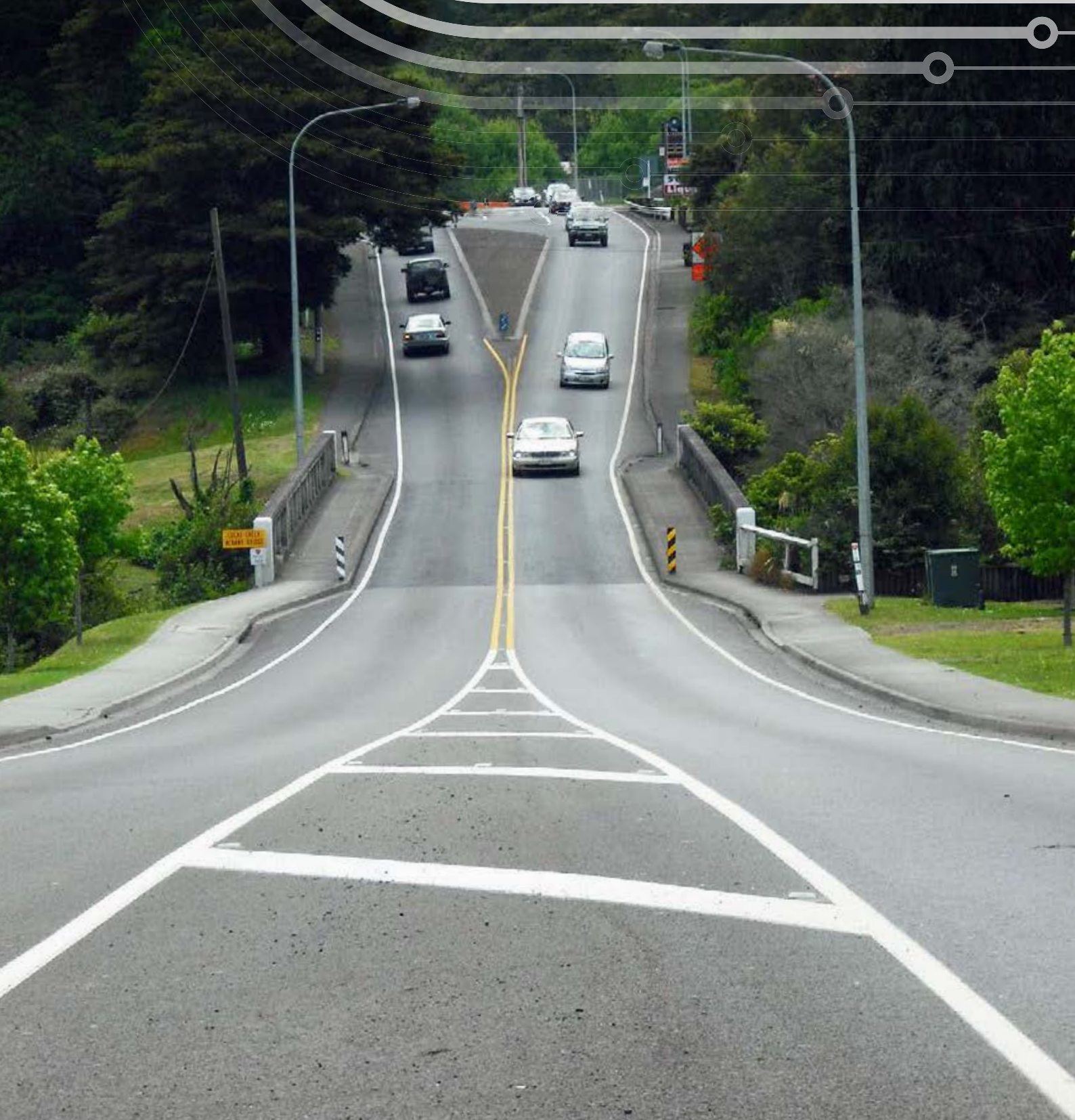


Urban and Rural Roadway Design



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01

Introduction

PURPOSE

The geometric design of the urban street and rural road networks is important to ensure that correct operation at the right road speed occurs in a safe and predictable manner. Design constraints will vary between projects, especially those within the rural urban boundary, but the general principles behind good road design do not change. The purpose of this chapter is to provide guidance on the issues that need to be considered when dealing with road geometry in Auckland, whether it is a new project or a retrofit of an existing road.

Street users should be able to observe the road environment, decide on safe speed and path to follow, and act upon that. When interacting with other users, they should be able to observe them, predict their likely action, decide on their response, and act. Geometric design should provide enough time for safe decisions and actions.

DEPARTURES

Where any deviations from the standards are necessary, they must be clearly documented and must follow the AT Departures from Standard process.

ROADS AND STREETS
FRAMEWORK (RASf)

The Framework sets out the process for planning or altering a transport network.

It provides guidance on the strategic types of street and the functions and features to be expected in each street, together with modal priorities.

It also describes the process for resolving conflicts for priorities. This should be used to resolve the common issues around general traffic provision with other modes of transport.

URBAN STREET AND ROAD
DESIGN GUIDE (USRdG)

This sets out principles for design of the various street types.

Chapter 1 Design Principles These principles must be understood by all designers as the basis for decisions, and the approach to be taken in the design process. In particular, this sets out how safety must be incorporated in all design work.

Chapter 2 Neighbourhood Design focuses on design aspects of planned networks, either as a means of designing the relationship between land use and movement, or for evaluating the local design context for a specific street or place within a neighbourhood. It also includes guidance on environmental design within a neighbourhood.

Chapter 3 Street Users takes each user group in turn, and describes their needs, specific design principles and the features that can be provided for them. Having understood principles and context, this chapter guides the choice of elements for each user to meet the planned function.

Chapter 4 Design Controls deals with the issues of geometric design that need to be considered, to ensure that drivers of vehicles in particular are guided to behave reliably in the way planned for them, safely and efficiently.

Chapter 5 Street Types and

Chapter 6 Intersections can then be used to put the elements together in accordance with the design principles into street and intersection layouts that will effectively deliver the planned outcomes. Typical layouts are shown, not as finished designs, but to illustrate the design considerations required to fit elements together into the design of a whole place.

This is to be developed later, to set principles for design of the various rural road types.

The Engineering Design Code - Footpaths and the Public Realm should be used with this chapter to fully define the overall road cross section. The two documents overlap along the kerb zone boundary with the Engineering Design Code - Footpath and the Public Realm acting as an overlay when providing for pedestrians crossing the roadway

The Engineering Design Code - Cycling infrastructure deals with people on bikes within roadway and footpath and the public realm and is to be used along with these Codes.

Objectives & general notes

The geometric design of roads has a direct impact on the following:

- Urban or rural amenity;
- Road Safety;
- Drainage Design;
- Environmental Impact;
- Material quantities and construction costs;
- Operation and Operational Capacity;
- Management; and
- Maintenance.

The design standards generally contained in most roading standards have traditionally been focused with road safety in mind and to provide for safe operation at the various design speeds. With the release of the Auckland Plan, a vision of a compact city has been established and as such built form and amenity of the environment is to be considered alongside safety and operation.

PROVISION FOR ROAD DRAINAGE

The geometric design (and its alterations) affects the ability for the road to provide drainage for surface water. Flooding from neighbouring watercourses and fixing the carriageway vertical alignment at an appropriate level needs to be considered.

ENVIRONMENTAL IMPACTS

The horizontal and vertical alignment of a road has an impact on the surrounding environment. Visual and noise impacts often depend on the elevation of the road, and the choice of surfacing material. The alignment also has an impact on the number of construction vehicles required to deliver or remove material from the site and therefore the impact on the local communities.

MATERIAL QUANTITIES AND CONSTRUCTION COSTS

The quantity of material required to be imported, excavated or moved has a direct impact on construction costs of a new alignment. Geometry has the largest impact on the requirement for material use and poor alignments, road widths or elevation can increase the costs substantially.

DESIGN FOR OPERATION

The design and alignment of the roadway, including intersection spacing and control methods, play a key role in the safe operational performance of vehicles and the roadway capacity.

It is imperative that roadways and the supporting movement environments are designed in such a way as to reduce impacts on the surrounding land whilst achieving the movement objectives as defined in the Roads and Streets Framework.

High movement corridors, may focus on movement efficiency, improving capacity, or safe travel times of various modes. Environments with a high place value may focus on capacity or speed reductions so that people on foot or bike are kept safe.

DESIGN FOR MANAGEMENT

The Auckland Transport Operations Center (ATOC) manages roads on a daily basis, particularly when emergencies and events affect traffic conditions. Other teams in Auckland Transport and Auckland Council also have management requirements. These requirements determine the Intelligent Transport Services (ITS) needs of a road which then affects what needs to be in the design. For example, CCTV to monitor traffic signals, pedestrian crossings and traffic flow, will need fibre to be installed along the road, if not already installed, to connect to Auckland Transport's communications network, which will need poles for the cameras and possibly a street cabinet. Similarly, CCTV to count vehicle, pedestrian and cycle numbers has requirements that can affect the design. Early engagement with Auckland Transport's operational and technology teams is necessary to identify requirements that need to be incorporated in to the design.

When designing, it is critical to consider how maintenance of the road environment can be achieved in a safe and cost effective manner that reduces the requirements for traffic management and its associated costs and disruption.

The road or street must remain safe and usable for all modes while maintaining the network. Maintenance requirements should be built in to the design for that. Early engagement with Auckland Transport's maintenance teams is necessary to develop a correct methodology that can be incorporated in to the design.



03

Design standards

ROADS & STREETS FRAMEWORK

This should be used to determine the street type, and the characteristics required, in order to set Design parameters.

TDM DESIGN TOOL BOX

AT publishes various design aids in the TDM Design Tool Box. These are to be used in all roadway design. They include CAD tools such as Design Vehicle profiles, software settings for vehicle tracking, templates for turning heads and intersection corners. These Tools describe and embed the design rules of this Code.

DESIGN STANDARDS FOR GEOMETRIC DESIGN IN NEW ZEALAND

The rules and requirements contained in this code will take precedence over any other standard unless agreed by departure, however the following geometric standards and advice notes may be used to supplement this code:

Austrroads Guide to Road Design:

- **Part 1** Introduction to Road Design
- **Part 2** Design Considerations
- **Part 3** Geometric Design
- **Part 4B** Roundabouts

OTHER DOCUMENTS OCCASIONALLY USED

Other documents that are sometimes needed are:

Austrroads Guide to Road Design Part 6A: Pedestrian and Cyclist Paths

Austrroads Guide to Traffic Management

New Zealand Heavy Haulage Association (NZHHA) Road Design Specifications for Over-dimensional Loads

04

Design parameters

MAXIMUM SAFE SPEED

The design speed of a road is the maximum speed at which a vehicle can safely travel on that road under good conditions.

DETERMINING FACTORS

The design speed is based on the:

- road and street type* (see Roads and Streets Framework)
- conditions of the road itself
- conditions of the surrounding land
- maximum speed allowed by law
- volume of traffic
- operating speed of the road, i.e. how fast traffic actually goes.

* In greenfield situations the road types shall be as agreed through the structure plan or precinct plan for the land in question in conjunction with the Roads and Streets Framework.

DESIGN SPEED VS. SPEED LIMIT

In the urban environment, as defined by the Auckland Unitary Plan and in accordance with network plans and Streets Typologies, the design speed of the road shall be the same or less than the intended speed limit of the street.



For rural roads or high speed urban roads with intended speed limit >60km/h, the 85th percentile speed shall be used with the design speed being 10km/h higher for the posted speed checks.

However, for rural roads, geometry should be determined to maintain a consistency along lengths of a particular type and character.

This design speed is used for alignment and intersection design. A higher operating speed may need to be used for safety-related design checks (see Section 4.3). This includes:

- Sight distances
- Clear zones
- Safety barriers
- Separation between users (eg. Buffer width between traffic lane and footpath or cycle lane, flush median and turning bays)

AUSTROADS GUIDES



Section 3 of the Austroads 2010 Guide to Road Design Part 3: Geometric Design contains detailed information on the assessment of the 85th percentile speeds and how it can be derived for rural and urban environments.

CONSISTENCY

Roads have to be geometrically consistent, so that drivers can negotiate them safely. If geographical constraints, road alignments or the environment cause the operating speed to vary along the road, the design speed has to change accordingly. These changes in speed have to be consistent with normal driver expectations and capability, otherwise drivers will not be able to react in time.

The design of the whole road environment (horizontal alignment, intersection spacing and control, adjoining land use and street activity, speed management features) should combine to present vehicle drivers with a consistent expectation and through this a desired speed not greater than the design speed.

Changes should be evident and should not be concealed by features, such as sharply-decreasing radius within a bend or by a crest curve.

URBAN ROAD SPEED MANAGEMENT

Where the intended Operating Speed is to be kept low for safety and urban design environment, care needs to be taken that the combination of road geometry and operating conditions can ensure that the Operating Speed does not exceed the intended speed. If this is demonstrated consistently, the Design Speed may be reduced below 50 km/h.

NOT ALL VEHICLES

Design speed does not cover all vehicles on the road, e.g. cars can travel faster than tractor-trailers. In some areas, e.g. with steep hills or sharp curves, a slower operating speed may apply to tractor-trailers. When designing such a road, take care to allow faster vehicles to safely overtake slower ones.

ROAD SIDE INFRASTRUCTURE

When proposing infrastructure that vehicles might conflict with, designers have to consider the interaction between operating speeds, visibility and stopping distances and survivable speed.

4.2 Design vehicles

DEFINITION

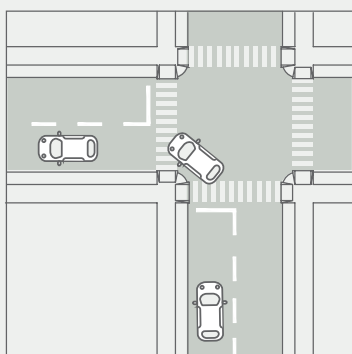
Design vehicles are selected motor vehicles with the weight, dimensions, and operating characteristics used to establish highway design controls for accommodating vehicles of designated classes.

PURPOSE

The Design Vehicle is used for the purposes of geometric design to ensure that the alignment is suited to the expected vehicle class.

RTS 18:2005 is not to be used for Urban or Rural roads in the Auckland Region. The guidance contained in this document must be used instead.

TURNING SPEED



Swept path analyses for intersections must be run using a turning speed appropriate to the context. The setting that permits steering while the vehicle is stationary may not be used.

Turning speed for buses and Check vehicles should generally be in the range of 5-25 km/h, giving regard to road design speed differential and desirable deceleration to the speed for the turn.

For roads with design speed greater than 50 km/h, turning speed may be increased where deceleration lane space cannot be provided and no conflict with people on foot or on bikes will occur.

High differential between turning speed and through traffic speed can be a significant safety risk. The design turning speed should correlate with the operating speed. For example, at an intersection on a 60km/h arterial road, the design turning speed may be 25km/h.

MANOEUVRE SPEED

Some manoeuvres such as parking, reverse turning or using vehicle crossings will require a lower swept path speed than intersections. Manoeuvre speed down to 3 km/h may be used.

ACCELERATION AND DECELERATION (BUSES)

Particular care needs to be taken with tracking speed when approaching or exiting bus stops noting that the vehicle is likely to be decelerating or accelerating. The turning speed used for tracking needs to account for this.

SWEPT PATH WIDTH

The path for design shall be the body width of the vehicle, plus 0.5 m clearance to allow for projections and variability in actual vehicle paths. Clearance shall be from an adjacent traffic lane or the face of a kerb (and may include a kerbside channel).

