PINE RIVERS SHIRE COUNCIL

DESIGN MANUAL

CIVIL INFRASTRUCTURE DESIGN

DESIGN STANDARDS

Part 1	**Design Standards for Roadworks**
Part 2	Design Standards for Stormwater Drainage Works
Part 3	Design Standards for Water Supply Works
Part 4	Design Standards for Sewerage Works

PINE RIVERS SHIRE COUNCIL

DESIGN STANDARDS

PART 1
DESIGN STANDARDS FOR ROADWORKS

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PART 1 - DESIGN STANDARDS FOR ROADWORKS

SECTION 5
INDUSTRIAL ROADS

5.1.0 INDUSTRIAL ROADS - DEFINITION

"Industrial Roads" are roads in service industry or general industry town plan zones, which primarily serve to provide access to frontage industrial allotments. **Industrial Roads** may also provide access to development in other zones, such as **Commercial or Business zones**.

5.2.0 DESIGN PHILOSOPHY

5.2.1 GOAL AND OBJECTIVES

As for Residential streets, the **goal** for industrial road standards is selection of design criteria which provide the **optimum combination** of:-

- safety
- amenity
- convenience
- economy
- environment

While the basic philosophy remains the same, the physical variations between the design vehicles for residential streets and industrial roads are such that the optimum solution in terms of design standards will in most cases be different.

5.2.2 SIGNIFICANT CHARACTERISTICS

The characteristics of the industrial environment which are significant in determining road design criteria are:-

- **mixed functions** – the road provides for moving traffic, vehicles accessing allotments, and parked vehicles
- **heavy vehicles** comprise a relatively high percentage of total traffic
- **parking demand** on the street is usually high
- **traffic speed** tends to be controlled by heavy vehicle movement, and the "friction" of accessing and parking vehicles
- **noise amenity** is not a significant issue in road design, due to the nature of the area
- **street layout** consists principally of "through" or "loop" roads, with cul-de-sacs avoided wherever possible, and generally with a minimum of two connections to the external road system

5.2.3 DESIGN PRINCIPLES

The design principles resulting from these characteristics are:-

- design must provide satisfactorily **for moving vehicles, access to / from allotments and on-street parking**
- design **geometry** should be based on appropriate **heavy vehicles**
- **minimum speed design** is the appropriate design basis, as speed restriction, from consideration of frontage allotment safety and amenity, is not a significant factor

5.3.0 SUBDIVISION LAYOUT

5.3.1 GENERAL

Subdivision layout and road design criteria are mutually dependent.

Several aspects of this relationship are referred to in more detail in later sub-sections, but this section summarises the **road design criteria** which should be considered in the **subdivision layout design**, and vice versa.

5.3.2 ROAD PATTERN

- **Avoid cul-de-sac roads** if at all possible. Loop roads are preferable.
- **Minimise the length** of a cul-de-sac, where its use is unavoidable.
- **Minimise internal traffic volume** where possible, by additional connections to the external road system. Desirably a minimum of two alternative routes should be available, for emergency use (e.g. fire).
- **Consider traffic implications** and requirements of any mixed uses (e.g. retail shopping).
- **Avoid creating through traffic routes** which will encourage “rat-running” by external traffic.
- **Provide for bus routes** within the development where appropriate.
- **Provide pathway connections** to minimise pedestrian and cyclist travel distances.

5.3.3 ROAD LOCATION

- **Alignment** of collector roads to be appropriate for design speed.
- **Minimise road gradients**, particularly on collector roads.
- **Minimise road crossfall**, for allotment access considerations.
- **Sight distance** appropriate for the design speed should be attainable.

5.3.4 INTERSECTIONS

- **External road connections** require careful consideration of number and location. This factor may govern the subdivision pattern.
- **Minimise total number** of intersections, subject to reasonable connectivity.
- **Separation distances** between intersections should be adequate.
- **Intersection angles** should be approximately 90°.

- **Sight distances** at intersections should be adequate (located in a sag is generally preferable).

- **Vehicle access** to each allotment should be available at a satisfactory location.

5.3.5 DRAINAGE

- **Minor drainage paths** are best located in roads, where practical.

- **Major drainage paths**, (where undergrounding is impractical) should be in separate open-space reserves.

5.3.6 ALLOTMENT LAYOUT

- **Avoid "hatchet" allotments** if possible, as they accentuate parking problems on the access road.

- **Minimise cul-de-sac allotments** accessing from the turning area, to reduce parking and traffic congestion in the turning area.

5.3.7 AMENITY

- **Preserve existing vegetation** wherever possible, on verges, islands, medians or park areas.

- **Maximise landscaping opportunities** on verges, medians, cul-de-sac turning islands, etc. (see also the Pine Rivers Shire Council Design Guideline for Landscape Construction on Road Reserve, Parks and Drainage Reserves)

5.4.0 ROAD CLASSIFICATION

The Design Standards for Roadworks recognises the following classification of Industrial Roads:-

- **Industrial Access road**
- **Industrial Collector road**

As discussed in Section 5.6.4 of the Design Standards for Roadworks, the distinction between the **Access road** and the **Collector road** is rather arbitrary, as both have a similar cross-section, with two moving lanes, and a parking lane each side.

As the traffic volume increases, however, there is an increase in the significance of the **traffic function** of the road, from the access road to the collector road, and this is reflected in the:-

- **higher design speed** of the Collector road
- **greater carriageway width** of the Collector road
- **higher standard alignment** of the Collector road, necessary to carry a substantial traffic volume, whereas the access road alignment is largely dictated by allotment configuration (e.g. 90º bends)

At the point where the capacity of the collector road is exceeded, frontage access allotments are no longer permissible, and the road must be a M**ajor Urban road** (see Section 3.0). Classification will depend on traffic volume, either a S**ub-Arterial** or **Arterial road** cross-section being generally appropriate.

5.5.0 DESIGN SPEED

5.5.1 DEFINITION

A selected **design speed** provides the basis for consistent design of all the geometric elements which comprise the road geometry, e.g. horizontal alignment, vertical alignment, sight distance, etc.

In the case of **industrial roads** the design speed is a design **minimum** speed, as conventionally used in road design, **not** a design **maximum** speed as used for speed-restrictive residential street design.

