MoES - D 2025 (DRAFT)

Design (Civil)

Manual of Engineering Standards

maitland
CITY COUNCIL

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D – DESIGN

Introduction

This Document D: Design forms part of the Manual of Engineering Standard (MoES) suite of Documents. Document G: GENERAL REQUIREMENTS serves as the primary, or introductory document providing information and guidance on how this Document functions within the entire suite. This document should be read in conjunction with other Documents in the entire suite.

This section provides essential guidelines for designing our road and stormwater systems. These guidelines ensure that our infrastructure can handle stormwater and traffic challenges while protecting our environment and ensuring the safe and efficient management of public infrastructure. By following these specifications, we aim to improve our infrastructure's resilience to natural elements, optimise traffic flow, and uphold environmental integrity. This manual is essential for engineers, designers, and stakeholders involved in developing and maintaining our urban and rural environments.

ROAD DESIGN

This Document D: Design deals with the requirements for the design of roads, vehicle access, paths and associated structures and embellishments. Details are not necessarily comprehensive for every possible scenario. The designer should refer to, and be competent with, the standards nominated as references. Generally, the parent documents for road design are the Austroads guidelines and Transport for NSW (TfNSW) publications and supplements. The designer should contact council with the relevant scenario to gain direction as to whether it is omitted on purpose, or if not discuss industry standards and the preferred way forward.

Engineering designs should include geometric details of, road and drainage layouts, their gradients, cross sections, and kerb returns. (See Appendix A for full details). All existing infrastructure, surface features and underground services must be shown on the plans.

All design proposals must be carried out by experienced and competent practitioners.

1. Geometric Design

1.1. Road Hierarchy and Specifications

Roadway infrastructure shall be determined and designed in accordance with, “Development Consent” issued by the consent authority, and the requirements of this Manual.

Widths of roads for residential subdivision are defined by their status within Council’s Road hierarchy, which adopts a Trunk road layout and maximum lot catchments for various road types. The Trunk Road layout includes a minor/ major grid spacing for trunk roads. The Trunk Road (grid) layout takes priority over the maximum lot catchment criteria. The following tables “ROAD TYPES” provides details of minimum road parameters. The table relates primarily to “greenfield” sites, generally applicable to large-subdivision release areas. For lot catchment calculations a potential density shall be used. Unless specified at a higher rate in the Local Environment Plan (LEP) or Development Control Plan (DCP) requirements, a minimum density of 15 dwellings per hectare shall be used for standard residential (release) areas such as R1 zone.

1.1.1. Road Width for Lot Catchment

For purposes of determining the appropriate road-width for a local lot catchment area, the assessment should be based on an assumed and reasonable traffic distribution analysis of the ultimate development and the contributing lots, along desire-lines to points of destination such as for

recreation, schools, shops, workplace, sports, open space, employment zones, etc. Site specific DCP's may already define some of the trunk road layout in terms of desire lines and destinations.

This approach may vary, resulting in higher hierarchy levels where the Trunk Road layout requires, and:

- Staged development may significantly increase traffic flow in an intervening period, affecting safety and amenity of the area.
- A new public roadway serves a function greater than the immediate local residential area serviced by the road. This may occur where the specific land-use development consent is over part only of a broader integrated area, with roads connecting other centres of population, a Public Transport route, or roads servicing commercial or school precincts, recreation facilities, or other major traffic generating destinations.
- There is potential to utilise a road as a "by-pass" of some traffic related constraint on another road, such as traffic congestion, traffic signals etc [In this case careful planning should be practiced in order to avoid such circumstances].

1.1.2. Consistent Road Width

Where lot catchment numbers trigger more than one road type within a defined length of road/street, unless justified, the higher road type shall be adopted. Opportunities where road width may be varied may be at intersections, traffic management device, curving horizontal alignment, or similar.

1.1.3. Impacts on Existing Roads

Where a new subdivision impacts on the existing local road network and roadworks such as pavement widening or rehabilitation are required, the road alignment and pavement needs shall be determined by Council independently of the following Road Type table considering traffic volume and type, the needs and amenity of the existing road network, and an appropriate service to the community. Road widths greater than those shown in the 'table', may be required.

Where works are required as part of the development to augment an arterial or classified road, Council shall determine independently of this Manual the needs for that road.

[Refer also to Local Area Precinct plans for possible specific parameters for road needs.]

1.1.4. Part-width Road Construction

Council primary requirement is for full width road construction. Due to the risk posed by these variable road widths and construction, the construction of part width streets as part of subdivisional developments is not encouraged. Subdivision design should avoid setting up this scenario against neighbouring properties. Trunk Roads should not be considered for part road construction.

Nominal "part-width construction" of roads may only be considered for subdivision servicing up to 10 lots or 150m in length unless justified otherwise, (with adequate traffic safety and convenience measures), to facilitate shared construction costs across property boundaries which share a common and existing road reserve, the subject in each case of separate development consents. Such part-width roads are considered an interim treatment to facilitate subdivision.

Part-width roads may be permitted along a property boundary, and generally parallel to that boundary, and adjoining undeveloped land not part of the subdivision which also has subdivision potential under a planning scheme.

Part-width roads is generally considered where the proposed road utilises an existing adjoining public road reserve (whether that road is unformed or formed in-part only) and where undeveloped land not

part of the subdivision also adjoins the opposite side of that road, and which has subdivision potential under a planning scheme.

The proposed part-width road must provide adequate safety for two-way traffic movement [one-way traffic movement may also be considered as an interim treatment].

The width of these road pavements may extend beyond the road centreline and should be a minimum of 6.0m wide for two-way traffic on local yield street, plus any parking lane or bike lane requirement against the subject property required by the relevant road type with wider road types. The overall construction width may be greater than the pavement width, subject to assessment of constraints such as kerb type (rolled type preferred), common boundary fencing type, pavement restraint or shoulder support, subsoil drainage, surface drainage, etc.

Where part-width construction is permitted within an existing road reserve (for roads with a catchment greater than 10 lots/150m) a minimum width of the parking lane against the property, two-way travel which includes a sealed shoulder 0.5m wide. A full-sized temporary turning area is generally required for brownfield road reserves. New greenfield roads shall avoid the need for temporary turning areas.

The applicant will cover all the cost of the design of the full street width and the construction of the part road width. Transition of design shall extend at least 100m past the end of construction to demonstrate future continuity. Pavement design shall also transition between the part road width and adjoining construction at 1:5 taper including drainage design and utility augmentation and/or relocation.

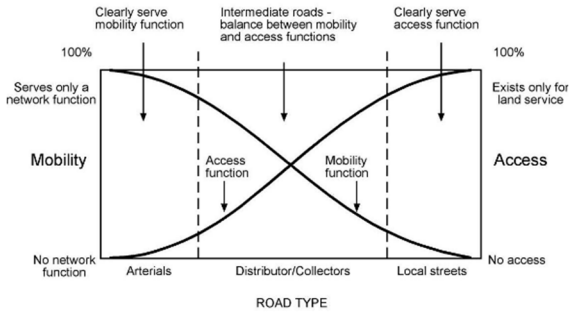
In all cases of part-width construction, “No Stopping” zones are necessary considerations and will need to address the Local Traffic committee process.

1.1.5. Crown Roads

Where Crown Roads are intended to be developed as part of a subdivision, such roads shall be constructed in accordance with this Manual and subsequently dedicated to Council (subject to relevant legislation and/or the Minister’s concurrence) as public road on the Subdivision Certificate.

1.1.6. Road function

The objective of council’s road hierarchy is to provide a road and street network that considers interactions between the differing road functions. Austroads and NSW Movement and Place provide the detail on the concepts and principles of roads versus streets.
At a fundamental level, the priority for streets is to provide quiet and calm access to and around properties, while the priority for roads is to distribute people efficiently to destinations. Any design of roads and streets needs to consider these documents and frameworks in setting up the road network and hierarchy.



(b) Road type and function – mobility vs. access

Source: Brindle (1987).

1.1.7. Trunk Road Framework and Spacing

The road network shall use a grid and or radial Trunk Road framework with the Major/Minor grid spacing as per the table below. Roads and Streets with two dedicated travel lanes shall be connected to other two-lane roads at the intervals specified in the minor/major grids.

Trunk Road Network Spacing

ROAD TYPE	SPACING TO SAME ROAD TYPE (M)	SPACING OF INTERSECTIONS FROM LOCAL NETWORK ONTO THIS NETWORK (TYPICALLY RESIDENTIAL AREAS)
Arterial road	**1.0km to 2.0 km** apart (Typically parallel, not grid)	Between 300-500 m Centres consider tighter spacing
Sub-arterial road	**0.8km to 1.6 km** apart (Parallel or grid)	Between 200-300 m
Major Grid - Trunk Roads	**800m x 800m** maximum spacing and grid Generally 600 x 500 considering natural constraints (topography/drainage/habitat)	Street block spacing as per DCP and intersection staggers as per MoES intersection criteria and Austroads/TfNSW. Required to also provide a public bus network that is adaptable and alternatives due to disruptions, etc
Minor Grid – Local Trunk Roads	Infill of major grid 300 min to 500 max (400m ±100m). For perimeter edge: 400m max walking depth to Bus routes, and for width keep the 300 min to 500 max **(See Figure below)**	Street block spacing as per DCP and intersection staggers as per MoES intersection criteria and Austroads/TfNSW/Bushfire

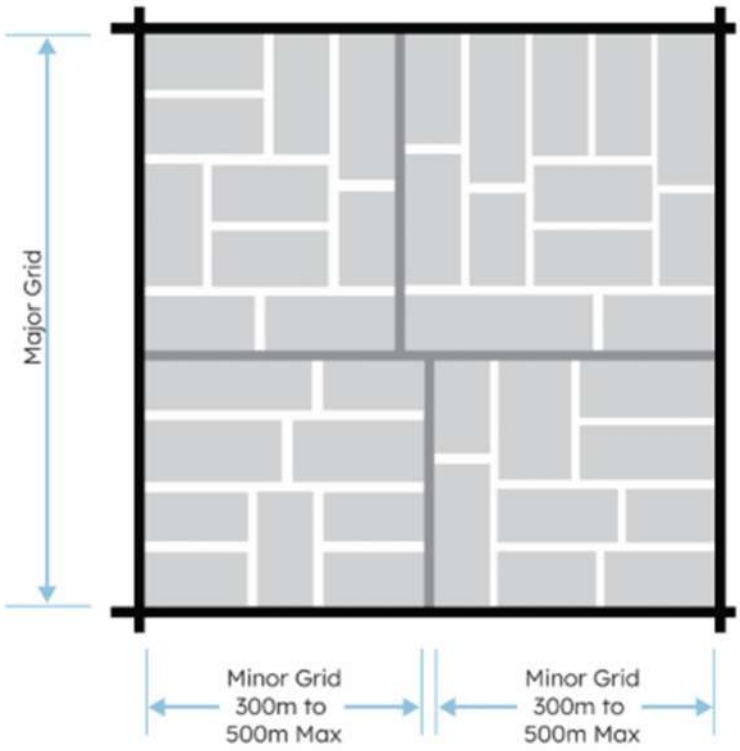


Figure. Minor/Major Grid

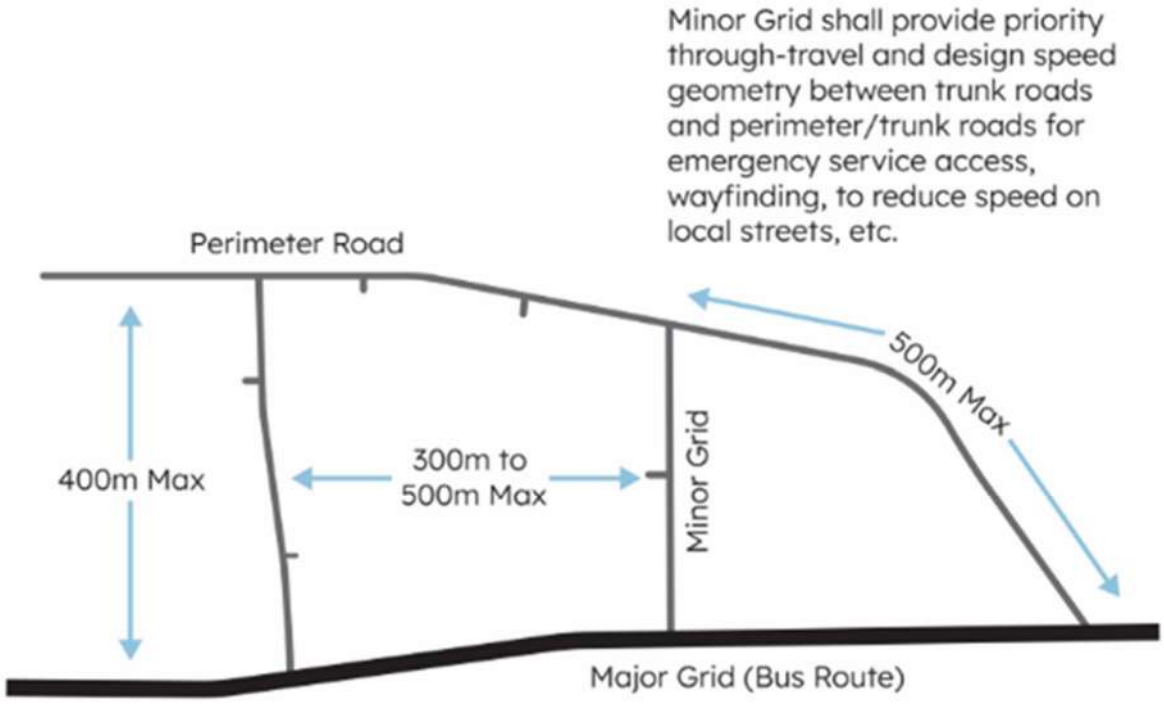
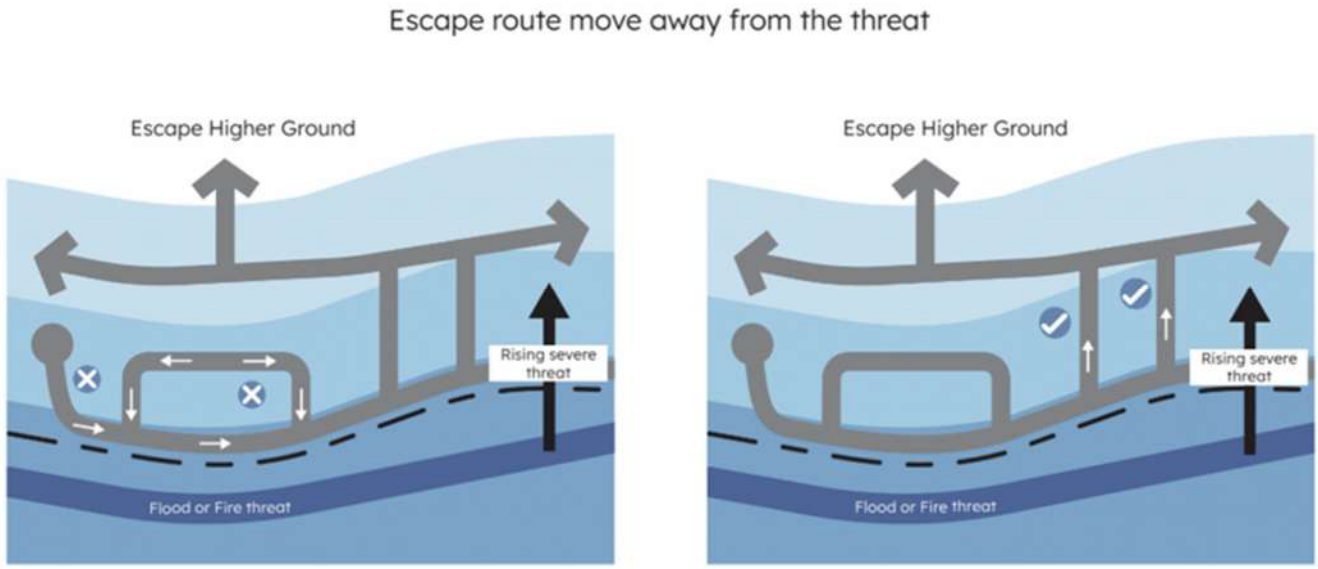


Figure: Minor Grid Width to perimeter/constraint Area (Flood, Bush, Riparian, Rural, etc)

1.1.8. Designing for Emergency Routes

Both local streets and trunk roads must provide layouts that provide safe and efficient routes between the hazard and the escape routes. Hazards include bushfire and flooding. Current documents endorsed by the emergency services shall be adhered to. Escape from flood will consider flood event greater than the 1% AEP because floods come in all sizes. The pictures below are examples from DESIGNING SAFER SUBDIVISIONS - Guidance On Subdivision Design In Flood Prone Areas, found on the SES website. These and other principles in the document are equally relevant to all hazards types.



Poor Design is indicated

Good design is indicated

1.1.9. Positioning of non-residential uses

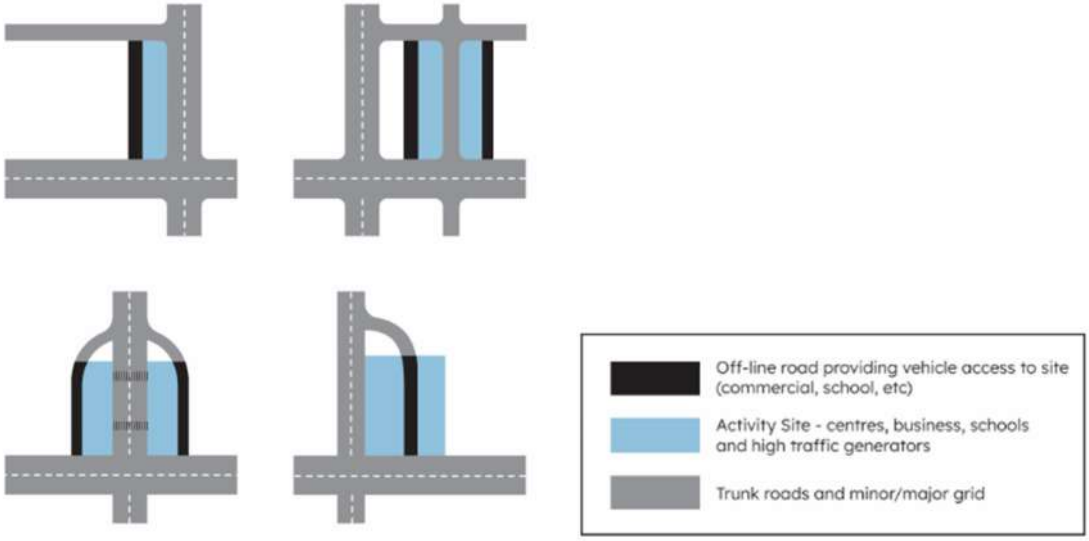
Commercial activity, centres and other focal point land uses like schools, community and sports facilities need to be well-located to be prominent, highly accessible, and yet not obstructive to the adjoining trunk road networks. Placing these types of development adjacent to but off-line to the higher order trunk road network needs to be carefully considered.

They should be closely situated near trunk roads with high-frequency public transport with a responsive road layout that can respond to change as the site and surrounding area matures. These centres and developments are best located adjoining too, and visible from higher order trunk roads and larger roads to help capture passing trade.

These sites would generally be indicated the spatial positioned during strategic planning processes

It is required to locate the vehicle access points off a lower order road with lower traffic volumes and safety conditions for pedestrians, bikes and public transport. The figures below show indicative Off-line scenarios. Larger activity centres that collocate commercial, community, recreation, schools and the like may need to use an adjacent precinct that clusters off-line but against the sub-arterial and trunk road network. In all scenarios the consideration to access via to other non-vehicle modes needs

to be highly considered in order to deliver pedestrian priority, followed by cycling, public transport and finally motor vehicles.



