FUNCTIONAL APPROACH CLARIFIES RESIDENTIAL ROAD LAYOUT DESIGN.

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Most design guides provide information on the detail design of residential streets. This is generally related to the need to account for the requirements of the motor car. The functions of residential streets are identified as:

1. *Providing access to abutting properties*
2. *Facilitating social activity.*
3. *Providing a corridor for the movement of motor vehicles.*
4. *Accommodating engineering services.*

The functional approach identifies two types of roads: one for access and the other for movement. Designing for these two distinct types of roads obviates the need to fulfill conflicting functions. This simplifies the design process, permits the creation of a residential environment conductive to social activity, and at the same time ensures that vehicular movement is not unacceptably tortuous.

Die meeste ontwerpgidse verskaf inligting oor detail aspekte van die ontwerp van residensiële strate. Gewoonlik het hierdie inligting 'n verwantskap met die vereistes van die voertuig. Die vier funksies van residensiële strate is soos volg:

1. *Om toegang tot die aangrensende eiendomme te verskaf.*
2. *Om die sosiale aktiwiteit te vergemaklik.*
3. *Om as 'n korridor vir voertuie te dien.*
4. *Om ingenieursdienste te akkommodeer.*

Die funksionele benadering identifiseer twee tipes paaie; die een wat toegang verskaf en die ander vir die beweging van voertuie. As die ontwerp die twee verskillende tipes paaie in ag neem, kan teenstrydige funksies vermy word. Hierdie vergemaklik die ontwerpproses, laat dit toe om 'n residensiële omgewing te skep wat die sosiale aktiwiteit bevorder, en ter selfder tyd verseker dat voertuigritte binne die residensiële area nie onnodig omslagtig word nie.

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1. INTRODUCTION

The Fouche Commission (South Africa, 1977) which was established to investigate the high cost of serviced residential erven, recommended *inter alia* that uniform and reasonable standards be determined. In 1983, the Department of Community Development published the "Guidelines for the Provision of Engineering Services in Residential Townships" (Community Development; 1983).

The Guidelines provide a comprehensive guide for designing engineering services. The "Planning Preamble" provides an extensive list of goals and objectives. However, the structure of the document makes the link between the objectives and the design guide difficult. As a result the guidelines are now beginning to be applied as standards. This was not the intention of the authors (Community Development; 1983; A47).

2. A REVIEW OF GOALS AND OBJECTIVES FOR RESIDENTIAL STREETS.

In order to determine a goal statement for the design of residential road networks, Del Mistro (1987) reviewed 19 sources and related these goals to the residential area, the road network and the residential street itself. These are summarized by listing the key words mentioned in the literature as shown in Table 1.

In terms of the residential area the goal can be summarized in terms of achieving livability. This includes social activity, catering for the pedestrian, privacy, environment and serving the needs of different users. The plan must consider the location of major vehicular trip generators and the sub-division of the area into usable erven. There could be some contradiction between the desire to use guidelines instead of standards and the ability of bureaucrats to approve plans quickly. Finally the layout should be economical.

All the references have a structured road hierarchy as a goal. This should be logical, perceivable and minimize through traffic. The network must take into account vehicular, pedestrian, cycle, bus and emergency and service vehicle circulation systems. There is a need to minimize the amount of internal travel, regulation and the danger posed by numerous intersections.

The residential street is essential as an access system for pedestrians, cyclists, motor vehicles, emergency and service vehicles. It should experience low vehicular volumes and speeds, and minimize vehicular/pedestrian conflict. The roadway can also accommodate engineering services, but road blockages due to maintenance should not prove serious.

TABLE 1.

SUMMARY OF THE REVIEW OF GOALS FOR RESIDENTIAL STREET DESIGN

Aspect.	R	N	S	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Livability	●			●					●	●										●	●	●
Social Activity	●															●	●					
Pedestrian Orientation	●					●		●			●		●	●								
Privacy	●																				●	●
Environment	●				●	●	●	●	●	●	●	●	●	●		●				●	●	●
Economy	●				●	●			●		●				●		●			●	●	●
Guidelines not standards	●						●			●												●
Quick plan approval	●									●										●	●	
Location of Major Generators	●			●																●	●	●
Usable stands	●			●						●												●
Differing user needs	●									●										●	●	●
Road hierarchy		●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Logical road system		●		●							●									●		
Perceivable road function		●		●													●			●		
Minimise through traffic		●		●									●				●			●	●	●
Vehicle circulation system		●		●	●		●	●	●	●	●				●	●	●			●	●	●
Pedestrian circulation system		●		●	●		●		●	●	●		●	●	●		●			●	●	●
Cycle circulation system		●																		●		
Bus circulation system		●		●																●	●	●
Emergency vehicle circ. sys.		●									●											
Service vehicle circ. sys.		●		●							●											
Minimise vehicle travel		●				●							●									
Minimise traffic regulation		●		●																	●	●
Minimise intersections.		●		●							●										●	●
No interference on ext. rds		●		●																●	●	●
Vehicle access system			●	●	●		●	●	●	●	●				●	●	●			●	●	●
Pedestrian access system			●	●	●		●		●	●	●		●	●	●		●			●	●	●
Cycle access system			●																	●		
Bus access system			●	●																●	●	●
Emergency vehicle access sys.			●								●											
Service vehicle access sys.			●	●							●											
Play in res. streets			●		●									●							●	
Shared surface			●				●	●	●	●	●			●								
Low vehicular volumes			●	●			●						●									●
Low vehicular speeds			●	●			●			●		●		●	●						●	
Minimise slow driving dist.			●																		●	●
Minimise ped./veh. conflict			●	●																●	●	●
Planned parking			●											●								
Alternative vehicular routes			●								●				●							
Accommodate utilities			●		●		●										●			●	●	●
Road blockages are not serious			●							●					●							
Flexibility			●													●						
	R	N	S	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19

R Residential area.	4 UK DOT	10 Ten Grotenhuis	16 Taylor
N Network	5 Essex	11 ANWB	17 SAICE 1976
S Street	6 Cheshire	12 UDIA	18 SAICE 1980
1 ITE	7 Northamptonshire	13 Trestail	19 Com. Dev.
2 Gruen	8 McCluskey	14 Colman	
3 Poulton	9 Teichgraber	15 Brindle	

From this overview, the residential street can be seen to have to fulfill the following four functions:

1. To provide access to abutting properties.
2. To facilitate social activity.
3. To act as a corridor for the movement of vehicles.
4. To accommodate engineering services.