5.5.2 SPEED PHILOSOPHY

Use of the design **minimum** speed, rather than a design **maximum** speed and speed restrictive design, is based on the following considerations:-

- during normal operating hours traffic speed is usually effectively controlled by heavy vehicle movements, and the "friction" caused by accessing and parking. Outside normal hours traffic volume is so low that there is little potential problem.
- noise amenity from traffic speed is not a significant issue, in view of the industrial activities of the area
- speed control devices which can control heavy vehicle speed with reasonable convenience are virtually ineffective for light vehicles

5.5.3 DESIGN SPEEDS

The standard **minimum design speeds** for industrial roads are:-

- **Access road - 40 km/h**
- **Collector road - 60 km/h**

These speeds may be varied in the following circumstances:-

- a **higher design speed** may be required for all roads where the **"speed environment"** in such that vehicle speeds are likely to routinely exceed the standard design speed, e.g. at the end of a long level straight length of road, a curve should be of greater radius than that required for the standard minimum design speed

- a **lower design speed** may be used on an **access road** in the case of a bend of approximately 90º, necessary to provide a reasonable allotment layout

  Design criteria in such a case are to conform to the recommendations of Section 5.11.7 of the Design Standards for Roadworks.

The **horizontal alignment** should be the limiting factor in all cases where the design speed used is less than standard, i.e. vertical alignment and sight-distance criteria should be appropriate for a speed equal to or greater than that for the horizontal alignment. This is because horizontal alignment is much more apparent to a driver than vertical alignment and sight distance limitations.

Where the design speed is lower than the general maximum speed (i.e. 60 km/h), advisory/regulatory speed signs are required.

5.6.0 TRAFFIC VOLUME AND CAPACITY

5.6.1 TRAFFIC GENERATION

Where specific future uses are known e.g. a particular large manufacturing plant, appropriate generation rates for that use or uses should be applied.

In most cases, however, the future industry uses will not be known, and given the potentially wide variation in traffic generation, dependent on location, industry type, number of employees, amount of retailing etc, generation rates assumed for road design must necessarily be conservative.

5.6.2 INDUSTRIAL GENERATION RATES

The Pine Rivers Shire Council adopted standard **Design Generation Rates for General and Service Industry** are:-

- **daily rate** - **400** v.p.d. per site hectare
- **peak hour** - **40** v.p.h. per site hectare
  Assumed direction split:-
  67%:33% i.e. **27:13 v.p.h.**
- **traffic composition** - **20%** **heavy vehicles**

"Per site hectare" refers to the total **allotment area** of industrial land in the catchment, i.e. it does **not** include roads, parks etc.

These generation rates are based on Queensland Transport recommended figures, adapted to the typical form of industrial development within the Pine Rivers Shire, and they have been confirmed as appropriate by traffic counts of existing developments in the Pine Rivers Shire (see "Queensland Streets" Section 9.4.0 for additional background data).

5.6.3 ASSESSMENT OF TRAFFIC CATCHMENT

Traffic catchment assessment must include not only the area of the subject development, but any likely future extensions or connecting roads to serve possible development of adjoining lands, in accordance with the Pine Rivers Shire Council Strategic Plan.

Where the traffic catchments are finite, i.e. there is no through traffic route either existing, or created by the new road system, the traffic volume on the new roads may usually be calculated by the method shown in Section 2.2.0 of the Design Standards for Roadworks, and the generation rates quoted in Section 5.6.2 of the Design Standards for Roadworks .

Where there is a **through traffic route**, however, assessment of the resultant traffic volume will generally require a specialist **traffic engineer**.

5.6.4 MAXIMUM CATCHMENTS

Collector Road

The maximum acceptable catchment (i.e. area of development sites only) for a collector road is determined by the **traffic generation** per hectare of the traffic catchment, and the traffic capacity of the collector road cross-section (one travel lane each way, and a parking lane each side - See Section 5.8.2).

The **traffic capacity** of the standard cross-section will vary with a number of site specific factors such as gradients, alignment, intersections, access and parking friction. Given these variables, and the possibility of occasional higher generating land uses and short period peak flows, capacity allowances must necessarily be conservative.

Based on an assumed **peak hour, one way** traffic capacity of 800 v.p.h., the adopted **maximum traffic catchment** for general design purposes is:-

- **30 ha**

Access Road

The maximum catchment for an **Access road** is dictated by **convenience** rather than traffic capacity, due to the more restrictive operating conditions in the narrower carriageway, lower design speed, and tortuous alignment to conform with allotment layout (e.g. 90º bends).

While quite arbitrary, a reasonable general limit is considered to be:-

- **8 ha**

Variations

Considering the necessarily conservative assumption in both traffic generation rates and road capacities, the Pine Rivers Shire Council may consider a submission by a professional traffic engineer for the use of a larger traffic catchment area in particular circumstances.

5.6.5 OTHER LAND USES

In cases where there are existing or proposed land uses other than industrial within the traffic catchment of an industrial road, **appropriate generation rates** for these uses must be applied in assessing the total traffic volume.

For **existing development**, traffic generation assessment may be based on the actual quantum of development, but where land is **undeveloped** assumptions are necessary as to the likely form and extent of future development.

The most likely non-industrial uses which may occur within an industrial road catchment are **retail shopping centre** (e.g. central business or local business zoning) and **commercial offices** (e.g. commercial zoning). For such uses the **peak hour exit** traffic generation will usually be more significant than the daily rate.

Generation rates for typical developments may be:-

- **retail shopping centre**
  (typical single storey centre)
  peak hour exit (one way) - **180 v.p.h./site ha**

- **commercial offices**
  (typical two-storey office
  block, ground level parking
  peak hour exit (one way) - **100 v.p.h./site ha**

5.6.6 EQUIVALENT INDUSTRIAL CATCHMENT

For **mixed uses** an **equivalent industrial catchment** area can be assessed, based on the relevant one-way peak hour generation rates, i.e.:-

- **industrial** - 27 v.p.h./ha factor = **1.0**

- **shopping centre** - 180 v.p.h./ha factor = $\frac{180}{27}$ = **6.7**

- **offices** - 100 v.p.h./ha factor = $\frac{100}{27}$ = **3.7**

Example:-

Industrial	15.0 ha	x	1.0	=	15.0
Shopping centre	1.5 ha	x	6.7	=	10.0
Offices	0.5 ha	x	3.7	=	1.9
"Equivalent Industrial Catchment"				**=**	**26.9**

which is acceptable for a Collector road, being less than 30ha.