ROAD TYPES – Table A

CATEGORY	LOCAL STREETS - RESIDENTIAL		Trunk Rd -Minor	TRUNK ROADS – MAJOR, ALL ZONES			
Street Types	Yield Street (l)	Local Street (l)	Local Collector (l)(v)	Local Distributor	Secondary Distributor	Primary Distributor (m)	Minor Sub-Arterial
Abbreviation	L8	L10	LT11	T12	T14	T15	T15.4
APPLICATION							
Context	10-12 Dw/Ha	15+Dw/Ha	Local Trunk Road	Trunk Rd	Major Trunk Rd	Major Trunk Rd	Major Trunk
Typical Lot No. [or VPD]	<200	<300	<300	<300	<400	<500	<6000vpd
Network Layout	<700m travel dist	<700m travel dist	minor grid	Major grid	Major grid	Major grid	See D1.1.7
Driveway access	Front loaded	Front or rear	Front or rear	Front or rear	Front or rear	Front or rear	Front or rear
ROAD WIDTHS MINIMUM (metres)							
Pavement (b)	8	10	11	12	14	15	15.4
Rd Reserve (a)	17	19	20	21	25	26	26.4
Travel lane	4m yield passing	3m	3m	3.5m	3.5m	3.5m	3.5m
On-road cycle lane	mixed travel	mixed travel	Mixed Parking	Mixed Parking	1 (r)	1.5 (r)(s)	1.7 (r)(s)
Parking lane	2	2	2.5	2.5	2.5	2.5	2.5
Verge (c)(g)(q)	4.5	4.5	4.5 & 5.5	4.5 (& 5.5)	5.5	5.5	5.5
Verge Paths	1x1.5m (e)	1x1.5m (2x1.5 for density)	1x1.5 or 2.5 (e)	1.5 or 2.5 (e) (add 1.5 for density)	1.5 & 2.5	1.5 & 2.5	1.5 & 2.5
Pedestrian refuge (v)	No	No	No	Only kerb blisters	Yes max 400m spacing	Yes max 400m spacing	Yes 200-300m spacing
ROAD FEATURES up to 15Dw/Ha							
Design ESA's (f)	*1x10^6	*1x10^6	1.5x10^6	2x10^6	4x10^6	5x10^6	1x10^7
(*) 5x10^5 for lot clusters less than 100 lots				*(Roundabout add 0.5 ESA)*			
kerb Type (d)	Roll	Roll	upright	upright	upright	upright	upright
Kerb return	8	8	8	8	8	8	8
Intersection Blisters	N/A	Optional	Yes	Yes	Yes	Yes	Yes
Line marking(p)	No	No	intersect's(m)	Yes, CL(j)	Yes	Yes	Yes
Bus route (o)	No	No	Not public route (p)	Yes	Yes	Yes	Yes
Design Vehicle	B85 Car	B85 Car	B85 Car	12.5m bus	12.5m bus	12.5m bus	12.5m bus
Check Vehicle	8.8m	8.8m	8.8m	12.5m	12.5m	19m	19m
Posted Speed	30-50	30-50	40-50	40-50	50	50	50

For Notes see below

Road Types Table B

CATEGORY						
Street Types	Sub-Arterial - Urban	Sub-Arterial [n] Rural	Arterial (council)	Busin/School Precinct	Industrial (min)	Laneway Residential
Road Abbreviation	SA13				I13	LR
APPLICATION	Urban	Rural	Rural	Business/Schl		
Context	Major Trunk Urban	Major Trunk	Major Trunk Network	Precinct Specific	Industrial	Not with L8
Typical Lot No. (or VPD)	<30,000 vpd	<30,000 vpd	>20,000 vpd	N/A	Also Use trunk roads	See D1.1.13
Network Layout / Spacing	See Table 1.1.7	Rural Context	See Table 1.1.7	N/A Precinct Specific	Use minor Major Grid	See Section XXX
Driveway access	Access denied	Consider Context	Consider Context	Front or rear loaded	Front-loaded	rear loaded
ROAD WIDTHS MINIMUM (metres)						
Carriageway [b]	13	TBD	TBD	15.4 - *or SA13 & Active Verge*	13	5.5 concrete
Road Reserve [a]	27.6 min	TBD ≈ 27+	TBD ≈ 32+	16.4 - 32.4	23	8.5
travel lane width	3.5m 2-4 lanes	3.5m 2-4 lanes	3.5m 2-4 lanes	3.5m	3.5m	5.5m
On-road cycle lane	in verge	separated cycle	separated cycle	1.7	Mixed Parking	N/A
Parking lane	3 incl buffer	Rd Shoulders	Rd Shoulders	2.5	3	No
Verge [c][g][q]	8.3 & 6.3	TBD / Context	TBD / Context	5.5 Schl 5.5 - 8.5 Busn	4.5 & 5.5 (min)	1.5
Verge Paths	4.5 & 2.5	TBD on Context	TBD on Context	Full Width or relevant paths	2.5 min	N/A
Pedestrian refuge [v]	Yes	N/A	N/A	Yes	Bus routes	N/A
ROAD FEATURES						
Design ESA's [f]	$1x10^7$ 3500 lots	TBD on ESA's	TBD on ESA's	$1x10^7$	$1x10^7$	$1x10^5$
	(Roundabout add 0.5 ESA)					
kerb Type [d]	upright	Usually N/A	usually N/A	upright	upright	No Kerb
Kerb return Radius	Design Vehicle Swept Path			-TBD	12 (min)	N/A
Intersection Blisters	Yes	N/A	N/A	N/A	N/A	N/A
Line marking [p]	Yes	Yes	Yes	Yes	Yes Partial	N/A
Bus route [o]	Yes	Yes	Yes	Yes	Yes	No
Design Vehicle	12.5m	19m	19m	12.5m	19m semi	B85 Car
Check Vehicle	19m	25m B-Dble	25m B-double	19m	25m B-Dble	12.5m
Posted Speed	50-60	70+	70+	40-50	40-50	10-50

For Notes see below

ROAD TYPES Table C – Large Lot and Rural Subdivision

CATEGORY						
Street Types	Local Large lot	Collector Large Lot	Rural - local only	Rural	Rural	Rural
APPLICATION						
Context	Max Lot Area.		AADT (2 way)			
	<5000 m^2		<500	<1000	<3000	>3000
Design speed	50km/h – higher speeds consider Austroads and safety of lane/shoulder/etc					
ROAD WIDTHS (minimums, consider space for drainage, utilities and ped/cycle needs)						
carriageway width [b]	8	9	9	10	11	12
Road Reserve [a]	19	20	20	20	20	21
travel lane width	N/A	N/A	6	7	7	7
On-road cycle	Mixed	Mixed	Shoulders do not include provision for cycle, or guardrail. Consult Austroads			
Total Shoulder Austroads AGRD3	NA	NA	1.5	1.5	2	2.5
Minimum Shoulder seal [b]	N/A	N/A	0.5	0.5	1	1.5
ROAD FEATURES						
Design ESA's [f]	Use ESA's based on Table A function and lots/AADT conversion					
Kerb [d]	Roll	Roll <5000 Optional @5000	Intersection returns as needed			
Linemarking	at intersection	Centreline	Yes	Yes	Yes	Yes
Bus Route / heavy vehicles	No	Yes	No	Yes	Yes	Yes

For Notes see below

Notes – Road Types Tables A to C:

a) Reserve width shall be increased where footway verges are greater than the minimum listed.

b) Additional width in accordance with this manual, Austroads or TfNSW standards may be necessary where on road cycle lanes, or greater component widths are required. For a rolled kerb profile, the nominal face of kerb shall be 150mm from the back of kerb.

c) Minimum width – See Table 3 concerning verge additional widths. May be reduced to 2.0m for roads up to and including Collector status where there is an adjacent public reserve and utilities are addressed.

Increased width to 5.5+m where shared paths are required. Verge widths will be increased where necessary to accommodate public utility services.

d) Edge restraints are required for AC wearing surfaces. Concrete edge beams may be permitted.

e) Where a path is upgraded to a wider path, an extra 1.5m path is not needed for local low-density streets.

f) Minimum Equivalent Standard Axles up to nominated maximum number of lots using minimum 15 dwellings per hectare. Use Higher densities if planning schemes or the development proposal exceed 15Dw/ha. Parameters do not include bus access to Local Streets.

g) Any verge width may be increased to provide a higher order verge for path desire line or meet required deep soil areas needed for tree canopy targets (Urban Heat canopy).

h) A shared path 2.5m wide minimum, or where pedestrian traffic is concentrated full verge concrete paving, shall be provided at council's discretion.

i) Formation width includes the whole road pavement as a full-width bitumen seal.

j) Line marking at (CL) Centreline for full length, extra as needed for refuges & other

k) Provide a 2.0m width of grassed footpath profile within footway verge.

l) Normally classified as "50km/hr roads" servicing the local subdivision only; not through-roads connecting remote areas.

m) Line marking at Intersections for 10m – 15m.

n) Sub-Arterial - Road connecting Arterial Roads to urban districts and carrying traffic directly from one district or precinct to another. See Austroads Pt 2. Arterial Roads are defined separately to this Manual where location and design parameters are determined by Council. 'Classified' Highways, Regional and State Roads are typically Arterial Roads.

o) Bus routes refer to public bus route. For school bus route in residential areas should be confined to 11m or greater width roads (excludes the school/facility itself). 11m also for intermittent bus like sports ovals

p) Additional line-marking to than listed may be required for delineation, safety. Consider bikes.

q) Where the route is planned to carry large numbers of trucks, the bike travel lane shall be widened to Austroads Pt 3 section 4.2 or change road type to Sub-Arterial -Major.

r) Bike width is contingent on a 3.5m vehicle travel lane

s) Council may require a dedicated bicycle path fully separated from the road pavement.

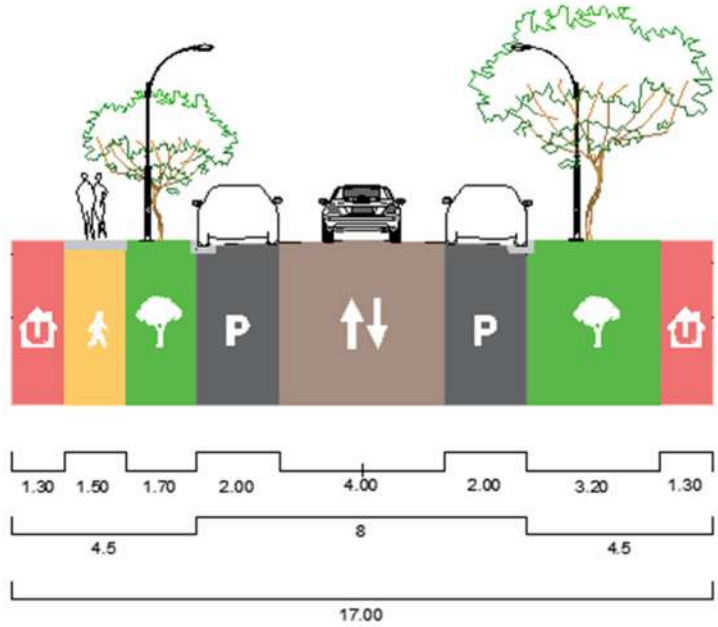
t) To a maximum of 300 lots, otherwise bicycle lanes or paths must be considered.

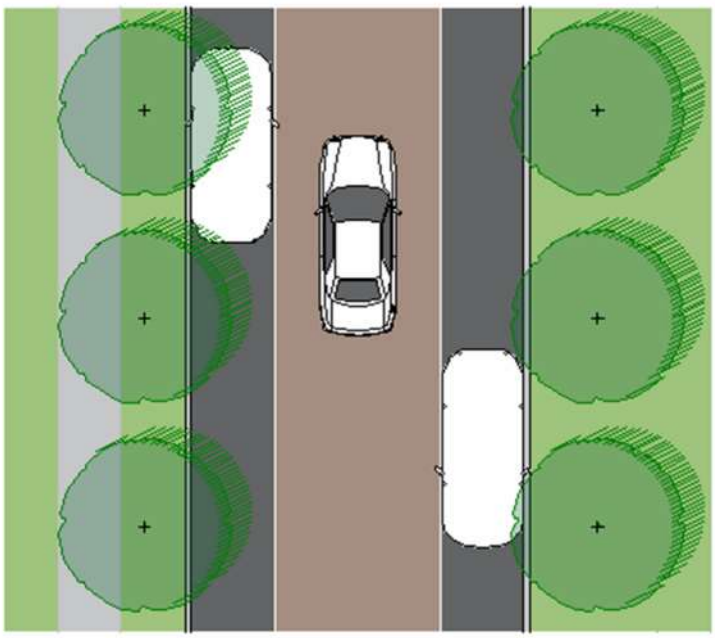
u) Not through-roads connecting areas remote from the subdivision.

v) For roads greater than 300 lots consideration should be given to safe street crossing points (pedestrian refuges etc) and aligned at 400m max spacing (i.e. at bus stop locations.)

ROAD CROSS SECTION – INDICTATIVE TYPOLOGY

ROAD NAME: L8 – YIELD STREET





Overview

L8 is low-speed environment for quiet low density residential. Streets rely on low parking for drives to yield in parking lanes to pass in 10m gaps. Swept paths into single driveways can be compromised.

Features

Footpaths 1 side for low density

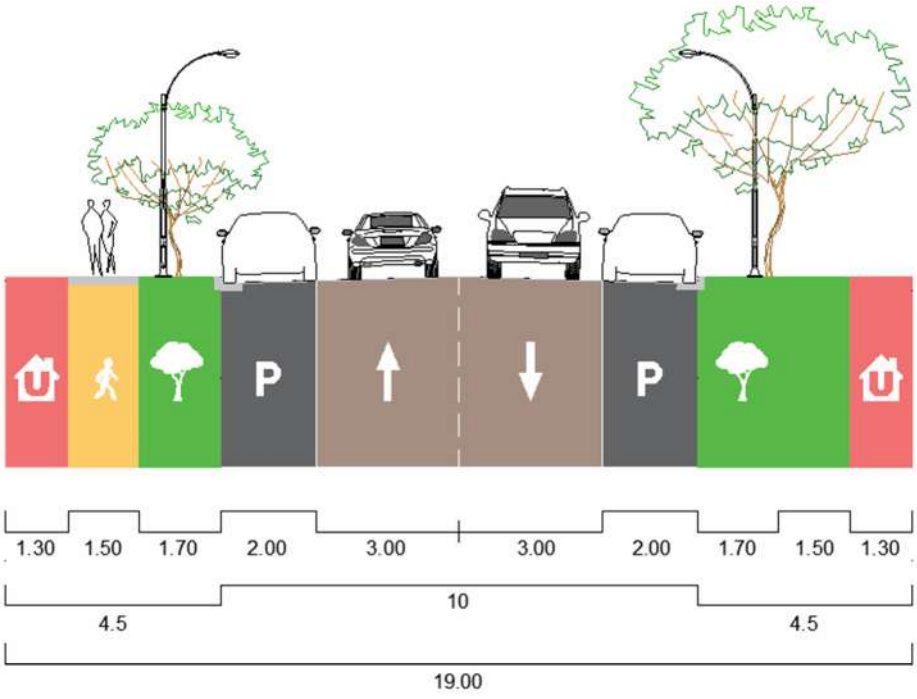
Used with minor/major trunk grid

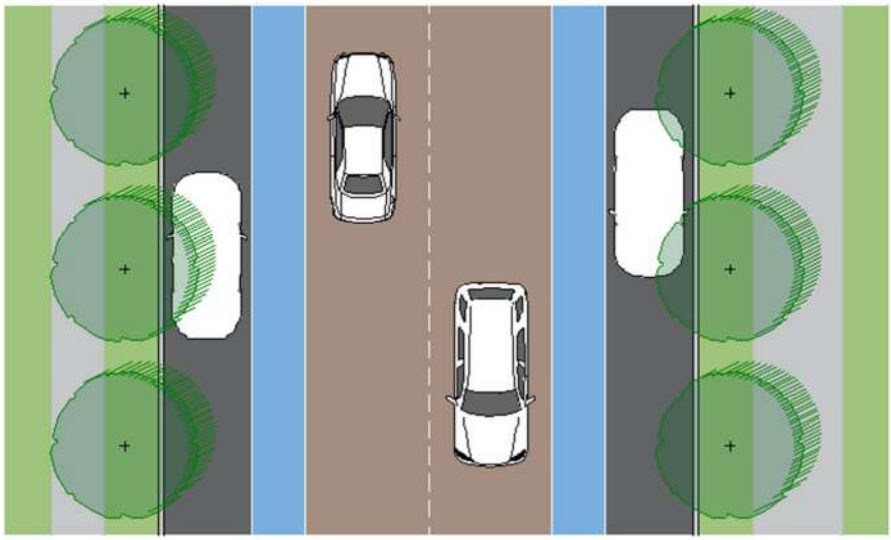
One lane supporting dual directional travel

Streets laid out in high permeability (modified) grid layout with short block lengths.

ROAD CROSS SECTION – INDICTATIVE TYPOLOGY

ROAD NAME: L10 – LOCAL STREET





Overview

L10 is a local street for low-speed environment where two travel lanes are needed. Also used as a non-perimeter (local) road for bushfire in all densities, Used for medium and high density residential

Features

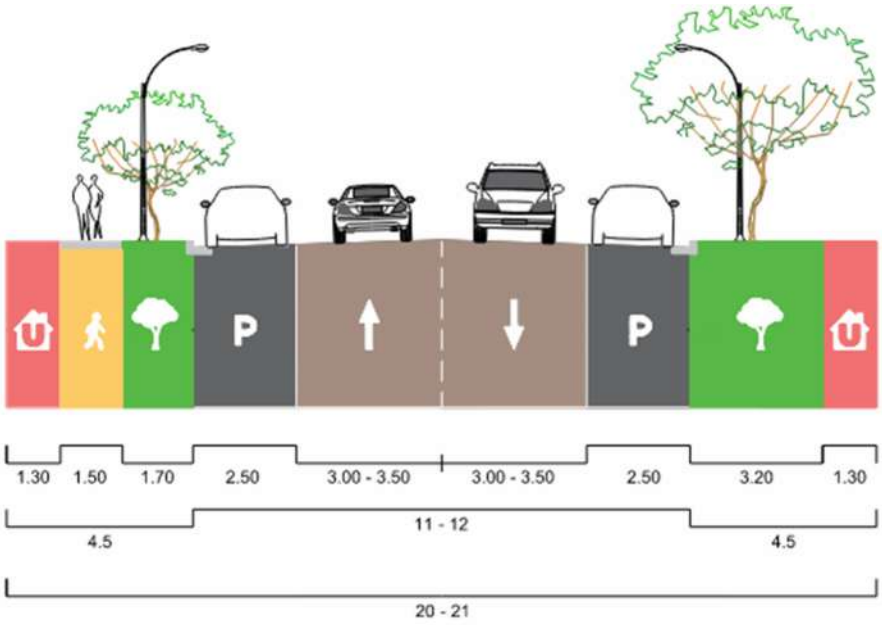
Footpaths 1 side for low density and consider 2 sides between medium and high density

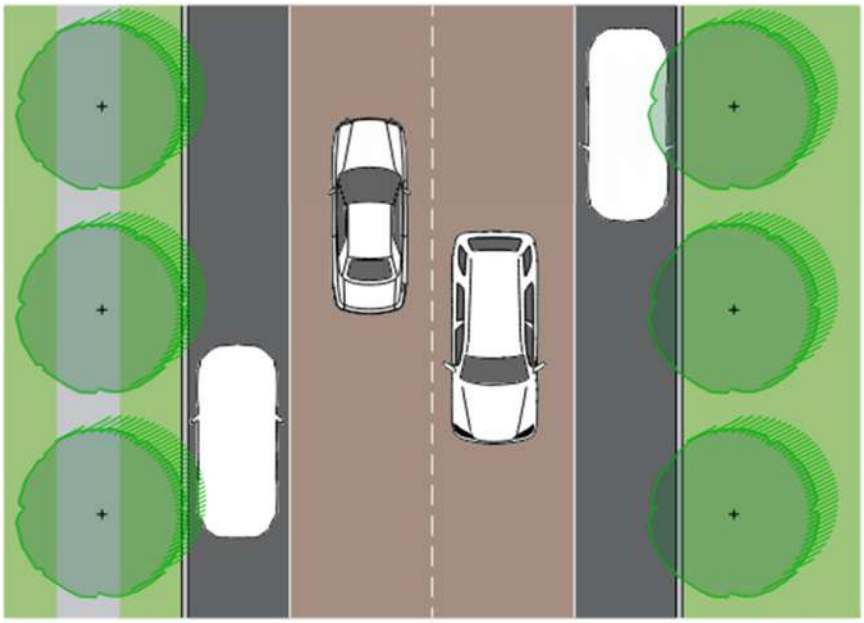
Used with minor/major trunk grid

2 travel lanes assist swept paths into single driveways found in these densities

ROAD CROSS SECTION – INDICTATIVE TYPOLOGY

ROAD NAME: LT11 – LOCAL TRUNK COLLECTOR & T12 – LOCAL DISTRIBUTOR





Overview

LT11 and T12 are the smallest of the Trunk roads. LT11's function includes collecting local streets to connect onto bus/trunk routes, and to be a two lane connector between perimeter roads as a minor grid. They provide wayfinding and legibility. Direct routes keeps speeding and travel times down on adjoining local streets.

Features

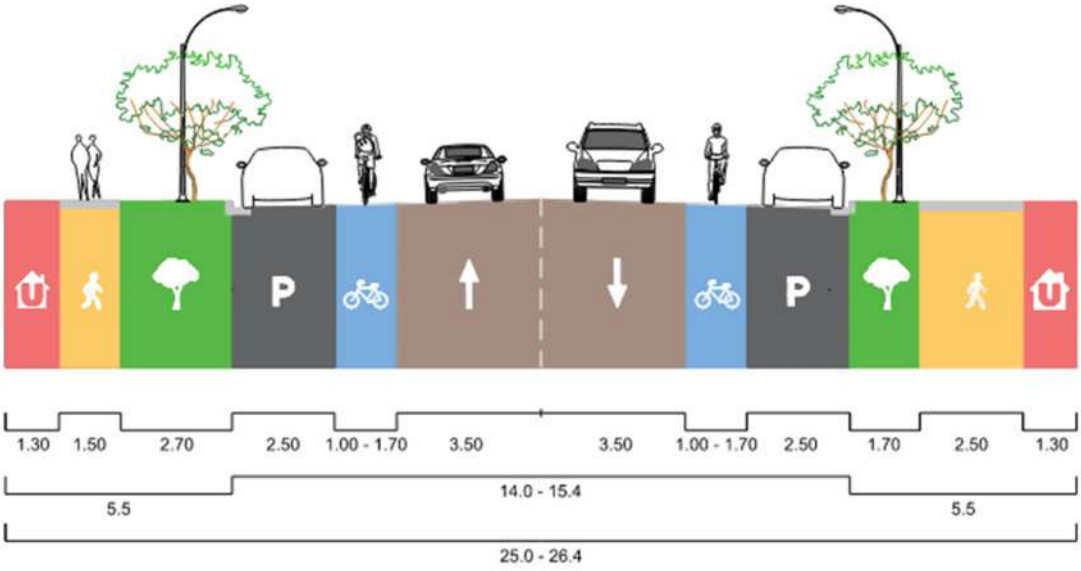
LT11 forms the minor trunk grid whilst T12 can be either minor or major subject to bus routes and/or lot yields

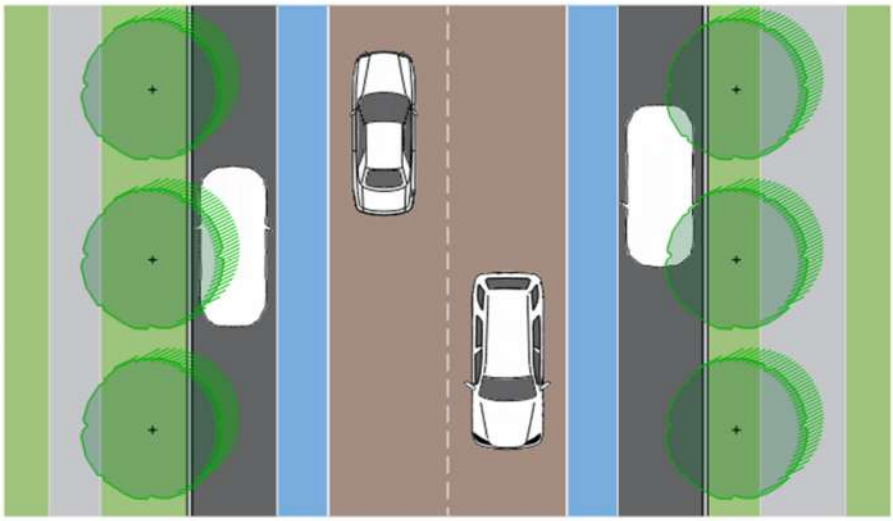
2 travel lanes and two parking lanes, line marking and wider parking lane widths.