At the same time the layout should be economical in terms of the area used for and cost of circulation within the residential area.

3. PROVIDING FOR ACCESS.

3.1 Pedestrian access.

Basic access is on foot. A pathway 0,75 metres wide would be adequate for one-way pedestrian traffic but a 1,00 metre wide path is required for two-way movement. If prams or wheel chairs are to pass each other, then 1,8 metres is required.

If one considers the need for fire engines and refuse vehicles to get within 45 and 25 metres of the dwelling respectively, then the extent of the pedestrian only network for residential areas is limited. Furthermore evidence in residential areas for lower income groups shows a great desire for those who have motor vehicles to park these on site, rather than in communal car parks.

3.2 Vehicular access.

The low vehicular trip generation rates and the directionality of vehicular flow (Cameron; 1981 and 1984) suggests that single roadways could be used to provide access to a limited number of dwellings (Single roadways are 3 metres wide.). Figure 1 was prepared to show the number of dwellings that could be located on a cul-de-sac and which would experience less that one opposing vehicle in all the peak hours of a working month. This figure is based on the trip frontage index which is calculated as the product of the length of the erf frontage and the peak hour trip generation rate. The graph also allows for different directional proportions.

To accommodate passing traffic, 4,1 metre wide roadways will be required for two passing vehicles, 4,8 metres for a heavy vehicle to pass a car and 5,5 for two heavy vehicles to pass each other. These widths apply to slow moving traffic.

3.3 Parking in residential areas.

Parking is needed for residents and visitors, and can be provided on-site, on-street or off-street. An examination of erf dimensions shows that erven smaller than 200 sq. metres cannot accommodate resident parking on-site, that erven smaller that 300 sq. metres can accommodate resident parking on site and that erven will have to be greater that 450 sq. metres to accommodate visitor parking adequately. An analysis of data collected by Cameron (1984), indicates that visitor parking

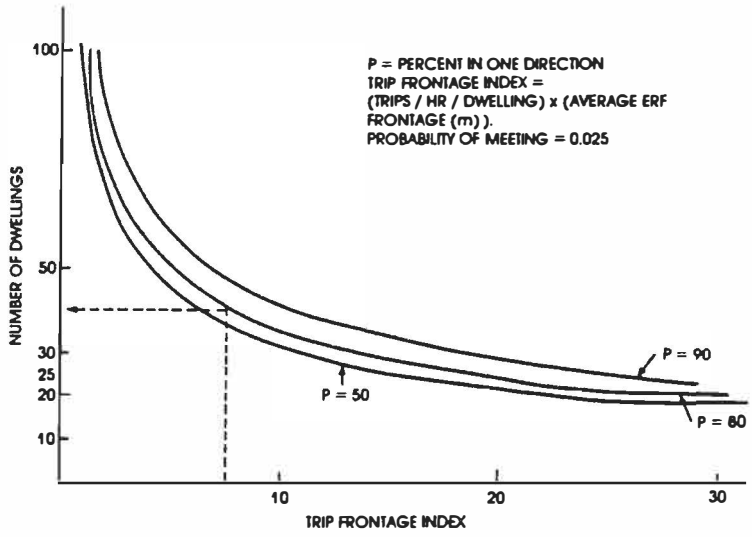

FIGURE 1. POTENTIAL FOR SINGLE LANE ROADWAYS

should be provided at average rate of 1,4 bays/dwelling. Assuming a random distribution of this average, four visitor parking bays will have to be provided if erven are considered individually.

3.4 Access to properties.

Trestail (1980) writes that one of the factors determining the width of road reserves is the need for vehicles to gain access to abutting properties. Since heavy vehicles are few, and those present during the construction phase do not have regard for driveway entrances; one need only consider the motor car. Figure 2 shows the turning path of vehicles driving between 3 and 4,8 metre roadways and a driveway with a 3 metre gate and 2,4 metre wide garage door. The 3 metre roadway would require a 7,2 metre road reserve, while the roadway with a 4,8 metre roadway would require a 5,4 metre road reserve. Both these reserve widths will not provide adequate sight distance for the vehicles reversing from the driveway. It will be necessary to ensure slow vehicular speeds unless verges of at least 4,5 metres are provided.