This method should only be used where the commercial and business uses are a relatively small proportion of the total catchment, as:-

- **generation rates are high**, compared to other types of land use

- **generation may vary considerably** dependent on actual development uses and form

- **peak hour timing** may differ from adjacent land uses

- **distribution of traffic** will generally be to two or more routes, and may differ from the distribution for the industrial use

Where the non-industrial uses are over (say) **2.0 ha** total catchment area, assessment of traffic volume and road capacities should be carried out by a specialist traffic consultant, with final approval being at the discretion of a Pine Rivers Shire Council engineer.

5.7.0 PARKING

5.7.1 PARKING DEMAND

Even with the planning requirement for provision of a reasonable number of parking spaces within the allotments, existing industrial estates show a generally **high demand** for on-street parking, with the great majority of parked vehicles being light vehicles rather than trucks.

5.7.2 PARKING PROVISION

A parking lane should in general be provided on **both sides of all Industrial roads**.

The only likely exceptions are at intersections, or on the inside of 90° bends (see Section 5.11.9 of the Design Standards for Roadworks).

5.8.0 CARRIAGEWAY

5.8.1 EDGE TREATMENT

The high incidence of on-carriageway parking, and vehicle movements to and from properties, requires provision of **concrete kerb and channel** to protect the pavement edges and to minimise maintenance requirements.

The standard profile shall be **Upright Kerb and Channel - Type 1** in accordance with the Pine Rivers Shire Council adopted standard drawing. This profile is preferred, as:-

- it helps to inhibit illegal parking on the verge, which should not be necessary with continuous parking lane provision

- construction of standard industrial crossings to properties requires full replacement of the existing kerb and channel

Detailed drainage design is to be in accordance with the Pine Rivers Shire Council Design Standards for Stormwater Drainage.

5.8.2 NUMBER OF LANES

From previous discussion, the following conclusions may be drawn:-

- **facility of vehicle movement** requires a minimum of two lanes (one each way) for moving traffic

  When the traffic volume reaches the capacity limit for one lane each way, two lanes each way could theoretically be provided, but this is generally impractical (see Section 5.8.5 of the Design Standards for Roadworks).

- **parking** demand requires provision of a parking lane each side of every road which provides property access

A special case could be the requirement to add service streets adjacent to the existing carriageway of a Major road (refer to Section 4.15.0 of the Design Standards for Roadworks).

5.8.3 LANE WIDTHS

Moving Lanes

Given the high percentage of heavy vehicles and frequent turning movements to access properties, the standard width for all moving lanes is:-

- **All roads - 3.5m**

Parking Lanes

Again, the higher percentage of heavy vehicles requires generous parking lane widths, particularly with the use of upright kerb profile.

The higher traffic volume and design speed on C**ollector roads** indicates the desirability of a greater parking lane width to:-

- **minimise the "friction" effect** of parked vehicles on moving traffic

- **assist turning into allotment driveways**, without crossing the carriageway centreline

- **provide width for an auxiliary turning lane** at intersections, without additional carriageway widening

- **provide width for cyclists** on the carriageway, where a cycle path is not provided

Standard parking lane widths are:-

- **Industrial Access roads - 2.5 m**
- **Industrial Collector roads - 3.5 m**

5.8.4 CARRIAGEWAY WIDTHS

From Sections 5.8.2 and 5.8.3 of the Design Standards for Roadworks, the standard carriageway widths for the various road classes are:-

- **Industrial Access roads - 12.0 m**
- **Industrial Collector roads - 14.0 m**

Widths are measured between channel inverts.

5.8.5 CENTRAL MEDIAN

Allotment access requirements will normally make a central median impractical. The unknown locations of future allotment entrances, and the length of median breaks required for articulated vehicles, inhibits use of a median with breaks, while a continuous median would require U-turning at intersections. The turning geometry of heavy vehicles is such that a continuous median would generally be acceptable only between roundabouts of appropriate diameter.

Without a median, the width of carriageway required for a road with greater traffic capacity than a Collector road, and access to properties both sides, is unreasonably great (approximately 20.0m). This is the basis for the **"no access"** requirement when Collector road capacity is exceeded.

Short **median islands** should be provided at major intersections, for traffic control, pedestrian refuge, and possibly for traffic signals (see Section 5.12.5 of the Design Standards for Roadworks).

Where a median or median islands are provided, the minimum widths should be in accordance with Section 4.10.5 of the Design Standards for Roadworks, and landscaping should be provided in accordance with the Pine Rivers Shire Council's Design Guideline for Landscaping Construction on Road Reserves, Parks and Drainage Reserves.

5.8.6 LINE MARKING

The extent of lane delineation should generally be as follows:-

- **Collector road**

  A **separation line** should be provided on the centre line (barrier line where necessary), and an **edge line** to delineate the parking lane.

  Marking of individual parking bays is **not** normally practical due to the length variation of vehicles.

- **Access road**

  For higher trafficked access roads a separation line should be provided as for collector roads. For access roads, however, with a lower traffic volume (traffic catchment less than approximately 4.0 ha) delineation may be deleted, except at locations such as sharp bends or crests where a separation line (or barrier line) should be provided.

All lane marking is to be in accordance with the **"Manual of Uniform Traffic Control Devices"** (Queensland Transport).

5.8.7 CARRIAGEWAY CROSSFALL

The normal standard carriageway crossfall and the **minimum** from surface drainage considerations is 2.5%, i.e. **1:40**.

The **maximum** crossfall should not normally exceed 3.0%, i.e. **1:33**.

The **centre crown** shall be the normal form of carriageway cross-section.

Occasionally, use of an **offset-crown** section may be appropriate on side sloping topography. Stormwater drainage, however, requires careful consideration to ensure that surface flow across the carriageway does not become a hazard to traffic, and that the flow in the channel on the lower side does not exceed acceptable criteria.

In general, where an offset crown is used, the high-side parking lane should fall to the channel on that side.

5.9.0 VERGE

5.9.1 FUNCTIONS OF THE VERGE

The Verge on Industrial roads serves the same functions as for residential streets, although the significance and requirements for these functions differ markedly.

- **Safety visibility**
  Provision of a parking lane provides a "buffer width" between the kerb and moving traffic for pedestrians, and for vehicles exiting properties.

  The internal allotment layout should be such that all vehicles exit from properties in a forward direction and hence the verge width is less vital for safety visibility. However the combined width of parking lane and verge can assist in reducing interference to through traffic, by vehicles entering allotments.