Generally, footpaths 1 side for low density and consider 2 sides between medium and high density

ROAD CROSS SECTION – INDICTATIVE TYPOLOGY

ROAD NAME: T14, T15, T15.4 – Trunk Roads





Overview

T14 to T15.4 are part of the Major Grid framework. Connecting neighbourhoods within the suburbs or release areas. Providing on-road and off-road cycle provisions.
Extra or bigger street trees can fit on the wider planting zone (side with 1.5m path)

Features

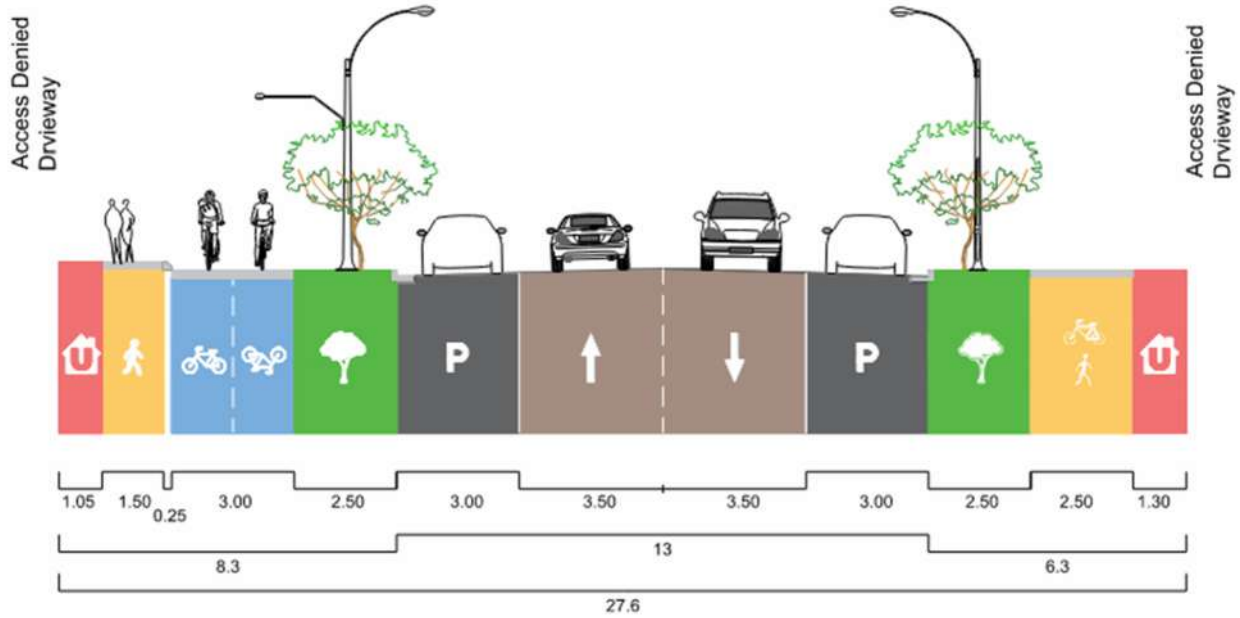
Dedicated on-road cycle paths as well as off-road shared paths (joint pedestrian & cycle) on 1 side and a pedestrian footpath on the 2nd side

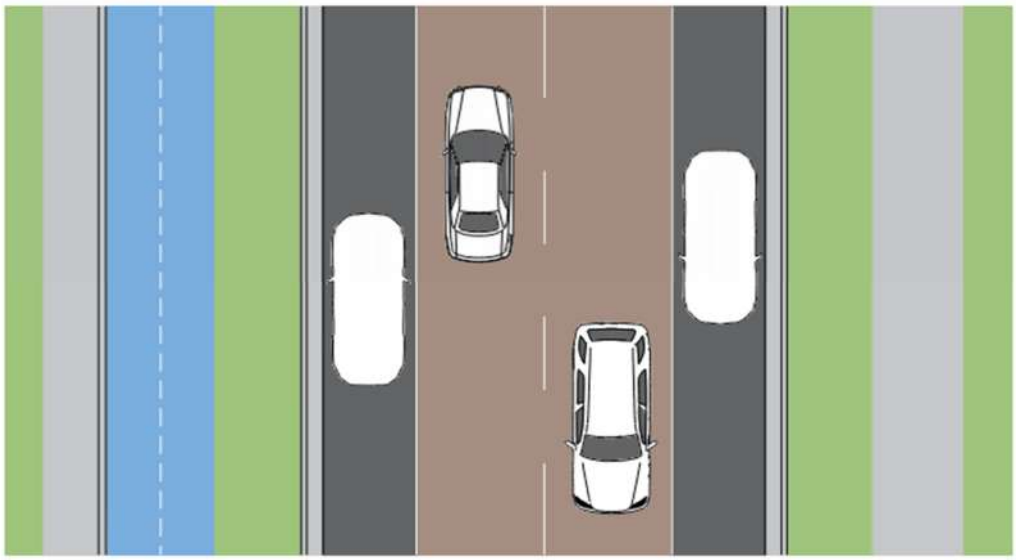
These streets balance the function of moving traffic and providing lot access.

The safety of pedestrian and cyclists need to be considered when crossing the streets

ROAD CROSS SECTION – INDICTATIVE TYPOLOGY

ROAD NAME: SA13 URBAN SUB-ARTERIAL





Overview

This feature road creates the character of a suburb. The function of SA13 is primarily traffic distribution. On-road cycle lanes are moved to the verge for improved safety, and access denied roads improve road amenity and also prioritises active transport in the verge. Lots still have pedestrian/postal frontage to this road

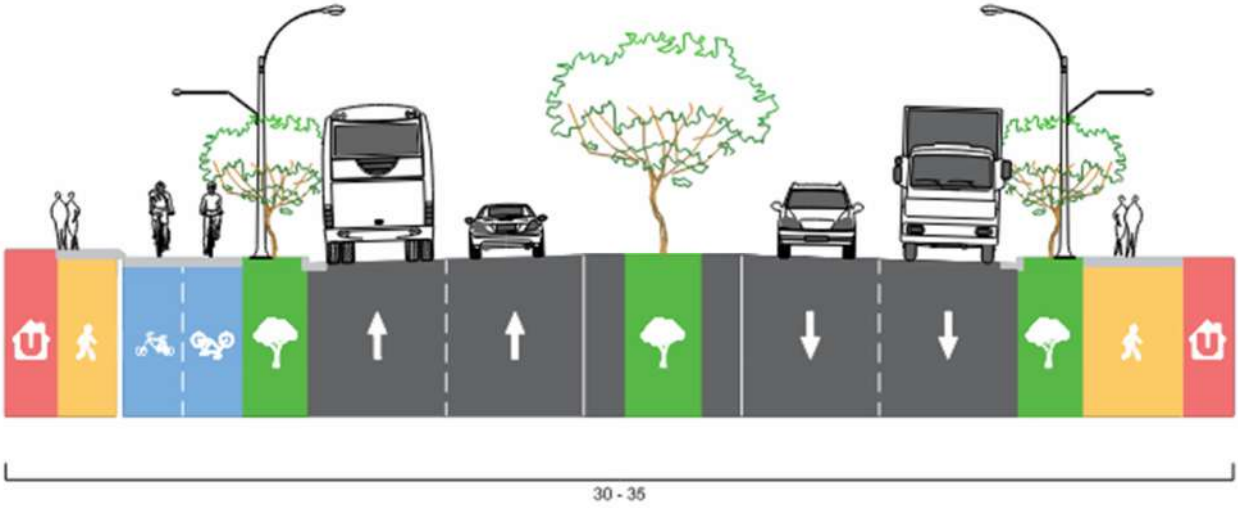
Features

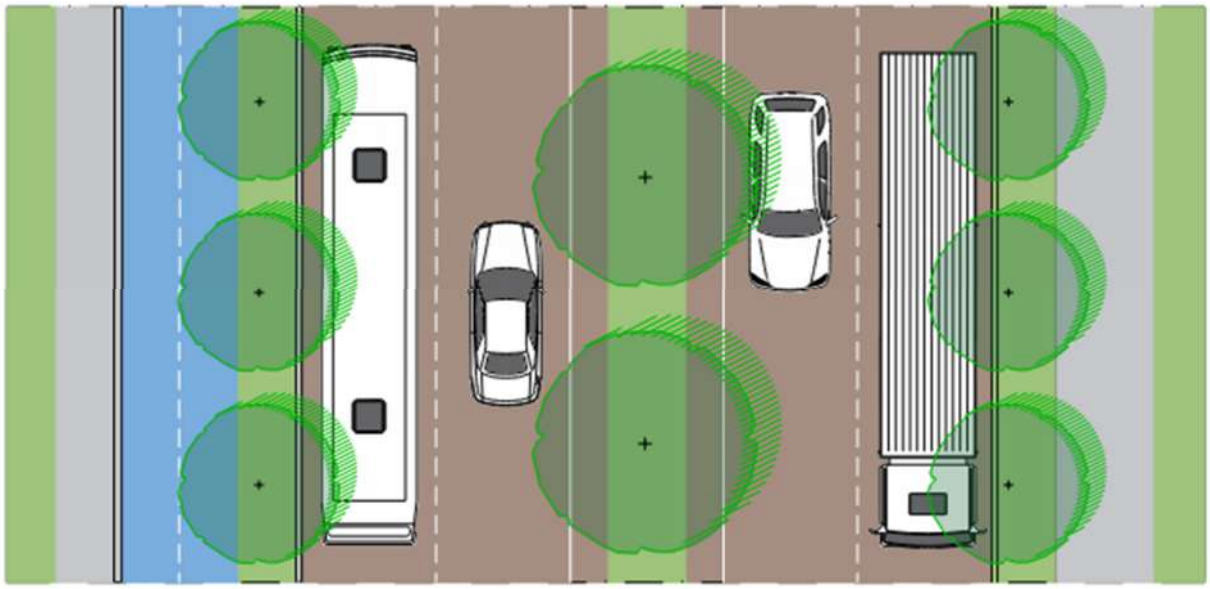
Dedicated off-road cycle paths. The other verge includes a shared path for family cycling mixed.

The safety of pedestrian and cyclists need to be considered when crossing the streets. Extra street-tree canopy is achieved on the wider planting zone (side with 1.5m path)

ROAD CROSS SECTION – INDICTATIVE TYPOLOGY

ROAD NAME: COUNCIL ARTERIAL





Overview

The council Arterial is for longer distances like suburb-to-suburb transport, generally connecting to highways or state arterials. The distribution and connectivity function of the road outweighs traffic volumes alone. Dimensions and typology should be pre-negotiated as part of Urban release areas.

Features

Larger roads include dual lanes in each direction whilst smaller roads may provide single lanes and joined pavements. In built up areas lots do not have frontage as access is from adjoining roads or parallel service roads. Central median, shoulder v's kerb and verges are determined by locality and circumstance.

1.1.11. Design Vehicles and Check Vehicles

These vehicles as listed in the road hierarchy table are used to determine the street and road widths including lane width and kerb radii. They influence the travel speed through intersections and behavioural speeds.

Design Vehicles – high frequency day-to-day users that shall stay within the designated travel lanes.

Check Vehicles – lower frequency users like garbage services that can cross the centrelines of the leaving or entering road. Generally crossing the centreline to halfway over the opposing direction lanes for each of the leaving and entering roads. Note: Seldom frequency vehicles like emergency vehicles and semi-trailers (during building construction) should be able to enter any road without damaging infrastructure including mounting kerbs, stormwater lintels, signage and utilities. Usually utilising the whole of travel lanes on both roads.

1.1.12. Components of Road Reserves

The following components of the road reserve are provided for clarification as to how the residential road types in the hierarchy have been developed. The components are listed to provide guidance to the makeup of those road types and may assist council engineers to action site specific and isolated changes that may be required due to exceptional circumstances. It is not provided to create individualised 'design-your-own roadway type. The Road Hierarchy Table shall be used as councils standardised road network.

Travel Lanes – Minimum Widths for Vehicles

	LANE WIDTH (1)	COMBINED TRAVEL WIDTH	NOTES
Local Street and Minor Trunk (non-public bus routes).	3.0m	6.0m	Eg. 10.0m road (2-6-2). 11.0m Local Collector Road (2.5-6-2.5)
Trunk Roads - Major	3.5m	7.0m	(includes Public Bus routes network)
Single Lane – Dual direction (yield) or one-way	4.0m	4.0m	eg. 8.0m Yield Street (2-4-2) and any single lane restriction for any road type

Notes: (1) Does not include roundabouts and other traffic scenarios that trigger a wider requirement

1.1.13. Parking Lanes - on-road

All roads within the road hierarchy table show how parking is provided within the carriageway. It is council requirement that all lots fronting a road will have on-road parking. Larger lot rural and rural residential will be considered on merit. Short sections of parking such as at roundabouts and traffic blisters can be omitted to comply with road design and legislative requirements. Lots with dual road frontage (front and rear) sometimes occur at entry roads to traffic signals and roundabouts, or an access denied road (denied driveways). Parking could be removed from one of the road frontages at council's discretion unless commercial or other high use activity abuts any of the road(s). Corner lots do not have the same concession except where intersection blisters occur.

Table XXX – Parking Lanes Widths (T=Travel Lane, P=Parking Lane)

PARKING LANES	MINIMUM WIDTH	COMMENTS / EXAMPLE
Local Streets	2.0m ** 2.25m* # 2.3m	e.g. on Yield Street (2-4-2), and 6.0m travel (2-6-2) **5.5m is considered a driveway width however is provided to clarify for Planning for bushfire non perimeter roads (2.25 - 5.5 - 2.25)* #if delineation or line marked between parking lane & travel lane
Trunk Roads and Local Collector	2.5m	Local trunk road. Major trunk roads with bike lanes between travel and parking lanes
Major Trunk Roads (with no on-road cycle lane	3.0m	Trunk Roads (generally over 6000vpd) with no separation on travel and parking lane.
Bus Indents/ Other Heavy Vehicle	3.0m	Bus indents minimum width (2.5m wide parking lanes will require blistered bus stops. ***Developers show stops on lot plans so buyers are notified.)***
*Industrial Road (13m wide)	3.0m	

(The words bay, and lane are interchangeable)

1.1.14. Minimum Combination Widths

There are occasional reasons to vary a standard road type such as taking local area traffic management device necking points. The following table and pictures give examples.

Photos show example how table below can be used for a pinch point, and a possible solution for retention of a significant tree. Photos from Google maps. These are to be used an council discretion.

Minimum Pavement Widths

NARROWED ROAD WIDTH LOCAL STREETS	MINIMUM WIDTH (M)	LANE TYPES *T = TRAVEL* *P = PARKING*	EXAMPLE
One Lane	4.0	1T	One-lane pinch point, one-lane turning circle
Two Lanes	6.0	TT or TP	Necking at intersection blisters. A short side road to save tree, or for slope
Three Lanes	8.0	PTP or TTP	Yield street or remove parking off one side of two-way street.
Four Lanes	10.0	PTTP	Local street and Bushfire non-perimeter road with lots and parking on both sides

Note: This Table overrides any other components where combined are of a lesser total width.

1.1.15. Verge widths

Verge widths must adequately consider the infrastructure that needs to be accommodated and installed. Verge widths in the road hierarchy table are minimum and any verge may need to be widened to accommodate site specific infrastructure needs. The table below provides some requirements.

Verge additional widths

VERGE ADDITIONS	WIDTH (M)	RESIDENTIAL ZONES
Minimum Verge Width	4.5#	Can accommodate 1.5m path and a small street tree.
Street tree	#	#Add additional width as needed for size of street tree and the minimum deep soil volume/widths. See Technical Guideline: Street Trees
Shared path 2.5m wide	+1.0	Match additional widths for wider paths (min 5.5m)
Other Path widths	Add width (1.5m generally catered for already)	Match additional widths for wider paths. See Section 1.3 Cycleways and Shared paths

Overhead Power	+2.0 min	Where overhead and underground both provided. Generally, behind the footpath and between the local utility combined trenching– to avoid streetlights/tree
Stormwater Pipelines E.g. Dual pipes (major system drainage)	TBD. pipe width + buffers/influence	Dual pipelines shall not be included under road pavement (excl crossings). Apply open channel or extra width to avoid allocations/trees
WSUD (biofilters, rain gardens, etc)	+1.0 min	WSUD pits located between kerb and footpath setback. (bio filters in concrete box systems behind kerb) between trees
WSUD swales	TBD	To be negotiated in a DCP only
Trunk utilities (water, sewer, gas, electrical or communication)	TBD	Additional verge width may be necessary for non-standard items.
Reduce verge adjacent public space	*	*See notes

*Additional widths add together with no discounting (except consideration of WSUD and Street tree allocation).

1.1.16. Local Area Traffic Management

Local Area Traffic Management (LATM) refers to traffic measures and strategies aimed at improving safety, particularly in residential neighbourhoods and local centres. It focuses on modifying traffic patterns to create safer, more efficient environments for pedestrians, cyclists, and drivers.

LATM measures are typically recommended for use on perimeter roads and local roads with 4-way intersections, especially where standard requirements are exceeded, such as long street block lengths, straight sections greater than 500 meters, or intersections with changes in priority.

Below are a few examples of LATM measures:

- **Line marking and median islands in parking lanes on perimeter roads**: These measures slow down traffic in residential areas. Note: Islands are preferred over kerb blisters to ensure a minimum 1.5-meter distance between the edge and travel lanes, due to expansive clay soils.
- **Islands before blisters**: Traffic islands placed before blister islands (small raised areas at pedestrian crossings) help guide traffic, reduce speed, and provide safe areas for pedestrians to wait while crossing, improving safety and reducing crossing distances.
- **Mountable roundabouts**: Small roundabouts at intersections help maintain traffic flow and reduce the likelihood of accidents compared to traditional stop signs and intersections.
- **Raised intersection platforms**: Elevated sections at intersections are designed to slow down traffic, enhance pedestrian and cyclist safety, and improve visibility.

1.1.17. For design requirements and further reference, please see *Austroads Guide to Traffic Management Part 8: Local Street Management*.Laneways (New Residential)

Residential Laneways are only to be used:

- When in parallel to roads with pavement widths of 10.0 metres minimum (i.e. two dedicated travel lanes of 6m combined travel width); and
- To provide increased density by creating a mix of lots ranging from 8.0 metres minimum to 12.5 metre maximum width and maximum depth of 25 metres; OR
- For access due to access denied high order roads.
- When part of an integrated application with the dwellings designed and forming part of the Development Application; and
- When they are of a straight design (i.e. no bends, C, T and H shapes). See Figure below; and
- Where they will not connect onto trunk roads; and
- When the design and construction will meet the following requirements:
- Concrete construction to central 'V' drain shape,
- When they will have a pavement width of 5.5 metres and two verges of 1.5 metres in width to support small street trees. *Addition of kerbs is undesirable and will require additional land width to ensure 1.5m deep soil behind back of kerb, and 5.5 pavement excluding kerbs. Increase reserve in 0.5m increments*
- 2.5 - 3.0% crossfall to centre
- Layback or V drain at road connection
- Coloured concrete Entry Thresholds allowed excluding through any path
- Splay Corners 2m x 2
- Maximum Lengths for Laneways:
- 100 metres long on a Block Length to control behaviour, speed, Crime Prevention Through Environmental Design (CPTED), and other. Variation whilst not encouraged will need LATM measures and greater travel widths

Continued below

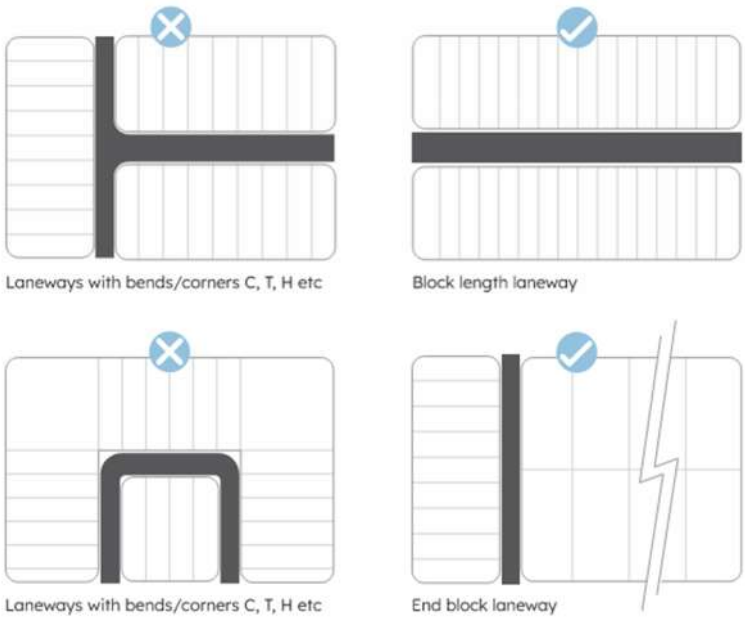


Figure - Configurations of Laneways

- All lots adjoining the laneway must utilise the laneway for vehicular/garage access.
- Streetlights must be placed at the entrances to laneways on the opposing side of street to maximise light penetration into the laneway, and within the laneway to council requirements.
- All utilities (excepting street lighting) must be provided from the primary road reserve.
- Maximum longitudinal grade of 5% on the laneway and a maximum lot grade to meet any DCP requirements for lots with laneway vehicle access.
- No lot drainage to connect directly to the laneway. All allotments on the laneway must be able to drainage stormwater to the street network, or a provided interallotment drainage line into the laneway pipeline.