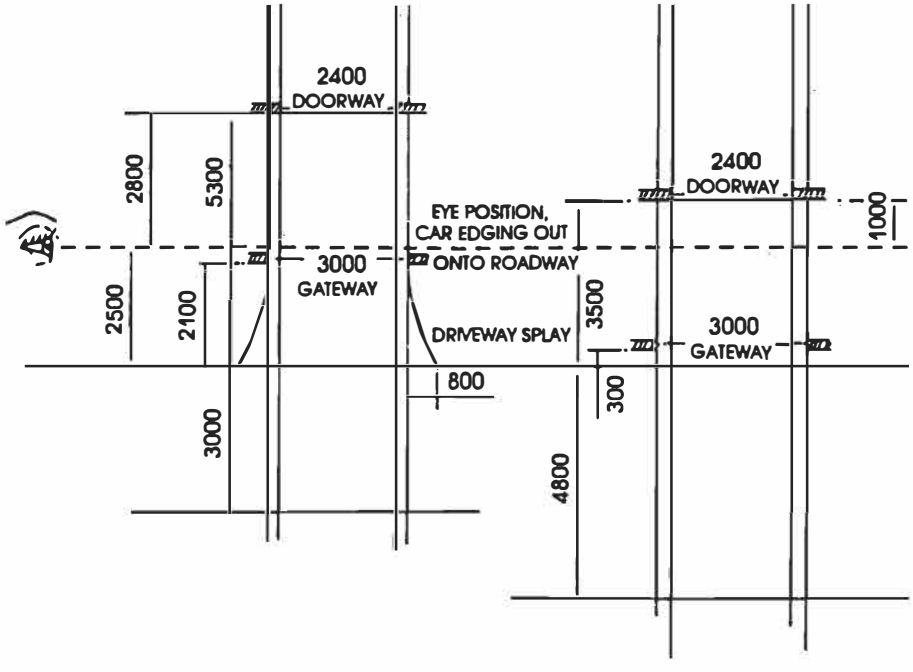

FIGURE 2. GATE AND GARAGE SET-BACKS AND ROADWAY WIDTHS

3.5 Summary.

The provision of access to properties can be based on either the pedestrian or vehicular requirements. A pedestrian only environment is limited due to the requirements of emergency and service vehicle access. Single roadways can be used for small clusters of dwellings and the road reserve could be as little as 5,4 metres if the roadway is 4,8 metres wide.

4. FACILITATING SOCIAL ACTIVITY.

4.1 Social role of the street.

Traditionally planners have considered the neighbourhood as the social unit for residential areas. Cognitive studies (e.g. Banerjee; 1984) tend to suggest that residents perceive their local street far more intensively than their neighbourhood.

Safdie (1970) gives as one criterion for housing that "a child of this age (3–6) should be able to leave the family and wander a minimum distance of 150 feet (50 metres), meet at least 10 friends of his age and find a safe place to play." Mead (1972) writes "although parents will tend to restrict the child's social interaction as a way of protecting the child, the child needs a variety of experiences if he is to grow up into an adult able to face the world". Mead also writes "every neighbourhood should have places where they (the older child) can move freely away from familiarity to trust strangers and the strange." With the concern which parents have for the well being of their children, the local street outside the dwelling must make an ideal venue for the social interaction and development of children. In this location:

1. Parents can supervise their children at play.
2. Children will meet other children and adults who have gained the approval of their parents either through acquaintance or in the implicit fact that their choice of dwelling implies acceptance of the neighbours as peers.
3. Parental knowledge of who are the neighbours will immediately identify strangers.

The social role of the residential street therefore relates to the communication between people and the safety of children at play. The success of these activities will be influenced by the physical

environment and the traffic conditions.

The literature does not provide adequate guidance in determining acceptable traffic conditions. Buchanan and Crowther (1963) in their Appendix suggest that between 400 and 500 veh/h. would acceptable. Clark and Lee (1974) provide a table which appears to permit as many as 20 000 veh/day; although they do suggest that the traffic volume in a local street should not exceed 200 veh/day nor travel faster than 30 km/h. Spitz (1983) limits the acceptable traffic volume to 1 200 veh/day; while Brown and Park (1982) consider visual intrusion to occur where the traffic volume exceeds 1 000 veh/h at 50 km/h and 700 veh/h at 30 km/h.

4.2 The residential street as an urban place.

If the residential street is to have a physical environment that will be conductive to social activity, then it needs to take the form of an urban place and not one of a vehicular corridor. Ashihara (1970) gives some guidance in this regard. He indicates that the ratio between the width of the urban space and the height of the surrounding buildings should be between 1 and 3. (This ratio can be translated into the distance between building lines on opposite sides of the residential street.)

4.3 Communication and traffic conditions.

Figure 3 is based on Webster and Gales (1970) and shows the impact of the noise level on communication. Assuming an interpersonal distance of 2 metres, communication can occur if the ambient noise level is less than 60 dB(A). Figure 4 shows the relationship between vehicle traffic, speed and noise levels. From this it can be seen that vehicular volumes of less that 250 veh/h travelling less than 30 km/h will not hinder communication.

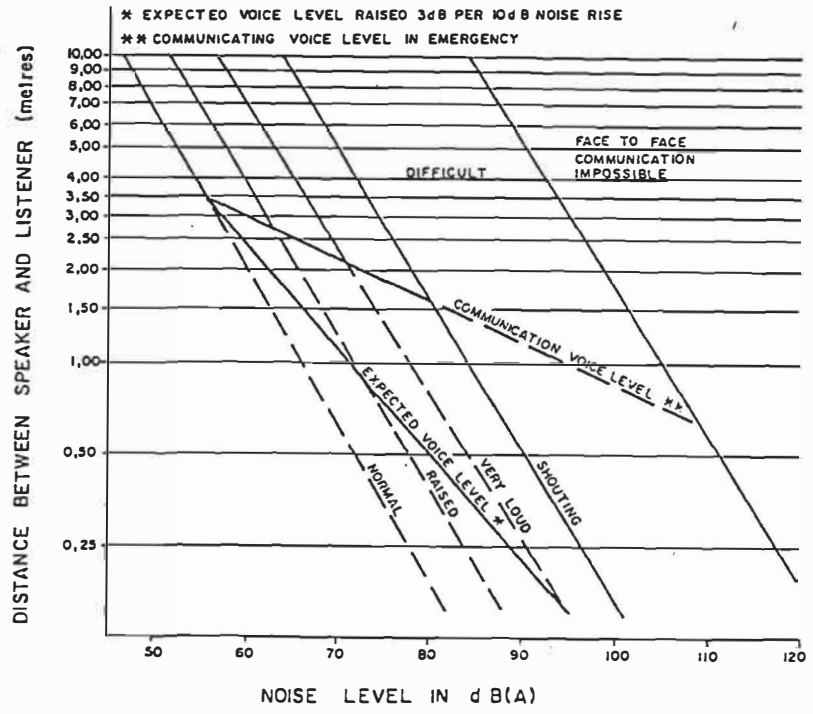

FIGURE 3. COMMUNICATION NOISE. (After Webster and Gales; 1970)