- **Parking**
  Provision of a parking lane should remove any necessity for vehicles to park on the verge, and the potential damage to kerb and channel and footpath paving by heavy vehicles is such that illegal verge parking should be prevented.

- **Amenity**
  Landscaping to improve amenity is **highly desirable**, but establishment and maintenance may pose practical problems. Some businesses, particularly those with a retailing function, may be diligent in landscape establishment and maintenance, while others may not. (Refer to the Pine Rivers Shire Council Design Guideline for Landscape Construction on Road Reserves, Parks and Drainage Reserves).

  Buffering for traffic noise attenuation is not a consideration in industrial areas due to the potentially higher noise generation of the land uses.

- **Utility services**
  On Collector roads, particularly, provision for major service installations may be required, e.g. trunk water, electricity, telecommunication and gas mains.

- **Changes in level**
  While industrial land should be relatively flat, changes in level between the road and the allotments are quite critical for access by heavy vehicles.

- **Pathways**

  The location of industrial development, and degree of public transport provision, is generally such that virtually all travel to and from industrial sites is by private vehicle.

  The use of public transport and pedestrian and cycle travel is, however, being actively encouraged in the Pine Rivers Shire Council transport strategies. Therefore Industrial roads should provide appropriately for pedestrian and cycle traffic.

  The verge cross-section of **all** roads should allow for possible pathway construction on both sides. In general, actual construction will be required on both sides of Collector roads, but on one side only of Access roads.

Cycle traffic can generally be accommodated in the extra width of the parking lanes on a Collector road, but in some cases the Pine Rivers Shire Council bikeway planning documents may indicate the need for a cycle path or dual-use path within the verge.

5.9.2 MINIMUM VERGE WIDTHS

The **minimum** verge width to provide for the above functions as nominated is **4.0m**.

Additional verge width may, however, be required in Collector roads to accommodate trunk services, or a dual-use path. In the latter case the minimum required verge width is **5.0 m**.

The Pine Rivers Shire Council adopted minimum verge widths are:-

- **Industrial Access road** - **4.0m**
- **Industrial Collector road** - **5.0m**

5.9.3 VERGE CROSS-SECTION

Standard verge profiles shall be in accordance with the Pine Rivers Shire Council adopted standard drawings.

5.9.4 ALLOTMENT ACCESS

Location and design of all allotment accesses shall be in accordance with the Pine Rivers Shire Council Design Guideline for On-Site Carparking and service Vehicle Facilities.

5.10.0 ROAD RESERVE

5.10.1 MINIMUM RESERVE WIDTHS

The **minimum** reserve width required is the sum of the carriageway width and the verge widths, i.e.:-

- **Industrial Access road** - **20.0 m**
- **Industrial Collector road** - **24.0 m**

5.10.2 ADDITIONAL WIDTH

Additional reserve width may however be required in special circumstances such as:-

- **trunk services**, requiring additional verge width
- **cycle paths or dual-use paths**, to provide sufficient verge width
- **at intersections**, to provide for auxiliary lanes and / or islands

TYPICAL INDUSTRIAL ROAD CROSS-SECTIONS

(REFER STANDARD DRAWINGS 8-10014 & 8-10015)

5.11.0 GEOMETRIC DESIGN

5.11.1 GEOMETRIC ELEMENTS

Geometric design includes a number of inter-related design elements, including:-

- horizontal alignment
- superelevation
- curve transition
- curve widening
- gradient
- sight distance
- vertical alignment

5.11.2 BASIS FOR DESIGN

The geometric design data in this section is based primarily on the recommendations in **AUSTROADS "Rural Road Design - 2003", and the Queensland Department of Main Roads "Road Planning and Design Manual".**.

5.11.3 HORIZONTAL ALIGNMENT

Design Basis

Since the design of industrial roads is based on the concept of a **design minimum speed** the limiting factor in horizontal alignment is the **minimum curve radius** appropriate for the selected design speed.

Minimum Curve Radius

Minimum curve radii for a given design speed are shown in Table 5.11.A. **"Absolute minimum"** radii are based on "side friction" criteria for standard 1:40 crossfall, either "favourable" or "adverse" to the direction of curvature. A truck with a high load may, however, tend to be unstable at these speed/radius combinations, and will appropriately negotiate such a curve at a speed 5 to 10 km/h below the design speed. The **"desirable minimum"** radii allow such a truck to negotiate the curve at the design speed.

"Absolute minimum" radii shall be used only with the prior approval of a Pine Rivers Shire Council engineer.

Design Speed (km/h)	**Absolute Minimum Curve Radius (m)**		**Desirable Minimum Radius (m)**
	Favourable Crossfall	**Adverse Crossfall**	**(Adverse Crossfall)**
30	19	22	26
35	26	30	35
40	34	39	46
50	53	61	72
60	80	93	132

Note: - Absolute minimum radii to be used only with approval.

MINIMUM CURVE RADIUS
Table 5.11.A

5.11.4 SUPERELEVATION

From the above it is apparent that there is little gained by superelevation on small radius curves, as the additional centreline radius of the outer lanes compensates for the adverse crossfall on those lanes.

Superelevation also introduces potential problems for allotment access and carriageway drainage, and hence will rarely be either necessary or desirable.

If superelevation is used the crossfall should be within normal crossfall limits, i.e. **1:40 to 1:33**, and application should be in accordance with the recommendations of AUSTROADS "Rural Road Design".

5.11.5 TRANSITION

Plan transition also is not normally required on industrial roads.

The application, however, of curve widening to the inside edge of each lane, as recommended in Section 5.11.6 of the Design Standards for Roadworks, provides a transitioning effect to the vehicle path on small radius curves.

5.11.6 CURVE WIDENING

Widening should be applied to all lanes, both moving and parking, on smaller radius curves, to allow for the greater carriageway width occupied on a curve by any vehicle, but particularly a longer vehicle.

Recommended curve widening is given in Table 5.11.B (adapted from the Queensland Department of Main Roads “Road Planning and Design Manual”).

Curve Radius (m)	Widening Per Lane (m)
50 or less	**Use a vehicle template – Auto Track or similar**
50 - 60	**1.25**
61 - 90	**1.0**
91 – 110	**0.75**
111 – 180	**0.5**
181 – 300	**0.25**
> 301	**0**

CURVE WIDENING
Table 5.11.B

Widening should be applied to the **inner edge** of each lane. For **short curves** widening is most easily applied by using appropriately larger lane line radii to provide the required widening at the centre of the curve. For **longer curves**, however, a uniform increased width may be provided over most of the curve length, transitioned by a larger radius curve each end.