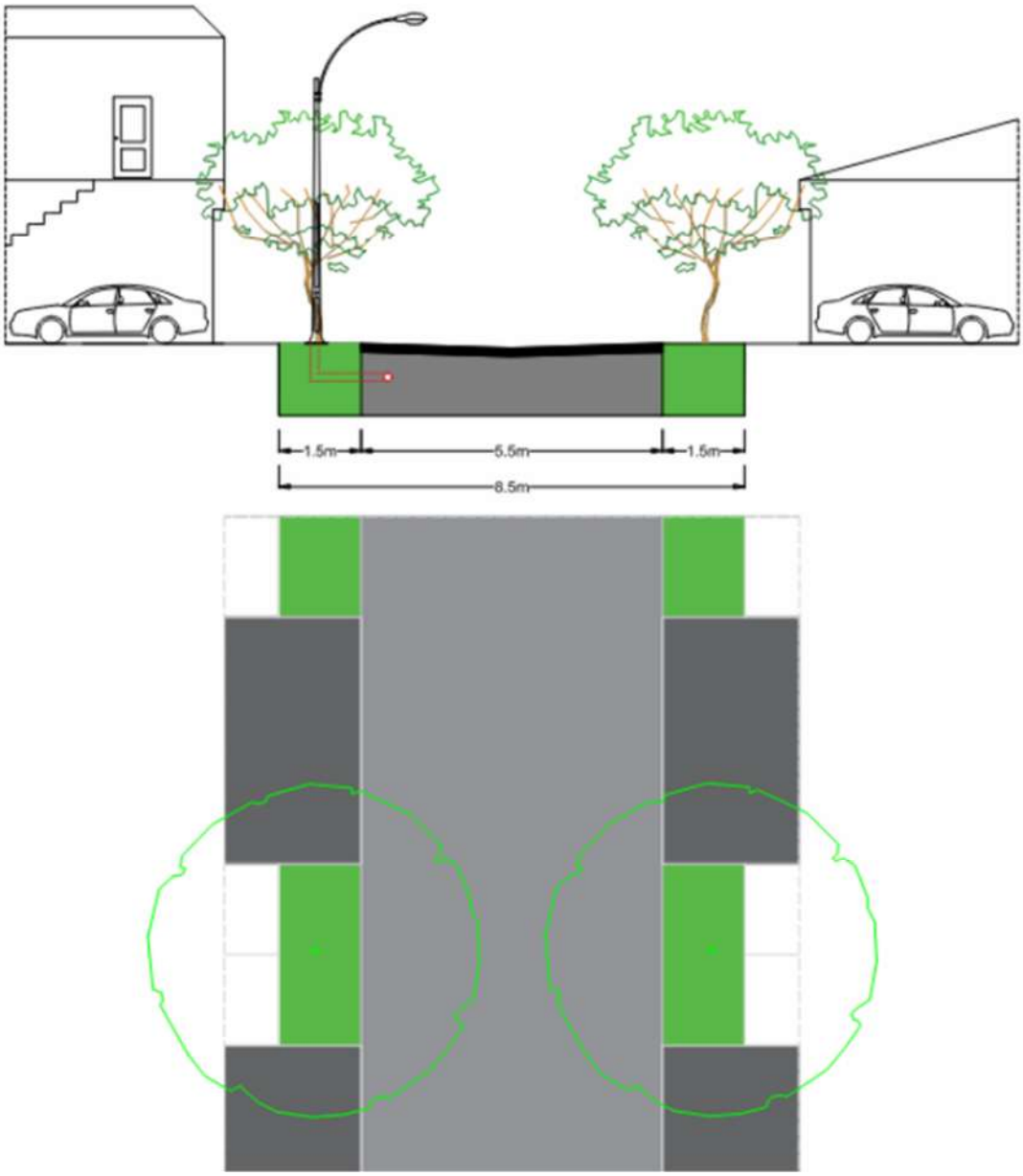


Figure: Residential Laneway Section

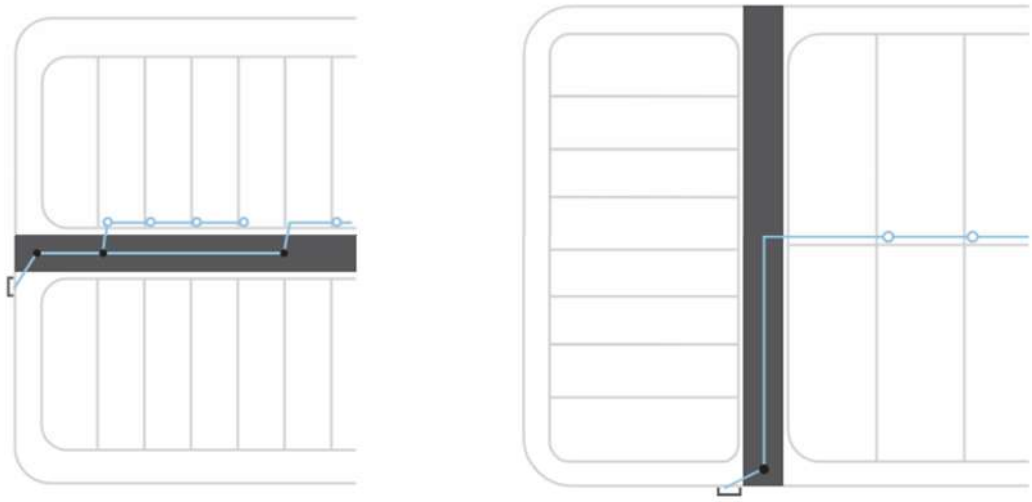


Figure: Indicative Interallotment drainage scenarios on Laneway

1.2. Footways, Footpaths and Steps

Footpath and footway parameters shall be designed in accordance with the Standard Drawings, other parts in this Document (i.e. 1.1.8, etc) and the following:

- Footway (verge) minimum widths – Provided in 1.1.8 and relevant Tables
- Footway crossfall - 4% standard profile.
- Footpath width - Provided in 1.1.8
- Footpath crossfall - ≤2.5% maximum. Recommend that construction plans should quote a 1.5% design crossfall to ensure the crossfalls are built within the specified limit.
- Longitudinal grades of footpaths shall match adjacent roadway/kerb grades. May transition to ramps/returns
- Where footpath grades exceed 12% special consideration shall be given to pedestrians.
- Steps are an undesirable element in public space design and should be replaced with ramps wherever possible. Where approved, they shall conform to the Building Code of Australia and handrails shall be provided.

Variation to these parameters will only be considered under exceptional justifiable circumstances.

A concrete footpath within the footway shall be provided, in principle as a minimum, in accordance with the Road Types in 1.1.8. Footpath warrants, particularly in the vicinity of, or within the desire-line of, commercial and school precincts must be determined in conjunction with such surrounding development (present and planned), and with direction/desire-line destinations. Footpaths in rural (RU1, RU2 & R5) zoned areas are not generally required unless specifically required by a planning instrument. Industrial (IN1) land will generally provide paths along bus routes and other locations as specified by council engineers.

1.3. Cycleways & Shared Paths

Cycleways shall be provided on routes as defined by the Maitland City Strategies or in accordance with any DCP or condition of development consent.

Off road cycleways (i.e., beyond the road pavement) are usually nominated “shared paths” being 2.5m minimum wide for both cyclist and pedestrian usage and shall be constructed in accordance with Standard Drawings SD012 & SD020. Such paths, usually located within footways that are 5.5m wide (See SD001) may also be located in open space corridors. Council may consider a shared path 2.0m wide were justified by special circumstances such as constraints of available corridor widths.

Shared path or cycleway connectivity between a road (i.e. a road reserve either existing or proposed, with or without a path) and the main path shall be constructed as a shared path, 2.5m wide.

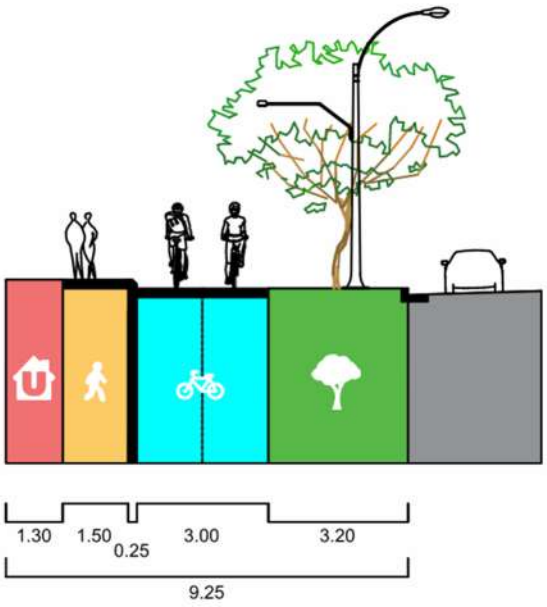
Pedestrian and Cycle Paths

PATH TYPE	FUNCTION	MINIMUM WIDTH (M)	MINIMUM VERGE	MAXIMUM LONGITUDINAL GRADIENT	PROFILE CODE
Minor path - footpath	Local access path with low traffic volumes; Pedestrian and low speed cyclist use.	1.5	4.5	Match road or in accordance with AUSTROADS AGRD Pt 6A.	A
Shared path	Commuting pedestrian & cycle path (up to 20km/h) where two way movements are common.	2.5	5.5	Match road or in accordance with AUSTROADS AGRD Pt 6A.	B
Trunk path (high use) – Trunk shared	Commuting path accommodate high level of pedestrians & cyclist (speeds up to 30km/h) in both directions.	3.0	6.0	Match road or in accordance with AUSTROADS AGRD Pt 6A.	C
Active Verge combination	Access denied driveways 3m Dedicated bike path and footpath	4.5 (3.0 & 1.5)	9.0+	Match road or in accordance with AUSTROADS AGRD Pt 6A.	D

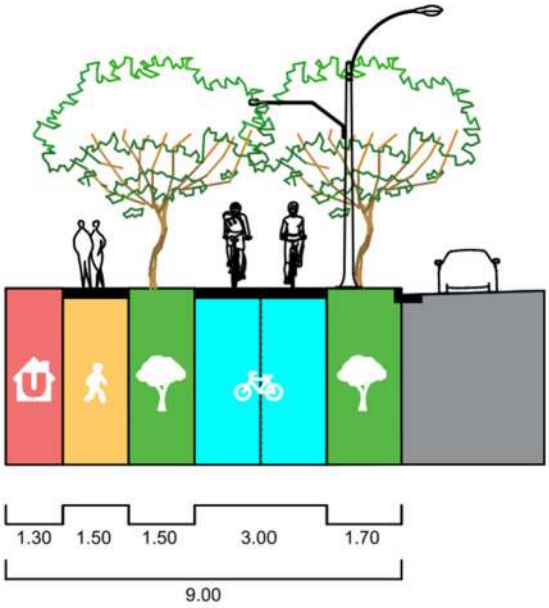
Example road profiles 5.5B–13–9D, 4.5A-8-4.5.

Examples below of Type D Active Verge use paths are provided below generally for use at Strategic (rezoning, DCP) phase but can include at Development Application phase when DCP’s and precinct plans do not exist.

Driveways are denied on these paths and verge on opposing side of the road. *Roads under 10,000vpd could negotiate for driveways on the opposing verge (within the DCP or Precinct plan) subject to the surrounding context and street environments being created.*



Example for Residential frontages



Paths Split for Commercial/Recreational

1.3.1. Kerb Ramps

Kerb ramps (pram ramps) shall be provided at locations to cater for road crossings but only when directing pedestrians to a continuing path, in accordance with Council's Standard Drawing SD019. The surface of the kerb ramps shall be coloured with a light terracotta colour oxide, with a stretcher bond brick stencilled finish. Ramps and their texture shall be perpendicular to the road and aligned to be directly opposing, to assist directional orientation of sight impaired persons.

1.3.2. Pathway (Corridors)

Pathway corridors between lots are not supported in low to medium density residential areas, and other locations with low use and low surveillance, due to poor Crime Prevention Through CPTED considerations. The necessity for pathways can be eliminated through effective design strategies such as adjusting street block lengths and orienting roads to align with natural desire lines and flowpaths.

In cases where a cul-de-sac is unavoidable and needs the bulb to connection for stormwater flowpaths or active connectivity, the bulb shall be extended to the adjacent road or park to negate the need for a pathway corridor.

In the case of mid-block pathways for stormwater and the like, align within a road or cul-de-sacs, or alongside for open channels. These configurations enhance CPTED surveillance and provide effective maintenance access.

Within this document 'pathway' refers to a laneway corridor bounded by private property (or the like) which links between public places to facilitate walking, cycling and can include stormwater overflows. Previously public pathways within dedicated land would have linked common destinations such as schools and commercial precincts and recreation areas. They may also have acted as stormwater overland flow paths. Pavement Treatments

Council will consider the construction of alternative pavement types, colours, textures, and widths on their individual merits, but their consideration will be restricted to areas of low lot catchment, and where, for example, residential lots are on one side of the street, or opposite to and adjoining a Public Reserve or "Open Space". Such pavements shall only be provided at the terminal end of residential streets and shall cater for a maximum number of five properties, including the corner allotment. In

addition, such pavements, if being considered as a connection between two streets, must not create an alternative route for "through traffic".

1.4. Horizontal Curves

The horizontal alignment should be carefully chosen to balance the topography, with the desired speed control and adequate safety, for all road users.

- In urban areas, a changing alignment is encouraged in order to maintain low traffic speeds. Curve radii are generally established by the approved subdivision plan.
- Long straights connected with short (isolated) radii curves are undesirable.
- The maximum deflection for which a curve is not necessary is 1.5 degrees.
- Horizontal curves on urban arterial, sub-arterial and distributor roads shall comply with Austroads standards. The desirable minimum curve length should be 70m and the minimum desirable radius, 400m (due principally to adverse crossfall). [Urban Road Design, A Guide to the Geometric Design of Major Urban Roads (AP-G69/02)] Consideration of newer Austroads standards is allowable.
- Horizontal curves on rural roads shall comply with Austroads & TfNSW standards for rural roads.
- “Broken-back” curves (created by a short length of intervening straight between two uni-directional curves) should be avoided in an urban street environment regardless of road hierarchy due to an unsafe changing alignment. Such curves are not permitted on roads of Collector status or greater, or within Large-Lot subdivisions. Exceptions may be granted by Council where travel speed necessarily varies appreciably (as may occur at sharp curves/bends approaching 900 or approach to a traffic control facility, interrupting traffic flow) and, where the connecting straight is greater than 150m between tangent points. Regardless, good design practice should prevail with improvement by the substitution of a single curve or a compound curve.
- Compound (uni-directional) curves with common tangent points should provide comparable radii ratios, generally not less than 0.75 (smaller divided by larger), although a lesser value may be considered in constrained urban situations.
- Reverse curves without tangent point separation, are not desirable and should be avoided.
- Where vertical curves are combined with horizontal curves, the combined respective sight distance requirements should ensure compliance with relevant standards.
- All curves must be assessed to accommodate large-vehicle access to urban areas taking into account the road hierarchy and the potential for passing of moving vehicles, and of parked vehicles.
- Travel lane widening for vehicle-tracking must be considered on major roads (roads with a carriageway width greater than an 11m) in relation to line marking and parking requirements. Generally, a 3.3m wide travel lane will accommodate large vehicles for a local street. [Ref Guide to Road Design – Part 3: Geometric Design 4.2.4 & 5]

1.5. Longitudinal Grades

For urban areas centreline longitudinal grade limits are as follows:

Longitudinal Grades

	FLEXIBLE PAVEMENT	RIGID PAVEMENT
Minimum	0.5%	0.5%
Maximum	16%	16% 25% privately owned*
Public Bus route maximum	10% (12% for less than 150m & not at a bus stops)	12%

Grading for an intersecting side-street shall attempt (where applicable) in the first instance to achieve a sag point in advance of the intersection. Where this occurs in deep cuttings, the deletion of the sag in favour of a dished concrete (being flat and wide – 40mm deep x 1.5m wide) may be utilised, subject to acceptable drainage considerations and vehicle vertical clearances.

Note: *A maximum grade of 25% is generally allowed for private access road where commercial-sized vehicles as specified in AS2890.2 are not required to enter the site. However, if the private access road is to cater to commercial vehicles such as service, garbage, and/or delivery vehicles, the minimum requirements of AS2890.2 must be met.

1.6. Vertical Curves

Crest vertical curves shall be designed as a minimum for Stopping Sight Distance (SSD) for the nominated design speed. Sag vertical curves shall be designed for riding comfort. Where minor changes in grade (less than 1%) occur, vertical curve lengths shall satisfy appearance criteria.

Reaction times shall be 1.5 seconds for urban and 2.5 seconds for rural areas.

In order to improve gutter flows and pit inlet capacity where grades are less than 1%, sag vertical curves in kerb and gutter design should be eliminated. An increase in the road crossfall in the vicinity of the sag pit to achieve this requirement will ensue.

1.7. Crossfall and Superelevation

Generally, roads should be crowned in the centre with 3% crossfall. Offset crowns are acceptable where warranted, to achieve satisfactory cross section profiles for adequate gutter/road capacity for stormwater runoff. Crown shall not occur in wheel tracks. Minimum width for roller compaction between kerb and crown, and for asphalt machine.

One-way crossfall may be applied in special circumstances subject to Council's concurrence (such as in difficult cross-sloping topography) with special attention given to control of the catchment contributing stormwater runoff to the gutter, (such as providing IAD pipelines) that does not exceed gutter capacity.

Superelevation should not be applied to urban streets but may be permitted on major urban and rural roads with design speeds generally of 70 km/h or greater, unless otherwise advised by Council.

1.8. Batters

Batters of cut and fill should generally comply with the following requirements unless otherwise advised by the geotechnical engineer. This is to ensure that property access, pedestrian safety, and maintenance issues are satisfactorily achieved. Refer to Council's Standard Drawing SD002.

Batter Slopes

BATTER TYPE	MAXIMUM SLOPE (HOR : VERT)
Road Reserves	4 : 1(1)
Lots between road and building envelopes *NOTE: Check Maitland DCP for other (lot) requirements*	4 : 1(2)
Public Open Space	5 : 1(3)

Notes:

1) This slope is nominated primarily for purposes of maintenance rather than batter stability.
   - Steeper slopes, up to 3:1 are permitted but should be avoided in front setbacks, building envelopes, mowing areas and vehicle access areas. Lots with steep batters shall be assessed for acceptable garage locations and driveway grades that conform to Council Standard Drawings SD008.
   - Where regular maintenance is expected, 6:1 should be provided. Where maintenance is not required such as for natural bush or shrub/native grass plantings, 3:1 may be permitted.
   - Confirmation by a geotechnical engineer of suitable batter slopes for particular soil types may be necessary.
   - Cuttings in rock may be near vertical, as recommended by an engineer.
2) Batters for lot fill shall be contained within the lot.
   - Road batters which extend into lots, should intersect with the natural surface level within the building line setback as adopted by Council.
3) Variations outside of these parameters will only be approved where justified.

1.9. Cul-de-sac, Turning Heads and Kerb Returns

Cul-de-sacs are discouraged due to various reasons including CPTED concerns and other factors. Council prefers connected roads and streets. These reasons include lot frontage challenges for driveways, on-street parking, garbage collection, utility pit space in the verge, street trees for urban heat island effects and lot shape issues. Cul-de-sacs are only considered if no other option is feasible, and if so, they shall be straight enough for visibility from the intersection to the bulb end. If they exceed the length and visibility requirement, road width should be increased accordingly for two dedicated travel lanes. Perimeter road cul-de-sacs shall be less than 200m long. Internalised cul-de-sacs (by lots) shall achieve a walkable perimeter in accordance with the DCP.

Other treatments such as 'T' and 'Y' heads are to be avoided in residential areas for reasons including pedestrian safety, reversing vehicles, unlawful parking/uses and other. T and Y heads are for generally

appropriate for service area turning where the public is excluded. Turning head layouts shall cater for manoeuvres of a single unit Heavy Rigid Vehicle (HRV), typically a garbage truck. See Council's Standard Drawing SD027.

The minimum pavement crossfall in all turning heads and areas shall be 2% and a maximum of 5%. In turning heads where the depth of excavation is significant, in order to reduce the effect of the cutting and batter, the crossfall from the circle centre may be adverse (positive).

Where planning for bushfire requires larger cul-de-sac radii, consideration of on-street parking within the centre of a one-way turning head should be explored instead of providing parking on the outside of the turning radii. The benefit includes less land-take, less pavement, urban heat canopy shade. Concrete construction may be required for shrink/swell soils.

Figures - aerial from Google maps

Nominal Kerb Face Radius (minimum metres)

	RESIDENTIAL	INDUSTRIAL, ENTERPRISE
Cul-De-Sac	10 12* Bushfire swept path (*parking needs to be added)	16
Transition	30	50
Kerb Return (at intersections) *Also see section 16.4	8	12
Kerb Return (at sharp mid-block bends	15 (inside radii) Local streets only <11m wide	Not appropriate – use design speed curves.