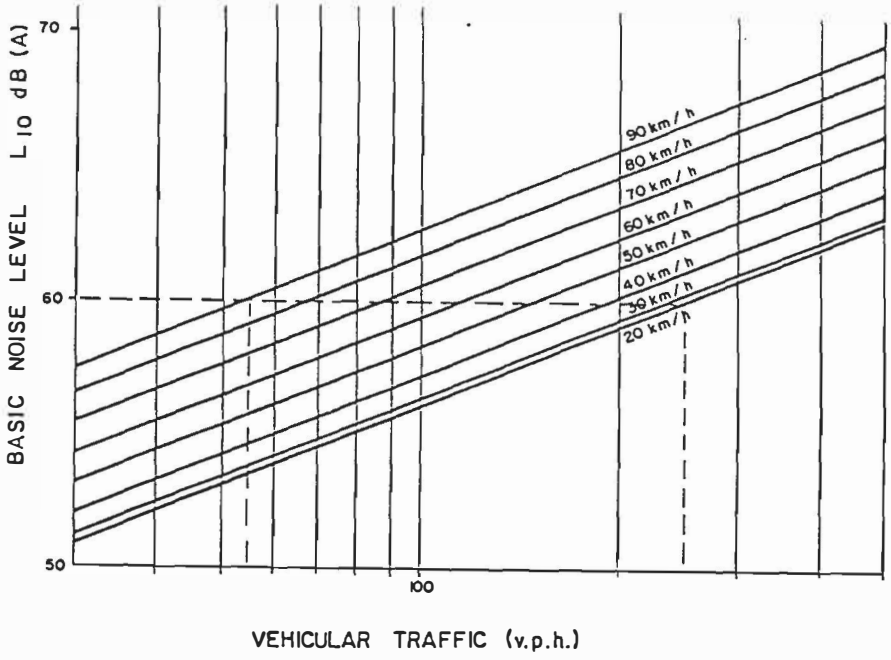

FIGURE 4. TRAFFIC VOLUME, SPEED AND NOISE. (After DOT; 1976)

4.4 Safety of children at play.

A study of attitudes of 672 respondents in six residential areas in South Africa (Cameron; 1984) shows that residents are most dissatisfied with the safety of their children playing in the street. The National Road Safety Council in its promotional literature asks children to promise not to play in the street. This request is prompted by the apparent danger which vehicles pose to them. However, there is a need for children to meet and play with other children and the potential for this in the local street has already been emphasized.

To facilitate this social activity it will be necessary to:

1. Provide children with adequate safety.
2. Ensure that the traffic free periods are adequate for meaningful play.

These two aspects can be addressed by determining safe vehicular speeds and estimating the relationship between traffic volume and the number and size of traffic free periods.

The speed of 30 km/h is frequently mentioned in the literature as the appropriate speed for residential streets (Clark and Lee; 1974; Community Development; 1983). The ANWB (1980) recommends a speed of 15 km/h.

Figure 5 shows the acceleration and deceleration patterns of vehicles entering and leaving curves in the eastern suburbs of Pretoria. It should be noted that the average speeds of vehicles through the curves is 18 km/h.

Figure 6 shows the combination of these curves for maximum speeds of 30, 40 and 50 km/h. The curves would indicate that speed restrictions at 50 metres would restrict vehicular speeds to 30 km/h. If the speeds through the restrictions could be reduced to 10 km/h then the spacing could be increased to 80 metres.

The literature does not provide guidance as to what children consider to be meaningful periods of time for play; a value of between 10 and 15 minutes would appear appropriate. The off-peak vehicular trip generation rates were found to be 0,32 and 0,43 for Elardus Park and Wingate Park respectively (Cameron; 1981). Assuming that these vehicles arrive randomly it is possible to calculate the traffic volume that would ensure, with 95 per cent certainty that there would be at least one period of 10 minutes without traffic during each off-peak hour. This was found to be 8 veh/h in the off-peak. While trip generation rates differ between residential areas, it can be related to a cluster of dwelling generating 35 veh. trips in the peak hour or 150 veh. trips per day.

4.6 Summary.

Figure 7 summarizes the discussion relating acceptable traffic speeds and volumes in the residential street if it is to facilitate social activity.

4.7 Density and the need for social space.

The "Guidelines" suggest that a motorist can be expected to travel slowly for 1 1/2 minutes (Community Development; 1983; B15). This value is not based on research and personal observation would suggest that a value of one minute be used until research shows that this value should be different. If the maximum speed is kept at 30 km/h then the average speed will be about 20 km/h. and the motorist could travel approximately 333 metres in one minute. Demographic data analysed by Del Mistro (1987) indicates that children in the age group 6 to 13 account for between 13 and 19 per cent of the population. Assuming that at least 30 children would be resident in the vicinity for 10 children to wish to

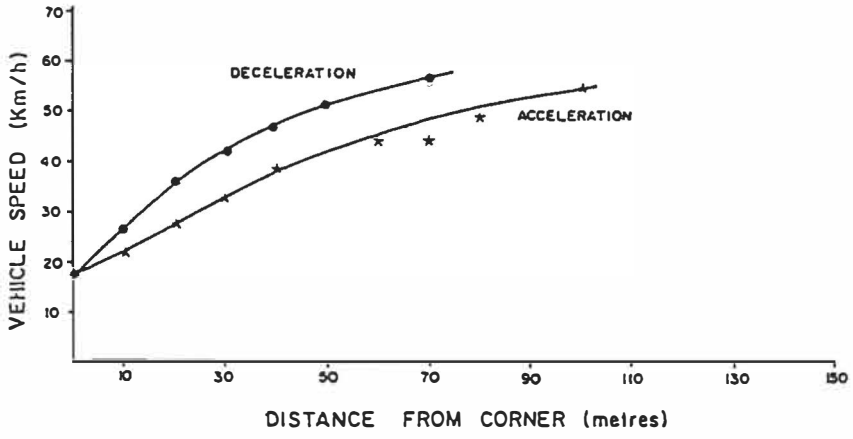

FIGURE 5. ACCELERATION AND DECELERATION PATTERNS.