Site specific designs should be based on the **AUSTROADS Design Semi-Trailer**, using and a vehicle template computer programme such as "Auto Track" or similar. The application of vehicle templates is to be based on the use of the design vehicle occupying each lane at the same time.

Note that the curve widening recommendations in this sub-section refer to subdivisional roads only. The geometric design of major roads is to be in accordance with standard AUSTROADS or Queensland Department of Main Roads practice.

5.11.7 APPLICATION OF HORIZONTAL ALIGNMENT

Application of the foregoing data to practical design may be summarised as follows:-

- **Collector road**
  - normal configuration will be standard crossfall with **no superelevation or transition**
  - for standard **60 km/h** design speed, the **desirable minimum** centreline **radius** will therefore be **132m**, absolute minimum 93m (Table 5.11.A)
  - curve **widening** will be required in accordance with Table 5.11.B, i.e. 0.50m per lane for 132m radius curve
- **Access road**
  - normal configuration will be standard crossfall with **no superelevation or transition**
  - **for a standard 40 km/h** design speed the **desirable minimum** centreline radius will be **46m** and absolute minimum 39m (Table 5.11.A). Curve **widening** on these radii

should be applied in accordance with Table 5.11.B based about a vehicle template plot provided by a computer programme.

- **for the special case of a bend of 90° deflection**, (approximately) where necessary to provide a reasonable allotment layout, a design speed of minimum **30 km/h** may be used, i.e. a desirable minimum centreline radius of **26m**, provided that the speed environment at the location is appropriately low, and that there is reasonable approach visibility to the bend. Widening is to be applied in accordance with Table 5.11.B). based about a vehicle template plot provided by a computer programme

  Figure 5.11.A illustrates possible geometry for such a situation.

- **Signing**

  - **advisory speed signs** shall be provided at all horizontal curves with a radius less than the desirable minimum for 60 km/h design speed (i.e. 100m radius). The appropriate advisory speed shall be based on the "desirable minimum" radii in Table 5.11.A.

5.11.8 GRADIENTS

The **maximum** longitudinal gradient on any industrial road should not, under normal circumstances, exceed **6.0%**.

Where this gradient, however, cannot be reasonably attained, the Pine Rivers Shire Council may allow an **absolute maximum** gradient of:-

- **Industrial Access road** - **10.0%**
- **Industrial Collector road** - **8.0%**

The **minimum** longitudinal gradient, based on drainage requirements, is **0.40%**.

5.11.9 SIGHT DISTANCE

While all industrial roads provide separate moving lanes for each direction of traffic, the potential conflicts from vehicles accessing properties, and on occasion double-parking, are such that the **general minimum sight distance** provided should be **twice the stopping distance** for the relevant design speed, measured between "eye heights", each 1.15m above the carriageway.

This is the same principle as applied to residential streets.

For the design speeds appropriate to industrial roads, required stopping distances and minimum sight distances are provided in Table 5.11.C (adapted from the Queensland Department of Main Roads “Road Planning and Design Manual”).

Design Speed (km/h)	Stopping Distance (m)	General Minimum Sight Distance (m)
60	65	130
50	45	90
40	30	60
35	27	54
30	22	44

Note: Distances do not include grade compensation

GENERAL MINIMUM SIGHT DISTANCE
Table 5.11.C

On **sharp horizontal curves** provision of the general minimum sight distance on the inside of the curve should be checked by the method in Section 2.10.3 (Figure 2.10.C), and, if necessary, an appropriate truncation of the property boundary provided. Elimination of the parking lane on the inside of the bend, as shown in Figure 5.11.A, will normally be required to ensure that the appropriate minimum sight distance is available.

5.11.10 VERTICAL ALIGNMENT

Criteria for vertical alignment of industrial roads are the same as for residential streets (see Section 2.10.5 of the Design Standards for Roadworks) and the design graphs in that section may therefore be used, **using the appropriate design speed** for the subject industrial road.

