourly distribution of the traffic generated by different types of developments. In developments where a variety of different uses is proposed, such as a regional shopping centre, the peak hourly movements associated with different businesses and attractions within the complex may occur at different times of the day and evening. In these cases the peak traffic flows for the overall development are not simply the sum of the flows for the individual businesses, but could be substantially less.

COMMENTARY 8 LINKED TRIPS

Another factor that serves to reduce the apparent impact of developments is the concept of linked trips.

Traffic generation data for movements into and out of certain types of development are available, as outlined in Section 4.4.5 and Appendix D. However, a percentage of the traffic generated by or attracted to a development will be present on the road network as part of the existing traffic volume. There is therefore a need to understand and be able to estimate how much of the generated traffic is new and how much is already on the road network prior to opening of the development. Historically, traffic impact assessments conservatively assumed that all generated traffic was new. More recently, 'discounts' have been applied to generated traffic to account for the 'drop-in' component, which is not new traffic to the network.

In this guide a trip is defined as a one-way vehicular movement from one point to another excluding the return journey. Therefore, a return trip to/from a land use is counted as two trips.

Trips can be broadly categorised into the following types:

- a linked trip is a journey where there is a chain of stops from origin to ultimate destination. A trip from home to work with stops at school and the post office comprises three linked trips; home to school, school to post office, and post office to work
- an unlinked trip is a journey with no intermediate stops.

For the purposes of a traffic impact assessment, the following three types of trips are commonly used:

- New trip – in traffic impact studies, unlinked trips are generally referred to as new trips. These are trips attracted to the development and without the development would not have been made, hence they constitute a new trip.
- Diverted drop-in trips – a linked trip from an origin to a destination that has made a significant network diversion to use the new development.
- Undiverted drop-in trips – a linked trip from an origin to a destination that previously passed the development site. It is also referred to as a pass-by trip and the new development is an intermediate stop on a trip that is made from an origin to a destination.

The diverted and undiverted drop-in trips are considered to be trips that are already part of the existing flows on the road network. The treatment of the different trip types varies with the level of assessment. Hallam (1988) provides a reasoned basis for separating assessment into three levels:

- regional assessment – consideration of the impact of a development in the context of the total urban area
- local assessment – consideration of the effect of a development over a substantial area focussed on the development
- access level – micro level assessment.

At the regional level, insertion of a new development could be considered to only increase travel by the new trips proportion of generation. Diverted and undiverted drop-in trips would already be on the network.

At a local level, both the new trips and diverted drop-in trips are introduced into the area and represent additional trips on the local network. This local network may contain roads of regional significance. The undiverted drop-in trips to developments on roads of regional significance can be regarded as already on the local network. It is important that these trips are considered. They must be re-routed from movements past the development to movements into and out of the development. For every two-development trips assigned as undiverted drop-in trips (one in/one out), one through trip should be removed from passing traffic.

Information on trip segmentation relating to the proposed development must be acquired from various sources and considered in developing traffic estimates. Trip segmentation is a term that means the proportions of new, diverted drop-in and undiverted drop-in trips that are generated by the type of development

A typical example of the segmentation of traffic generation for shopping centres and fast food outlets is shown in Table C8 1.

Table C8 1: Segmentation of traffic generation for shopping centres

Development	Trip segmentation		
	New (%)	Diverted drop In (%)	Undiverted drop in (%)
Shopping centres > 20 000 m^2	63	18	19
Shopping centres 3 000 m^2 – 20 000 m^2	50	22	28
Shopping centres < 3 000 m^2	50	32	18
Fast food outlets	40	25	35

Source: Queensland Department of Main Roads (2006)

The distribution of generated traffic to the road network is briefly discussed in Section 4.4.7. The generated traffic determined by generation rates, the application of trip segmentation percentages and its impact on existing flows is applied in assigning the generated traffic to the affected network.

The generated traffic is ‘laid over’ existing traffic flows to determine link volumes (mid-block) and intersection movements for the road network with the development operating.

COMMENTARY 9 LEVEL OF SERVICE

Level of Service (LOS) is defined in terms of service measures such as speed and travel time, freedom to manoeuvre, traffic interruptions, comfort and convenience. The practical application of LOS to different road environments takes into account factors such as volume/capacity ratios, terrain types, proportion of heavy vehicles and road gradients. For a comprehensive account of capacity and level of service refer to the Guide to Traffic Management Part 3 (Austroads 2009d) and TRB (2000).

Each of the six LOS represents a range of operating conditions and the driver's perception of those conditions, and can generally be described as:

LOS A

Level of service A is a condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.

LOS B

Level of service B is in the zone of stable flow and drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream, although the general level of comfort and convenience is a little less than with level of service A.

LOS C

Level of service C is also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.

LOS D

Level of service D is close to the limit of stable flow and is approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems.

LOS E

Level of service E occurs when traffic volumes are at or close to capacity, and there is virtually no freedom to select their desired speeds and to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause flow breakdown.

LOS F

Level of service F is in the zone of forced flow. With it, the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs, and queuing and delays result.

Road authorities generally prefer to design new rural road projects for LOS A or B at opening and LOS C – D in the design year. However, some rural projects and most urban projects will have practical and financial limits on the extent of work that can be achieved and consequently the performance criteria will have to be negotiated throughout the traffic analysis process. In this regard an analysis of the existing level of service on the road network provides a useful benchmark by which to assess changes as a result of development.