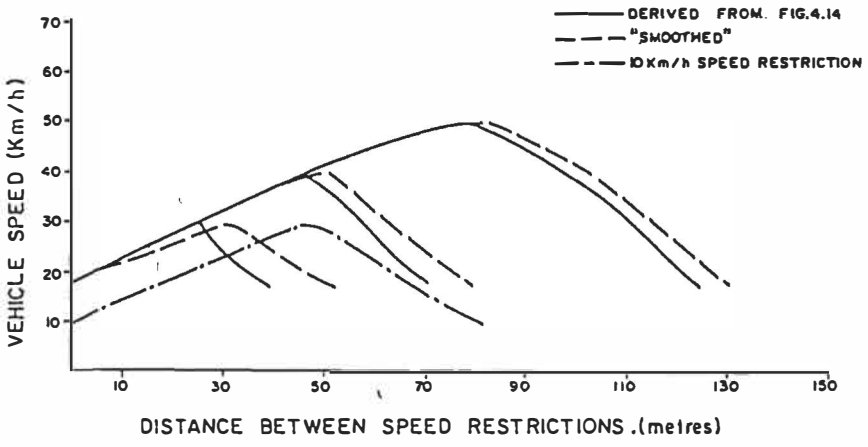

FIGURE 6. SPACING OF SPEED RESTRICTIONS

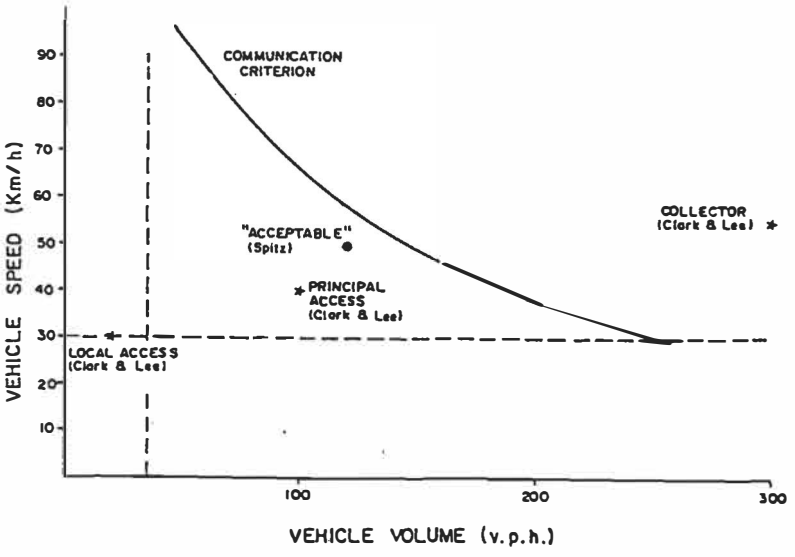

FIGURE 7. ACCEPTABLE TRAFFIC CONDITIONS

play, then depending on the household size these children would be found in dwellings ranging between 20 and 80 in number. If these dwellings are to be located on 333 metres of residential street then the average erf frontage would range between 30 and 8,5 metres.

It should be noted that as the erf size increases, the distances that children will have to walk to aggregate sufficient children to play increases, and secondly large erven tend to have many play facilities located on site. It therefore becomes apparent that when erven are greater that 800 sq metres that these factors negate the need to restrict vehicular speeds in residential streets.

5. STREETS FOR THE MOVEMENT OF VEHICLES.

5.1 Residential streets in context.

The average motorist will travel along a road at speeds which he considers safe and comfortable. On sections of straight residential streets where there is no law enforcement, some motorists will travel as fast as 100 km/h. This is unacceptable. At the same time motorists cannot be expected to travel at slow speeds for longer than a minute. This suggests the need for two types of road; an access road along which motorists travel slowly, access is gained to abutting residential properties and social activity can occur in the street; and a collector/distributor road along which vehicles can move without undue interference.

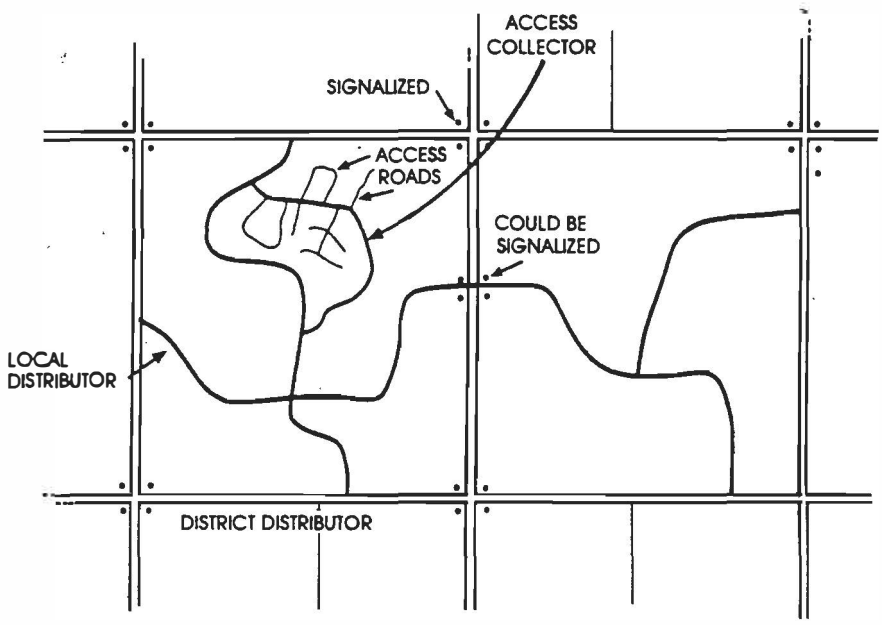

FIGURE 8. LOCAL AND DISTRICT DISTRIBUTORS.