The following points, however, should be noted:-

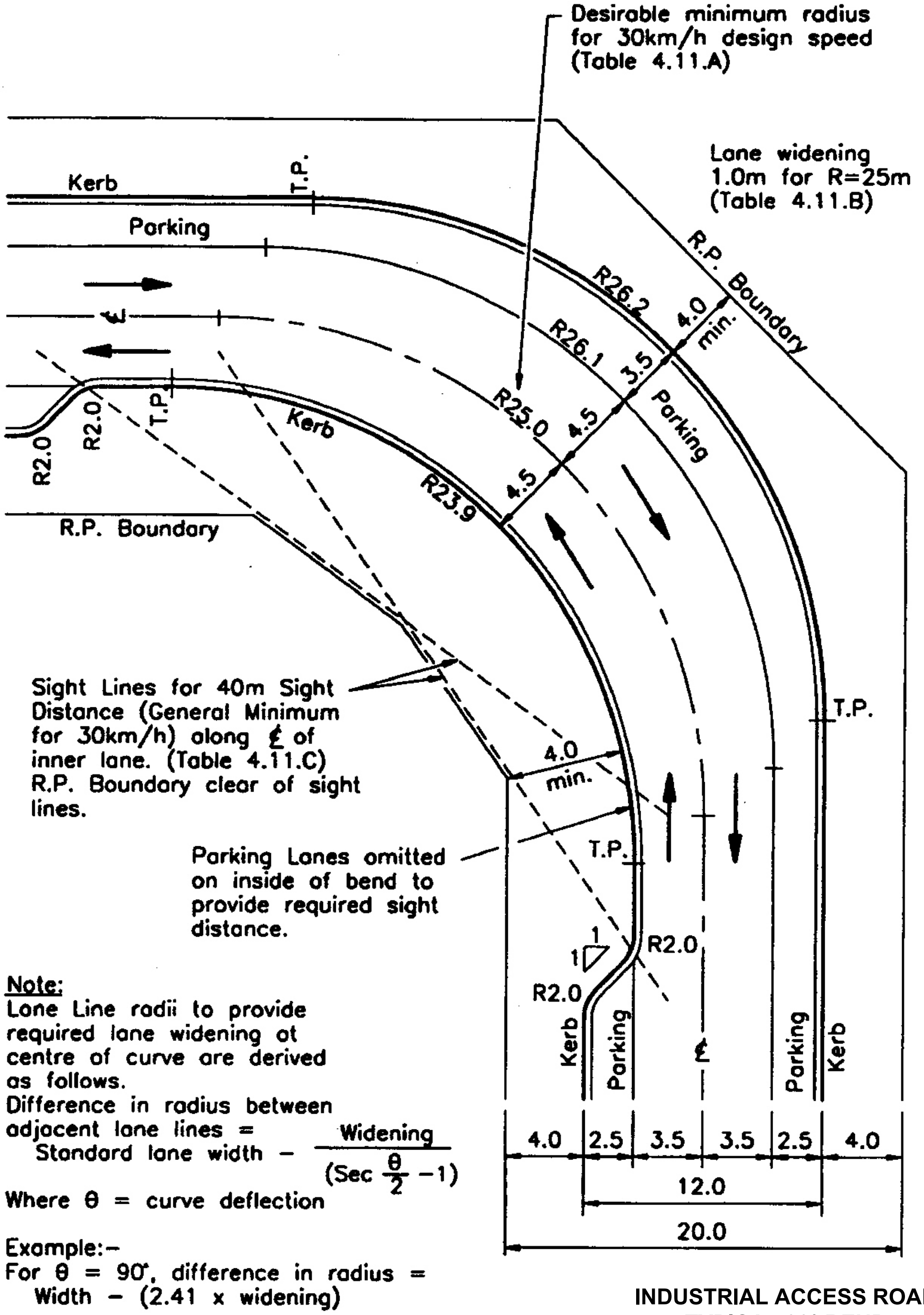
- **Speed environment**

  Because industrial roads are not designed on a speed restrictive basis, the actual speed environment may, in places, considerably exceed the minimum design speed.

  As vertical alignment is not nearly as obvious to drivers as the horizontal alignment, vertical alignment should **always be designed as generously as possible**, particularly in higher speed environments.

- **Underpasses**

  The only occasion where the greater driver's eye height for trucks (1.8m compared to 1.15m for cars) may be a disadvantage is at underpasses. In such cases sight distance for this greater eye height should be checked.



INDUSTRIAL ACCESS ROAD
TYPICAL 90° BEND

Figure 5.11.A

5.12.0 INTERSECTIONS

5.12.1 LOCATION OF INTERSECTIONS

The general principles of subdivisional layout applicable to intersections are:-

- the total number of intersections should be minimised
- ideally, roads should intersect only with others of the same or adjacent classification, e.g. an access road should **not** intersect with a major road, but should intersect with a collector road or a service road

5.12.2 TYPES OF INTERSECTION

Within industrial areas, appropriate intersection types are:-

- **T-Junction - priority controlled, three-way**
- **Roundabout - three or more ways**
- **Signalised - three or four-way**

T-Junctions with normal priority control will be the most appropriate form of intersection for most access roads and collector roads.

Roundabouts require a considerable area to provide the geometry necessary for articulated vehicles, but may be appropriate for 4-way intersections on collector roads.

Signalised control may be required for intersections on collector roads, or for intersections on to an external major road system.

5.12.3 SPACING OF INTERSECTIONS

Intersections should be located sufficiently far apart to:-

- separate traffic movements at each intersection
- provide a reasonable time interval between driver decisions

Desirable minimum intersection spacings (centre line to centre line) are:-

	Access Road	Collector Road
On same side of through road	**60m**	**100m**
On opposite sides of through road:-		
- left-right stagger	**60m**	**150m**
- right-left stagger	**40m**	**60m**

Subdivision layout constraints may however require some compromise.

5.12.4 DESIGN VEHICLE

The standard design vehicle for industrial road intersections shall be **AUSTROADS Design Semi-Trailer**, turning at radius **15m** (outside front wheel-path).

The designer, however, should consider whether there is a likelihood of larger vehicles (e.g. B-doubles under special approval) requiring access to a particular Industry or site within the area.

5.12.5 T-JUNCTIONS

Alignment
Alignment of the approach roads should be such as to establish without any ambiguity the major road/minor road priority.

The angle between the road centreline should be **90°**, unless some skewing is essential, in which case the **minimum** angle is 70°. The minor road centreline should be straight for a minimum of 20m from the tangent point of the kerb return, to avoid the tendency for traffic to "cut the corner".

Kerb Radius
Kerb radii at intersections are controlled by the left-turning movement. Turns between **access roads** or between **access and collector roads** will generally be from the moving lane to the moving lane, the turning path cutting across the parking lanes in each street.

In such a case for a 90° intersection, a **12m kerb radius** will provide for a design vehicle turn (see Section 5.12.4 of the Design Standards for Roadworks) without encroaching over the centrelines of either road.

Turns between **collector roads**, or between a **collector road and a major road**, will generally be **from** a left-turn lane against the kerb, **to** the left-hand moving lane in the other street. In these cases a site specific intersection design will be required.

Lane Widths
In consideration of the high percentage of heavy vehicles, **all lanes**, both through and auxiliary (e.g. left turn and right turn) should generally be **3.5m minimum width**.

Median Islands
Central median islands are desirable to:-

- separate opposing traffic movements
- provide a refuge for pedestrians crossing higher-volume roads

Their necessity will depend on the intersection geometry and vehicular and pedestrian traffic volume. As a general guide, however, they will **not** be required at the intersection of two access roads, **may** be required at the intersection of an access road and a collector road, and will **generally** be required at an intersection of two collector roads, or at **any signalised** intersection.

Detailed Design
All design details for T-Junctions are to be in accordance with **AUSTROADS "Guide to Traffic Engineering - Part 5 - Intersections at Grade", 1988**.

5.12.6 ROUNDABOUTS

Roundabouts on industrial roads differ from those on residential streets in that they are **not** designed on a speed-restrictive basis, but in accordance with normal roundabout design practice.

Hence all detailed design should be in accordance with **AUSTROADS "Guide to Traffic Engineering Practice - Part 6 - Roundabouts", 1993**, using the AUSTROADS "Design Semi-Trailer" as the design vehicle as amended by the pine Rivers Shire Council Design Guideline DG 01 – "Roundabouts".

A computer programme such as **"Auto Track"** should be used for the geometric design of roundabouts.