TRACKING PROFILES

The design and check vehicle profiles can be downloaded from the Transport Design Manual home page. Software settings for intersection and manoeuvre design should be in accord with AT Design Tools guidance.

BUSES

Bus tracking must use all standard AT bus types as defined as per the tracking profiles above in each instance where a road is or could be used by buses.

FREIGHT, OVER DIMENSIONAL AND OVERWEIGHT ROUTES

Where the road is part of a freight, over-dimensional or over-weight route it is a requirement that tracking be undertaken to show the effect this will have on any proposed design. All freight routes, whatever street type, require 19.45 m semi as Design Vehicle and 23m truck & trailer as Check vehicle.

DESIGN AND CHECK VEHICLES FOR EACH ROAD TYPE

Design vehicles are the largest vehicles that frequently use particular roads. They are expected to be able to remain within their allotted traffic lane.

Check vehicles are larger vehicles that may be expected to use a road from time to time. They may not be able to remain within a traffic lane at all times, but encounters between them and other Design vehicles must take place in a predictable and safe manner.

The following road types/design vehicles must be used at all times, unless it can be demonstrated that a different design or check vehicle is appropriate in a specific case.



TABLE 1 DESIGN VEHICLES

Vehicle	Description
50%ile car	This is more manoeuvrable than the 6.3m van. It should be used as a Check vehicle for all intersections and conflicts to establish a maximum Safe Path speed. This is required for Safe to Go and Safe Avoidance checks.
85%ile car	This is the minimum vehicle size to be used for residential vehicle crossing design.
6.3m van	A car with trailer very closely matches the 6.3m Van (2m wide) therefore it is easier to use a van for the design vehicle. This is the basic vehicle that all roads should accommodate.
8.3m truck	More appropriate than RTS 18 8 m rigid truck.
10.3m truck	This vehicle is required for separated waste streams, and is the most frequent check vehicle for all residential streets. Rear steering axle and body overhang result in significant tailswing to accommodate. Also necessary for design of turning heads.
12.6m rigid	More appropriate than RTS 18 11.5 m rigid truck.
12.6m bus	Required bus for all urban bus routes.
13.5m bus	Rear-steer axle results in significant tailswing, which should be checked for all current and potential bus manoeuvres.
Other bus	Refer to TDM home page for all bus types to be included in all routes (in or out of service, schools and repositioning) that may be used by buses.
17.9 m semi	Largest vehicle for service deliveries to retail (eg. Supermarkets).
19.45m semi	General design vehicle for freight routes (HPMV).
23m truck & trailer	Check vehicle for freight routes (HPMV, car transporter).

TABLE 2 DESIGN VEHICLES FOR STREET TYPES

Mid-block				
Road Classification	Design Vehicle	Tracking type	Check Vehicle	Tracking type
Local (residential or retail)	6.3m Van	A	10.3m Truck	A, B
Local (Commercial or Light Industrial)	8.3m Truck	A	17.9m Semi	B
Local (Industrial estate with significant freight movement)	12.6m Rigid	A	23m Truck & Trailer	B
Local (Bus route)	12.6m Bus	A	13.5 m Bus	B
Collector (Residential – no bus route)	8.3m Truck	A	10.3m Truck	B
Collector (Commercial)	12.6m Rigid	A	19.45m Semi	B
Collector (Bus route)	12.6 m Bus	A	13.5m Bus	B
Arterial (first general lane)	19.45m Semi	A	23m Truck & Trailer	B
Arterial (additional lanes)	8.3m Truck	A	23m Truck & Trailer	B
Arterial (Bus or Transit lane)	12.6 m Bus	A	13.5 m Bus	B
Intersections				
Road Classification	Design Vehicle	Tracking type	Check Vehicle	Tracking type
Local ► Local (residential or retail)	6.3m Van	A	10.3m Truck	E
Local ► Local (residential – bus route)	6.3m Van	A	13.5 m Bus	E
Local ► Local (Commercial/Industrial)	8.3m Truck	A	17.9m Semi	E
Local ► Arterial or Collector	As above	A	As above	D
Collector ► Collector (Residential – no bus route)	8.3m Truck	A	10.3m Truck	D
Collector ► Collector (Commercial)	12.6m Rigid	A	19.45m Semi	D
Collector ► Collector (Residential – bus route)	12.6m Bus	A	13.5m Bus	D
Collector ► Arterial	As Table 2 for the Collector	A	As Table 2 for the Collector	D
Arterial ► Arterial	19.45m Semi	C, F	23m Truck & Trailer	B, C

TABLE 3 TRACKING TYPE

A	Remain within marked lane, or allow safe encounter with conflicting Design vehicle where no lane is marked
B	Do not cross a marked centreline or flush median to penetrate opposing traffic lane
C	May use adjacent lanes in same direction
D	Conditions B, C apply on major (or crossing) road, E on minor (or terminating) road
E	May use full road width to turn
F	For multiple turning lanes, Design vehicle and a 8.3m truck must be able to turn together without penetrating opposing traffic lane

PRINCIPLES FOR SWEEP PATHS

Swept paths should be determined for the appropriate range of design and check vehicle with tracking type controls on lane use, and at appropriate turning speeds.

- Kerblines should follow swept path closely, with 0.5 m clearance from wheel track, to minimise risk of wheels damaging the kerb.
- Where a check vehicle is allowed to penetrate another traffic lane, there shall be clearance to allow for the swept path of a design vehicle using that lane.
- If that clearance is not available, encounter between a check vehicle and a design vehicle must be at a low speed, with visibility to enable one to stop and allow safe passage for the other, including for visibility of other users (safe encounter).

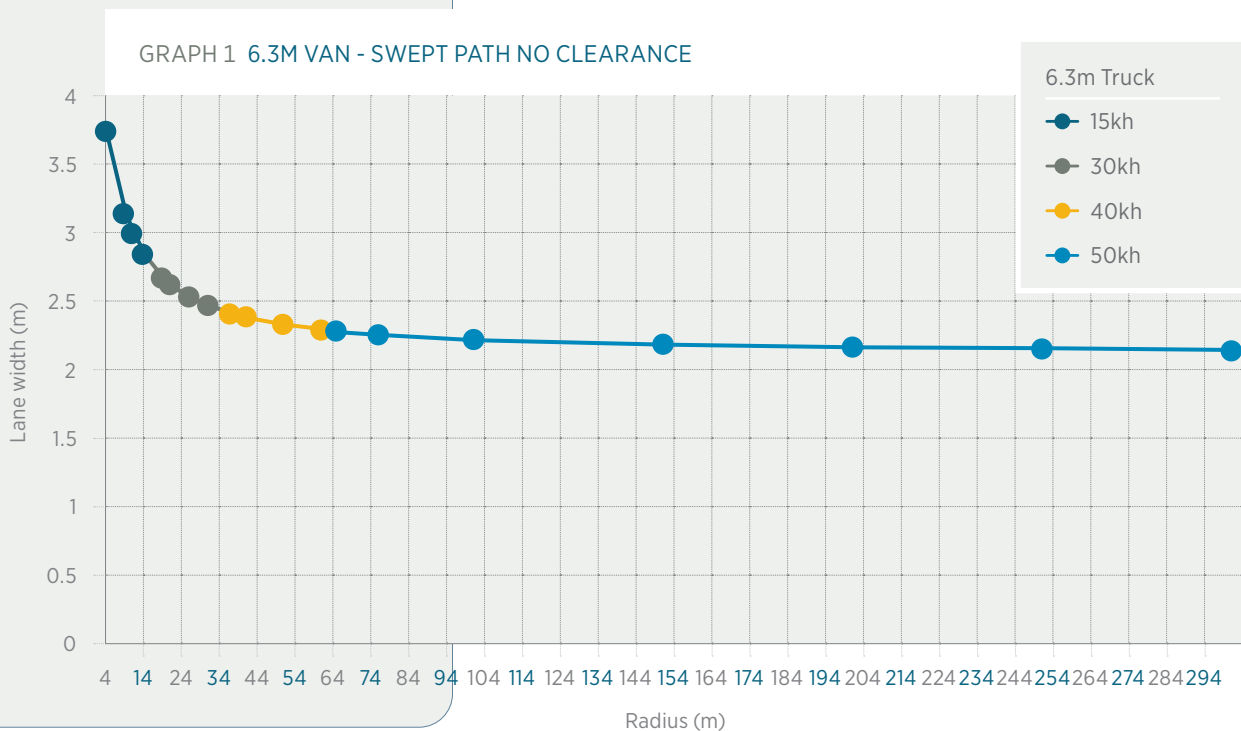
OTHER DESIGN CONSIDERATIONS



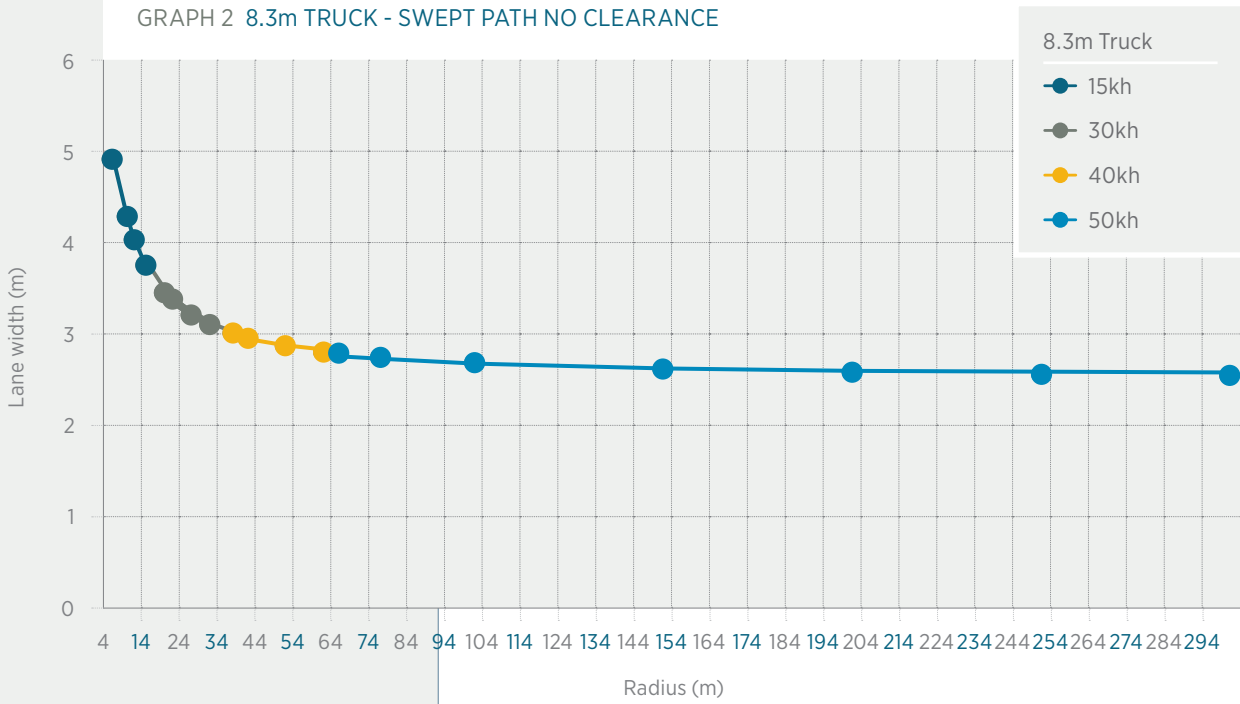
If a Design or Check vehicle will not fit all planning cases effectively, it may be necessary to use an alternative design vehicle, eg. a local road in a commercial area will require the tracking of larger vehicles appropriate for a particular industry served, residential streets providing service & delivery access to a supermarket or other specific consented land use, or roads leading to a boat ramp may require design for car and large boat trailer.

- It is acceptable to use variable drive speed to track the vehicle if it is not the design vehicle (but not turning wheels at stop).
- Considerations must be given for emergency vehicle use at all times, however they are not required to track fully in their lane.
- Where a body swept path overhangs a kerbline, protection for path users must be provided, usually by a buffer strip.
- At signal controlled intersections, vehicle swept paths must have regard to detector location.

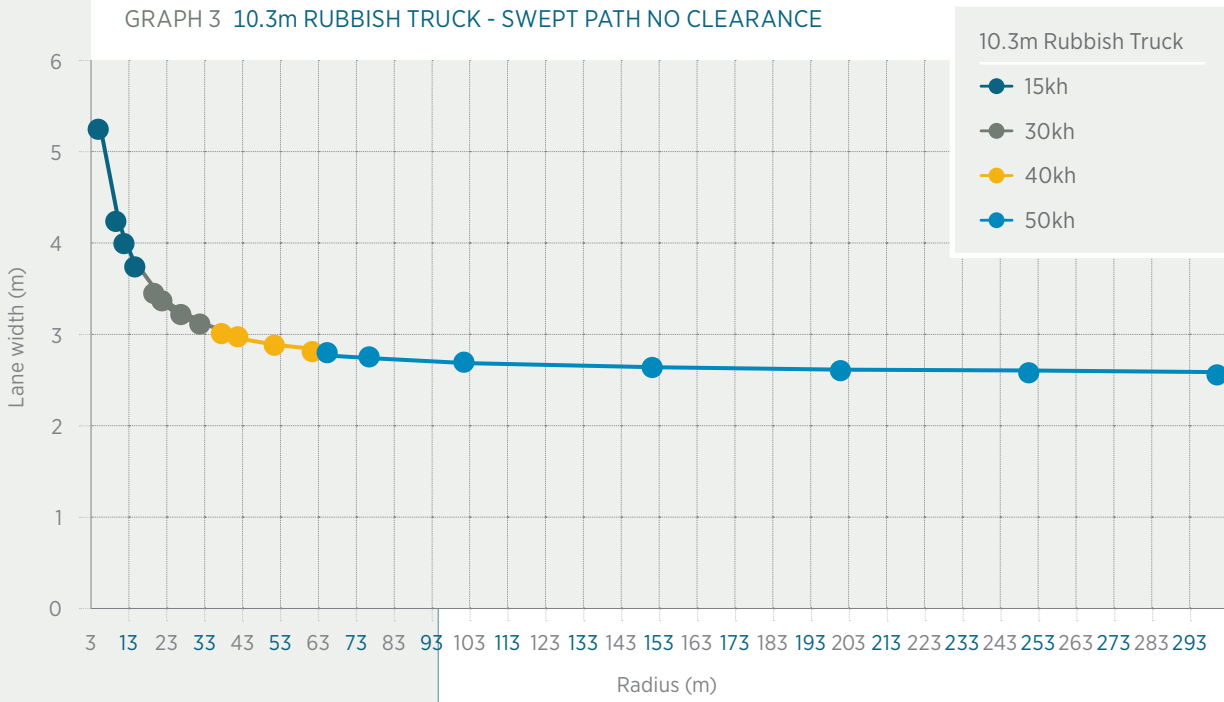
4.2.1 SWEEP PATH GRAPHS FOR DESIGN VEHICLES