Figure 8 shows diagrammatically the "super-block" bounded by district distributors.

This super-block will generally accommodate between 1 000 and 2 000 dwellings. The road that serves this area is the local distributor. To ensure the traffic efficiency of the district distributor the number of access points to it will be minimized. Therefore it is possible that the local distributor could carry as many as 1 000 vehicles in the peak hour. Signals will control the intersections between district distributors. The volume of traffic exitting the residential area and the need for traffic progression along the district distributor could motivate the signalization of the access points to the residential area as well.

The access route into the residential area can also serve as the bus route. A bus route can be contrived to resemble that shown in Figure 9 so that no location is further than 400 metres from the bus route (City Tramway; 1974). It should therefore be possible to restrict the bus

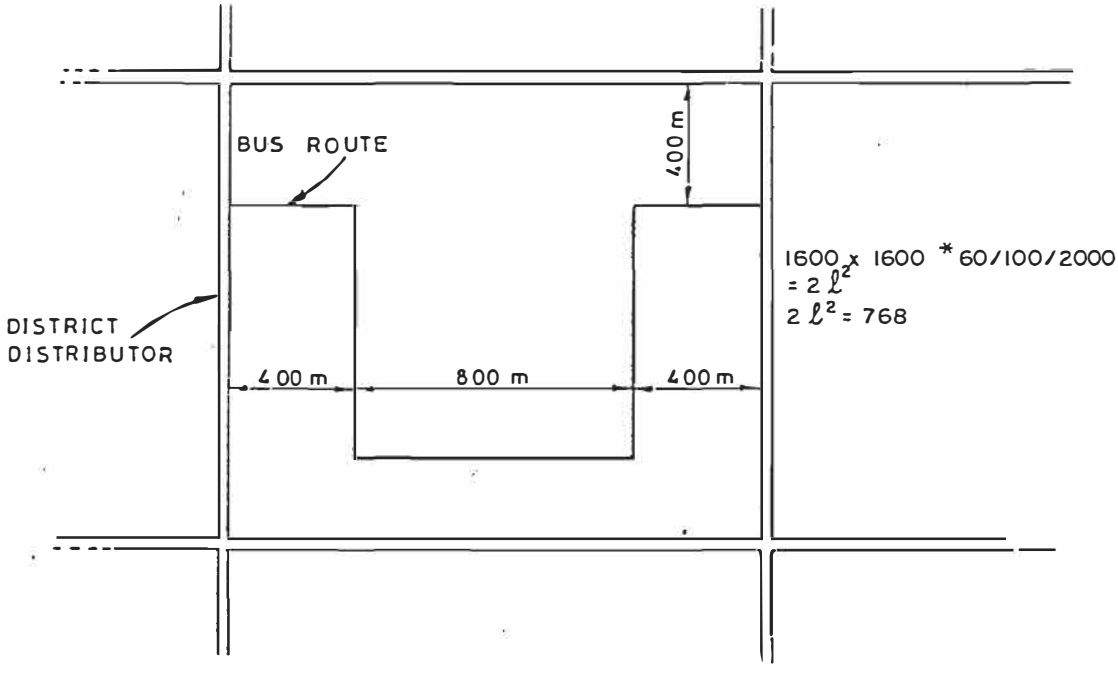

FIGURE 9. DIAGRAMMATIC BUS ROUTE.

route to the local distributor; if the average erf size is less than 800sq metres.

Between the local distributor carrying 1 000 veh/h and the access road carrying less than 150 veh/day there would appear to be a need for another road type. because:

1. The length of access roads to reach the local distributor would be too long to ensure slow speed driving.
2. The number of intersections along the local distributor would not result in smooth traffic flow.

This type of road is known as the access collector. It should not carry more than 300 veh/h if its intersections with the local distributor are not to be congested (HMSO; 1966).

The question arises whether access should be allowed onto this class of road from abutting residential erven. If one considers the vehicular volumes and speeds then direct access should be avoided. Direct access is generally motivated on the grounds of reducing unnecessary road length. Figure 10 diagrammatically dispels this notion.

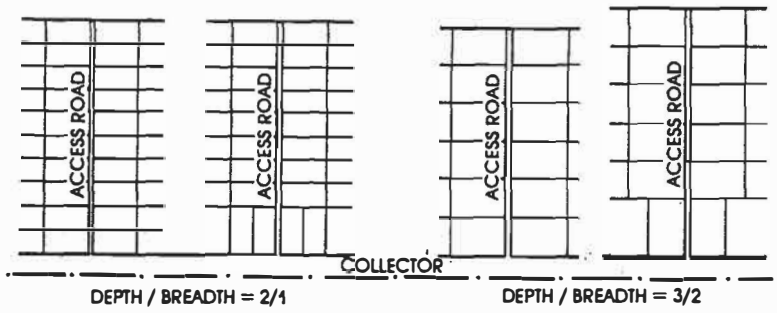

FIGURE 10. EFFECT OF PERMITTING ACCESS OFF ACCESS COLLECTORS.

5.2 Roadway width

Figure 11 shows the width of roadways required by passing vehicles. The local distributor which serves as the bus route and is the main access route into the residential area must accommodate the free flow of heavy vehicles. To achieve this Figure 11E shows that a roadway width of 7,4 metres would be required. Since access to abutting properties is restricted, parking embayments need only be provided at specific locations where non-residential properties can gain access.