5.12.7 ROAD RESERVE BOUNDARIES

Truncations
In general, for T-Junctions with straight road alignments and 90° intersection angle, truncation of the road reserve boundary is **not** required for sight distance consideration.

For other geometry this situation should be checked using the method of the above design references and truncations provided if necessary.

Truncations **will**, however, be required to ensure that the verge width around the intersection is not less than the standard verge width for the relevant road classification. For a T-Junction with 12m radius circular curve kerb-line, and geometry as above, the required truncation is **8m tangent length** along each road boundary. This may be provided either as a single chord, or as a number of chords to a circular arc.

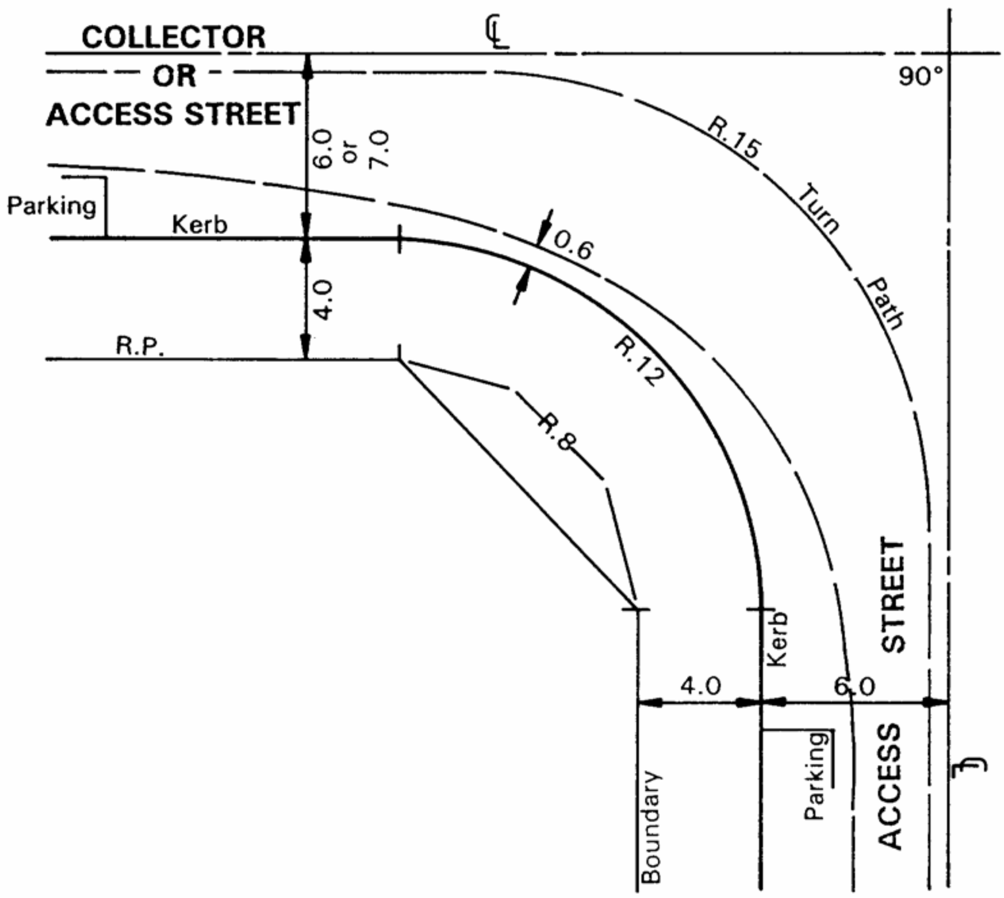
Widening
Provision of intersection median islands, and/or carriageway widening for auxiliary lanes, will often require local widening of the road reserve in the vicinity of intersections.

5.12.8 LINE MARKING AND SIGNAGE

All intersections are to be line marked and signed in accordance with the **"Manual of Uniform Traffic Control Devices"**.

5.12.9 LIGHTING

All intersections are required to be effectively lit, generally in accordance with the criteria of Australian Standard **AS.1158 "Code of Practice for Public Lighting - Part 1"**, and Section 7.13.0 of the Design Standards for Roadworks.



INDUSTRIAL ROADS
TYPICAL INTERSECTION
Figure 5.12.A

5.13.0 MANOEUVRING AREAS

5.13.1 GENERAL

Facility for vehicles to turn must be provided at the end of all cul-de-sac roads ("manoeuvring areas").

In the case of industrial roads, the necessity to design for heavy vehicles, and high parking demand, mean that manoeuvring areas require considerable areas of land and carriageway construction, and have great potential for traffic and parking congestion.

Hence the subdivision layout should **use cul-de-sacs only when unavoidable**, and in such cases, the cul-de-sacs length should be **as short as possible** (see Section 5.3.2 of the Design Standards for Roadworks).

5.13.2 MANOEUVRING

Traffic volume, high incidence of parking, and heavy vehicle movements in industrial manoeuvring areas are such that only the **single-movement turn** is acceptable from safety and property damage considerations.

5.13.3 DESIGN VEHICLE

Manoeuvring areas shall be designed with geometry to accommodate the **AUSTROADS Design Semi-Trailer**, turning with an outside front wheel path radius of **12.5m**, for a worst-case situation (i.e. with parked vehicles both sides).

Outside overhang should also provide clearance for the AUSTROADS Design Single Unit Truck (this overhang being greater than for a Semi-Trailer).

5.13.4 PARKING

The **demand** for parking in cul-de-sac manoeuvring areas is generally high, as the restricted allotment frontages tend to inhibit the provision of allotment parking spaces visible from the street.

The **supply** of kerbside parking in the manoeuvring area is restricted however, by the relatively high proportion of kerb length taken up by allotment driveways. In some cases this may be such as to completely inhibit parking around the manoeuvring area, but generally there will be some **limited scope** for kerbside parking.

Therefore in designing the manoeuvring area it must, in general, be assumed that **parking will occur** along the kerb.

If, as is desirable, a central island is provided, parking may also occur against the island kerb, but this is less likely, being an "unnatural" way to park, and since the kerb radii are quite sharp. Parking may also take place on the island itself.

The most practical solution to these parking issues is probably to provide a number of **indented parking bays within the central island**, or elsewhere within the immediate vicinity of the turning area, for smaller vehicles at least.