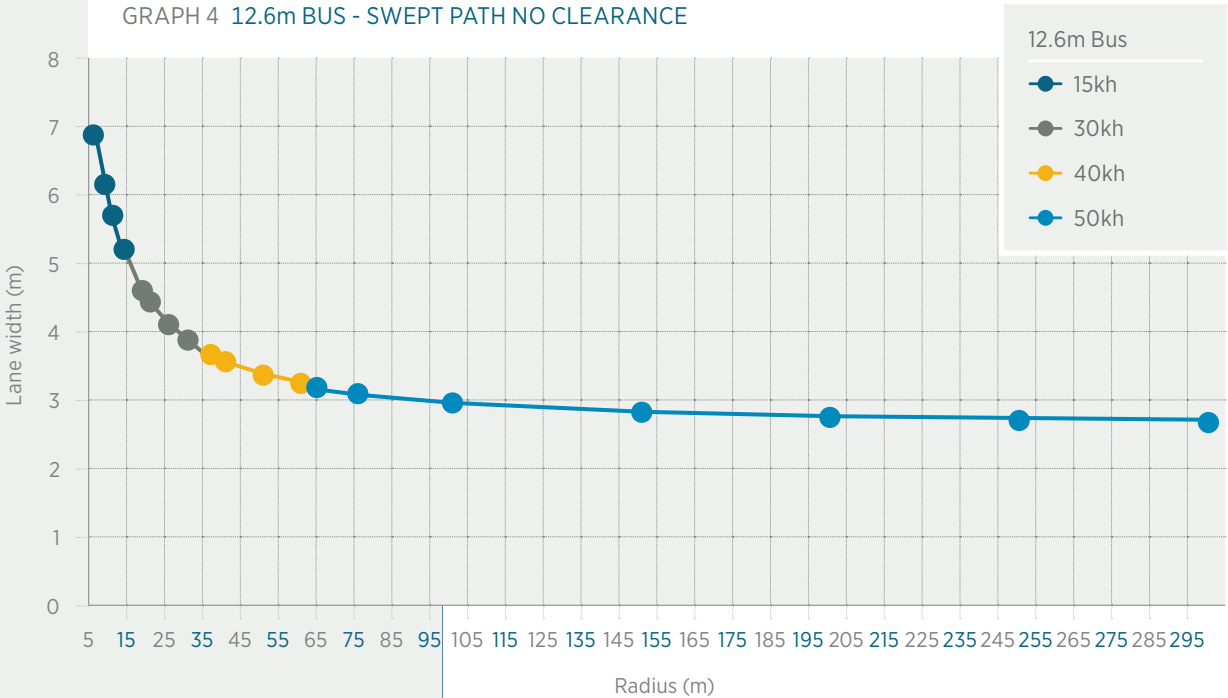
GRAPH 2 8.3m TRUCK - SWEEP PATH NO CLEARANCE



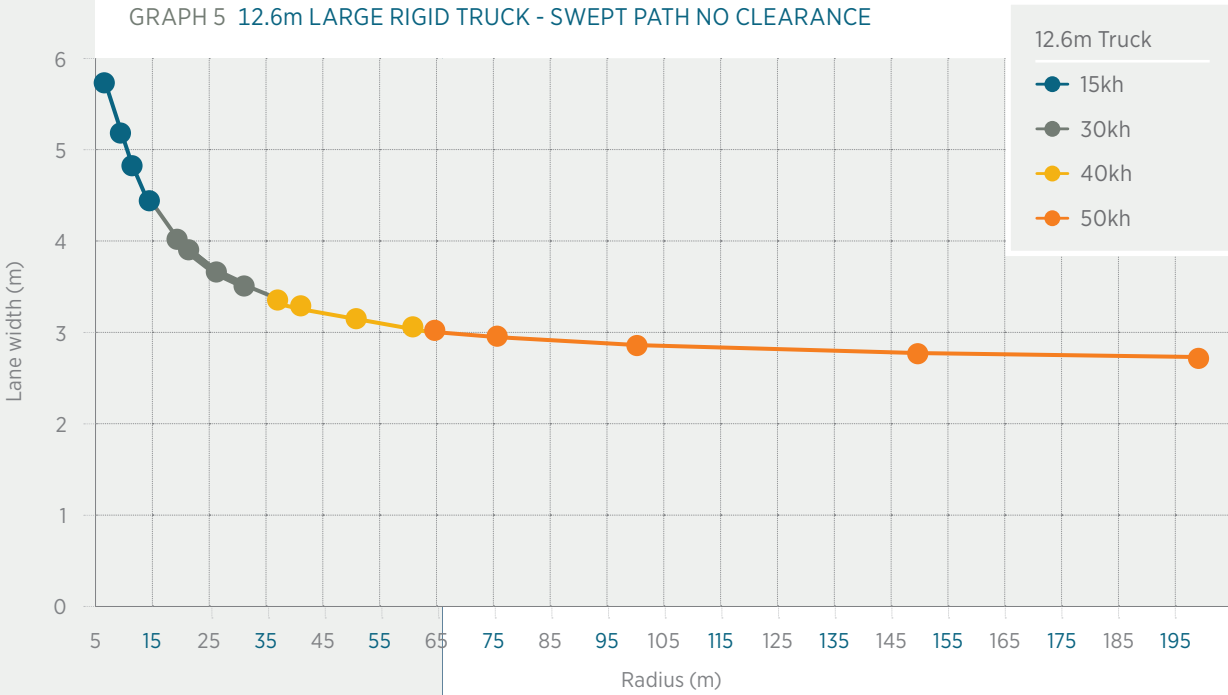
GRAPH 3 10.3m RUBBISH TRUCK - SWEEP PATH NO CLEARANCE



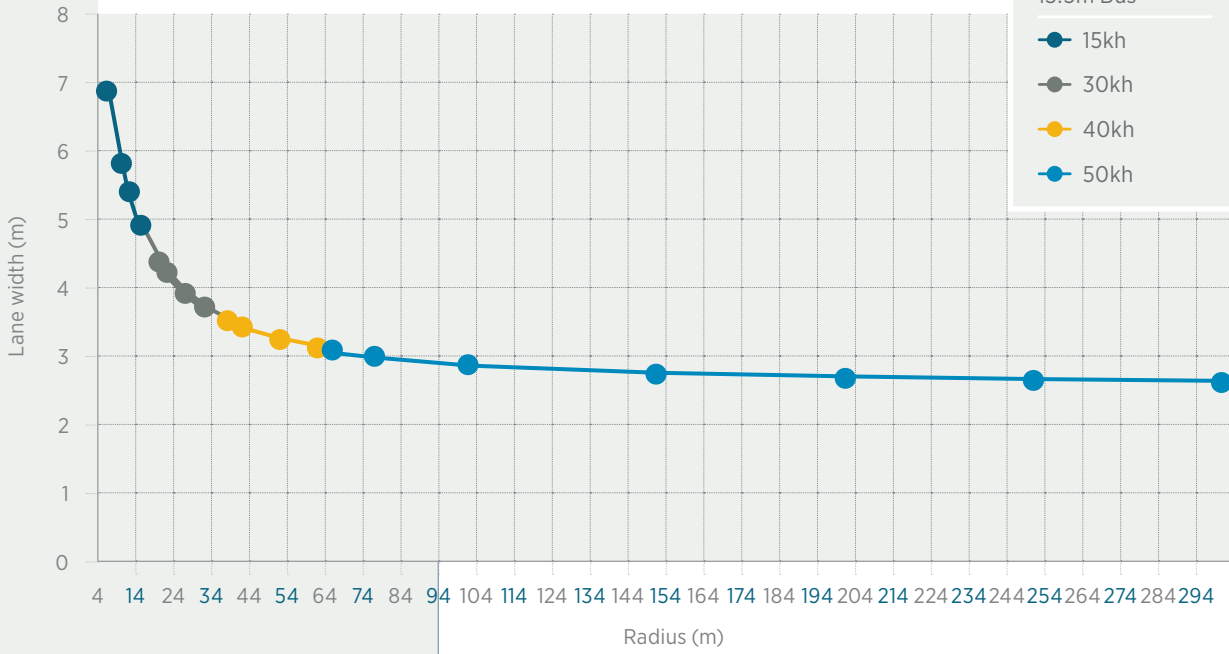
GRAPH 4 12.6m BUS - SWEEPED PATH NO CLEARANCE



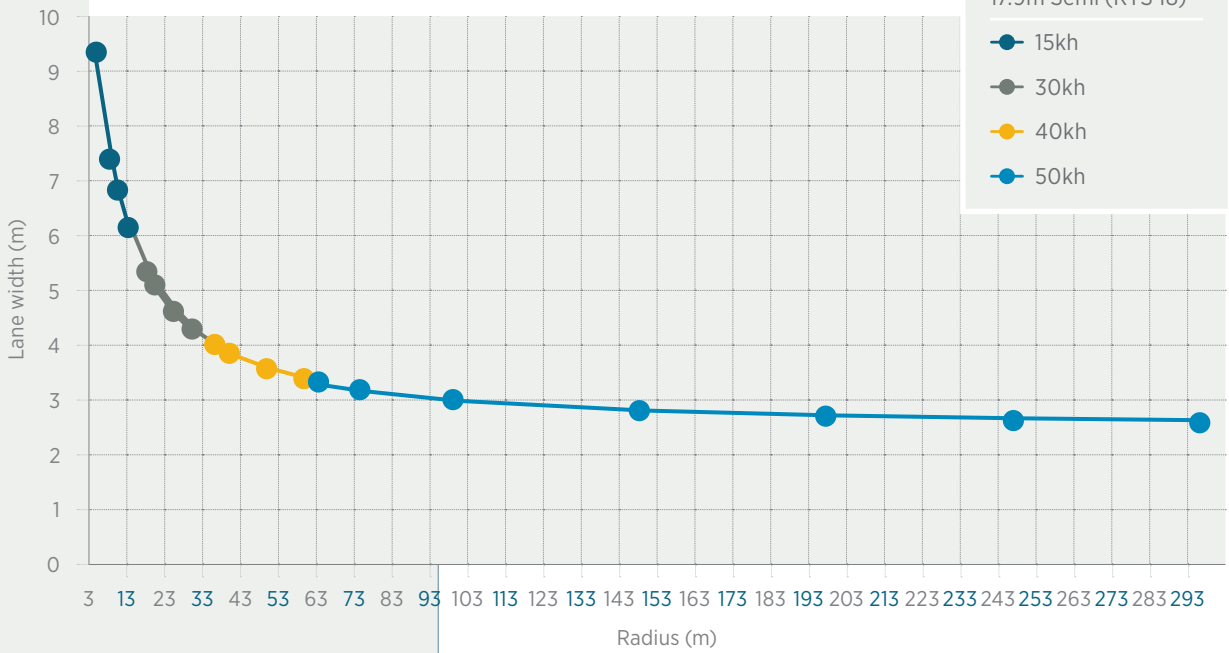
GRAPH 5 12.6m LARGE RIGID TRUCK - SWEEPED PATH NO CLEARANCE



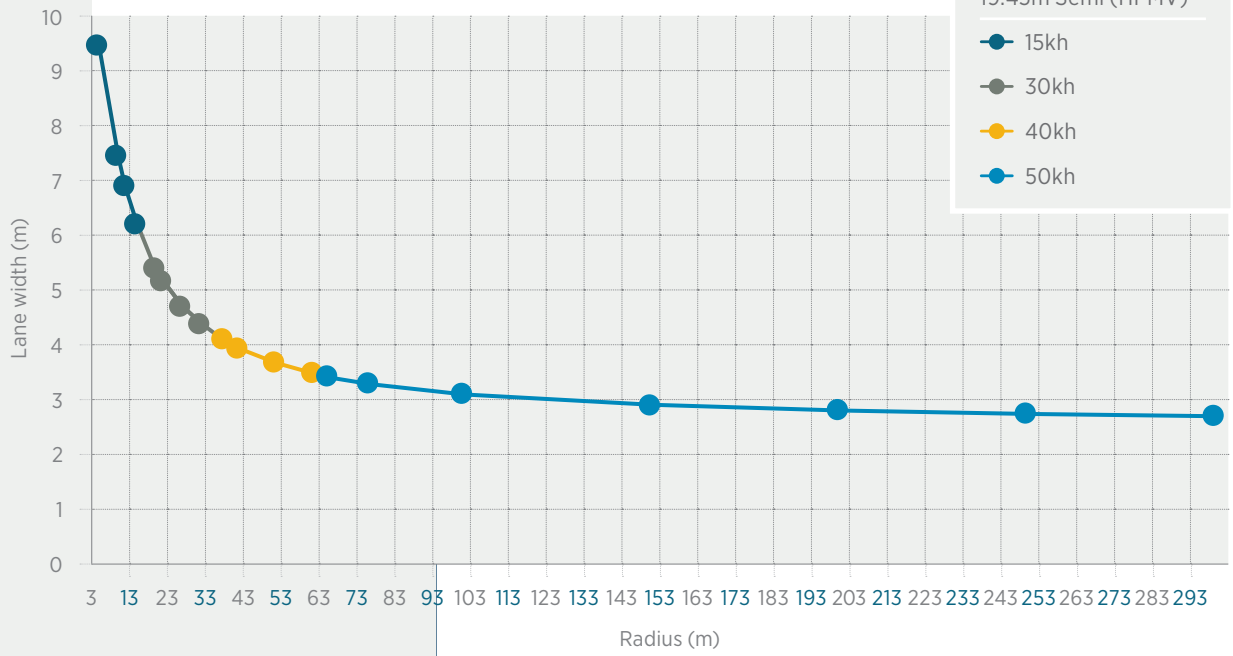
GRAPH 6 13.5m BUS - SWEEPED PATH NO CLEARANCE



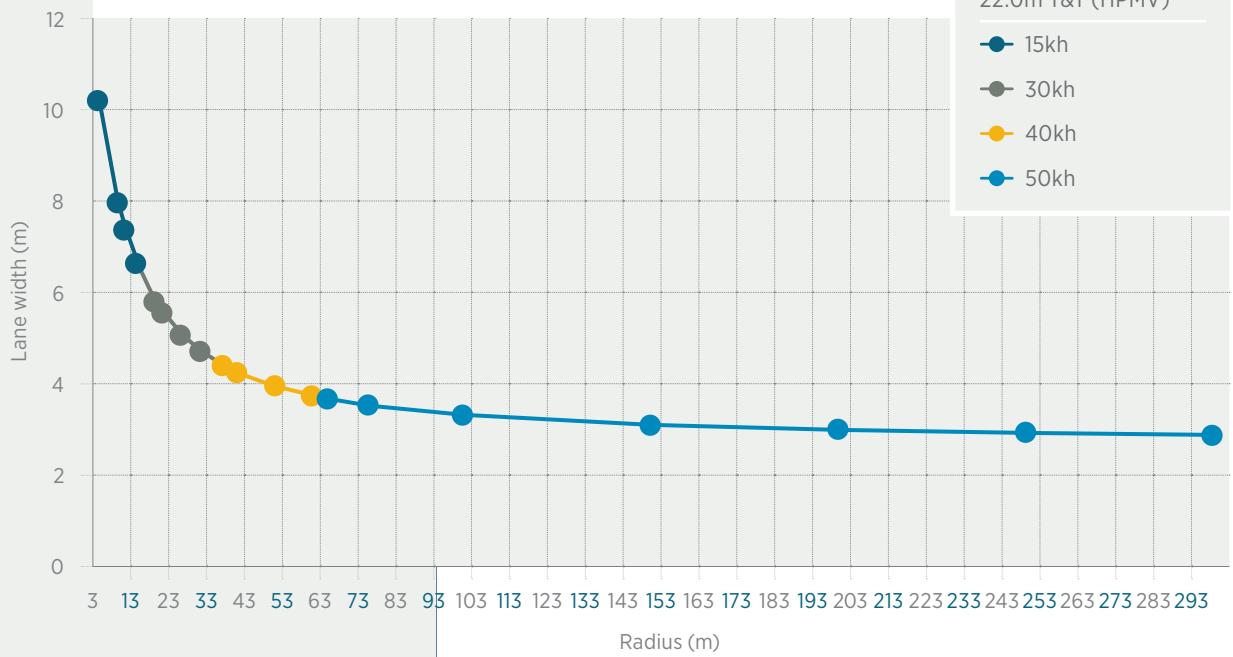
GRAPH 7 17.9m SEMI (RTS18) - SWEEPED PATH NO CLEARANCE



GRAPH 8 19.45m SEMI (HPMV) - SWEEP PATH NO CLEARANCE



GRAPH 9 23.0m T&T (HPMV) - SWEEP PATH NO CLEARANCE



DEFINITION



SAFE ROAD USE

DIFFERENT TYPES OF SIGHT DISTANCE

SAFE PATH

4.3 Visibility for safety

Sight distance is the distance along the path that the user takes from a point of observation to a feature, obstacle, or another road user. Sight distance can be calculated, based on the geometry of the road, vehicle assumptions, driver behaviour and observation of hazards.