The heavy vehicle trip generation rate of residential properties is estimated at 0,06 veh/h (Cameron; 1981). To accommodate the volume of traffic using the access collector a roadway width of 6,0 metres (Figure 11D) should be adequate

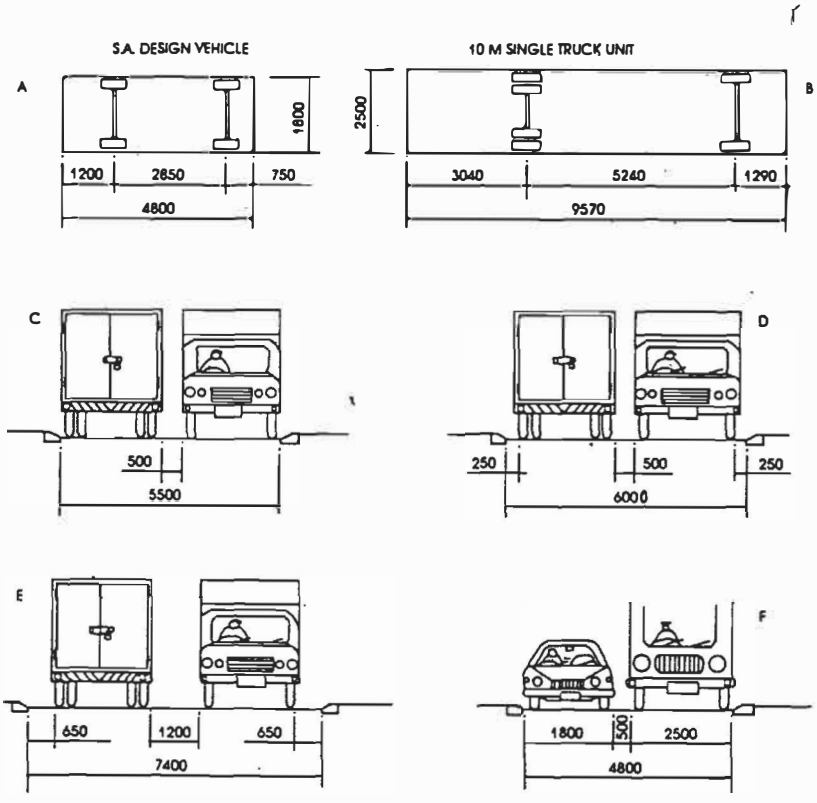

FIGURE 11. ROADWAY WIDTHS FOR PASSING VEHICLES.

5.3 Design speed.

In the preceding sections it was proposed that only the access roads provide access to abutting residential erven, with the access collector and local distributor roads serving the movement of vehicles. The operating speed in the access roads should be kept below 30 km/h. This can be achieved by a geometric layout that inhibits the free flow of vehicular traffic. The access roads could therefore be designed as urban places. Since the local distributor is the link between the residential area and the surrounding road system it should be designed with a minimum design speed of 60 km/h. While the access collector should enjoy slower speeds, it will also need to be designed to a minimum design speed of 60 km/h. The introduction of speed restrictions could be considered and their spacing could be determined from Figure 6.

6. ACCOMMODATING ENGINEERING SERVICES.

6.1 The engineering services.

The fourth function of the residential street results from the fact that the road reserve is in public ownership; i.e. vested in the Local Authority. Therefore it is available as a corridor for the engineering services required to serve the residents. In the South African context these services include stormwater, sewerage, water supply, and electricity and telephone cables.

6.2 Envelopes for engineering services.

The envelopes for the engineering services are shown in Figure 12. (These are based on Community Development; 1983 and Lamprecht; 1984). Generally, cables are laid 600 mm and pipes 1 000 metre below ground level. In practice pipes and cables are not laid centrally within their envelope. It is therefore proposed that 500 mm be allowed between the envelopes of adjoining services.

6.3 Road reserves to accommodate engineering services.

Three factors must be taken into account in determining road reserve requirements to accommodate engineering services:

1. It has become standard practice to accommodate sewers midblock where possible. Collector sewers can be provided for after their need and location have been established.
2. In a hierarchical road system, it is unlikely that access roads, be they culs-de-sac or loops will be longer that 300 metres. Generally, stormwater for these roads can be accommodated on the surface; although special provision will have to be made to remove stormwater from low points.
3. Evidence (Kouloumbis; 1984) indicates that maintenance of engineering services is very infrequent in residential streets. It should therefore be possible to consider the location of engineering services below the roadway in access roads.

Figure 13 shows the minimum road reserve width required to locate post office and electricity cables and water pipes to be 4,7 metres. This may be considered to be the configuration for services in an access road. (Section 3.1 showed that the minimum road reserve