	Ensure width allows driveway on the short width, OR provide a 1.0m wide 88b restriction on DP & title restricting vehicle access and manoeuvring.	If unavoidable, B-Double and 19m turning paths are the check vehicle for industrial and Enterprise respectively

Note: Listed requirements are minimums and may need enlarging. Eg Bushfire

2. Intersection Design

Intersections for the control of converging, merging, and diverging traffic streams may employ various design elements which are generally referred to as “traffic control facilities”, being, Major Facilities such as, Traffic Signals, channelised (with auxiliary lanes), Roundabouts in urban and rural environments, and Minor Facilities, such as Local Urban and Rural Intersections, as defined below.

Intersection requirements shall be implemented in accordance with Austroads guidelines and as supplemented by TfNSW standards, and in accordance with development consent. As generally encompassed by Austroads standards, warrants for typical intersection requirements shall be determined based on design objectives parameters such as: safety, traffic capacity and flow, sight distances, crash history, lighting, consistency, driver expectation, and including: speed, travel time, interruptions, queuing, freedom to manoeuvre, driving comfort and convenience, and operating costs; factors embodied in the Level of Service (LoS) of an intersection.

“General objectives for intersection design are to:

- Design the intersection to be as safe as possible.
- Cater appropriately for the movements of road users.
- Provide adequate facilities for all road users (including pedestrians, those with a physical impairment and cyclists)
- Maximise driver comfort.
- Minimise maintenance and replacement costs
- Minimise adverse environmental effects.

One option to improve capacity (and safety) is through channelisation and auxiliary lanes, to separate movements on an approach and provide storage space or remove conflicting flows, and to raise capacity by eliminating constraints on the priority flow” (Austroads Pt 6), and to achieve an outcome “to maintain capacity of the through road…to operate with very minor interference to the through movement” (TfNSW).

Intersections shall be designed to accommodate the legal speed limit of the road existing at the time of construction approval.

Application of an Extended Design Domain (EDD) approach will not be considered unless adequately justified, whereby removal of constraints to achieve Normal Domain Design (NDD) is unreasonable or prohibitive.

For traffic-control design features, Council and TfNSW Traffic and Development Committee requirements may be inherent within the consent, or otherwise approved through or associated with,

the Subdivision Works Certificate (SWC)/Section 138 of the Roads Act (S138) process for traffic device features such as signposting and linemarking.

2.1. Traffic Signals

All traffic signal facilities (including those for pedestrians) shall be approved in design and construction by the TfNSW through appropriate agreements with the WAD (e.g. Works Authorisation Deed).

2.2. Channelised Intersections

Channelised intersections (CH), together with auxiliary (AU) lanes to provide safety in diverging, storage and continuous flow of vehicles and cyclists, shall be provided in accordance with Austroads guidelines and as supplemented by TfNSW standards.

Intersections shall incorporate the following (but not limited to):

- Adequate capacity for the projected design life
- Adequate Stopping Sight Distance (SSD) where applicable, Approach Sight Distance (ASD), Safe Intersection Sight Distance (SISD) and, Minimum Gap Sight Distance (MGSD) where practically possible, as the circumstances require.

[Where an intersection is required in the vicinity of a crest vertical curve, it should be placed at the crest rather than immediately beyond the crest, where sight distance may be compromised.]

- Compliance with “turn treatments”.
- Provision of auxiliary lanes
- Provision of islands medians and kerbs where required.
- Provision for utility services, cyclists, pedestrians, disabled access, and lighting where required.
- Provision for 19m (and “B-Double” where on an approved route) articulated vehicle turning paths.
- Provision of signposting, pavement markings and furnishings, including raised pavement markers in accordance with TfNSW standards.
- Intersection angles should be perpendicular wherever possible, otherwise within the limits according to road design standards.

2.3. Roundabouts

Roundabouts shall be designed in accordance with Austroads and TfNSW Guidelines.

General geometric layout principles should be confirmed with Council prior to preparation of a detailed design. Particular attention will be given by Council to future traffic needs as they relate to the number and configuration of approach and circulating lanes. Wherever possible and appropriate, two approach lanes should be adopted. Pavement markings shall be utilised for dedicated traffic-lane movements. Two lane circulating roundabouts must employ two travel lanes at departures.

The following principles should also be addressed: -

- Roundabout shall be designed as on-grade cross fall unless council specifies otherwise.
- Circulating vehicle paths catering for a 19m Articulated Vehicle (AV). See Austroads / TfNSW including requirements for single lane and two lane circulating scenarios as appropriate.

- Council can determine a lower design standard for local streets and up to a local collector road. i.e. smaller island and larger anulus could be considered on merit.
- Consider roundabout pavement design requires as part of the geometric design process. See section 12.2 for pavement requirements.
- Adequate design capacity and strength, with a 40-year (min) design life.
- Appropriate sight distance and provision for future services, pedestrians, cyclists, drainage, lighting, signposting, and line marking.
- A maximum through-movement deflection radius in accordance with TfNSW Guidelines.
- An absolute maximum adverse radial crossfall of 4%
- Splitter islands, where pedestrian movement is expected, should be of sufficient width to accommodate “refuge” design parameters.
- Suitable landscaping in the central island (where approved) providing sight lines at the adopted design eye-height.
- Subsoil drainage for any landscaped (unsealed) areas.
- Subsoil drainage at the perimeter (upright) kerb returns.
- On-road cycleways are to be provided for arterial and sub-arterial roads and in accordance with the Bike plan.

2.4. Minor Intersections

2.4.1. Urban

In urban environments intersections configured within the standards of kerb radii and road-width within this Document shall generally be adequate for traffic access needs in local streets. Roads with higher levels of traffic usage such as Collectors or greater, should be assessed regarding traffic volumes and safe traffic usage in accordance with Austroads standards, addressing auxiliary lane potential for left and right turn manoeuvres. Use of regulatory signposting and linemarking in accordance with SD030 can usually accommodate most movements. Entry and exit movements for heavy vehicles that cross the road centreline within high volume roads are not permitted. (See “Kerb Returns” below)

Staggering of intersections, to achieve a desirable minimum separation distance of 40m between opposing road centrelines, is desirable on all road types. Four-way intersections on Trunk roads shall be roundabouts or traffic signals. Occasional four-ways on local to local streets is allowable but some treatments may be required such as central median, v-drain flush thresholds and/or other treatments to increase safety and visually distinguish priority of the intersection legs. .

2.4.2. Rural

In rural, or transitional urban/rural environments (being generally where the legal speed limit is greater than 60kms/h), and where single-lane two-way roads are impacted by a new road junction, intersections shall be assessed regarding traffic volumes and safe traffic usage in accordance with Austroads and TfNSW standards, addressing potential for auxiliary lanes for left and right turn manoeuvres, and flag lighting.

2.5. Kerb Returns

Kerb returns shall be provided at all road or street intersections. Any variations to this requirement are subject to Council’s determination, such as within RU zoned areas where returns may, if justified, be deleted.

An adequate kerb radius/road-width relationship shall be adopted for the maximum sized expected design vehicle (usually a 19m Articulated Vehicle - AV) to provide acceptable access to a subdivision and for manoeuvrability within intersections. In urban environments the usual minimum standard kerb radius is 8m, although, depending on the type or the Level of Service (LoS) of the intersection, Council shall determine an acceptable sweep path (and hence kerb radii) that may or may not employ cross-lane vehicle manoeuvres.

To cater for single-lane approach and departure for AV requirements at square intersections, the nominal minimum radius is 15m.

3. Public Transport (bus)

A public transport route within this Manual refers to an approved road type or route traversed by a bus. A "bus route" (not being a school bus route) is determined by:

- TfNSW and council, in consultation with the local bus providers consultation or
- A planning instrument (i.e. DCP, Precinct Plan) or
- Development Consent

Public Bus routes should be confined to roads providing a carriageway width of 12m or greater in R1 & B zoned areas when determining either the route along an existing road or determining the alignment of a new/proposed road.

School bus route can utilise roads down to 11m with consultation with council in conjunction with the local bus companies and Council.

Bus facilities such as bus stop and parking areas, signposting, set-down paving, and shelters shall be provided where required by Council, and designed in accordance with Council's requirements and Austroads Standards for individual items, as follows:

- Bus set-down verge paving and shelters where required shall conform to Council's standard
- Bus shelters, unless otherwise approved by Council, shall be the adopted style current at the time of installation.
- Road pavement for bus lay-by parking areas at major destinations such as business and school terminals, shall be provided in concrete.

Typically, shelters may be required as part of major release areas and may be located along a route within the release area or on a route nearby or adjoining the area.

For new subdivision release areas, the applicant for the development or the designer shall submit to Council verification of arrangements made (or otherwise) with TfNSW and local bus companies of public transport routes (existing and planned) and of any specific requirements for those routes, such as bus stop/set-down locations, for consideration by Council for implementation within the road design.

4. Structures

Designs related to concrete, masonry, steel, and timber elements, such as for bridges, large culverts, retaining walls, headwalls, subdivision entry features, etc, shall be carried out in accordance with relevant Australian Standards and TfNSW Design Standards, and shall be certified by a practicing structural/civil engineer.

All precast and pre-assembled structures shall be similarly certified for structural adequacy. Where design elements are ancillary to a Construction Certificate for *Roads & Drainage*, documentation shall be submitted to Council for each component.

4.1. Retaining Walls/ Benching

Retaining walls in this Manual relate to their location, design, and construction as part of a subdivision, and as part of a development (Document L: Lot Scale Engineering) whereby they are an integral part of a development approved with consent under the Environmental Planning and Assessment Act (EP&A Act). These guidelines may be applicable for other scenarios beyond the intent of this Manual.

Note: Within private lots, Council's DCP shall take priority over this section where discrepancies exist.

4.1.1. Location

These requirements are given for scenarios where a S138 approval, or a Section 68 of the Local Government Act (S68) stormwater approval may involve a retaining wall. Even in these scenarios council may still require that the some DCP requirements should still be met. The location of retaining walls shall be determined by Council and the design engineer and should adopt the following guidelines:

- In public Land – retaining walls are not supported or encouraged. The use of batters is the preferred method for grade changes.
- At public/road reserve boundaries – Fill retaining walls within the adjoining lots and on the boundary. Cut retaining walls shall be set back within the property to wholly contain the wall, footings, subsoil and any other features. Consideration of zone of influence into the road reserve shall also be considered. Zone of influence shall not extend to under the current or future road pavement and generally not under paths.
- At adjoining lots (common boundaries) – refer to council DCP
- At stormwater overland flow paths – within the dedicated flow path or easement, being of concrete or masonry construction suitable for a flow path.
- Obstructions, such as walls or any other above-surface structures are not permitted within easements including those that act as overland flow paths.

Retaining walls within stormwater drainage easements (Inter-allotment Drainage) are not desirable due to the potential interference with the stormwater pipe and difficulty for access to the pipe for maintenance purposes.

- If a retaining wall is permitted/required, then the following guidelines/actions should be considered:
- Avoidance of adverse impacts on the pipe from any structural elements of the wall
- Footings shall be finished below the zone of influence * of the drainage line and no loading shall be directly applied to the pipe without a detailed design demonstrating mitigation of the load.
- * The zone of influence is defined as a line drawn at 1:1 slope from the invert of the pipe.
- Maintenance of a reasonable means for physical access for personnel and light machinery to "lay, place and maintain a line of pipes" (Conveyancing Act).
- Adequate measures to eliminate any potential loading on a pipe that passes through a wall or its footing.

- If a retaining wall is permitted/required and an adjustment to the pipeline is also required, a review of the hydraulic design of the pipeline, such as Hydraulic Grade Line, surcharge, pipe capacity, etc, must be made to ensure that there is no compromise to stormwater flows, that may create an adverse affectation on properties that either benefit, or surround the proposed adjustments.

4.1.2. Design

Retaining wall design shall be in accordance with AS 4678 Earth Retaining Structures, and be certified by a qualified engineer, taking into account loads from existing or future anticipated dwellings, pools, vehicles, etc.

Excessive cut and fill and subsequent retaining structures are not desirable. Retaining wall heights for public land if supported, such as for road embankments shall be subject to Council's approval through development consent. The consideration of tiering versus high would be considered by council in each location and context of safety, fencing, maintenance and other

Where approved by Council, retaining walls shall:

- Be designed in accordance with the Australian Standards
- Be of the materials in the specified locations, as nominated in the section of the Manual.
- Where supporting a public/road reserve, be constructed in masonry or reinforced concrete.
- Where supporting lots adjacent to public/road reserves may be other than concrete/masonry, being installed in accordance with the manufacturer's recommendations.
- Where located within a public/road reserve, under justifiable circumstances, be constructed of reinforced concrete or an approved masonry specification.
- The subsoil drainage for the retaining wall must be connected to either the kerb and gutter, road pits, or an interallotment drainage system (which is sometimes located in front of the lot). NOTE: the retaining wall drainage cannot be directly connected to the road subsoil systems. The design must include detailed information on the subsoil drainage components of the retaining wall and its connection to the downstream system/discharge point.

5. Ancillary Design Requirements

5.1. Safety Audit

A Road Safety assessment, where required by Council, shall be conducted in accordance with the TfNSW Road Safety Audit process.

5.2. Traffic Control Devices (Traffic Committee)

Traffic control devices may include a sign, signal, marking, structure, or other device to direct or warn traffic (incl. pedestrians and cyclists) on a road or road related area that is prescribed by the regulations. Traffic control devices may also be of a type to reduce travel speeds to match urban design requirements where road geometry cannot provide that control. Such devises may also be used in conjunction with street landscaping and furniture.

The devices, including associated signposting and linemarking, shall be designed where applicable, in accordance with TfNSW, Australian Standards or Austroads guidelines, and Council's requirements. Any new and adjustment of regulatory signages and line markings will be presented to Council's Local Traffic Committee, upon receipt at Council of an acceptable engineering design.

Roads with an 11.0 metre (or greater) carriageway width, centreline and/or edgeline marking may be required. Raised pavement markers shall be provided where required by Council at intersections in accordance with TfNSW standards, in conjunction with line marking at locations that warrant particular traffic safety considerations.

The manoeuvrability of an articulated design vehicle shall be considered for traffic control devices.

5.3. Street Name Signs

Street signs shall be provided to Council's standard specifications and Standard Drawing SD029. An application for new street names shall be lodged with Council and be supported by adequate justification for the proposed names. Names shall conform to the guidelines of the Geographical Names Board.

5.4. Guard fence & Guideposts

Guard fence refers to any approved type of safety barrier such as concrete barrier/kerb, steel W-Beam or wire rope. Where possible, effective road design should aim to negate the need for guard fence. Where there is a warrant, and where unavoidable, guard fence shall be provided in accordance with the current TfNSW Design standards or as directed by Council. Guard fence on the outer edge of a road carriageway shall be located within a constructed or extended road shoulder which shall be bitumen sealed.

Guideposts shall be provided in accordance with TfNSW.

5.5. Pavement Edge Restraints

Concrete restraints such as kerbs, flush edge-beam restraints or kerb & gutter shall be provided on both sides of all roads on urban residential subdivisions as determined by Council.

5.6. Subdivision Staging and Temporary Turning

Staging of subdivision shall create staging boundaries that avoid the need for temporary turning heads. Temporary turning heads have been problematic as they have been inappropriately removed during construction of the next stages. This leads to safety issues and damage to public and private property as there is no suitable turning area during the next construction phase for garbage services, residentials and construction traffic.

Principal Control: The requirement is to have turning available including during the next stage of construction (without the need for management plans or temporary traffic control).

Stage boundaries should finish with a closed loop or at a T-head of a permanent intersection.

Trunk Roads shall a staged to create a loop due to the larger size vehicle and the road function (use of a local street is allowable to create the loop).

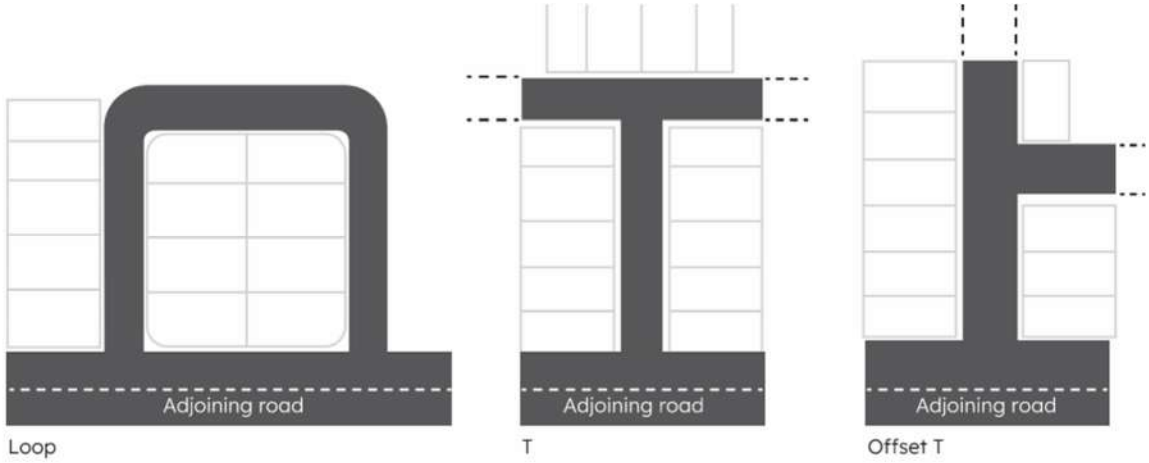
Any lot should not be released unless every road that adjoins its boundary is completed in the stage.

A chevron sight board shall be placed at the termination of the prolongation of the centreline of the road.

Stage boundaries need to consider utilities and design including stormwater and streetlighting. Any proposal may need extra pits for the temporary situation or change the stage boundary/turning solution to avoid the infrastructure and issue.

When staging at a permanent T intersection, the length of the legs shall be maximum 30 to 35 metres being the general depth of a lot.

The following examples are for use internal to the site



At property boundaries it may not be feasible to create a loop or T. Justification shall be provided for any alternate solution that can address the Principal Control

Temporary Turning Treatments – Only for use at the property boundary

Shall provide AC wearing course treatment due to heavy screwing turning movements.

Temporary turning 'heads' shall provide dimensions in accordance with SD027.

The following (temporary turning) Examples below are used at the site boundary where other permanent options are not feasible. See Standard Drawings for details

Figure: Temporary Loop, Temporary Offset T (see limitations on Std Dwg), and Temporary Cul-de-sac.
Note: Diagrammatic representation only – Turning and lots are Not To Scale

-Lots will be withheld from the stage where easements for access are needed. Easements to extend 4.5m behind edge of turning area. +
-Asphalt will be required in the gutter for vehicle comfort, etc, and stormwater pits (i.e. double V grate) need to be located at the upstream side
NOTE: DA approvals that pre-date this version of MoES can use the temporary cul-de-sac provided in MoES – D 2025.

Vehicle swept paths may be requested dependant on layout, or type of road. Major trunk roads and commercial/industrial will need to cater for the relevant design vehicle.

5.7. Driveways and Crossings

Also known as footway crossings or vehicle crossing is the section of driveway that crosses the road reserve between the front boundary and the edge of the formed road pavement.

A technical Document is provided for Driveway Crossings as there are multiple ways a driveway can be applied for and required. These include with building construction with a Development Application, Complying Development and simply as a driveway application outside of these processes. Additionally, subdivision of vacant lots also needs to demonstrate that a location for a driveway is feasible in the creation of each lot.

Development must use the Technical Document: Driveway Crossings to demonstrate that a compliant driveway location is being proposed, or for the scenario of a vacant lot that a location can be achieved.

5.7.1. Driveway Handles (dual)

Driveway handles, including battle-axe handles, can come in a couple of forms. Those are internal driveway corridors within subdivision or easement, and a battle-axe handle within lot access handle or an easement including a reciprocal right of carriageway / right of access.

Council's DCP is the governing document for Development Applications when access easements and handle widths are involved.

5.7.2. Rights of Access / Carriageway (No Handle)

Where site constraints dictate, particularly within the existing built environment, a right of access / carriageway in lieu of an access handle may be considered.

5.7.3. Underground Services

Services, including stormwater conduits, shall be provided within and along the full length of individual access handles.

5.7.4. Driveway Pavement

Driveway pavements shall be provided along the full length of the access corridor handle prior to issue of a Subdivision Certificate in accordance with Standard Drawing SD012, including splays at each end and may be shared between adjoining properties. Pavements within Rights of Carriageway for all zone areas shall be provided as heavy-duty "commercial/industrial standard" slab type reinforced concrete, or to a greater design as determined by expected usage.

In single-lot residential areas concrete drive wheel-strips within the handle length are encouraged in order to reduce impervious surfaces and hard surface expanse. Pavement widths are subject to an assessment for the potential for vehicle-passing and turning movements.

5.7.5. Linemarking and Signposting

All linemarking, pavement markers and signposting shall be set out in accordance with the approved plan or as varied by Council. All linemarking set-out shall be inspected by Council prior to placement. Warning signs and temporary pavement marks must be employed in any interim period.

Application rates for beads and paint shall be in accordance with Austroads.

All new linemarking and signposting on public roads must be carried out after ensuring the surface is clean and free of loose aggregate, if applicable. A clean surface ensures better adhesion of the linemarking materials and leading to more durable and visible markings. The work shall be completed as soon as practicable after the wearing surface is finished and ideally within one week of completion. This helps to maintain the effectiveness and longevity of the linemarking and reducing the risk of it being compromised by contaminants or traffic wear.

- Pavement marking materials are essential for road safety and clarity, each offering unique benefits and applications. Applicants should consult with Council covering with a single coat bitumen spray seal with 10mm (max) aggregate over an existing spray seal utilising a bitumen-spraying vehicle (or an alternative approved method for very minor needs) or,
- Removal by sandblasting or grinding on an existing asphalt surface.