For safety, sight distance must be long enough so that users can react to any change in road condition, expected or unexpected in a way that avoids harm to users, damage to vehicles and damage to infrastructure.

Although a sight distance must be calculated and used to confirm geometric design, it is the time taken to observe, decide and act, and the time taken to evade, slow or stop, that are critical. Design measures should ensure that sufficient time is provided, without distractions, for safe action.

Visibility envelope is the vertical and horizontal line-of-sight envelope that must remain clear between the observer and the object, as the observer and/or object move along their paths.

Three particular road user tasks need to be assessed to ensure road infrastructure can be used safely by all: –

- 1. Safe Path** Each road user must be able to see the way ahead of them to identify a safe path to follow, to choose, and to achieve a safe speed to approach features.
- 2. Safe to Go** When their path brings them into an area that may conflict with other users such as an intersection or a crossing, they must be able to see approaching users for long enough to judge a safe opportunity to enter the conflict area.
- 3. Safe Avoidance** They must be able to see unexpected stationary or moving hazards that may be in their path, or about to cross their path, in sufficient time to respond and avoid collision.

Austrroads, Guide to Road Design Part 3: Geometric Design (GRD3); Austrroads, Guide to Road Design Part 4A: Unsignalised and Signalised Intersections (GRD4A); and Austrroads, Guide to Road Design Part 4B: Roundabouts (GRD4B) describe various sight distances that are normally considered. They are grouped below according to task type.

GRD3 also provides guidance on applying sight distances to specific circumstances:

- Sight distances on horizontal curves
- Sight distances on horizontal curves with roadside obstructions
- Headlight sight distance (This should be consulted when assessing safety on unlit roads)
- Horizontal curve perception sight distance

Identify where a feature requires a reduction of speed from the initial design speed. Ensure a Visibility Envelope sufficient for observation and slowing at $d=0.25$ (Preferred).

	<p>Confirm ability to stop or give way to a priority user movement using Approach sight distance (ASD). Object may be varied from limit line road marking, provided Observation time allows correct judgement of the intended stop position.</p> <p>Care should be taken to avoid misleading observation of the path ahead, such as a bend which becomes tighter beyond the visibility envelope of the initial observation. Crest vertical curves can obscure the path ahead.</p>
<p>SAFE TO GO</p>	<ul style="list-style-type: none"> • Minimum gap sight distance (MGSD) • Crossing sight distance (CSD) • Overtaking sight distance (OSD) • Intermediate sight distance
<p>SAFE AVOIDANCE</p>	<p>Within Safe Path speed, check Stopping sight distance of cars and trucks (SSD) for hazards on or suddenly entering the road</p> <p>On the approach to intersections, crossings or complex conflict zones, check SSD with added observation time, or increased coefficient d, rather than simple application of Safe intersection sight distance (SISD), to show responses to the various hazard cases.</p>
<p>USER TYPE</p>	<p>Generally, safety is to be assessed for car drivers as the Design Vehicle. Checks for Heavy Vehicles should be made in all cases where they are a Design Vehicle, and any case where they are a Check Vehicle and assessment is likely to be significantly different from the Design Vehicle.</p> <p>Assessment of speed and stopping characteristics of other User types should be made using Urban Street & Road Design Guide.</p>
<p>SIGHT DISTANCE FOR RURAL ROADS</p>	<p>The formulas should generally be used as described in GRD3 and GRD4A to generate the appropriate sight distances for the road speed.</p>
<p>SIGHT DISTANCE FOR URBAN ROADS</p>	<p>Safe road use is more complex in urban streets. Opportunities for conflict are more frequent, change of path and speed are more frequent and it may be necessary to react to a new hazard while already changing speed or direction.</p> <p>User tasks need to be identified and assessed in turn and in combination.</p>
<p>OBSERVER POSITION</p>	<p>The observer may be stationary or moving, and eye height will vary with user type. Parameters from GRD3, GRD4A and GRD4B should be used for eye height.</p> <p>Where the observer is stationary, the position should be the probable safe position, allowing 2.5 m from the front of a vehicle and 1.0 m from the front of a cycle or pram for a footpath user or cyclist.</p> <p>When the observer is moving, the first point of observation is located along the time path of the observer, using constant speed, or reducing speed when responding to an intersection, curve or other feature.</p> <p>At intersections with limited visibility, the observer may make a number of decisions to move forward, and observation position should take account of likely behaviour, and whether this should be allowed, or discouraged to avoid risk of blocking a conflict area.</p>

OBJECT POSITION



Object size and distance must be considered, especially for high approach speeds. This affects recognition of a hazard likely to require action to avoid.

Fixed features may be on the ground, or vertical features. Although calculation for approaching and intersection or crossing generally requires observation of road markings at a limit line, the definition of the object may be considered more comprehensively to choose a speed reduction that will allow a user to stop where necessary.

Traffic Control Devices should be deemed to supplement the correct identification of features requiring slowing or stopping, not substitute for observation of the feature.

A curve, traffic calming feature, intersection or crossing may be considered as a whole, to assess what a user needs to observe to correctly identify it and respond in time.

The object may be another road user, and may be moving. The path of the other user, predictability of behaviour, and the time taken to reach a point of conflict, must be considered in defining the period of observation and reaction.

For Safe to Go, the “object” may be a gap in moving traffic. MGSD requires that the gap must be visible to the observer for long enough to correctly identify it and choose to proceed. A correction may be made, to not proceed if the gap is then judged too small. Safe Avoidance SSD can be assessed, for an accelerating or constant-speed observer to be able to stop clear of the priority user path. This should be checked where error of judgement is likely due to restricted observation time, or geometry likely to make speed estimation difficult.

OBSERVATION AND REACTION TIME

This varies for the three tasks, the road conditions and capabilities of different users.

A complex environment requires more features and risk areas to be observed, but also results in greater alertness.

Observation of a moving hazard in the peripheral field of vision causes a more rapid reaction to avoid harm – if the hazard is observed.

Some hazards, such as approaching vehicles at a distance on a straight road, curves passing out of field of vision, complex intersections, or users who may move, stop or change direction need more time to be observed and a decision made.

These factors must be considered when selecting times for calculation.

FRICITION AND VEHICLE

The sight distance calculations are greatly influenced by the road surface coefficient of friction and the correct design vehicle.

Standard friction rates of 0.35 for cars and 0.26 for trucks should be assumed to allow for variation of surface conditions over time, and weather conditions.

HAZARD OBJECT CHECK VEHICLE

High-friction surfaces should be assessed with increased coefficient of friction for Safe Avoidance only, as this performance will not affect the choice of Safe Path deceleration rate.

Austrroads GRD3 gives guidance for unsealed roads.

In good conditions, the sideways acceleration acceptable to a single-occupant car driver is greater than the design friction factor. A factor of 0.48g should be used to assess the path speed of a 50%ile car approaching a Conflict Zone. This is necessary to allow sufficient observation time of such a vehicle, regarded as a moving hazard, and to assess the potential collision speed for survivability.

Path speed is also affected by traffic calming and other features. For straight, unobstructed roads, Initial speed can be taken as 10 km/h above posted speed limit, as in conventional design guidance.

INITIAL SPEED

Initial speed is generally taken as the design speed for the road. This should be adjusted down to the comfort speed on a curved path, based on sideways acceleration.

Initial speed may be affected by another task already in progress, such as reducing speed to make a turn. It is then necessary to find the point along the user's time path at which a second calculation is needed such as Safe Avoidance of an unexpected hazard.

For Safe Avoidance, a check may also be needed for 85%ile speed, if this is significantly greater than design speed, which it may be on a straight, wide road.

For Safe to Go, the initial speed may also be calculated from stopped, as at a limit line or crossing.

DECELERATION RATE

Road geometry should not be designed based upon braking in an emergency. Departure from desirable deceleration may require mitigation through design. This should generally include ensuring no other departures locally affect safety.

The deceleration or acceleration rate rate is obtained by multiplying g (9.81 m/s^2) by a coefficient d .

Deceleration rate for Safe Path design should be $d = 0.25$ (2.5 m/s^2).

Deceleration rate for Safe Avoidance assumes stronger braking and is affected by sideways friction when turning, and by road gradient.

A check may also be made for the maximum friction rate available, depending on vehicle and surface, to assess probability of stopping to avoid collision or reducing speed sufficiently to avoid harm, if a collision is not completely avoided.

ACCELERATION RATE

When considering acceleration of a design car from stationary, or from an initial speed, for Safe Path or Safe to Go, use the table below. This may apply to observer, object user, or both. Coefficient d should be modified by adding 0.005 for each % grade down, or subtracting 0.005 for each % grade up (0.0025 when speed greater than 50 km/h).

TABLE 4

Initial speed		Acceleration rate		Coefficient d
(km/h)	(m/s)	(km/h/s)	(m/s ²)	
≤40	≤11.11	4.7	1.3	0.13
50	13.88	4.3	1.2	0.12
60	16.66	3.6	1.0	0.10
70	19.44	3.2	0.9	0.09
80	22.22	2.9	0.8	0.08
90	25.00	2.5	0.7	0.07
100	27.77	2.1	0.6	0.06
110	30.55	1.8	0.5	0.05

FINAL SPEED

Final speed may be the comfort speed for a low-radius bend, the manoeuvring speed for turning at an intersection, or stopped for a signal control or give way control.

For Safe to Go, the final speed may be the Design speed at the end of acceleration.

CONFLICT ZONE

Identify the area bounded by overlapping user path dimensions. This is the Zone within which two users may collide, unless one safely gives way to the other. Sight distance is measured along the time path of each user on the approaches to the Conflict Zone.

Safe to Go assessment is made for each user who should give way to another.

CONFLICT ZONE CLEARANCE

Both observer and object may pass through a conflict zone at different times when assessed for Safe to Go, and no harm will occur.

However, a user may be blocked or stop and be unable to clear the conflict zone as intended. Safe Avoidance assessment needs to be made for this.

COLLISION

If a collision is not avoided, design should seek to ensure that it occurs at a speed that avoids serious injury to users. This may occur when users do not take safe avoiding action. For this reason, it is preferable that areas of conflict should be located where user speed and kinetic energy are lowest.

ROAD/RAIL LEVEL CROSSINGS

Specific controls for sightlines for road/rail level crossings are included in the AUP.

ROAD SIDE CLEARANCE ENVELOPE

Areas within the visibility envelope generated by a particular sight distance must be kept clear of obstructions. Vegetation must be maintained at a height no greater than 600mm above ground level.

This is in addition to the clearance envelope for roadside structures and vegetation to avoid them being struck by vehicles.

4.4 Design for maintenance

Where utilities, and manholes in particular, have been given a departure to be in the roadway then chambers and lids must not:

- Be placed in the wheel track
- At the deceleration or acceleration zones of an intersection
- In the middle of an intersection

Consideration must be given and demonstrated that routine maintenance, such as resurfacing, can be achieved without excessive traffic management. This will necessitate the review of the wider network and establishing whether the designed road widths, lengths, and intersections are appropriate and that full road closures can be avoided or that any detours are short in length and follow routes that can accommodate the diverted traffic.



4.5 Network utilities

Network Utility pipework and ducting will only be allowed in the roadway where it is deemed to be for transmission, i.e. no local connections to adjacent property lots or catch pits. Local or distribution utilities shall be placed outside the roadway, within the space covered by berms and footpaths. Auckland Transport will only consider departures to these principles if it can be clearly demonstrated that placing the utility network within the roadway is a last resort and all other avenues, including departures from other relevant codes, have been found to be impracticable.

Utilities approved with an Auckland Transport Departure from Standard to be within the roadway, need to be at 1m deep minimum or outside of the road formation, whichever is greater. Depth evaluation must include compaction vibration effect on the formation and potential damage to the utility network.

Where Intelligent Transport Services are deployed there will normally be a need for ducting under the road to connect signals, and signs. Where an intersection is designed without any CCTV or Traffic lights then consideration should be given to putting ducting under the road to enable these to be added later.

For details on utilities in the footpath and roadside, see the footpaths and the public realm chapter.



NOTES

Once the design speed has been established, the constraints that will apply to the developed alignment can be determined. These could include:

- Level constraints caused by site fronting the road;
- Headroom clearance at structures;
- Overhead and underground services;
- Drainage requirements;
- Neighbourhood planning;
- Land take; and
- Any public commitments

An initial alignment is prepared, taking in to account any pre-agreed departures and then further relaxations and departures can be established if required to achieve the best alignment. The ability to seek departures near intersections is more restricted and will require more detailed justification.

- There may be a requirement for curve widening.
- Negative chainage systems should not be used; start the main alignments before the start of the works.
- Corner kerblines at intersections should have positive chainages which relate to the minor or side road.
- The ideal alignment across any structure is straight. Avoid small radii and transitions.

LEGIBILITY

Horizontal alignment should be consistent with other roads of the same Type. Where the Type changes or where a constraint requires a change such as a tighter radius bend, ensure that users have time to observe and understand the change and adopt a Safe Path speed appropriate to the alignment. Avoid an alignment that obscures a significant feature or hazard around a curve that invites approaching at a speed too great to observe and react to the hazard.

DESIGN SPEEDS
50KM/H OR LESS**5.1.1 Urban Road Alignment**

For all urban roads with a design speed of 50 km/h or less, the horizontal alignment may be based on straights and circular curves. Lane lines and kerblines shall be determined or confirmed by the use of vehicle tracking.

Table 2 Design Vehicles for Street Types, with Table 3, defines controls on tracking to encourage safe encounters.

DESIGN SPEEDS
GREATER THAN 50KM/H

On roads that may continue to have a higher design speed than 50 km/h in future, the designer may introduce transition curves applicable to the higher design speed. Transition curves must be calculated as outlined in the Austroads Guide to Road Design – Part 3: Geometric Design.

LOCAL & COLLECTOR ROADS

In addition to the above design approach, the horizontal alignment may form part of traffic calming measures. See Code of Practice: Traffic Calming Devices & Local Area Traffic Management.

MINIMUM CURVE RADIUS

The minimum radius for curves between intersections must be calculated as outlined in the Austroads Guide to Road Design – Part 3: Geometric Design. This requires calculation for Design speed below 40 km/h.

SAFE ALIGNMENTS

Rural road alignment should remain consistent through the length of a road, or a change of character and geometry should have a clear threshold.

Hazards should be made conspicuous, with signs or safety barriers included where necessary. Bends and intersections should not be obscured by vertical alignment.

HIGH SPEED RURAL ROADS

Where the posted speed is 60kph or greater, then the geometry should be designed in accordance with Austroads Guide to Road Design – Part 3: Geometric Design

5.2 Vertical alignment**LEGIBILITY**

Vertical alignment should ensure that no features such as bends, intersections or crossings are obscured beyond a crest curve that cannot be clearly observed and understood by an approaching user in sufficient time to adjust their approach path and speed appropriately.

ALL RURAL ROADS

For rural roads, the design of the vertical alignment must be as outlined in Austroads Guide to Road Design – Part 3: Geometric Design.