5.13.5 DESIGN DETAIL

Kerb Radius

The **design turn radius of 12.5m** is practical but less than ideal. This figure is, however, considered a reasonable compromise, as it will often happen that parking does not occur on one or both sides of the manoeuvring area, thereby allowing a greater turning radius.

Allowing for outer overhangs, clearances of 0.6m and a parking width of 3.5m (long vehicles on curve), the appropriate minimum **outer kerb radius is 17.5m**.

Approach Alignment

To allow a design vehicle to follow the design turning path, the approach and departure alignment of the kerb should provide a **straight of minimum 15m** length between the tangent points of the manoeuvring area curve and the reverse curves from the standard width carriageway. These entry/exit curves should be not less than **20m radius**.

Central Island

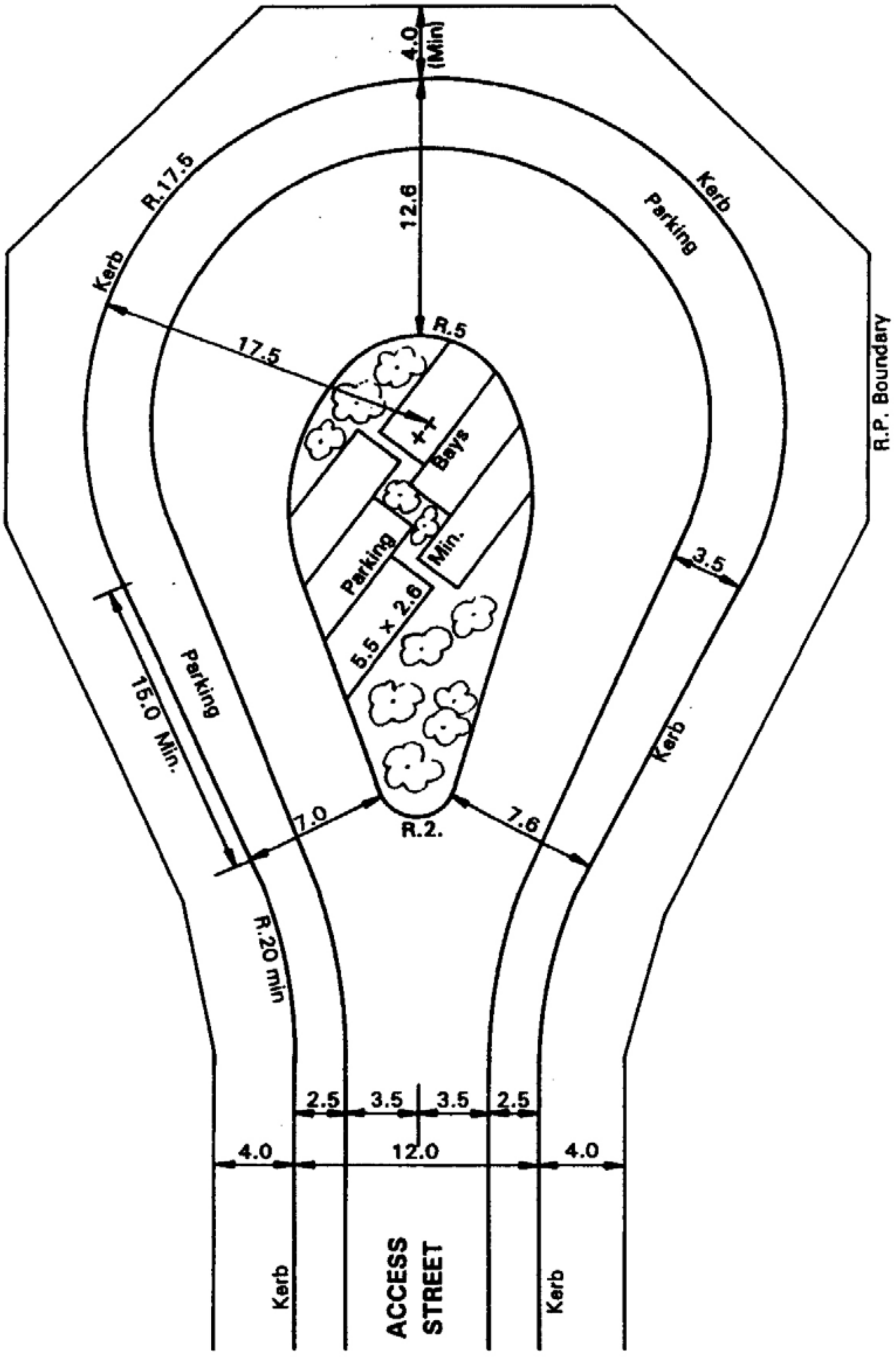
A central island should allow for the design vehicle turning path, plus a clearance of 0.6m to the kerb line. The shape of the island may not be symmetrical but a "nose" radius of 5.0m will generally be appropriate.

Parking bays within the island should conform to normal standard dimensions, but care is necessary with parking bays on the "departure" side of the island, to ensure practical entry geometry.

Landscaping of the island should be provided in accordance with the Pine Rivers Shire Council Design Guideline for Landscape Construction on Road Reserves, Parks and Drainage Reserves".

5.13.6 DESIGN EXAMPLE

Manoeuvring area design geometry will often be site-specific but a design example based on the above principles is shown in Figure 5.13.A.



TYPICAL INDUSTRIAL TURNING AREA
Figure 5.13.A

5.14.0 INDUSTRIAL ROADS SUMMARY

SUMMARY TABLE

	Access Road	**Collector Road**
Traffic Catchment (max)	8 ha	30 ha
Design Speed (min)	40 km/h (i)	60 km/h
Carriageway:-		
- Moving lanes	2 x 3.5m	2 x 3.5m
- Parking lanes	2 x 2.5m	2 x 3.5m
- Total width	12.0m	14.0m
Verge Width (min)	4.0m	4.0m (ii)
Reserve Width (min)	20.0m	24.0m (ii)
Footpaths (iii)	One side	Both sides
Gradient:-		
- Maximum (iv)	10%	8%
- Minimum	0.4%	0.4%
Sight Distance (min)	60m	110m
Carriageway Crossfall	Two Way	Two Way
- Minimum	1:40	1:40
- Maximum	1:33	1:33

Notes:-
(i) May be reduced to 30 km/h in special circumstances
(ii) Greater width may be required
(iii) Subject to the Pine Rivers Shire Council pedestrian/cycle network design
(iv) Maximum desirable gradient 6.0% on all roads

Table 5.14.A