6. Roads For Large– Lot Residential

For road dimensions refer to the Road Types - Table C of this Document. Subject to Council approval the follow design elements should be applied/considered:

- Road pavements shall be provided with an asphaltic concrete or bitumen wearing surface in accordance with the requirements of this Manual.
- The requirement for a table drains (swale) on the low side of the road is subject to specific design geometry such as downhill batter slope, road longitudinal grade and swale-drain relief. In situations where the batter slope is significant, the longitudinal grade is low, and the catchment area is small the swale may be deleted.
- In lieu of a swale, one-way crossfall on the road pavement against the natural topography is optional.
- Swale (or table drains) that may be crossed for vehicle access should be designed wherever possible to provide vehicle clearances for a dished invert crossing in accordance with AS2890, to avoid the necessity for a pipe crossing. Acceptable grades can often be achieved with reshaping of the natural surface within the property.
- In cut situations where a dished crossing is not practical, a 5m long, 375mm (minimum diameter) Class 4 new concrete or equivalent pipe, with attached sloping headwalls, shall be provided for each lot, preferably in the centre of the lot but subject to adequate sight distance requirements. The pipe size should provide sufficient capacity for the 10% AEP storm event for the contributing catchment area or sized to take the majority of the table drain flow, ensuring that major overflows and driveway overtopping can be contained within the road reserve. Driveway details are shown on Council's Standard Drawing SD013.

7. Rural Roads

Rural roads in this Manual are assumed to be new roads within RU zones that either, service rural properties fronting the road, or roads (new or existing) that extend access to those roads from an existing public road. Such roads do not usually relate to existing rural roads under Council's control, such as a classified "main road", although Council may apply the design principles herein to those roads where works on those roads are necessarily the subject to development consent.

The parameters shown in Road Types - Table C of this Document are specific to subdivisions with a minor vehicle catchment; otherwise, rural road & drainage design shall conform generally to the parameters required by Council based on Austroads and TfNSW design guidelines.

7.1. Rural Design Elements

Subject to Council approval the follow design elements should be applied/considered:

- Rural roads shall be provided with a two-coat bitumen flush seal wearing surface across the full formation width.
- Table drain (swales) shall be grassed with a stable medium such as a jute-mesh type product or similar means.
- Driveways for vehicle access shall be provided, including a recessed access where appropriate where a vehicle with trailer can park clear of the road pavement.
- Clear zones shall be provided in accordance with the Austroads & TfNSW Design standards.

PAVEMENT DESIGN

In general, all infrastructure elements whether public or private including community title subdivisions and lot-specific features must be designed to last for the relevant design life of 25 to 40 years, unless higher durations are specified within MoES or by relevant standards including Australian Standards.

The minimum design life for road pavement including public and private (such as community title subdivisions etc.) shall be:

- Flexible, 35years (Unbound Granular and containing one or more bound layers)
- Rigid (Concrete) - 40 years
- Private roads - 25 years including Segmental Block

8. Road Pavements

All road pavements shall be designed in consideration of design traffic loadings and evaluation of subgrade materials, environmental factors, and available materials.

8.1. Pavement Types

Typical pavement types are as follows:

- Unbound granular flexible pavement which may contain one or more modified layers.
- Bound granular flexible pavement.
- Rigid pavements (concrete)

8.2. Design Report

For purposes of determining an acceptable sub-grade & pavement design, designers should satisfy themselves that the pavement materials will perform to achieve the pavement design life, and that the design will satisfy characteristic deflection testing for construction purposes.

Refer to Document C: Construction and Appendix D for pavement material specifications and testing requirements.

A pavement design for all new road works shall be prepared for approval by council, subject to a geotechnical engineer's report. The report shall utilise 10 day soaked "Californian Bearing Ratio" (CBR) testing undertaken on the relevant subgrade in accordance with AS1289 and shall recommend a

design CBR and a pavement design thickness, determined using the methods outlined in Austroads standards for pavement design, based on Council's minimum standard Equivalent Standards Axle (ESA) requirements. Sub-grade and/or pavement material modification may form part of the design. The geotechnical report and pavement design report shall be submitted with the engineering plans. The engineering plans shall show pavement layer thicknesses (including the nominated ESA and design CBR parameters) based on the reports. Where alternative pavement designs are offered, the alternative design shall be presented by the supervising geotechnical engineer and be submitted to the council Engineer for approval prior to construction of the pavement. Generally, pavements shall be consistent over long lengths of road, such that alternative designs for short sections of pavement are avoided.

In deep cuttings, fills or other instances where testing of subgrade is not possible until completion of bulk earthworks, pavement design or re-evaluation of a design shall occur upon assessment at subgrade level.

8.3. Minor Pavement Works

For minor works within a public road (such as short lengths of shoulder, kerb & gutter in-fill, minor road widening or access works) full testing described above may not be necessary, subject to an engineer's assessment.

Minimum requirements may be as follows: -

- 30mm AC10 over a 10mm primer seal or a 2-coat bitumen seal.
- 300mm minimum compacted thickness of a granular base course material for low-traffic roads (200mm may be considered for very minor traffic loadings) and 300mm minimum compacted thickness of a heavy bound granular base course for heavy-traffic roads and industrial areas.
- A compacted and stable subgrade.

Alternatively, the developer may submit a design report for alternative pavement treatments.

8.4. As-Built Records

Records of actual pavement construction, including where pavement amendments occurred, or where alternative pavements were approved, together with any subgrade replacement or modification, shall be collated as a final report to accompany the Works-As-Executed (WAE) plans and documentation.

9. Design Traffic Loadings

The design traffic loadings of Equivalent Standard Axels (ESA) are provided in the Road Types table in Section 1.1.8. The nominated values may be increased by Council, subject to an assessment of any special circumstances for subdivision or development, where a higher value is adopted, based on ultimate traffic generation for the catchment area, originating from:

- Strategic planning for future rezoning of land.
- Ultimate development of current zoned land.
- Staging of works and the resultant development and construction traffic.

Council or the TfNSW reserve the right to nominate specific ESAs for Arterial roads such as a State or Regional roads. A general minimum of $1x10^7$ will apply.

10. Subgrade Evaluation

Investigation and testing of existing subgrade materials shall be conducted by a practicing geotechnical engineer (Level 1 responsibility AS3798) using a NATA-registered laboratory in accordance with AS 1289.0. A pavement design report including subgrade investigation and 10-day soaked CBR test results establishing the "design CBR" and "shrink and swell results" must accompany the Subdivision Work Certificate or equivalent design approval process and be submitted to Council for approval.

Design subgrade CBR shall be determined in accordance with current Austroads, TfNSW Supplements and Australian Standards. At the time of publication these were Austroads Guide to Pavement Technology - Part 2 Pavement Structural Design', A Supplement to Austroads Guide to Pavement Technology Part 2: Pavement Structural Design, Roads and Maritime Supplement to Austroads Guide to Pavement Technology Part 2: Pavement Structural Design and AS 1289.0.

The testing authority shall confirm in writing that the location and depth of testing has been adequately defined, and what method and survey accuracy was used to positioning and height. The evaluation must assess natural material properties as follows:

- To a depth of one (1) meter below the design pavement subgrade levels (unless rock is encountered).
- With sample data recordings of borehole logs at intervals no greater than 50m and testing at intervals no greater than 100m.
- In variable conditions, the intervals shall be reduced to each homogenous sub-sections of subgrade.
- A minimum of two (2) samples must be taken for the of each lot (work lot) and/or road segment.
- Each soil layer with each log shall be tested and the lowest/poorest result used as the governing input fore all relevant factors including CBR, shrink/swell/fit for purpose.
- Council must be satisfied that the location and depth of the test samples have been accurately surveyed to ensure they represent material that will remain in place when the subgrade is exposed.

Assessment of the supporting subgrade strength shall conform to Austroads Pavement Design guidelines. All pavement investigations and designs by the geotechnical engineer shall include comments on Austroads AGPT02 and supplements, and TfNSW Supplements, addressing the extent of testing, site investigation, assessment, and pavement design.

The report will include discussion and consideration on section 5.3 AGPT02 Factors to be considered in estimating subgrade support. Including but not limited to:

- subgrade variability
- target compaction moisture content and field density achieved
- moisture changes during service life
- pavement cross-section
- the presence of weak layers below the design subgrade level
- What allowances have been made for any changes in subgrade moisture content that may occur after construction while the pavement is in service.
- 5.3.5 Moisture Changes during Service Life including saturation or drying of the shoulders due to influences of street trees, utility crossing, water mains and stormwater
- Expansive soils and Volume changes
- Edge effects generally within the 1 to 2 metres of the sealed surfacing.

Subgrades need to be improved when subgrades are either soft and or expansive in accordance with TfNSW Supplement to AGPT. Table is provided below however further requirements are contained within the supplement.

DESIGN SUBGRADE CBR	CBR	SWELL
	<2.5%	≥ 2.5%
<2%	Working Platform Needed	Working platform and capping layer
≥2%	N/A	Capping layer

Working platform is minimum 200mm thick for presumptive CBR 3.

Design provisions shall be provided for Expansive subgrades. 10-day soaks shall be used due to Maitland rainfall conditions (eg 5.6.2 AGPT02 and Table 6 TfNSW Supplement)

Determination of moisture conditions

A select layer shall be added – between at least 300mm to 600mm thick as recommended by the Geotech engineer to be **fit for purpose and achieve the design life for the reasonable moisture range for the life of the pavement**

The select layer shall be 'in addition' to the minimum (Empirical) pavement design as per section 12 below. i.e. Do not use mechanistic design to reduce the buffer distance.

Design of select layer must include:

- permeability < $5x10^{-9}$ m/s
- CBR > 8%
- swell < 1.0%
- A select (capping layer) shall be between 300 and 600mm thick as justified by the geotechnical engineer to achieve the design life and project reliability
- Out of specification quarry gravel unless a homogenous site product to verified too, and approved in writing by Maitland City Council (MCC).

11. Subsurface Drainage

Subsurface drainage must be provided to protect the subgrade and pavement in locations that necessitate its use such as boxed construction, cuttings, or areas with high water tables or in areas where subsurface moisture requires treatment.

Subsoil drainage pipes shall be provided on both sides of road pavements and where required by design, at new-to-existing pavement joints (see SD003, SD035 & SD032)

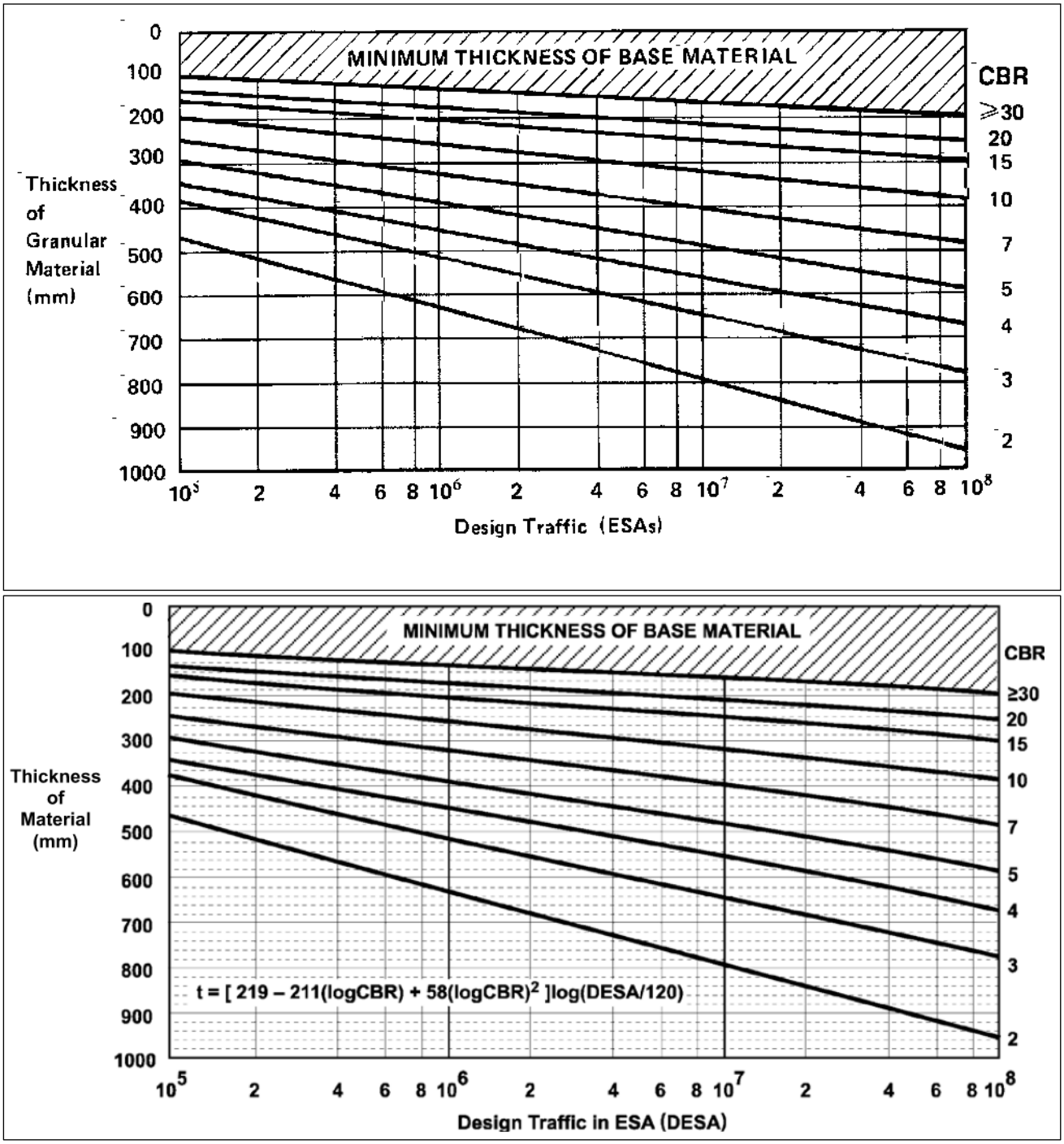
Where highly expansive soils and/or high moisture conditions are encountered special care should be taken for the placement of subsoil drains with respect to the any potential adverse effects upon the road pavement from significant moisture removal from the deeper levels of the subgrade.

12. Pavement Design

Public road pavements shall comprise of at least one subbase layer and one basecourse layer with a sealed wearing surface. Pavement layers may be combined into a single layer of base course material.

12.1. Flexible Pavement

Pavement thickness designs shall be based upon assessed subgrade strength and the following charts, with the nominate/approved traffic loadings.

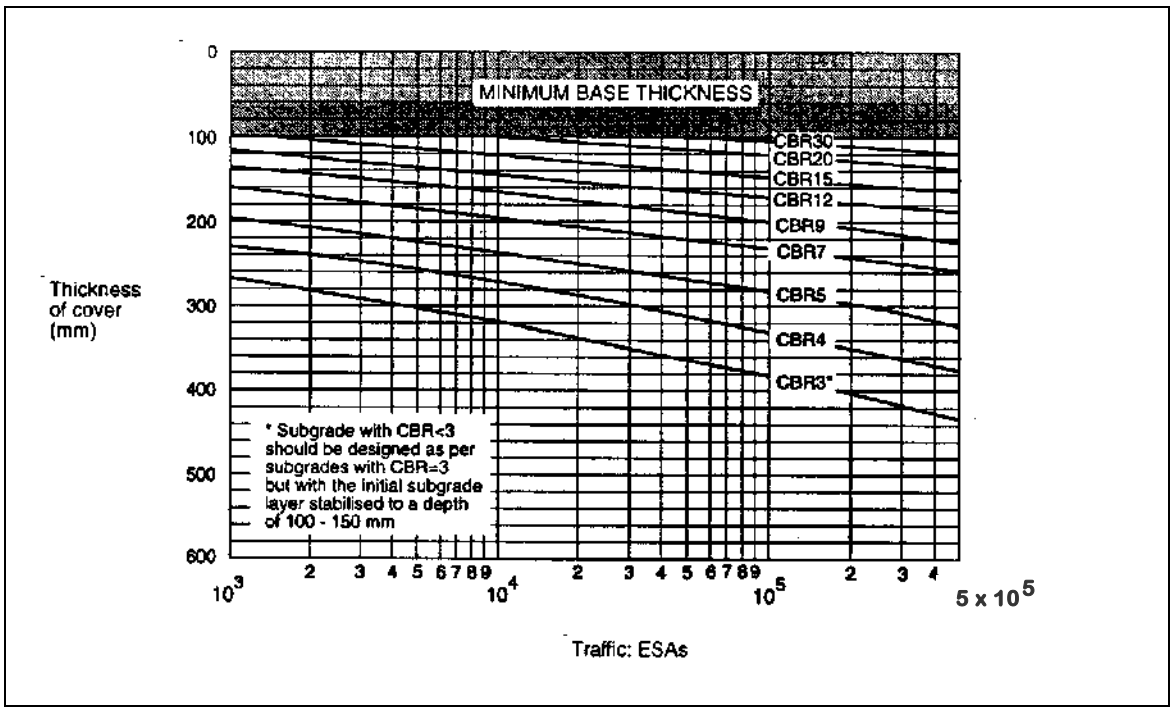


Design chart for granular pavements with thin bituminous surfacing.

From Austroads Pavement Design Guide.

The minimum pavement thickness for flexible pavements will be derived as follows:

- Overall pavement thickness shall be a minimum of 300mm (excluding any select layer).
- The asphalt thickness (AC) shall be excluded from the total granular pavement calculation.
- Base-course shall be determined from the Pavement Thickness Design Chart, where the minimum thickness is 100mm. Ideally the depth is 150mm to align with kerb depth.
- Sub-base thickness shall be determined from the Pavement Thickness Design Chart, using the relevant CBR curve by subtracting the base-course layer thickness from the required total pavement thickness. Irrespective of the foregoing, the minimum sub-base thickness shall not be less than 125mm.
- Any Select or capping layers shall be additional to the minimum pavement thicknesses determined by the charts
- Asphaltic concrete (AC) thickness shall have a minimum thickness as follows
    - Local Streets up to $4x10^5$ - 30mm thick DG10 gap graded mix
    - Design traffic over $4x10^5$ - 45mm thick DG14 dense graded mix.
- The pavement designer should be satisfied that the design will meet the requirements of this Manual in respect to permissible deflection and pavement life.
- Where a combined sub-base/base single-layer (with for example bound materials) pavement is proposed, a geotechnical engineer shall report on the proposal, nominating the materials (source) and relevant compaction and testing methods.



Design chart for granular pavements with thin bituminous surfacing.

Based on a 90 percent confidence level (for minor rural roads).

12.2. Rigid Pavement (Concrete)

Rigid pavements on public roads shall be designed in accordance with the following documents:

- Concrete Pavement Design for Residential Streets - Cement and Concrete Assoc. of Aust.
- Pavement Design - Austroads Standards
- TfNSW supplements and directory notes to Austroads standards.
- TfNSW Concrete Pavement Manual.

Minimum thicknesses shall be:

- Sub-base - 150mm minimum
- Base - 170mm minimum

The base shall be jointed, reinforced concrete.

Details prepared by an engineer, are required for (but not limited to):

- Subgrade preparation to achieve a design CBR.
-
- Rigid Pavement thickness and design: Determine the pavement thicknesses/design as follows:
  - Design traffic up to 10^6 ESAs will use Austroads AGPT02 (including Figure 12.2 for Ver 2019).
  - Design traffic over 10^6 ESA will use Austroads AGPT02 (including Figure 8.4 for Ver 2019).
- A nominated maximum slump and testing procedure
- A proposed thickness for sub-base and base courses
- Steel reinforcement
- Joint types and locations
- Interface treatments between layers.
- Placement, compaction, surface texture and curing methods.
- Nominating the finished surface to be rake-textured in accordance with the TfNSW rake specifications.
- Nominating the application of a curing agent.

12.3. Segmental Block Pavement

Segmental block pavements, where permitted, shall be constructed of concrete or clay pavers. Such pavements shall be designed in accordance with the following: -

- Clay segmental block pavements: -
- Up to 10^6 ESAs – Clay Segmental Pavements – Design manual, Clay Brick and Paver Association.
- Between 10^6 ESAs and 10^7 ESAs – The design will involve the above document and Austroads Pavement Design Manual with the method producing the thicker design to be adopted.
- Over 10^7 ESAs – Austroads Pavement Design Manual.
- Concrete segmental block pavements.
- Up to 10^6 ESAs – Cement and Concrete Association Technical Note 35.
- Over 10^6 ESAs – Austroads Pavement Design Manual.

Concrete pavers shall be 80mm thick Shape ‘A’; clay pavers being 65mm thick Class ‘4’ being laid in a herring bone pattern. All areas of block paving shall be provided with a suitable concrete edge

restraint. Large paved areas shall be bedded and laid in accordance with the supplier's guidelines. Allowance must be made for an adequate number of expansion joints and restraining beams.

Shape "C" concrete pavers may be permitted in small infill areas such as residential street thresholds. (see below)

12.4. Accessways

Accessways to specialty-use areas or facilities such as public utility plant, parks, pollution control devices etc. where heavy vehicles are expected to gain access, shall be a minimum of 3.5 metres wide and constructed in concrete in accordance with the publication by the Cement and Concrete Association of Australia – "Concrete Pavement Design for Residential Streets". Generally, the following parameters shall be maintained (see SD012):

- 150mm thick.
- 32 MPa 28-day strength.
- Two layers of SL72 mesh fabric.
- Sub-base, 100mm compacted thickness of "road-base" material.

12.5. Roundabouts Pavements

All roundabout road pavements servicing industrial subdivisions or commercial areas shall be constructed of fibre reinforced concrete in accordance with TfNSW Concrete Roundabout Pavements: Technical Guide Issue 4 or greater.

All roundabout road pavements servicing residential subdivisions shall be constructed of 190mm AC base and wearing course (A15E binder) with heavily bound sub-base or 5MPa concrete sub-base. Council may require a concrete roundabout for significant locations such as large sub-arterial roads, large numbers of heavy vehicles or other.