URBAN ARTERIAL ROADS > 50KPH

The design of the vertical alignment must be as outlined in Austroads Guide to Road Design – Part 3: Geometric Design.

ALL URBAN ROADS < 50KPH

The design of the vertical alignment must be appropriate for the site location.

Sag / Crest curves: Appropriately designed to achieve at least the minimum rate of change of gradient for Design speed. Start with Sag K value of 9 and Crest K value of 10 and reduce if necessary. In addition, crest curves are to achieve Safe Stopping Distance visibility.

NOTES

Where traffic calming measures are required, refer to Engineering Design Code - Traffic calming.



ROAD DRAINAGE DESIGN



5.3 Longitudinal gradients

The minimum acceptable longitudinal gradient is based on acceptable road drainage criteria. See Engineering Design Code - Road Drainage.

PREFERRED GRADIENT

As much of the road network as is practicable should not exceed 5%, to allow maximum accessibility for path users.

Where topography prevents this, a maximum grade over route length of 8% may be acceptable.

Gradients steeper than 8% will require treatments for pedestrian routes alongside the road.

These steeper gradients should only be used where acceptable alternative accessible path routes are provided.

MAXIMUM GRADIENT

Gradients should not be steeper than 8%, but may be increased above 8% where topographical constraints exist.

Maximum gradient with departure from standard should be as low as possible and may not exceed 12.5% for vesting as public road.

06

Camber, cross-fall and super-elevation

CARRYING WATER

In addition to longitudinal fall, transverse fall is used to carry rainfall from the road surface to the edge or edges of the road. Without this, standing water may cause aquaplaning of vehicles due to the blocking of the tyre tread.

CROSS-FALL AND CAMBER

Cross-fall and camber describe fall across the width of a road to remove water from the surface.

- Cross-fall: Surface water is conveyed to one side of the road.
- Camber: Surface water is conveyed from the centre of the road to the edges of the road. Camber is not a straight fall, but rather a downward curve from the middle of a road towards the edges. A road with camber is often referred to as having a “balanced carriageway”.

TRANSVERSE GRADIENTS

Transverse gradient refers to the angles of the fall in a camber or cross-fall. The amount of upward curvature is rarely specified and most geometric modelling software have no provision for doing so.

SUPER-ELEVATION

Super-elevation refers to the use of transverse fall for safety and passenger comfort when cars pass through bends - “banking” to transfer some of the lateral forces of the movement into downward pressure on the vehicle. Super-elevation should always be preceded and followed by transition curves.

6.2 Design considerations

6.2.1 Cambers and cross-falls

MINIMUM TRANSVERSE GRADIENT

Because of Auckland's high rainfall, minimum transverse gradients of 3% towards the outer edge of the road should normally be used on all sealed roads. However, where existing features prevent this, the camber or cross-fall may vary between 2% and 4%. On unsealed roads, minimum transverse gradients of 4% towards the outer edge of the road should normally be used.

MAXIMUM TRANSVERSE GRADIENT

The maximum transverse gradients are 5% for sealed roads and 6% for unsealed roads respectively. Greater transverse gradients require approved departure from Auckland Transport.

TRANSVERSE GRADIENT IN RELATION LONGITUDINAL GRADIENT

Transverse gradient steeper than 3% (up to 5%) is preferred on steep roads to encourage drainage towards the road channel.

Where longitudinal gradient is less than 1%, crossfall must not be less than 3%, to encourage sheet flow to road edge.

INTERSECTION

At intersections, the camber of the major road should take priority and the minor road should be designed so that it grades into the channel line of the major road.

If this cannot be achieved, the crown of the minor road should not extend into the traffic lane of an arterial or collector road.

ADVERSE CROSS-FALL

Adverse cross-fall (fall towards the outside of a bend) will not be permitted on roads with design speed greater than 50 km/h.

6.2.2 Super-elevation

AUSTROADS GUIDE



If super-elevation is to be used, it must be applied as outlined in the Austroads Guide to Road Design Part 3: Geometric Design Section 7.7 Super-elevation.

Super-elevation is not permitted on local or collector roads and is unlikely to be required on arterial roads within urban areas.

MAXIMUM

The maximum super-elevation should be limited to 5% in areas where pedestrian movements are prevalent.

To achieve the design speed for the road, super-elevation on curves is required where the longitudinal gradient is steeper than 8%.

07

Standard road configuration

7.1 Road reserve and public right of way

DEFINITION: ROAD

"Road" is the legal name given to the strip of publicly owned land between abutting property boundaries that is specifically gazetted and vested to become a road. It generally includes the roadway, as well as footpaths and berms.

UNFORMED AND PAPER ROADS

An Unformed Legal Road (or paper road) is a legally-recognised road that is usually undeveloped but provides public physical and legal access to a land allotment. Please see Auckland Transport Unformed Road Policy for information on requirements.

ELEMENTS

The overall cross section of the road reserve is made up of:

- berms (which may include service trenches),
- footpaths and
- roadways.

Berms may include street furniture, vegetation and trees, stormwater management devices, side slopes and retaining structures; and landing pads for bus stops.

Footpaths may include cycle paths.

Berms and footpaths together are referred to as Roadside.

Roadways may include cycle lanes facilities, parking bays and raised medians.

WIDTH

The road reserve width is the combined width of all the different elements and can often include additional unused width for future capacity upgrades.

CONSISTENCY

Street types provide guidance on elements and their combination. Adjoining streets and lengths of street with similar function should seek to maintain consistent overall width.

NARROW STREET

A proposed carriageway 7.0 m wide or less is considered a narrow street. If the carriageway is narrower than this, parking may need to be restricted to only one side of the road. For expected traffic greater than 50 vph or 500 vpd, on-street parking bays shall be provided in narrow streets to meet expected parking requirement and keep two traffic lanes free.

ROAD CROSS SECTION

Typical cross sections and standard road reserve widths are not provided here. These must be derived from the elements necessary to meet the required level of service for all the design objectives of the street type.

Where specific site constraints affect the width of road reserve available, care must be taken to ensure that the width provided for each element in the design does not create safety or service deficiencies for any of the users to be provided for.

SEE ALSO



Code of Practice Chapters on Pedestrians and the Public Realm, Road Drainage and Bike Infrastructure.

PURPOSE

Clearance envelopes ensure that infrastructure is placed so that it is not struck by road users passing by, causing injury, damage to vehicles or damage to infrastructure.

7.2 Road reserve cross section

7.3 Clearance envelopes

STANDARD CLEARANCES



Clearance envelopes are shown in Standard Engineering Details GD0001, GD0002 AND GD0003.

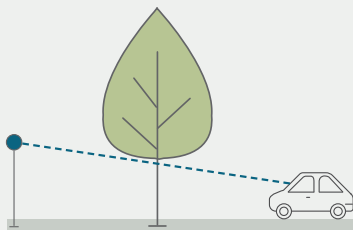
CLEARANCE FROM FIXED STRUCTURES

Vertical and horizontal clearances are shown on GD0001.

Generally, a horizontal clearance of 0.5 m beyond a vertical kerb or road shoulder will be required to allow for any vehicle or road user coming adjacent to that edge.

This may need to be increased in places, especially close to tight bends, intersections, vehicle crossings, parking or loading zones where the front or rear of a vehicle may overhang the road edge by more than 0.5 m. Specific vehicle tracking should be used in places where this effect is not easily defined.

CLEARANCE FROM VEGETATION



Vertical and horizontal clearances are shown on GD0002.

Clearance for vegetation requires an allowance for growth. Where trimming or pruning may be required to maintain clearance, this should allow for reasonable operational intervals between inspection and trimming activities. The allowance should be at least as shown, and should be increased if appropriate.

Clearance must also take account of deflection of vegetation under wind and the weight of rain, and the risk of injury or damage from this.

CLEARANCE ON BUS ROUTES

Double-deck buses place passengers close to the extremity of the clearance envelope. Additional clearance allowance should be made, especially at intersections and at stops, for front and rear overhang when turning.

Road crossfall may bring the top of a bus closer to infrastructure. The camber clearance Design Tool should be used to determine additional clearance for crossfall at specific locations.

OVERDIMENSION VEHICLE ROUTES



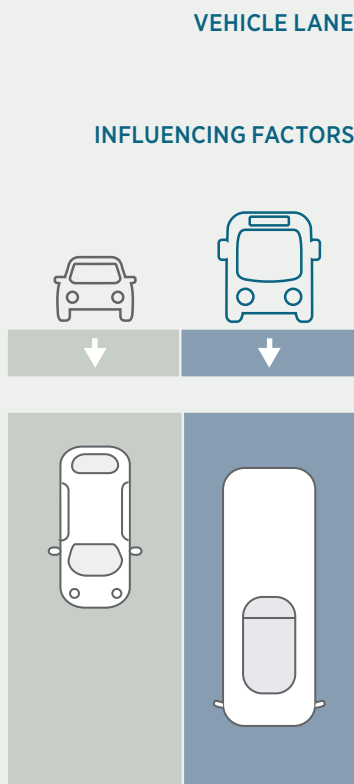
For Overdimension routes, the clearance envelopes must be in accordance with New Zealand Heavy Haulage Association (NZHHA) Road Design Specifications for Over-dimensional Loads or as agreed with AT Road Corridor Access. See also GD003.

STREET FURNITURE ZONE

See Footpath, pedestrian facilities and the public realm chapter.

The street furniture zone should provide sufficient width for any street furniture proposed or anticipated to be installed while maintaining the clearances specified in this section. It may be necessary to increase the width of the street furniture zone for any items that require more than the specified minimum width, to meet clearance requirements. The concept design of all street furniture, including CCTV poles, street cabinets, etc. should be confirmed before sight-lines are finalised.





7.4 Lane widths

Vehicle lane width is measured between the centre of line markings, and to the edge of road seal. A concrete drainage channel is not to be included in traffic lane width.

Lane widths should be suitable for the road classification and expected traffic volumes. They are generally between 2.7m and 4.2m. Lane width has a significant effect on operating speed.

A regional arterial is likely to have a high movement function, therefore the lanes should be designed to allow vehicles to move freely and safely.

A local road is more focused on the residents that use the area to walk and play, so the lane configuration should be one that creates a slower environment with narrower lanes.

Roads carrying bus routes, or a significant proportion of heavy vehicles, will require lane widths suitable for the appropriate Design Vehicles.

Generally, wider than 3.4 m can lead to poor channelling of traffic, higher speed and reduced safety.

Width greater than the preferred should only be considered for FTN bus routes or freight routes, or for interface with existing road widths that cannot be amended.

A lane width greater than 4.2 m can lead to vehicles forming two lines of traffic and generally should be avoided.

ARTERIAL ROADS

For arterial roads, it is expected that the design vehicle shall track within its lane at all times. The check vehicle shall be used at curves to ensure that it does not cross the centre line (or lane line on multilane roads).

URBAN LOCAL AND COLLECTOR ROADS

For local and collector roads, the design vehicle should generally be accommodated in lane unless bypassing an obstruction. The check vehicle can occasionally track outside of lane and shall be used to ensure that interactions between the paths of design and control vehicles will result in safe encounters.

RURAL ROADS-GENERAL

Safe clearance distance between the swept paths of vehicles travelling in opposite directions must be provided, with regard to visibility and approach speed. Judging the position of an approaching vehicle on an unlit road at night can be difficult.

RURAL LOW SPEED LOCAL ROAD

For rural local roads with a design speed of 50km/h or less, the design vehicle should generally be accommodated in lane unless bypassing an obstruction. The check vehicle can occasionally track outside of lane and shall be used to ensure that interactions between the paths of design and control vehicles will result in safe encounters.

ALL OTHER RURAL ROADS

Design and check vehicles should be able to remain within the left side of the road, whether a centreline is marked or not.

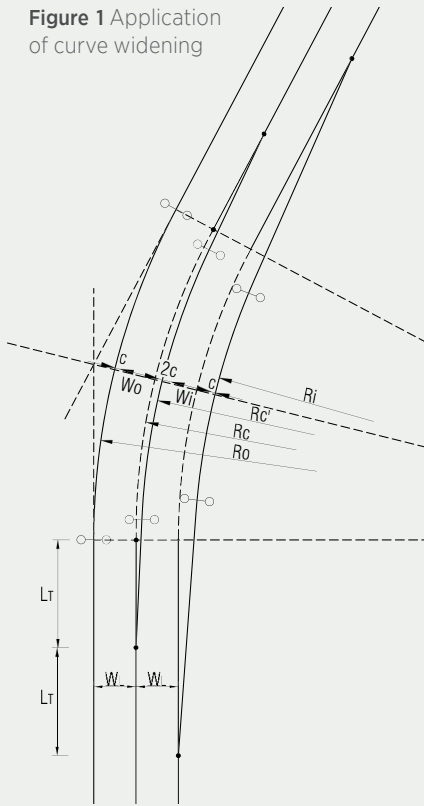
CURVE WIDENING

Curve widening additional to the lane widths given below may be required at bends. On roads with bendy alignment, consistent wider lanes may be preferable.

Minimum curve radius relative to Design Speed for each design and control vehicle is given in Graphs 1-9 and shall be used for all curves.

APPLICATION OF CURVE WIDENING

Figure 1 Application of curve widening



- Rc = Alignment nominal radius
- Ro = Outer kerb radius
- Rc' = Derived centerline radius
- Ri = Inner kerb radius
- W_L = Lane width on straight (to kerb)
- C = Path clearance
- W_o = Outer path width
- W_i = Inner path width
- L_T = Taper length



Widening shall be determined for appropriate combinations of Design and Check vehicles as required in Tables 2 and 3.

Tracking width shall be determined from Graphs 1-9.

Clearances shall be added.

The outside kerblines should generally be a circular curve joining approach and departure kerblines.

Widening should be developed by a straight line, tangential to the inner radius of each lane. The start of the taper should be set back from the outer tangent point by the length of the Check vehicle, for each lane in sequence working inwards.

Reverse curve steering should not be required, except for speed management measures or to deal with constraints that cannot be otherwise managed. If constraints require, the Check vehicle may follow a path with reverse curve, but only if this is clearly legible to the driver on approach.

TABLE 5 SPEED ENVIRONMENT > 50 KM/H

Road	Lane width	Notes
Arterial	3.5m preferred 3.0m minimum	The minimum width cannot be used on a bus or heavy freight route.
Collector	3.3m preferred 3.0m minimum	Collector roads should rarely have a speed environment > 50 km/h.
Local	3.1 preferred 2.7m minimum	Local road speed environment > 50 km/h will be rural roads only.
For speed environment > 50 km/h, shoulder must be provided.		

TABLE 6 SPEED ENVIRONMENT 50 KM/H OR LESS

Road	Lane width	Notes
Arterial	3.2m preferred 3.0m minimum	Preferred width increased to 3.5 m on FTN bus route or designated freight route. The minimum width cannot be used on a bus or heavy freight route.
Collector	3.2m preferred 3.0m minimum	
Local	3.0m preferred 2.7m minimum	Preferred width increased to 3.5 m for freight access to industrial land uses. The minimum width cannot be used on a bus or heavy freight route. Parking restrictions may be required if the minimum width is used.

Note: Designers are required to use the Preferred width. The Minimum width is a guide for Departure where existing site constraints prevent achieving Preferred width.

WIDE KERBSIDE LANES

Wide kerbside lanes may be required for functions that change through the day (e.g. a parking lane becomes a clearway at certain times) or to allow people on bikes to share the lane with other traffic. Redevelopment of existing roads may need to address unmarked parking lanes. There are two ways of using wide kerbside lanes to aid people on bikes.

- **Parking prohibited at all times.** In this case, the lane has to be wide enough for motor vehicles to pass people on bikes safely.
- **Parking prohibited for parts of the day or week.** The kerbside lane has to be wide enough for people on bikes to pass parked cars and to avoid opening doors, but not so wide that traffic shares the lane with parked cars. (See Clearways below)

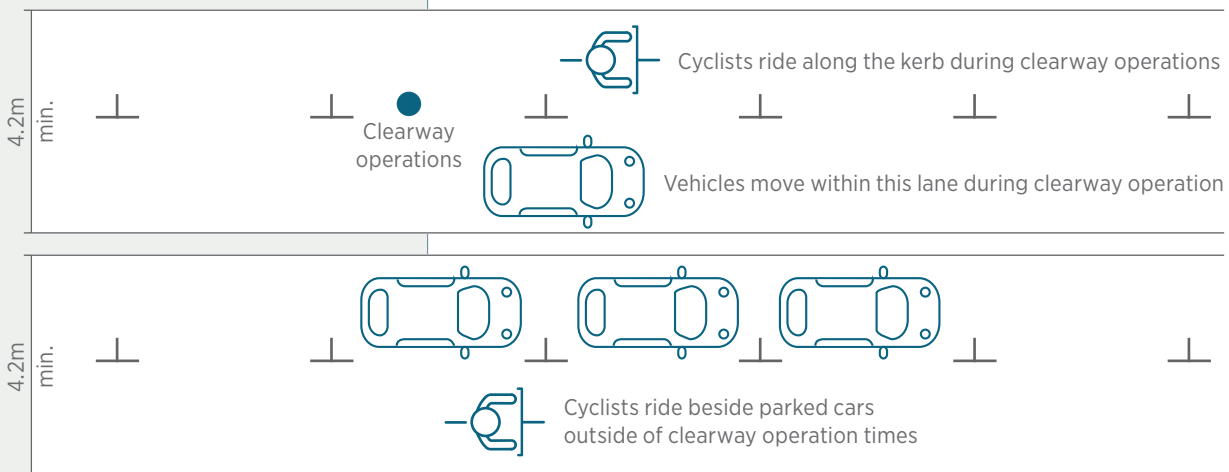
Wide kerbside lanes should be between 4.2 and 5.0 m wide. Traffic lanes should not be between 3.5 and 4.2 m wide (except for specific curve widening).

Any kerbside lane exceeding 5.0 m width should be marked with a parking shoulder edge line for lane discipline. A separate cycle facility should be created where practicable.

Clearways can be reasonably safe for confident people on bikes in the mid-block, but they introduce problems at intersections, as cycle facilities crossing the side streets cannot be marked. (People on bikes travel in a kerbside position during clearway operating times, but outside of parked vehicles at other times.) A more desirable solution is to provide a protected cycleway where there is a clearway.

CLEARWAYS

Figure 2 Clearway use by people on bikes with parking during off-peak periods.



BUS ROUTES

Where the road is identified as an existing or potential bus route, these lanes may have to be wider. Parking behaviour and traffic composition may affect bus service reliability. Early discussions with AT Metro are needed to ensure that bus movements are provided for.

ROADS & STREETS FRAMEWORK



7.5 Special vehicle lanes

Special Vehicle Lanes have a defined usage and accessibility to limited vehicle types. The criteria for special lanes in Auckland are described in the Auckland Transport Roads and Streets Framework. Width of lanes should be based on the vehicles authorised to use them and safe clearances from other traffic lanes.

Provision for additional signage, poles and CCTV infrastructure is required in Special Vehicle Lanes. Networking and power considerations are essential. Auckland Transport's Business Technology department must be engaged in the provision of Special Vehicle Lanes.

AUCKLAND CYCLE NETWORK



7.6 Cycle facilities

Roads with identified cycle networks must include suitable facilities for people on bikes. All other roads may form part of a local cycle network and must have appropriate provision for people on bikes, including access to nearby cycle routes.

CYCLING INFRASTRUCTURE GUIDANCE



Further guidance can be found in the Engineering Design Code - Cycling Infrastructure.

KERB-SIDE PARKING



7.7 Parking

Kerb-side parking can be provided within the road reserve in different configurations – either parallel to the direction of travel or perpendicular to the kerb.

A kerbside parking shoulder should be separated from traffic lanes by parking bay or continuous shoulder markings.

PARKING DESIGN



Parking standards for on-street car parks or Auckland Transport owned car parks are described in the Engineering Design Code - Parking. This includes turning tracks and appropriate dimensions.

USES



Traffic islands are raised features that channel traffic to:

- Create safe zones for turning vehicles.
- Provide a refuge for pedestrians.
- Separate roads that intersect at an acute angle.
- Reduce speed.
- Prevent some movements totally, such as cars cutting a corner at partially blind intersections.



RESTRICTED PARKING



Parking must be restricted on approaches and exits of traffic islands so that the traffic lane is not blocked. "No stopping at any time" should be marked over a length determined by operating speed, road layout and sight distances.

VISIBILITY



Traffic islands must have Keep-left signs placed at approach ends and mountable kerbs must be painted with white reflective paint for visibility when used on OD routes or arterial roads.

ROBUSTNESS



Kerbs used to create traffic islands must be keyed into the road surface by 60mm to prevent lateral shift on impact. Preformed islands bedded direct to road pavement must be secured with pins into the road surface.

7.9 Medians

7.9.1 Flush medians

DEFINITION

Flush medians are used to segregate traffic, while still allowing vehicles to turn right into side streets and properties without slowing the traffic flow. The drawback of flush medians is that they limit side friction, so can often lead to higher speeds.

USE

Flush medians should be provided only where the Roads and Streets Framework has determined that:

- Separation of opposing road users is desirable for safety;
- right turning traffic is interfering with through traffic on the arterial roads causing accidents or problems with delays;
- where the carriageway is excessively wide and there are no other practical solutions.



Flush medians must not be used to encourage right turns across multiple general traffic lanes, but may be used where this is unavoidable such as arterials with bus lanes.

TURNING

Where a flush median is meant to assist with turning movements, a minimum width of 2.5m is required to safely accommodate the design turning vehicle.

However, if the tail of a turning check vehicle will encroach on the through lane to its left, consider increasing the median width to prevent this.

If this is not practicable, consider reducing the median width so that a turning check vehicle occupies through lane and median, to avoid vehicles passing on the left being at risk from tailswing.

ACCEPTABLE WIDTHS

The width of a flush median depends on the environment, as shown in the table below.

Road	Flush median width
Arterial	2.5m where turning is allowed 0.5m for buffer separation
Collector	Flush medians are not to be used except locally for safety
Local Roads	Flush medians are not to be used at all, visual narrowings should be provided.

TRAFFIC ISLANDS

Traffic islands may be needed within a flush median to avoid the median being used as a traffic lane.

On the approach to an intersection with a significant right turn movement, a flush median may be used for extended right-turn stacking where there is a high proportion of turning traffic. Right-turn bay marking should be extended to accommodate most queuing, and a traffic island may be needed to prevent right turning traffic stacking beyond a point where other movements (e.g. property access, or an opposing right turn) make stacking unsafe.

Pedestrian refuges may be provided at traffic islands, but generally only for crossing a single traffic lane each side.

7.9.2 Raised medians

SEPARATING OPPOSING TRAFFIC

Raised medians are a way to segregate opposing traffic lanes to improve safety and increase traffic flows. This is achieved by preventing vehicles from turning right into or out of side roads/ private access and restricting access to concentrated points along the route. Alternative routes should be available for those needing to turn right or access properties.

WITHIN FLUSH MEDIAN

A raised median can be constructed within a flush median should additional protection be required.

PEDESTRIAN CROSSING

Raised medians can also accommodate pedestrian crossing points. The width must be appropriate for the expected volume of pedestrians and to accommodate prams, wheelchairs and where appropriate dismantled bicycles.

RESILIENT NETWORK

Carriageways divided by a raised median must provide sufficient width to deal with incidents such as broken down vehicles and safe working areas for planned maintenance.

Where a carriageway consists of a single traffic lane, traffic must be able to divert informally or by planned closure to other roads that have capacity and are safe to use for the traffic type and volume displaced by an incident.

A reinforced over-run area may be suitable in some cases for incident resilience.

PEDESTRIAN CROSSING DESIGN



Further design advice can be found in the Engineering Design Code - Footpaths and the Public Realm.

7.10 Road shoulders

DEFINITION

The road shoulder is an extension of the carriageway by a minimum of 0.5m to provide structural support to the sealed road. It is often used in conjunction with a clear zone, on higher-speed or roads.

ACCEPTABLE WIDTHS

The table below outlines the acceptable widths in different situations.

Shoulder width	Situation
0.5 – 1.0m	Only to be used on low-volume rural roads when doing pavement overlays/ rehabilitations.
1.0m	The minimum width next to a safety barrier and the recommended minimum for most situations.
1.5m	The preferred width for a sealed shoulder.
2.0 – 2.5m	For use on higher speed and/or higher volume roads, particularly where vehicles have to be able to stop outside of the running lanes.

PARKING

If parking is allowed in the road shoulder, the minimum safe zone clearances must still be maintained.

CYCLING



Where shoulders may be used by cyclists on rural roads, see Cycling Infrastructure chapter

URBAN AREAS



In urban areas, road shoulders should not be provided unless there is a good safety reason to do so and the Design speed is 70 km/h or more.

ROAD SAFETY BARRIERS IN THE URBAN & RURAL ENVIRONMENT



The purpose of roadside barriers is to improve safety for people and the road or street environment. It serves to reduce the severity of crashes by dissipating the kinetic energy of errant vehicles. Barriers, however, in themselves pose a hazard and provision of them needs to be balanced between the safety benefits they provide as opposed to the safety hazards they create.

Where a road safety barrier is required in the urban environment (i.e. those roads and streets that are within the current urban boundary as defined by the Auckland Unitary Plan), careful consideration must be given to the nature and land use context of the corridor as to whether the barrier and the supporting terminals should be installed.

In the rural environment, provision of clear zone should be considered first, and safety barrier limited to hazards that cannot be protected by clear zone or other safety management.

The primary approach should be to consider whether the local road or street environment can be managed through speed management and roadway design changes. The approach speed can often be reduced to the point that which a barrier is not necessary and vehicles can safely navigate the environment without needing additional protection. Speed management can be achieved through the implementation of local area traffic management and designed to ensure that drivers can respond to hazards outside the carriageway in a safer manner.

If the operational speeds along the road cannot be reduced sufficiently by local speed management controls then the provision of barriers may be necessary. The provision of barriers needs to be considered against the adjacent land uses, driveway positions, accessibility arrangements and urban amenity.

Auckland Transport will not accept barrier installations where other speed or volume reduction measures have not been investigated first and it is agreed by Auckland Transport that barriers are appropriate.

PURPOSE AND STANDARD



The design of road safety barrier systems must be compliant with 'crash tested design' or approved under Section 3: Approval of Road Safety Barrier Systems of NZTA standards for road safety. Changes to the crash tested, approved design configuration will render the barrier system non-compliant with the specification. All road barrier systems must be installed and maintained in accordance with the manufacturer's instructions.

STEEL GUARDRAIL



Steel guardrail is to comply with the requirements of MASH1. NZTA M23:2002 lists systems which are deemed to comply

CONSTRUCTION

with this standard and refer to additional systems in AS/NZS 3845:1999. Systems not listed but which comply with MASH 1 are also deemed to comply.

All guardrail installed is to be 2.7mm thick with posts at 1905mm spacings.

'W'-section guardrails, backing pieces and splice bolts shall comply with Specification NZTA M/17P for bridge guard rail.

RHS Sections for the posts and cable anchor fittings may be hot rolled complying with NZS/BS 4848 or cold rolled complying with AS1163.

Commercial grade nuts and bolts are to be used in the assembly of the handrail/guardrail components and shall comply with AS 1111.1 and AS 1112.3. The bolts shall be property class 4.6 and the nuts shall be property class 5.0. Special M20 bolts for cast in brackets and U bolts shall similarly be of property class 4.6.

Timber posts, boards, bollards and block out piece shall be Pinus Radiata No1 framing grade in accordance with NZS 3631, treated to NZMP 3640 Hazard Class H4 after cutting and drilling. Timber shall not be used unless its moisture content has been lowered to below 20%, by kiln or natural drying.

AT requires Consultants and Contractors carrying out design and/or supervision work involving road safety barriers to have attained the NZTA "Barrier Design & Certification Qualification" (BDCQ) which is applicable for design and have someone available within their organisation will this qualification to sign off road safety barrier designs and/or installations.

OTHER SYSTEMS

Guardrail barriers and other systems that are not "pre-approved" by Auckland Transport (AT), will be considered on a case-by-case basis depending on the context of their proposed application. Approval for their use must be obtained from the Auckland Transport Departures Committee.

**END TERMINALS/
END TREATMENTS**

Leading end terminals and trailing end anchors are to comply with MASH1.

The appendix to NZTA M23 lists along with NRCHP350, the current approved generic and proprietary terminal alternatives and the Contractor shall seek approval from the Auckland Transport Representative for the use of any proprietary system.

CONCRETE BARRIERS

Where individual sections of concrete barriers are to be installed or replaced the barrier shall be constructed so as to match the adjoining barrier profile. If a length of barrier is to be replaced the barrier length shall comply with the requirements of NZTA M23.

OTHER REQUIREMENTS

Road safety barrier systems must be designed and installed in accordance with the following:

- AS/NZS 3845:1999
- NZTA M/23
- NZTA M/17P
- NZTA RTS5
- NZS 3109: 1997

- NZS 3114: 1987
- AUS3: 1997
- AS/NZS 1554.5:1995
- AS/NZS 1554.5:1995 A1
- NZTA's Bridge Manual SP/M/022
- NZTA Geometric Design Manual, Section 7- Roadside Features
- NCHRP 350
- NZTA, RTS 11 – Urban Roadside Barriers and Alternative Treatments
- AUSTRROADS Guide to Road Safety
- AASHTO – Roadside Design Guide, 4th Edition 2011

7.12 Clear zones

DEFINITION

Clear zones allow drivers to attempt to regain control if their vehicle leaves the carriageway. It should be free of obstacles, unless they are frangible and can break or collapse on impact.

STATE HIGHWAY GEOMETRIC DESIGN MANUAL

Clear zone is measured from the outside edge of the lane and includes any berms, batters and footpaths adjacent to it. The required width depends on the site, as set out in the NZTA State Highway Geometric Design Manual Part 6, section 6.5 The Clear Zone.

RURAL ROADS

All rural roads must have a clear zone as outlined in the NZTA State Highway Geometric Design Manual.

URBAN ROADS

While most urban roads do not require a clear zone, in some circumstances where there are, higher speeds or a history of crashes and vehicles leaving the carriageway, a clear zone may be considered as part of any improvements to the road. However, such a zone is a last resort if there are no practical alternatives.

7.13 Cul-de-sac geometry

TO BE AVOIDED

Cul-de-sacs should be avoided when designing new extensions of the public the road network.

REQUIREMENTS

If cul-de-sacs are required, pedestrian and cyclist accessways must be included where possible to improve the permeability of the transport network.

All cul-de-sac heads require a detailed design, showing levels and dimensions.

MAXIMUM GRADIENT

The maximum gradient in any direction within the turning area of a cul-de-sac should not exceed 5%.

GEOMETRY

Acceptable dimensions for standard turning heads are shown in Standard Engineering Details GD series. Vehicle tracking is not required for the design vehicles shown if these layouts are utilised.

An interim turning layout is included for residential local streets that are to be extended as an approved planned development

ROADS AND STREETS FRAMEWORK

ROADSIDE DESIGN

BERM

08



KERB AND CHANNEL GUIDELINES

stage. This is not intended to be used as a permanent or long-term turning head, where extension of that road is uncertain.