Adequate design capacity and strength, with a 40-year (min) design life for concrete. For other pavements add additional ESAs to the largest connecting road type (see section on pavement design). Increased heavy vehicles may need additional ESA considering Industrial or sub-arterial sized ESA's. See Rigid Pavements

12.6. Intersection Thresholds

Where intersection thresholds are approved, they shall be provided in accordance with Standard Drawing SD025 – sheet 1, as a "heavy duty" plain concrete pavement as shown on SD012, with reference to SD026 where a dished drain is necessary.

Coloured concrete is not considered a satisfactory long-term treatment, but where approved, colour additive must include hardener (75-90MPa), be applied as a minimum of two coats and be sealed with a polymer solvent based sealer. Texture may be applied to a maximum depth of 5mm.

12.7. Pavement Joints

All vertical pavement joints (new-to-existing), whether longitudinal or transverse, shall be benched a minimum of 300mm. (with reference to SD032). Pavement joints and the wearing course shall be positioned away from lane edge lines and under wheel paths to avoid accelerated wear and cracking.

Unless the adjoining pavements consist of the same material, and satisfactory compaction bonding of those materials can be achieved, subsoil drainage shall be provided in accordance with TfNSW QA Spec R37 “Intra-pavement Drains” at the direction of Council or the geotechnical engineer.

13. Wearing Course

For the application of bituminous surfacing, refer to Document C: Construction.

For alternative decorative finishes, Council’s approval is required to use such finishes in public roads. Smooth and/or irregular surfaces for roads and footway crossings, such as “deep-stamped” or “exposed river gravel” paving, is not permitted. Supporting documentation shall be submitted with any request to decorative finished products and shall include: -

Full specifications of the product.

- Durability and colour fastness
- Skid/abrasion resistance.

14. Existing Pavement Reconstruction

Where required by Council, existing road pavements shall be reconstructed, rehabilitated or re-surfaced. A pavement design shall be prepared for and approved by Council based on this Document adopting an ESA value as determined by Council.

Where new works abut an existing natural gravel pavement, it is preferred that the new pavement materials be an approved natural gravel in accordance with the specifications of this Manual. (Refer to “Pavement Joints” above).

Circumstances where construction works may be necessary are:

- Where either the existing pavement or surface quality are assessed by Council as incapable of sustaining the additional traffic loads from the development
- Where vehicle turning movements occur, such that an asphalt wearing surface is appropriate to control premature surface deterioration.
- Where a longitudinal surface profile is significantly irregular
- Where surface shape (e.g. crossfall) does not conform to standard design parameters.
- Where small local “patching” type pavement failures are required by Council.
- Where works coincide with Council’s Forward Works *Management Plan*.

The limits of such works shall be determined by Council, but will normally be applied to development that:

- Creates new intersections onto an existing road.
- Requires shoulder or parking lane works.
- Warrants new or replacement kerb and gutter.
- Has frontage to or requires vehicle access along an existing road that exhibits stress and/or has significant surface deterioration, and (subject to geotechnical testing) exhibits a failure to meet design requirements in this Manual.

Best design practice shall be employed such that a holistic approach is achieved, eliminating partial (“patchwork”), or part-lane, pavement sections

STORMWATER DRAINAGE

15. General

This Document addresses stormwater design for the development of land (principally as greenfield subdivision sites) and does not assume coincidental influence from Hunter River flooding beyond normal flow levels, nor addresses drainage structures which may be affected by flooding of the Hunter River. Drainage structures inundated by such flooding are not prohibited by this Manual, although particular requirements may apply.

Stormwater drainage systems shall be designed to achieve the following goals:

- An underground “minor system” of conduits that eliminates inconvenience to traffic and pedestrians.
- An overland (open style) “major system” that conveys stormwater flows within suitable velocity/depth limits, generally located within public land for residential zones, or where approved or unavoidable or undesirable to council in rural, within private land covered by an easement.
- Detention of stormwater flows that mimics natural, pre-developed flows for all storm events up to and including the 1% AEP storm event.
- Retention of stormwater flows to achieve target water quality standards.
- Control of stormwater flows to minimise the impacts of erosion and sediment in the environment.
- Consideration of upstream and downstream catchments in their ultimate developed state to achieve a total system which does not adversely affect existing systems or properties within the flow path and catchment.
- Minimisation of the maintenance burden of Council
- Enhancement of the urban landscape.
- Employment of principles of Water Sensitive Urban Design and Stormwater Reuse.

16. Design Standards

Drainage design for roads, reserves, and inter-allotment systems the subject of this Document, shall adopt the principles of a major/minor drainage system in accordance with the current publication of Australian Rainfall and Runoff (ARR) and Australian Runoff Quality (ARQ) and as specified in this Manual. Other accepted reference material may be used, with acknowledgement.

All calculations must be carried out by competent persons, qualified, and experienced in hydrologic and hydraulic design, utilising drainage models that are accepted as current industry standards.

The requirements of Council’s Hunter River Floodplain Management DCP shall be observed for all developments.

17. Hydrology

17.1. Rainfall Data

Rainfall Data and other parameters shall be derived in accordance with ARR for the particular location and catchment. The ARR Hub and Bureau of meteorology websites provide details.

MUSIC Input Parameters for the Maitland area may be available from Council.

17.2. Annual Exceedance Probability

Minimum design Annual Exceedance Probability (AEP) for the major/minor systems are:

Minor System

MINOR SYSTEM	AEP (%)
Residential 'R1' & 'R5' (Streets and IAD)	10
Business 'B' & General Industrial 'IN' (Streets and IAD)	10
Public & Drainage Reserves (acting as flow paths)	10 (1)
Rural 'RU' - Longitudinal Drainage	20

Major System

MAJOR SYSTEM	AEP (%)
Urban trunk drainage conduit at road crossing	1% plus freeboard (2,3)
Rural – Low-point Culvert Crossings	5 (4)
Overland flow paths & trunk drainage	1 (5)
Structural adequacy of major drainage items	PMF (5)
Land depressions with no outlet	PMF
Safety including pedestrians/vehicles Safety for vehicles only	0.4 m^2/s. Max velocity x depth product and 0.2m max water depth 0.6 m^2/s. Maximum VxD

Notes:

1) May be reduced (minimum being20% AEP) only in special circumstances, subject to specific design merits.
2) Freeboard at the road reserve could be ignored for local streets (excluding trunk roads) if velocity x depth product is achieved, and alternative routes exist.
3) Depending on road hierarchy. Typically (subject to Council approval), Distributor Roads and higher should provide flood-free access up to the 1% AEP. Lower order roads may be inundated, with a design aim to maintain at least single-lane traffic movement in the 1% AEP.
4) Applies to minor roads. The 1% AEP event shall be catered for, typically including a causeway with signposting and water depth markers.

5) Probable Maximum Flood (PMF)

As a first step approach, the designer should attempt to contain the whole of the major storm discharge within the road and footway cross section. (see ARR: Book 9 Runoff in Urban Area, Chapter 5: Stormwater Conveyance).

Trunk drainage system (major) shall be provided when the minor system exceeds 10% AEP, or under road pipe size is unreasonable, generally 15 hectares maximum catchment need to convert to major system open channels or similar. See D19.1 Overland Flowpaths

Council may require that the design AEP's for the subject drainage system be varied in certain circumstances.

17.3. Catchments

The catchment at an outlet is defined as the limits from where surface water will make its way by either natural or manmade features to this outlet.

Catchment area land-use shall be taken into consideration and be based upon current and possible future planning constraints and zonings. The ultimate developed state of each catchment shall be adopted. Notwithstanding the table below, in some areas Council may nominate design parameters regarding higher urban density uses.

Catchment plans showing the proposed pipeline layout shall be included in Engineering Design plans.

17.4. Fraction Impervious

Hydraulic calculations shall be based on the following fraction impervious figures:

Fraction Impervious Rates for Land Uses

LAND USE	FRACTION IMPERVIOUS (MAX)
Residential Low Density (Min lot size – m^2)	
<1500	0.75
1500 to <2500	0.5
2500 to <4000	1000 sq.m
Over 4000	1250 sq.m per lot
Medium Density Residential Zones and Small Lot Density	0.8
Road Reserve	0.8

Business Areas	1.0
Industrial Areas	0.9
Active open space - Public Recreation Areas (mowed and with improvements)	0.4
Passive open space - Parkland, Natural Public Reserve	0.1

17.5. Coefficient of Runoff

Coefficients of runoff shall be determined in accordance with ARR. Full details of coefficients used shall be provided in the calculation documents.

17.6. Partial Area Effects

17.7. Rational Method

Rational method has predominantly been superseded in ARR and may only be used for small scale developments at Council's discretion. Rational method calculations to determine peak flows shall be carried out in accordance with ARR, utilising the Kinematic Wave equation or an appropriate computer programme. Time of Concentration and modelling parameters shall be in accordance with ARR. The surface roughness coefficient, pipe capacity check, and pit inlet efficiency are provided in Appendix C.

17.8. Hydrological Models

Hydrologic and hydraulic models (such as RAFTS, DRAINS, MIKE 11, or HECS-RAS) shall be utilised for subdivisions and large-scale developments, providing the requirements of the latest ARR are met. Summary of calculations shall be provided within Engineering plans. Where computer analyses are used, details of all programme program input parameters and output data files shall be provided in the stormwater report.

18. Hydraulics

18.1. Hydraulic Grade Line

Hydraulic calculations shall substantiate the hydraulic grade line (HGL) adopted for the design of the system and shall be shown on the drawings.

Controls for a downstream hydraulic grade line design are as follows:

- Hydraulic grade line levels based on downstream calculations including pit losses at the starting pit in the design event.
- If the downstream start point is an existing pit and the HGL is unknown, a level of 0.15 metres below the pit inlet in this pit shall be adopted.
- If the downstream start point is an outlet into an open channel and;
- the design storm is the minor event, the outlet pipe shall be the downstream control,

- the design storm is the major event, and the design flood levels in the channel are unknown, the top of the outlet pipe shall be the control,
- The flood levels are known, the control shall be 1% AEP flood level.
- Where appropriate the Hunter River Flood shall be considered as an outlet control.
- The HGL level in drainage pits shall be not higher than 150mm below the top of the inlet grate, gutter, or lid in the minor storm event.

18.2. Underground Drainage System

Drainage systems shall be designed as gravity systems and as an overall pipe design having due regard to upstream and downstream systems.

Dual pipes are not supported longitudinally under pavement/kerb (including piping above 10% AEP).

18.2.1. Pipe Conduits

Minor drainage pipe/conduit systems shall conform to the following requirements:

Piped Conduit Requirements

PARAMETER	REQUIREMENT
Minimum pipe size	375mm
Minimum box culvert size	600mm wide x 300mm high
Minimum flow velocity	0.6m/sec.
Maximum flow velocity	6.0m/sec (1)
Minimum pipe grade	0.5% (2)
Minimum pipe class	2 for drainage reserve, 4 under kerb line and road crossings .
Pipe Depth - Under road -crossings and longitudinal (6) and to neighbouring sites	1.1m between top of collar and invert of kerb

Notes:

1. If exceeding, subject to greater scouring considerations and velocity/depth coefficient.
2. Unless otherwise approved in writing by Council Engineers.

- Pipe size reduction, from large upstream pipes to smaller downstream pipes is not permitted, unless approved in writing by Council.

The designer shall nominate on the plans all specific pipe details and their alignment and level. All drainage pipes within Council controlled drainage systems and to be dedicated to Council shall be

reinforced concrete rubber ringed jointed (RCP) spigot and socket type. Concrete pipes shall comply with AS 4058 “Precast Pressure and Non-Pressure Pipes”. The class of pipe proposed will be determined to suit the design use and shall comply with the Concrete Pipe Association of Australia (CPAA) minimum cover or Australian Standard 3725 “Loads on Buried Pipes” requirements. Fibre reinforced (FRC), Blackmax and plastic pipes are not permitted for public system.

Pipes should be provided with sufficient cover to avoid conflicts with service conduits (see pipe depth), ensuring adequate protection from damage during construction and to prevent pipe collars from protruding into the road pavement.

18.2.2. Box Conduits

Precast reinforced concrete box culverts (RCBC) shall comply with AS 1597. The minimum size shall be 300mm high by 600mm wide. Only cast in-situ slabs are permitted for box culverts in public ownership; precast base slabs are not supported.

18.2.3. Pipeline Radii

The minimum radius on which pipes may be laid shall not exceed the manufacturer’s recommendation. Where smaller radii are required, the designer should consider short pipe lengths, extended collars, or alternative chord configuration.

18.3. Trench Stops

Thrust blocks/collars shall be provided generally where pipe grades exceed 12% and/or in embankments for storing water, to prevent seepage piping.

18.4. Pits

18.4.1. Pit inlet capacity

Blockage factors of 0.5 (50% blocked) for sag and 0.8 (20% blocked) for on-grade pits shall apply in the major storm calculations. Consideration of applying a factor to the minor storm should be considered where excessive debris is likely to be a factor.

18.4.2. Pit locations

Pit locations shall be provided to:

- Prevent ponding.
- Allow change of alignment, grade, or pipe size/number.
- Enable adequate vehicle entry points to lots. Preferably, pits should be located:
  - In the central section of lot frontage in residential areas, and
- At the high side of each lot in industrial areas, immediately downstream of the prolongation of the common side boundary, in order to provide direct discharge points for each individual lot, and/or IAD drainage systems.
- Prevent gutter flows crossing an intersection and/or a pram ramp.
- Limit flow widths to table below:

Overland Flow Parameters (10% AEP)

GUTTER FLOWS	WIDTH
Gutter flow at intersection	1m
Gutter flow at bus stop and pram ramps	0.5
Gutter flows general	2*
Pits upstream of kerb returns	<30m radii
*During major storms, one lane in each direction of travel free of water must be achieved in a multi-lane road and a width of 3.5m (one lane width) clear of water down the centre for residential streets. Water depth shall be limited to top of kerb to prevent flow from the roadway entering onto the property.	

Subject to the above table, the maximum recommended spacing of pits is: -

Maximum Pit Spacings

PIPE SIZE	SPACING
Less than 1200mm	80m
1200 or larger	100

18.4.3. Pit construction

Pit Construction shall conform to Council's Standard Drawings. Non- standard pits include; greater than 2.5m high or 900 long, or 1450 wide and with oversized soffits, should try to be avoided. Where needed shall be designed by a structural engineer, and the details provided in Engineering design plans.

Pre-cast pits for public infrastructure

- have structural certification and list conformance to relevant Australian Standards.
- shall be a minimum 150mm thick for pipes of 600mm diameter or over
- <600 diameter shall be a minimum 150mm thick for every pit unit/riser
- all protrusions including pipe and subsoil are to provided. No cutting or modifications are allowed as structural certification is voided
- 100mm cover of all block-outs to side walls, top edges and soffit, (sub soil on merit)
- shall only be 4 sided rectangular pits
- minimum 200mm clearance from top of soffit to bottom of precast lintel/grate units i.e. 350mm from top of soffit to seal/lip of gutter

- rebates shall be provided at lift joints, flush joints are not generally acceptable.
- Not appropriate for multi cell wall protrusions

18.4.4. Extended Kerb Inlet (EKI)

Lintels shall have a desirable maximum nominal length of 3.6 metres and a minimum nominal length of 1.8 metres. In brownfield developments, a minimum nominal length of 1.2 meters may be considered under extreme circumstances and limitations. The general maximum in industrial areas shall be 2.4m to avoid potential breakage due to heavy loads. Nominated kerb inlet length refers to clear opening length, (refer to SD039 for details). A 150mm minimum race depth shall be provided at lintels.

18.4.5. Step irons

Step Irons shall be provided in pits deeper than 1.2m from pit invert to top of kerb. Step irons are to comply with AS1657 and start no lower that 600mm below invert of gutter with 300mm spacings.

18.4.6. Benching

Provide benching in pits to reduce ponding and sediment, and improve hydraulic efficiency.

18.4.7. Grates

Grates shall be provided at all pits unless directed by Council or as specified on the plans. Grates in road/public lands shall be provided with lock-down 'J' bolts. Road gutter grates shall be a minimum of 900mm long and shall include RHS steel reinforcement supports of the grate at both the lip line and the gutter line. Grates in pathways shall be "bicycle safe" to avoid tyres entering grate, to the manufacturer's recommendations.

Grate loadings shall conform to the intended use of the grate or adjacent area.

Class B type grates may be utilised in parks and reserves. Class D type grate shall be utilised in roads.

Grates within flowpaths such as table drains, catch drains and watercourses, shall be "raised" (see SD041).

Grates which may be subject to blockage by tree branches, twigs, leaf litter etc, shall, unless approved otherwise by Council, be typically an TfNSW "median pit" raised grate (TfNSW Drawing No. MD. R11.B33.A.1 or similar), providing a grid opening of 150mm x 200mm.

18.5. Hydraulic Losses

The pressure change coefficient "K" shall generally be determined from the 'Missouri Charts' and the 'Hare Equations'. The Hare Equations shall only be used as a guide and the Missouri Charts shall have precedence where discrepancies between the two exist.

Computer program default pressure change coefficients (K) shall not be acceptable unless they are consistent with the above statement.

Pipe friction losses and pipe sizes in relation to discharge shall be determined using the Colbrook White Formula with the following coefficients for roughness, unless circumstances exist that may give effect to "poor" pipe surface quality:

Pipe Friction Losses

PIPE TYPE	ROUGHNESS COEFFICIENT
Concrete Pipes	0.15
FRC, PVC, PE, PP	0.03

19. Overland Flow Paths

General

Flow paths shall be provided to convey runoff from rainfall events that exceed the minor pipe system capacity. Flow paths shall cater for the 1% AEP flows. These flow paths shall be public roads and drainage reserves linked to provide a continuous flow at acceptable velocities and depths.

For reasons of public safety, the coefficient of velocity and depth, should not exceed 0.4 for the major storm event (v.d < 0.4). Higher velocity, depth products may be permitted by Council where a risk assessment shows limited adverse effect to public safety such as in rural areas.

Where flow paths other than the normal road reserve are necessary, the minimum corridor width shall be minimum 3.5m running parallel to a road reserve and shaped to contain the 100-year flows within an open channel (major system drainage). Overland flow paths as 'pathway corridors' between lots are not supported in low to medium density residential areas due to poor CPTED. See D 1.3.2 When running along open space, etc, where one side has full casual surveillance, should have as a minimum treatment a concrete invert, and the remaining area of the flow path fully turfed with couch grass (beyond any concrete paving). The flow path shape shall provide reasonable access for vehicles where necessary for maintenance purposes and on the low side of a road should incorporate a weir within the section of the footway crossing, ensuring that property boundary levels are flood-free (with 100mm minimum freeboard), thence graded to direct the major storm flow downstream. A Typical flow path section is shown on Standard Drawing SD037.

Overland flowpaths (public stormwater) are not supported over private property and should be dedicated as drainage reserve. Large lot rural zones can be considered for easement over existing gullies. Any agreement for easements across private property will only be accepted if the piped system and pits are designed for the 1% AEP flows, with a 50% blockage factor applied for pit entry capacities. An emergency overland flow path, over the piped system, shall be provided. The easement surface/shape shall be protected against alteration or by obstruction by a "restriction" on the property title, and by the construction type (i.e. concrete invert to appropriate scale of the flows. Overland flowpath shall be a minimum 300mm deep trapezoidal channel and maximise the width of the easement width, and convey at least 50% of the 1% AEP volume.

19.1. Freeboard

For the calculated 1% AEP flow level in the road gutter and for major flow paths in drainage reserves, a minimum of 100mm freeboard (being measured from the top of water level) shall be provided to properties boundary surface levels. Particular care should be given to properties at levels lower than the footpath or reserve. Where design allows, greater freeboard heights should be achieved.

20. Open Channels

Open channels generally form part of the trunk drainage system that cater for the major events (1% AEP) and shall be designed with smooth transitions with adequate access for maintenance and cleaning.

Design of open channels (including safety and maintenance matters) shall be in accordance with ARR providing:

- A minimum of 300mm of freeboard to the top of the channel (600mm in mine subsidence areas).
- A minimum of 500mm freeboard to adjacent dwelling floor levels.
- Maximum side slopes on conventional grass lined channels shall be 6H :1V for grassed batters for mowing, 4H:1V for landscaped
- Friction losses in open channels shall be determined using Mannings “n” values, or as approved by Council.
- Provision for low flow structures within open grass lined channels shall be provided. In addition, subsurface drainage may be required to prevent water-bogging of the channel bed. The low-flow design parameters shall be nominated in the design and be approved by Council.
- Open channels need to provide all-weather maintenance access along drains and open channels starting from a public road. Provide a minimum of 200mm thick 3m wide gravel track, or concrete access depending on the scope and nature of the drain. The access may be required on both sides where the arm reach of maintenance machinery is exceeded. Turning paths shall be provided to accommodate the excavator and dump truck.

The following design features should be avoided:

- Hydraulic jumps/supercritical flow
- Transitional changes in cross section
- Superelevated flows

Channels shall be signposted with a “WARNING” sign in accordance with Standard Drawing SD038.

21. Major Drainage Structures (Bridges & Culverts)

Major structures shall be designed to cater for the AEP event referred to in section 3.2. Major structures in rural areas shall be designed to accommodate flood events as nominated by Council. Bridges shall generally be designed to provide a waterway area catering for the 1% AEP event for the contributing catchment, including afflux (300mm minimum), any freeboards and blockage factors.

A certified structural engineer’s design shall be required for bridges and major structures and shall be in accordance with Australian Standard AS5100, and culverts designed in accordance with Austroads Waterway Design.

22. Stormwater Volume & Quality Control

The purpose for the control of flowrate and quality of stormwater runoff from new development is to minimise potential adverse effects generated from development on the downstream environment, and to maintain as close as practically possible the pre-developed flow regime, with the employment of storage structures for detention or retention such as earth basins, usually incorporating pollution control facilities (wetlands, concrete GPT’s etc).

22.1. Detention Basins and Ponding Structures

The basin access must meet the following design requirements:

- Freeboard above 1% AEP in any basin is 500mm to floor levels.
- The gravelled access track around the perimeter of the basin shall be 3m wide on straight sections and 4m wide on bends, with a minimum design (inside) turning radius of 10m.
  Note: A swept path plan for maintenance vehicle movements (MRV) around the track may be requested by council when irregular geometry warrants.
- All-weather vehicle access typically concrete must be provided to the concrete GPT and to the 3m wide gravelled maintenance track (minimum thickness of 200mm).
- A concrete turning head following SD027 standards shall be installed where necessary to accommodate forward movements of maintenance vehicles. The turning head can be part of the access track perimeter.
- A concrete surround with adequate space adjacent to the concrete GPT opening must be included for maintenance crews to stand while operating the sucker hose for cleaning. Dimensions should be determined in consultation with Council.
- A 3m to 4m offset from the outside edge of the access track to the property boundary and/or fences must be provided for safety of loading trucks, as well as for excavator turning and movement.
- For maintenance purposes of basin and other structures, vehicle access around the item shall be an all-weather access road
- Access to and including the standing area to GPT's shall be provided as concrete. T head turning shall be including unless reversing is in a straight line and less than 20m in length.

22.1.1. Type & Location

Basins and structures come in different types including wet or dry. Wet basins may include an artificial wetland facility, that incorporates a deep-water zone.

Dry basins drain to empty but may include a bio-retention treatment and/or a localised silt trap at pipe inlets. Within a "dry" detention basin, trickle flow channel or pipe drainage, together with a grid of subsoil drainage shall be provided across the basin floor. The minimum slope of a dry basin floor should be 2%.

Location and positioning

Basins and structures must be located immediately against a public road where they are readily accessible by maintenance vehicles from a public road, must be contained within a Drainage Reserve and have casual surveillance for public safety, and preventative anti-social behaviour. The long side of the basin should adjoin the road, and achieve surveillance from the (centre of) dwelling frontage of two (2) lots to each area of the basin drainage reserve. Note: lots can look across a road.

A basin will need a flood study/assessment in accordance with Flooding DCP requirements when located within/below the 1% AEP flood level to consider suitability and impacts to and from the flood. Where a basin is located in a flood plain the design should achieve its maximum elevation (RL) to limit inundation by flood waters. The lowest desirable level of the spillway shall be higher than the 5% AEP event in the flood plain.

22.1.2. Capacity & Discharge

Detention basins retaining stormwater runoff shall be designed so that peak discharges from new development are not increased beyond that of the pre-developed environment for the critical storm events up to and including the 1% AEP event. Basin design should result in a “flowrate which fills the basin to the greatest extent, or possibly the longest time. Where a drainage system is complex, it is likely that storms of different durations will be critical for various parts of the system” (ARR). To satisfy this requirement it is expected that a multi-staged outlet will be necessary to control the outflow, ensuring adequate flow-rate control for the more frequent storm events. A drainage report and calculations shall accompany the detailed design proposal.

Flood routing should be modelled by methods outlined in this Manual and shall include assessment for a basin catering for the total contributing catchment, inclusive of the catchment with its potential of being fully developed.

22.1.3. Overflow

The overflow weir, or high-level outlet for any basin shall be set at a level and have the capacity to maintain the 1% AEP flood event for the approved detained discharge rate..

The overflow weir (and spillway) should be designed in accordance with weir design principles. The weir crest shall be constructed in concrete, keyed into the embankment, and be designed to avoid possible failure in extreme storm events (greater than the 100yr event). The spillway down the embankment wall and at its toe should be protected from erosion with, as a minimum treatment, an approved robust stabilised (reinforced) earth/turf treatment including protection against turbulence/erosion at the embankment toe.

22.1.4. Outlet

Pipe systems shall contain the design outflow through the detention basin embankment with suitable bulkhead (trench-stop) protection to prevent water infiltration and “piping” between the conduit and the surrounding material. The pipe inlet structure shall be designed to avoid blockages, where a catchment may be the source of significant amounts of vegetation matter (see “Grates” above). Outlets shall include a device for energy dissipation.

22.1.5. Water Depth

Temporary water depth calculated for the 5% AEP event, in either a wet or a dry basin, shall be limited to a maximum of 1.2m (above either permanent water level, or dry floor). Where justified by reason of restrictive access, available area or other reasons, a greater depth may be considered.

22.1.6. Embankment

STORMWATER BASIN SLOPES	MAXIMUM SLOPE
Internal batter below top of embankment	1:6 grass or (basin) landscaped 1:6
Internal batter slope above floor/Permanent Water Level PWL	1:6 grassed or landscaped 1:6 landscaped
External batter slope below basin embankment	1:6 grass or landscaped

	1:4 (basin) landscaped where topography or area is restrictive (needs 1:6 mowing between landscaped and boundary
Submerged batter for 500mm below PWL Max submerged batter after ledge	1V:8H 1V:3H
Above embankment and the maintenance track	1V:3H landscaped

Note: (Basin) Landscaped refers to native grasses, small shrubs and groundcovers but excludes trees. See landscape requirements for stormwater

The embankment shall be designed, and supervised in construction, by an engineer. The embankments shall be founded on and bonded to sound natural clay material incorporating a keyway and be compacted to (density and moisture) specifications prepared by a geotechnical engineer. Full details shall be shown on the plans. The embankment, batters and basin floor shall be fully turfed with couch grass.

22.1.7. Dams

Existing dams that are intended to remain or be adjusted for use as part of a detention system shall be reported by geotechnical investigation for adequacy for the purpose. The report shall be submitted as part of the engineering design.

22.1.8. Gross Pollutant Traps & Basin Inlets

All basins should incorporate permanent concrete Gross Pollutant Traps (GPT), to collect silt, trash, and litter from the road drainage system. Plastic and fibreglass GPT units are not accepted for public drainage systems.

As a temporary arrangement, road drainage discharge should be treated, within the basin floor with a sediment-pond/silt-trap. This area should generally be confined to the basin inlet pipe discharge point(s), being located and/or protected (e.g. off-line to accept minor flows only) to avoid scour and dislodgement of sediment. Such traps may eventually become redundant upon stabilisation of the subdivision catchment and may be removed by Council.

A note shall be included on the plans to ensure that the pollutant traps shall be cleaned out prior to issue of “practical completion”.

Where practical, basin inlet pipes for inter-allotment drainage may be separated from the road inlets and associated pollution controls due to the relatively “clean” nature of the stormwater discharge.

22.1.9. Safety

Detention basins shall be signposted with a “WARNING” sign in accordance with Standard Drawing SD038.

The designer shall take into account the requirements (in terms of potential risk/threat to downstream property/community) of the NSW Dams Safety Committee regarding a basin/dam proposal making reference to the NSW Dams Safety Act.

22.1.10. Access for Maintenance

The basin access track shall be of compacted gravelled 200mm minimum thickness on a compacted and stable subgrade. For large basins, the track may need to be continued to the basin floor for maintenance of the biofilter. The crossfall of the access shall be maintained at the standard 3% (maximum 5%). Access grades and changes in grade are to comply with AS2890.2 for a medium rigid design vehicle. Suitable turnings shall be provided as necessary to facilitate service vehicle turning manoeuvres and enable the service vehicles to exit the basin area in a forward direction.

22.2. Stormwater Quality

Stormwater runoff from areas that may be a source of pollutants, such as roads and gardens, shall be treated to provide a means of "polishing" of the runoff prior to its discharge beyond the site. Constructed wetlands, bio-retention filters, silt traps, gross pollutant traps etc, shall be employed for this purpose. Exposed areas of soil/gravel shall be stabilised against erosion.

Design and construction parameters for constructed wetlands, silt traps, swales, bio-retention filters, etc, shall be determined with recognised computer software such as *MUSIC*, with supporting reference made to the publication "*The Constructed Wetlands Manual*" (1988); Water by Design publication "*Construction and Establishment Guidelines - Swales, Bioretention Systems and Wetlands*"; Landcom publication "*Managing Urban Stormwater – Soils & Construction*" or their equivalent.

The following table shall be used as a target for pollutant retention goals.

Post Construction Stormwater Management Targets

POLLUTANT	RETENTION CRITERIA
Suspended Solids	80% of average annual load
Total Phosphorus	60% of average annual load
Total Nitrogen	45% of average annual load
Gross Pollutants >5mm	70% of average annual load
Litter > 50mm	Retention up to the 4EY (3-month flow)
Oil and Grease	90% of average annual load

The above retention criteria relate to "reduction of average annual load" of stormwater pollutants that may be expected from a fully developed catchment or site.

22.3. Constructed Wetlands

For wetlands to operate efficiently they should be "off-line" accepting, typically, flows up to the 1-year ARI storm event. General objectives for wetland area design are as follows:

- The shape of the wetland should be designed to optimise the treatment of the flows with lengthy flowpaths through the wetland.

- Wherever possible, existing natural drainage gullies should form part of a stormwater and runoff drainage management system incorporating detention basins and/or wetlands to alleviate stormwater peaks and retain pollutants.
- Wetlands should be well-designed creating an attractive, safe amenity and be highly visible for both the adjoining residents and passers-by.
- Walking paths should have frequent contact adjacent to the wetland edge.
- Vegetation should be designed such that generous unobstructed view of the wetland is provided, but with dense planting where access should be restrictive, such as near deep water.
- The design should ensure that emergent macrophytes are minimal and manageable.
- Surrounding slopes to wetlands should be gentle and offer convenient tractor-mowing access – general maximum of 5H:1V.

The planting list for each section of the wetland shall be provided with the design, refer to Council's preferred species list available in Standard Drawing SD048.

A management plan, including lifecycle costing (MUSIC), shall be submitted with the design indicating a Program of On-Going Maintenance, appropriate for the particular wetland design. All wetlands shall be provided with a valve/pipe mechanism (other than mechanical pumping) to drain to the lowest possible level for periodic "clean-out" and harvesting of vegetation growth. A typical cross-section of a constructed wetland utilising the general objectives above is shown in Standard Drawing SD050.

Wetlands shall be signposted with a "WARNING" sign in accordance with Standard Drawing SD038.

22.4. Swales

Swales assist in the attenuation of flow and the removal of pollutants. Swales are most effective as source controls as opposed to end of pipe solutions.

Vegetated swales are suitable for catchments where they can convey flows longitudinally, with ultimate relief into a drainage conduit, device, or system, and are commonly used as an alternative to kerb and gutter within the road. Swales are intended to be non-trafficable and should only be employed where vehicle crossing is not required, such as within medians of dual carriageways and adjacent to reserves.

Where for a particular reason vehicle access is required, a concrete driveway may be provided across swales either within the swale invert or with a culvert/pipe.

Swale velocity depth coefficient should be kept below 0.4 and longitudinal slope of the swale should be kept between approximately 1% and 4%.

Swales must be fully vegetated on a sandy loam topsoil to ensure maximum filter effectiveness, and plantings, other than couch grass, will be considered on their low-maintenance merits, having regard to flow capacity and long-term maintenance. Woodchip is not permitted. Refer to SD046.

22.5. Bio-Retention Systems

Bio-retention systems are filtration devices sometimes located within smaller detention basins which comprise of porous subsurface soil layers and pipes and in some circumstances suitable vegetation (other than grass turf) to filter stormwater. Plant species shall be chosen from Table 15 of the CRC Water Sensitive Cities – Adoption Guidelines for Stormwater Biofiltration Systems (2015).

Like swales, these systems must be non-trafficable and designed for easy maintenance.

A concrete edging strip measuring 300mm in width and 250mm in depth installed on a gravel bed (or alternatively an SFM kerb profile on 100mm compacted gravel) is essential between the basin's turf floor and the basin bio-retention stem. This measure defines and safeguards the bio-retention treatment area, preventing erosion, ensuring operational efficiency, offering structural stability, promoting longevity, and enhancing visual aesthetics. Other WSUD Treatments

Examples of other common WSUD treatments that may be provided include:

Primary Treatments:

- Pit inlet protectors
- Trash Racks
- Gross Pollutant Traps (e.g. Baramy Traps, CDS Units, ECOSOL Units, Humeceptor, Humeguard or other manufacturer's equivalent)

Secondary Treatments:

- Wet Basins
- Bio-retention swales
- Infiltration systems
- Vegetated Filter Strips
- Sand Filters
- Surface Retention
- Porous Paving

Tertiary Treatments:

- Constructed Wetlands
- Bio-retention

22.6. References for WSUD Design

- WSUD Technical guide for Western Sydney (Upper Parramatta Catchment Trust 2004)
- WSUD Basic Procedures for "Source Control" of Stormwater – a handbook for Australian Practice (Argue 2004)
- WSUD Engineering Procedures Stormwater (Melbourne Water 2005)
- Australian Runoff Quality – A guide to WSUD (Engineers Australia)
- SE Qld WSUD Engineering Design Guidelines (Healthy Waterways, June 2006)
- Water Smart Model Planning Provisions (HCCREMS 2007)
- Water Smart Practice Notes 1 to 11 (HCCREMS 2007)

22.7. Fencing

Warrants for fencing of permanent water wetlands, ponds, basins, and concrete GPT's shall be determined based on a risk assessment. Where pool-fencing style is approved, the fence shall be installed with tamper-proof screws (as approved by Council) or be welded to deter vandalism/theft.

Additional fencing as per SD057, or as specified by council, may be necessary along overland flowpaths and drainage reserves at the discretion of Council to prevent unauthorised access and or

where public safety is a concern. Fencing should not be proposed as a treatment to vary safe slope requirements. Access points and gates must be designed and installed to allow authorised entry for maintenance.

A concrete mowing strip 100mm deep and 350mm wide shall be constructed along the fence line. Additionally, mass concrete footings must be provided according to the specifications outlined in SD057 for public fences.

See Standard Drawing SD057 for Council's "wire rope" style fence option.

23. Allotment Drainage

This section addresses interallotment drainage requirements with the focus on major subdivision works. For small project developments such as two or three lot subdivisions refer to *Document L: Lot Scale Engineering.*

Inter-allotment drainage (IAD) shall be provided to every lot that cannot adequately drain to its street frontage. The drainage shall be designed to accept concentrated developed flows from each lot for the 10% AEP event. Where new lots adjoin existing properties minor/major flows from those existing uphill properties shall be catered for, with a pipe/pit/flowpath system. Depending on circumstances benefiting easements may be necessary.

Pipes shall be a minimum diameter of 150mm UPVC, PE or PP and have minimum cover of 300mm (greater where subject to vehicle loads), designed to flow full without surcharging at pits. Concrete pipes should not be used for IAD expect for crossing a road verge. Minimum grade shall be 0.5%. Where IAD pipes are laid parallel to sewer mains, a clearance of 750mm between pipe centrelines should be provided. Where pipes are 300mm diameter or greater, the outside clearance shall be 450mm. If practical, the sewer shall be laid closest to the dwelling being served.

The maximum capacity for an interallotment drainage line shall be the 8 lots desirable, 10 lots maximum, and does not exceed 300mm diameter. Other zones is maximum 8 to 10 lots but could negotiate on the maximum area if demonstrating lot numbers are fixed long-term.

Inter-allotment Drainage Line Pipe Sizes

Subject to hydraulic design the following pipe sizes may be used as a minimum requirement.

NO. OF DWELLINGS SERVED (LOTS <600SQ.M)	PIPE DIAM MINIMUM (MM)
Up to 2	hydraulic design, 150 min
3 to 6	hydraulic design, 225 min
7 to 10	hydraulic design, 300 min

23.1.1. IAD Connecting to Kerb

For single-allotment drainage, each lot within a subdivision that drains to the road, shall be provided with a galvanised steel pipe or rectangular hollow section (RHS) with a minimum sectional area equivalent to a 100mm diameter pipe (7850mm^2) across the footway. The conduit shall be located adjacent to the side boundary or at the lowest point of the lot frontage, connected to kerb outlet insert and extended into the lot being serviced with a pit just inside the property boundary.

23.2. Pits

Grated pits shall be provided to the low corner of each lot serviced, in accordance with Standard Drawing SD043, unless otherwise approved. Pits shall be concrete, to the following dimension:

Inter-Allotment Pit Depth: Size Relationship

DEPTH (MM)	SURF. DIM. (MM)
< 900	450 x 450
900 - 1200	600 x 600
1200 to 1500 (pipes discourage at these depths but may have to get under retaining wall footings)	600 x 900

Pits shall be depressed 100mm below the surrounding ground level, to provide efficient surface water inflow. A 450mm wide turf strip shall be laid around the perimeter of the pit. Segmental pit risers shall be adequately sealed at the joints.

Each pit shall have a capped stub for the dwelling connection, and all pit/pipe joints mortared. (Refer SD043). Where pit depth is designed to drain low areas of lots, the riser shall enter the pit at its base.

Interallotment drainage pits shall be 1.2m maximum deep to ensure reasonable access and maintenance by lot owners without requiring excessive excavation, machinery and/or shoring for pipe replacement. Pipes can be kept high in the pit and a drop pit used to get under retaining wall footings.

24. Drainage Easements

Within lots, easements shall be provided over pipe systems and overland flow paths. The minimum width of easements shall be as follows:

Piped Drainage Easement Widths (Minimum)

TYPE AND DIAMETER (2)(6)	EASEMENT WIDTH (M) (3)(4)
IAD up to and including 300mm dia. (1)(2)(3)	Greater of 1.5m OR (2.0 x trench depth) + pipe diameter
IAD greater than 300mm dia. (2)(3)	Greater of 2.5m OR (2.0 x trench depth) + pipe diameter
Public Drainage System up to & including 1200mm dia. (2)(3)(6) (5)	Greater of 3m OR (2.0 x trench depth) + pipe diameter
Public Drainage System 1350mm dia and greater (2)(3) (5)	Greater of 5m OR (2.0 x trench depth) + pipe diameter

Notes:

1) Where site constraints exist, such as in-fill developments, 0.9m wide IAD easements may be considered for 2 lot maximum to pass down the side of an existing dwelling.
2) For pipe diameters larger than specified and for multiple pipe systems, the minimum clearance from the outer edge of the pipe to the easement limits shall be 1.0m.
3) The specified easement widths will need to be widened where excessive pipe depth occurs as machinery access and shoring considerations occur. Additionally for side slope.
4) Easement width shall be increased by 0.5m increments.
5) An additional easement width of 3m applies to stormwater channels and major swale drains where access for maintenance vehicles is necessary. Maintenance tracks are required on both sides when width exceeds maintenance machinery reach. See any requirements for open channels and maintenance.
6) Depths over 1.5m are not acceptable for IAD. Any public pipelines exceeding 1.5m in depth must be adequately benching or battered to Safework NSW requirements and the easement cover the extent of batter, etc.
7) All Drainage lines are to be centrally located within the easement.
8) The width of excavation shall be contained within the easement

25. Stormwater Outlet

Permanent, durable, and effective scour protection and/or energy dissipaters shall be provided at pipe outlets (and inlets where warranted).

In the absence of a defined natural watercourse or stream, points of discharge of concentrated stormwater onto an adjoining property, shall not be permitted without the agreement of the affected property owner. Where an agreement is reached with the adjoining owner, a letter and a drawing shall be signed and submitted to Council as evidence of the agreement, prior to issue of the DA. Drainage easements shall be created, as necessary, prior to or upon certification under part 4A of the EP&A Act.

Where permitted, piped discharge shall be in a suitable watercourse and shall extend a minimum of 10 metres past a building or future building envelope.

Similarly, discharge through parks or reserves, if permitted under the plan of management, should be directed to suitable watercourses. Easements are required on public land that is not drainage reserve.

26. Subsoil Drainage

Subsoil drainage shall be designed for installation in areas that are susceptible to groundwater seepage into the pavement and subgrade, and may be in the form of pipes, strips and/or mats.

Subsoil drains shall be placed on each side of all road pavements and in all stormwater pipe trenches within the road pavement in accordance with Standard Drawings SD035 & SD003 with flush points placed behind the kerb (level with the kerb), as a screw-locked plastic fitting in a concrete surround and should be placed at approximately 60m intervals. Flush points within drainage pits are not permitted.

The design should indicate a subsoil drain “lead-in”, 3.0m long installed in Inter-Allotment Drainage lines where the line connects to the road pit, and at every second pit upstream within the IAD pipeline.

Subsoil drainage shall be shown at new pavement interfaces with existing pavements.

All subsoil pipes shall be, nominally, 100mm diameter, and be “socked” with geotextile fabric.

27. Access Restriction to Drainage Structures

A risk assessment shall be undertaken on any open drainage structure that could be readily accessed by the public. If that assessment indicates a necessary treatment, and/or at Council's discretion, a barrier grate shall be provided.

28. Earthwork and Regrading

Site regrading and bulk earthworks must be designed and constructed in accordance with the DCP and the development consent. Should minimise cut, fill, offsite haulage and environmental impacts. A cut and fill balance diagram within an earthworks management plan must be submitted to Council.

A certified geotechnical engineer shall have level 1 responsibility in accordance with AS3798 unless otherwise agreed in writing by council in advance. A comprehensive Geotech report shall be provided in accordance with Australian Standards, and council requirements.

Filling on land adjacent to developments requires written consent from adjoining landowners.

Site fencing and barricades should avoid encroachment into public roads and lands. Where unavoidable and approved, works shall be prioritised to minimise disruption times, or made safe and re-opened until works can recommence.

If filling of existing dams or watercourses is authorised, the geotechnical report must outline necessary works. The certifying geotechnical engineer, as per AS 3798, holds Level 1 responsibility unless otherwise agreed upon by Council.

Batter slopes and requirements shall be in accordance with Maitland City Council Development Control Plan and MoES.

Surface grading shall ensure no surface ponding will occur, and flows are directed to the required discharge points without creating erosion problems.