Other layouts that vary from these dimensions or are required for design vehicles other than those given must be designed with tracking for the appropriate Design vehicles in accord with Section 4.2.

Parking near cul-de-sac can be provided in various ways, subject to manoeuvring and safety issues. No Stopping controls must be marked to the extent shown in the Standard Engineering Details or sufficient to protect the swept path of Design vehicles used for non-standard designs.

7.14 Footpaths and berms

Footpaths should be provided for network objectives described in the Roads and Streets Framework

See the Urban Streets and Roads Design Guide and the Engineering Design Code - Footpaths and the Public Realm for requirements outside the roadway.

Outside town centres, a rear berm may be provided next to footpaths to carry the utility services.

A front berm may also be used as a buffer between footpath and traffic lanes.

Embankment or cutting slopes may need to be included in the road reserve, to meet the natural ground surface, unless constructed and then returned to the adjoining property title.

Where a berm forms a buffer between the footpath and the kerb and a bus stop is required, the position of the bus stop must be agreed with AT Metro in advance of construction so that appropriate platform can be built into the design. Platforms are necessary to enable safe and efficient boarding and alighting of customers to and from buses. See the Engineering Design Code - Public Transport: Bus Infrastructure.

Kerb and channel

8.1 Purpose of a kerb and channel

The primary purpose of a kerb and channel is to provide:

- Storm water control.
- An edge restraint for the pavement.
- A visual definition of the edge of the carriageway.
- A barrier to prevent vehicles crossing onto the footpath or berm.

It is essential that the Auckland Transport Kerb and Channel Guidelines (PDF 71KB) are read via the embedded hyperlink before reading the rest of this section.

8.2 Design requirements

8.2.1 Urban roads

BOTH SIDES

Kerbs and channels or stubs must be provided on both sides of the full length of all urban roadways, as outlined in the Auckland Transport Kerb and Channel Guidelines and the appropriate standard details for the function of the road.

SEE PLANS



Standard Engineering Details series KC show standard details of kerbs and channels.

KERB TYPES

Select the type according to the table below.

Kerb Type		Situation
1	Standard kerb & channel	General use to separate roadway from roadside, where surface water is to be conveyed to a collection point. May not be suitable for design speed > 60 km/h.
1A	Reinforced haunching	Any location where the back of the kerb is not supported its full height by concrete paving or planted berm.
1C	On side	Only for vehicle crossings that must be trafficked soon after construction.
1S, 2S	Shear Key	Where a kerblines may be subject to vehicle strike, unless fully backed by rigid paving.
2A	Battered kerb & channel	As Type 1, where it is likely that vehicle tyres may rub.
2B	Mountable kerb & channel	As Type 1, but where vehicles may occasionally cross the kerblines.
3	Extruded standard kerb & channel	General use to separate roadway from roadside, where surface water is to be conveyed to a collection point. May not be suitable for design speed > 60 km/h.
4	Vehicle crossing	Cut-down of Type 3 where installed continuously where a vehicle crossing is to be constructed.
6	Extruded mountable kerb & channel	As Type 3, but where vehicles may occasionally cross the kerblines.
7	Extruded standard kerb and nib	As Type 3, but where a channel is not required for surface water conveyance.
7	Extruded standard kerb vehicle crossing	Cut-down of Type 3 where installed continuously where a vehicle crossing is to be constructed.
8	Edging	Edging between footpath and planted berm.
9	Edging nib kerb	Transition beam at end of Type 12 kerb on bridge.
10	Standard kerb and nib	As Type 1, but where a channel is not required for surface water conveyance.
11	Traversable kerb	Edge of paved areas frequently over-run by large vehicles (such as roundabout islands).
12	Safety kerb	Across bridge decks or atop retaining walls, where a vehicle containment kerb is required.
13	'Kassel' bus stop kerb	Kassel Kerbs® should be used for all bus stop, both new and when being renewed. See HYPERLINK
14	Cycle path angled kerb	At edge of cycle path.
15	Cycle path mountable kerb	At edge of cycle path where cyclists frequently cross.
16	Flat edge beam	Edge containment for pavement construction where road layout does not require vehicle containment or separation of roadway from foot or cycle path.
17	Mountable Kerb for Over-dimension routes	Specific mountable kerb for use on traffic islands, pedestrian refuges and central islands on roundabouts on official Heavy Haulage over-dimension routes.

Note: Alternative designs for special purposes must be submitted as Departure from standard.

CHANNEL TYPES

Pre-cast or stone kerbs, or extruded equivalent types, should be chosen to suit the circumstances of the project, (location, construction methods, adjoining features that should be matched).

Stone kerbs are not to extend across vehicle crossings, bike or pram ramps.

Channels are to be used only where needed for road drainage. Select the type according to the table below.

Channel Type	Situation	
1	Standard kerb & channel	General use to separate roadway from roadside, where surface water is to be conveyed to a collection point.
3	Extruded standard kerb & channel	General use to separate roadway from roadside, where surface water is to be conveyed to a collection point.
5	Pram Crossing	Any location where footpath or cycle path is to cross a roadway
17	V-dish	Where Type 1 or 3 kerb is interrupted by parking bays.
18	Deep V-dish	Between paved areas that fall towards the channel eg. large car parks.
19	Round dish	In shared or pedestrian paved areas.

TRANSITIONS

8.2.2 Pram and cycle crossings

At pram and cycle crossings, the kerb must form a V-shaped channel with raked sections at either side. A flush transition with no lip must be provided between the footpath and the channel. The length of any transition kerb will be affected by acceptable grade of berm or footpath behind the kerb.

Where different kerb or channel types meet, transition sections are required, generally 600 – 1200 mm long.

The shape of the transition should provide for safety of users, avoid trips or sharp corners that may damage wheels.

Care is needed with surface levels where heights of adjoining types differ, and so that channel drainage can continue without ponding or siltation.

When using Kassel Kerbs the specific Kassel transition blocks must be used as per the manufacturer's specification, or an in-situ concrete transition to suit the adjoining kerb profile if necessary.

FURTHER GUIDANCE



The detailing of pram crossings is dealt with in more detail in Footpath, pedestrian facilities and the public realm chapter.

PARALLEL

8.2.3 Kerb extensions and indentations

Kerbs must be parallel to the centreline of the road. The only exception is transitional angles where the road width changes or where the kerbs are tied in to the existing kerb line.

USES



Kerb extensions and bays may be formed to provide:

- pedestrian crossing points
- local area traffic management
- parking bays
- amenity planting areas
- bus kerb extensions and inset bays
- swales or other storm water control devices.

Kerb extensions must not cause hazards for road users, particularly for cyclists. Also pay attention to road marking, signage and lighting as they may need improvement.

8.2.4 Rural roads

Kerbs and channels will generally only be required in rural areas:

- Where grades are steeper than 8%
- In cuttings to minimise earthworks
- In areas of potential instability
- To direct water to suitable discharge points
- At signed or marked bus stops to provide a platform for passengers to board or alight from a bus.

09

DEFINITION

Vehicle crossings provide a way for vehicles to enter and exit land next to the road boundary. They are located between the edge of the roadway and the road corridor boundary, across footpaths or berms. Vehicle crossings must not compromise the design criteria for existing or future bus facilities, footpaths or cycleways.

UNITARY PLAN



Any vehicle crossing must comply with controls in The Auckland Unitary Plan or hold valid a Resource Consent.

CROSSING TYPES

All vehicle crossings must be designed in accordance with the relevant Vehicle Crossing (VC) drawing contained in the Engineering Design Code - Standard Engineering Details.

WIDTHS

A driveway crossing must be no wider at the boundary than it needs to be, e.g.

- A two-way driveway in a residential zone that is 5.5m wide will require the crossing to be 5.5m at the boundary or may be narrowed to 2.75m if there are passing places with clear sight lines.
- One way access in a centres/mixed use zone may only need to be 3m wide.
- Access to a car park or petrol station that also provides truck delivery access should restrict the width available for car access by means such as over-run paving, to manage turning speed, vehicle path and safety of footpath users.

DESIGN VEHICLE

Design Vehicles should be selected from Section 4.2 according to land use.



The standard design vehicle for residential vehicle crossings is the 85thile car. Note that a larger vehicle may be desirable, depending on land-user specific requirements, such as a boat trailer.

Where an oblique change of grade occurs that differs between the left and right wheel tracks of the Design vehicle, any wheel of the vehicle must be not more than 120 mm above or below a plane defined by the surface level at the locations of the other three wheels.

GEOMETRY

Crossing flare should be optimized to produce the minimum turning speeds and swept paths for the road environment.

PRIORITIES

The pedestrian path through route should be continuous in grade, cross-fall, colour and texture across the driveway, with no tactile warning indicators; the vehicle crossing and driveway must be considered subservient to the pedestrian through route.

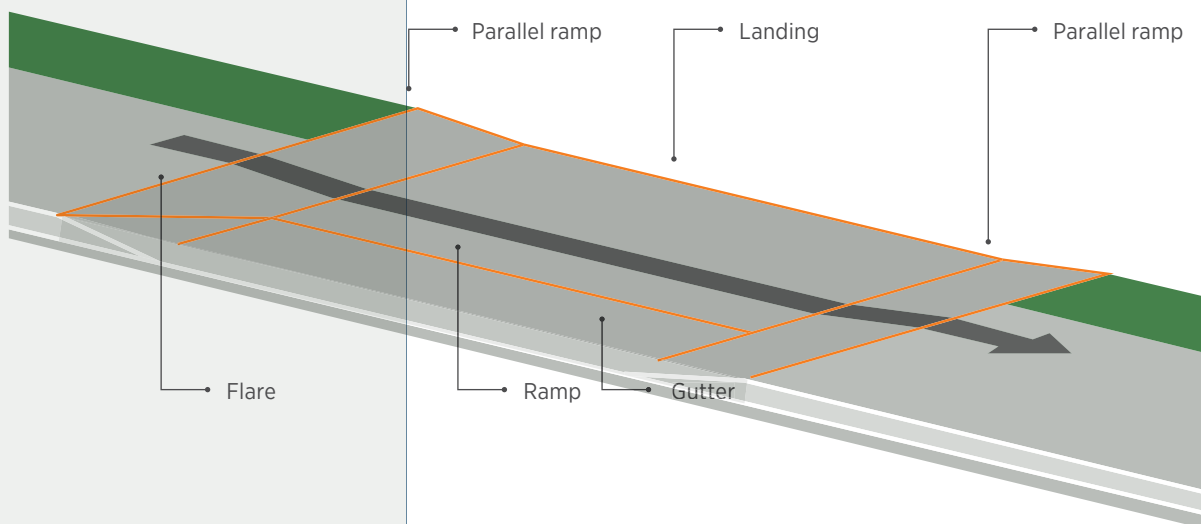
PATH THROUGH-ROUTE

The levels and width of the pedestrian through route should not be altered, except that the width may be reduced to not less than 0.9 m where necessary to provide the vehicle ramp down to the channel line.

Path crossfall should be 1-2% where possible, or within $\pm 3\%$ where constrained.

For steep driveways requiring a change in the level of the footpath through the crossing, footpath ramps either side of the crossing should not exceed a grade of 8%. If this is not possible, the grade should not exceed 12% and the level difference at this grade should not exceed 75 mm. Check surface water flow depth to avoid flood nuisance.

Figure 3 Dropped footpath for steep driveway



LOCATION

Vehicle crossings should be located so that drivers entering and leaving have adequate sight distances along the adjacent footpath, cycleway and road.

ROAD CHANNEL

Where adjoining kerbline has a drainage channel, the channel profile shall be continued across the vehicle crossing.

If existing precast concrete kerbing can be removed without disturbing the existing channel, the channel may be retained for residential crossings.

In all other cases, existing channel must be removed and the adjoining road edge reinstated.

INFRASTRUCTURE	<p>Infrastructure such as catchpits, poles, fences and manholes must be at least 1 m from any part of a vehicle crossing. Avoid affecting existing infrastructure if possible.</p> <p>Any infrastructure that cannot be avoided will require mitigation measures. If network utilities are affected, approval from the relevant Network Utility Operator is required (or from Auckland Transport's Business Technology team as appropriate).</p>
RETAINING STRUCTURES	<p>Driveway designs should take all reasonable measures to reduce the need for retaining structures or level adjustments. However, should this be considered too onerous, any proposed structure will be subject to an encroachment notice. In this case, all future maintenance, renewal, removal costs, etc. must be borne by the property owner and placed as an encumbrance on the property file.</p>
GRADE	<p>Consideration shall also be given to the grade of the driveway to help prevent vehicles scraping and storm water entering the driveway.</p> <p>If existing road crossfall exceeds 3%, the grade of the 900 mm ramp from the channel shall be reduced from 15 % so that the grade change at the channel does not exceed 18%.</p>
STORM WATER CONTROL	<p>Vehicle crossings over roadside drains must be designed and constructed in accordance with Road Drainage chapter</p>
SURFACE WATER FLOW	<p>The driveway should ramp down from the footpath across the kerb line to the channel invert with a freeboard of 200mm (i.e. height above the channel) to contain storm water within the road. Development or redevelopment of a vehicle crossing must not result in changing the flow of surface water in the roadway, unless alternative drainage is provided. Care should be taken to avoid flow from the roadway discharging onto property if it does not currently do so, or from adjoining land into the roadway. Where surface water discharges from the roadway onto adjoining land as overland flow, this must not be reduced or redirected to another property without Resource Consent.</p>
CATCHPITS	<p>Catchpits should not be located within the width of a vehicle crossing. Where a proposed crossing affects an existing catchpit, the catchpit shall be relocated to the side of the crossing. In any event the catchpit must be installed in a bus and cycle friendly manner.</p>
SCOUR AND EROSION	<p>Where the vehicle crossing is in a rural environment, no silt, gravel or debris of any kind may run from the property onto the roadway or into drains.</p>
PRIVATE DRIVEWAYS	<p>Any private driveways must be designed following the appropriate grades for private driveways in The Auckland Unitary Plan.</p>
REDUNDANT CROSSINGS	<p>If a vehicle crossing is made redundant by the alteration to land next to the road boundary, the property owner must be required to give up the licence or permit associated with that crossover. The crossing should then be replaced to match the existing footpaths and kerbs.</p>

10

Intersection design & types

USRDG INTERSECTION PRINCIPLES



DESIGN APPROVAL

TRAFFIC MODELLING

INTERSECTION CAPACITY

INTERSECTION SAFETY

CORNER KERBLINES



10.1 General principles

Good intersection design is based on sound geometric design and user criteria where safety is a primary consideration.

Intersections principles are:

- As compact as possible
- Part of a multi-modal network
- Integrate time and space
- Intersections are shared spaces
- Design for context

See the USRDG for more detail on these.

The designer must provide evidence that the design will meet capacity, safety and turning movements of intended vehicles and all other road users.

Traffic modelling must show that the design can mitigate the effects of existing traffic and that generated by new development unless directed otherwise by Auckland Transport Planning and Investment Division. Where applicable, consideration should be given for future network traffic change, with an appropriate design year to be approved by Auckland Transport. The assessment could include intersection modelling, using appropriate software.

Where AT set target capacities for a route, or intersections on a route, new intersection design should provide capacity appropriate for the network locally. Generally, capacity should be consistent with that of adjoining intersections except where improvements to these are planned through a network plan, structure plan or project.

Proposed intersections must be evaluated using the Safe System Assessment Framework. Intersection type and layout should ensure survivable conflicts while providing the required Level of Service for all user types.

While catering for appropriate design and check vehicles, urban corner kerblines should be kept compact to minimise vehicle speeds and pedestrian crossing distances.

Kerblines should be designed to suit the effective swept path of design and check vehicles, tracking in accord with the Design Control section above.

The Compound Corner template, contained in the Engineering Design Code - Design Toolbox shows how corner kerblines can be designed for many urban local streets, collector and commercial streets. Urban Arterial streets may require specific design using the same principles:

- Swept paths should be determined for the appropriate range of design and check vehicle with controls on which vehicles must remain within lane constraints, and at appropriate turning speeds.
- Kerblines should follow swept path, with 0.5 m clearance from wheel track, to minimise risk of wheels damaging the kerb.
- Body swept path should be used for lane constraints
- Where a check vehicle is allowed to penetrate another traffic lane, there shall be clearance to allow for the swept path of a design vehicle using that lane.
- If that clearance is not available, encounter between a check vehicle and a design vehicle must be at a low speed, with visibility to enable one to stop and allow safe passage for the other, including for visibility of other users.
- Where a body swept path overhangs a kerblines, protection for path users must be provided, usually by a buffer strip.

It is also possible to achieve the compound corner using a smaller radius circular curve and adjacent roadside features. In this case, it is a requirement that both intersecting roads have on-street parking or similar that creates the wider effective radius. See the Urban Street and Road Design Guide: Chapter 6 Intersection Geometry - Effective Turning Radius for an example of this.

The drawings show grid lines allowing assessment of clearance widths.

The compound corner template must be used for all intersection designs unless a departure from standard has been submitted and approved.

KERB CROSSINGS

Kerb crossings must be provided at each kerb-line at all intersections as outlined in the Engineering Design Code - Footpaths and the Public Realm and NZTA RTS 14. They must be located to ensure adequate sight distances for both pedestrians, cyclists and drivers. Pram crossings should generally be located to provide the shortest crossing distance, but also in a location where visibility is not restricted by parked vehicles, buildings, walls or vegetation. Tactile indicators must be provided at all pram crossings, and also guide indicators where needed to lead to all safe and universally-accessible crossings.

RAISED TABLE CROSSINGS

Raised table crossings may be used:

- Where footpath or cycleway users have priority over turning traffic
- Where there are large numbers of path users and low turning traffic volume
- Where corner kerblines and road widths do not provide desired turning speed control

Their use must consider differential design speeds of through and turning traffic, effect on through traffic capacity, visibility and safety of path users.

It is expected that raised tables are to be installed on all local side streets that connect to collector or arterial street types. See Code of Practice: Local Area Traffic Management for further details.



PARKING NEAR INTERSECTIONS



Line markings for No stopping at any time must be provided over sufficient length to ensure parking does not occur within the swept paths of design or check vehicles.

It is preferable that corner kerblines should define traffic lanes, and that parking should have indented bays with kerblines return to the traffic lane.

Where existing streets have continuous parking shoulders without returns near intersections and only where the existing kerblines cannot be altered, the swept path of design and check vehicles must be kept clear by No Stopping At Any Time markings and the corner kerblines must be designed to match the swept path. This will generally be a small radius curve.

LEFT TURN SLIP LANES

In an urban location, left turn slip lanes should only be provided where there is clear traffic and/or safety justification. They should be avoided where there are high pedestrian volumes. If provided, a left-turn slip lane must be designed considering pedestrian safety and convenience and appropriate sight distances must be achieved. A zebra crossing should usually be provided to give priority to pedestrians. A one-way table must be used to emphasise the crossing and manage vehicle speeds.

DESIGN FOR MAINTENANCE

This requires:

- understanding maintenance activities; routine, renewal and utility access
- designing for safe and economical activities
- designing for efficient Traffic Management
- resilience of network during maintenance.

Infrastructure, especially access chambers and pole-mounted assets, should be located to minimise exposure to damage and for safety of workers and road users.

SELECTION OF INTERSECTION CONTROL

Each new or upgraded intersection should be evaluated to determine the most appropriate form of intersection control. A robust assessment of all options is necessary, giving due consideration to effects on the wider road network. Level of service for all road users must be considered, and performance in traffic conditions on different days and times of day. The Safe System Assessment Framework must be used to ensure potential conflicts are survivable while providing the required Level of Service for all user types.

AUSTROADS GUIDE



Designers are referred to the Austroads Guide to Traffic Management Part 6 – Intersections, Interchanges and Crossings, which provides guidance on selecting the type of intersection and their functional design.

TRAFFIC CONTROL



Legislation for intersections in New Zealand is covered by the Land Transport Rule: Traffic Control Devices 2004 (TCD rule). Further requirements for signs and markings are provided in the Traffic Control Devices Manual.

10.2 Priority controlled intersections

AUSTROADS GUIDE



The rules and requirements contained in this code will take precedence over any other standard unless agreed by departure, however Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections may be used to supplement this code.

10.2.1 Geometry

SIGHT DISTANCE

Sight distances at intersections must comply with Sight distances in Design parameters above. Any existing intersection to be altered must comply, or must seek approval for Departure.

INTERSECT AT 90°

Intersections must be designed so that the side road enters the through road at preferably 90° and generally no less than 80°.

Where constraints prevent this, a specific design to meet General principles must be developed.

COMPOUND CORNERS

The use of narrow traffic lanes and design for safe speeds in the urban environment means that circular arc corners are seldom satisfactory. Speed is often unacceptably high for 50%ile car, crossings for people on foot or on bike are too long or too far into the side street and kerbs are subject to vehicle damage. The compound corner templates in GD004 have been developed to suit urban intersections for the design and check vehicles most commonly using them. Where these templates are used for the conditions and vehicles specified, no tracking drawings are required. Tables 1, 2 and 3 should be used. Traffic lane widths can determine which compound elements are required.

Staggered intersections must be offset by at least 15m from centre line to centre line, and the offset should be increased to accommodate anticipated vehicle movements (e.g. bus, truck swept paths; turning traffic queues). Offset direction should preferably be left onto main road then right into side road. Offset may need to be increased to ensure vehicles follow safe paths at safe turning speeds.

Crossroad intersections on high-speed or high-volume roads should be avoided.

CURVES

Intersections on curves should be avoided, particularly where the side road is on the inside of the curve. Specific geometric design for vehicle tracking is required, based on compound corner principles.

10.2.2 Sign control

TRAFFIC CONTROL DEVICES RULE



The Traffic Control Devices Rule applies under all circumstances, as does the design guidance of the Traffic Control Devices Manual, which currently includes the Manual of Traffic Signs and Markings (MOTSAM). Stop control must be provided where required and as directed in these documents.

STOP SIGN CONTROL

Stop signs are required:

- at blind intersections where lack of visibility makes it unsafe* to approach the intersection at a speed greater than 10 km/h;
- at intersections of an unusual layout or unusual traffic pattern where it is essential to give one controlled approach priority over another controlled approach.

Stop sign control must be resolved by the Traffic Control Committee.

CROSSROADS

*Note: Deemed unsafe if, from a point 9 metres from the intersection limit line on a controlled approach, a driver cannot see a vehicle on an uncontrolled approach at a distance (in metres) of 1.2 times the 85thile operating speed (in km/h) of vehicles on the priority route.

All crossroad intersections must have a stop or give way control as a minimum.

OTHER INTERSECTIONS

All other intersections must be controlled by give way signs and markings as a minimum, except where all of the following criteria apply:

- The priority road has less than 2000 vehicles per day.
- The adjoining road has less than 500 vehicles per day.
- The approach visibility meets safe intersection sight distance standards.

* Note that this does not apply to rural situations.

DESIGN GUIDE

The rules and requirements contained in this code will take precedence over any other standard unless agreed by departure, however the following geometric standards and advice notes may be used to supplement this code:

- Austroads Guide to Road Design Part 4B: Roundabouts,
- NZTA Guidelines for marking multi-lane roundabouts
- NZTA Manual of Traffic Signs and Markings.

SAFETY

Generally speaking, a well-designed roundabout is safer than other forms of intersection. This is particularly true in high-speed environments, as roundabouts can reduce vehicle speeds.

When designing urban roundabouts, extra care must be taken to ensure vehicle speeds are at or below 25 km/h.

Entry speed on all arms should match closely to circulating speed and not be significantly greater than the slowest users (cyclists, buses or trucks), and reduction from approach speed to entry speed should be managed in stages if necessary.

URBAN ARTERIAL ROADS

If well implemented, roundabouts can be an appropriate form of control at urban arterial intersections, but all options must be assessed.

DESIGN SPEED

An appropriate design speed is critical to ensure safe operation of a roundabout. Current Austroads guidelines advise lowering entering speeds to match circulating speeds. Speed on the approach and exit of a roundabout is typically controlled by horizontal deflection, but in certain circumstances vertical deflection can be used. The appropriate form of speed control must be evaluated for each site.

SIGHT DISTANCE

Decision-making by drivers and other road users is critical to safe operation. Time to point of conflict is affected by speed, so ensuring low speed improves safety by reducing required sight distance. Consideration must be given to the number of potential hazards to be observed, and the direction of sight to those hazards, to simplify the decision to proceed. Meeting safety criteria for visibility may also improve capacity performance in safe gap acceptance.

SIZE

The size of a roundabout has a significant role in capacity performance.

Generally, larger roundabouts provide greater capacity. Roundabouts can be signalised or metered to aid management of traffic flow. However, it may not be possible to retrospectively signalise some smaller roundabouts.

Existing roundabouts can often be improved in both capacity and safety by increasing island diameter.

CYCLISTS AND PEDESTRIANS



Cyclist safety and pedestrian amenity can be compromised at multi-lane roundabouts and these users require special consideration.

Single-lane roundabouts should be used unless capacity requires multi-lane design.

In town centre environments or near schools, particular attention should be given to ensure crossing points are designed conservatively to take into account vulnerable users. These pedestrians may be less mobile and/or less able to judge traffic speed and driver intentions.

Options for pedestrian crossing facilities at roundabout include:

- Pedestrian refuges
- Zebra
- Signalised crossings
- Raised table crossing points. These help to minimise vehicle speeds and reduce the risk of crashes. They should always be considered on multi-lane approaches and exits. But not on bus routes.



Where desire lines to serve the local network for cyclists and pedestrians can be moved away from a roundabout, a mid-block crossing may be effective at a safe distance from the roundabout.

10.4 Signal controlled intersections and crossings

GEOMETRY

Use Tables 1, 2 and 3 to determine vehicle path requirements. Geometry should be designed as 10.2.1 but with additional considerations for signal phasing. Vehicles cannot cross into lanes that will be occupied by stationary vehicles held by signals.

DESIGN APPROVAL

The process for design, review and approval of a traffic signals design is documented in the Auckland TMU Traffic Signal Design Review Guidelines.

KEY REFERENCE DOCUMENTS

The Auckland Transport Traffic Signal Specification covers the requirements of all signal equipment including: local signal controller and cabinet, detectors, lanterns, target boards, visors, poles and push-button assemblies. This specification also covers the installation and commissioning of traffic signals, ducting and associated equipment including the supply of all materials, tools, plant, labour and supervision for the works as outlined in the contract specification and any relevant basis of payment.

DESIGN GUIDE

Traffic signal controlled intersections must be designed as outlined in:

- Austroads Guide to Road Design Part 4A: Unsignalised and Signalised Intersections

AUCKLAND TRANSPORT SPECIFICATION VARIATIONS

AUCKLAND TRANSPORT DESIGN GUIDELINES

ADDITIONAL AUCKLAND TRANSPORT DESIGN REQUIREMENTS



GUARANTEE

- NZTA Traffic Control Devices Manual

National Traffic Signal Specification dated November 2012; Revision 3.

The National Traffic Signals Specification (NTSS) shall be varied as follows:

- NTSS R3 2.3.1: All new traffic signal controllers must be RMS specification TSC4 compliant.
- NTSS R3 2.7: All traffic signal poles must be painted, not powder coated.
- NTSS R3 2.7: Finial caps of metal are not acceptable.
- NTSS R3 2.7: Finial caps must be fastened so that they cannot be removed if fastening bolts are loose.

In addition to the above key reference documents, Auckland Transport's specific requirements are currently based on the TMU Traffic Signal Design Guidelines dated August 2010 V3.0 with the following variations:

- 3.2: All overhead lanterns must be 300mm in diameter.
- 3.2: Lantern bodies can be of aluminium or polycarbonate construction.
- All traffic signals are to be managed by Auckland Transport's traffic control system.
- A new traffic signal controlled intersection or crossing will require CCTV cameras and associated equipment to connect to Auckland Transport's communications network by a fibre connection. This network allows Auckland Transport Operations Centre (ATOC) to manage signals and view the intersection.
- Where Intelligent Transport Services are part of a road, the routing of the communications networks needed for road and adjacent roads must be considered. This is likely to require ducting under the road and access points for cabling.
- Alignment is important and intersections must be sited such that the side road enters the through road preferably at 90° and generally no less than 80°.
- Pedestrian crossing facilities must be provided on each leg of intersections located in town centres, and should be provided on each leg in other situations.
- Pedestrian countdown timer lanterns may be used at signalised mid-block crossings and at intersections operating an exclusive pedestrian or 'Barns Dance' phase. They are not to be used on two stage pedestrian crossings, or at intersections that do not operate with an exclusive pedestrian phase. They should be used in town centres, near public transport interchanges, near schools or at any other location with high pedestrian movement. The use of countdown timers requires approval from the Delegated Manager.
- In areas where high pedestrian demand is expected (such as town centres and near schools), new signals shall be designed to operate at a cycle time of no more than 100s. If operating at cycle times higher than 100s phasing shall be designed so that all pedestrian movements can be called twice per cycle.

Any new equipment supplied and installed by the contractor must be guaranteed against defective materials and workmanship for 12 months from the date of installation. The exception is LED modules of vehicle and pedestrian lanterns which must be guaranteed for 5 years. The guarantee must also cover the installation of the equipment supplied.

During the guarantee period, the contractor is responsible for making good any defects at no charge to Auckland Transport. Auckland Transport is entitled to recover any costs it incurs in rectifying faulty equipment, materials or installation during the guarantee period.

The contractor's guarantee must not become invalid as a result of an alternative contractor servicing the equipment.

10.5 Grade separation

USE

Grade separated intersections are occasionally necessary to provide adequate capacity at major intersections. This form of intersection provides maximum vehicle throughput and minimises vehicle delays. However, this can be at the expense of pedestrian and cyclist amenity.

APPROVAL

Any proposal for a grade separated intersection needs approval from the Auckland Transport Chief Engineer.

DESIGN GUIDE

Grade separated intersections must be designed as outlined in Austroads Guide to Road Design Part 4C: Interchanges.

10.6 References/guidelines

- Austroads Guide to Road Design, in particular the following parts;
 - Guide to Road Design Part 3: Geometric Design
 - Guide to Road Design: Part 4 Intersections and Crossings – General
 - Guide to Road Design Part 4A: Unsignalised and Signalised Intersections
 - Guide to Road Design Part 4B: Roundabouts
- Austroads Guide to Traffic Management Part 6: Intersections, Interchanges and Crossings
- NZTA Manual of Traffic Signs and Markings (MOTSAM)
- NZTA Traffic Control Devices Manual (TCD Manual)
- NZTA Road and Traffic Standards Series parts;
- RTS 1 Control at Crossroads
- RTS 14 Guidelines for facilities for blind and vision-impaired pedestrians- NZ Transport Agency
- RTS 18 New Zealand on-road tracking curves for heavy vehicles
- TMU Traffic Signal Design Guidelines dated August 2010 Version 3.0 (PDF 1MB) or later revision
- National Traffic Signal Specification dated 1 September 2005; Revision 2 (PDF 665KB), which is available via the embedded hyperlink.
- Transfund Road Safety Audit Procedures for Projects.