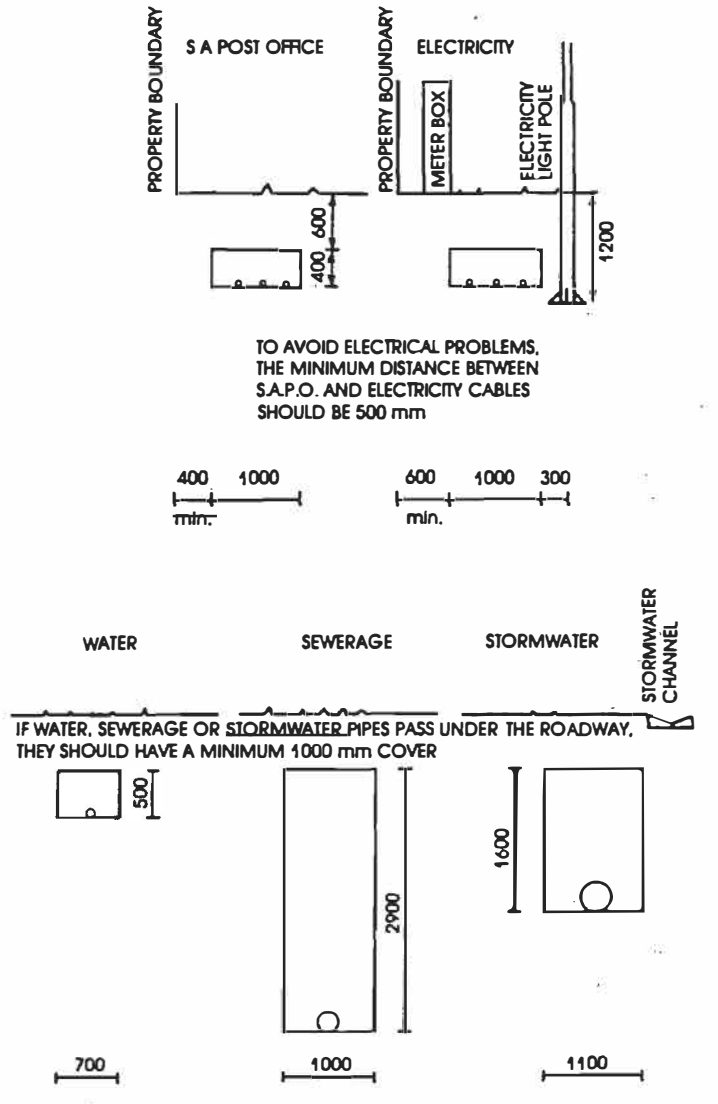

FIGURE 12. ENVELOPES FOR ENGINEERING SERVICES.

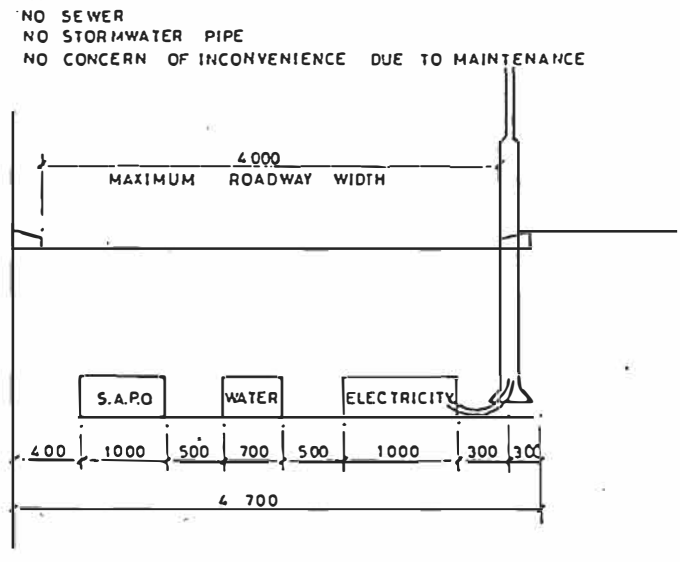

FIGURE 13. LOCATION OF SERVICES IN AN ACCESS ROAD.

for an access road would need to be 5,4 metres.)

If stormwater pipes are also to be located within the road reserve then the minimum width would need to be 6,3 metres.

In the case of the access collectors and local distributors, it would be unacceptable to close the road for the routine maintenance of engineering services. Figure 14 shows that the road reserve width required to include post office and electricity cables and water and stormwater pipes would be 12,4 and 13,8 metres respectively. If sewers were also to be accommodated, then the minimum reserve widths would need to be 13,9 and 15,3 metres respectively. Local widening could be required for shoulders and turning lanes.

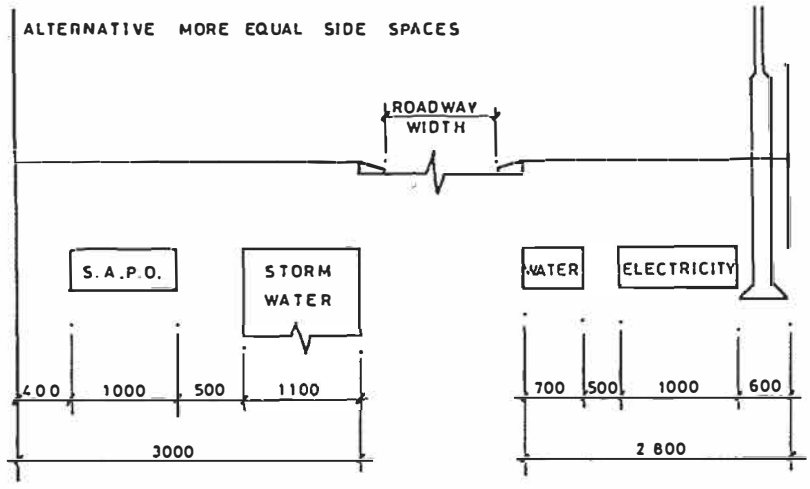

FIGURE 14. ROAD CROSS-SECTION SERVICES UNDER THE VERGES.

7. DISCUSSION.

7.1 Compatibility of functions.

While the provision of engineering services could in some cases dictate the width of the road reserve, the function of accommodating engineering services will generally be compatible with the other three functions since it is fulfilled below ground level.

The function of vehicles gaining access can be compatible with pedestrians and cyclists gaining access provided that vehicle speeds are kept below 30 km/h. If vehicle speeds are kept low, then the function of facilitating social activity will also be fulfilled; hence the first two functions are also compatible.

The function of movement is not compatible with the social activity function. It has been suggested that two types of roadway should be provided to overcome this incompatibility. This would have the following implications:

1. Access roads would be designed as urban places and not in respect of the requirements of highway engineering.
2. Access collectors and local distributors should be designed using traditional highway engineering. Access to residential properties should not be permitted from these roads.
3. The road reserve widths for access collectors and local distributors can result in a corridor format. The minimum road reserve widths for access roads should only be used to guide the urban designer in designing access roads as urban places.
4. Finally, it must be stressed that the requirements of highway design or those of engineering services should not dictate the design of the residential access road.

7.2 Cost implications of the functional approach.

The Guidelines (Community Development; 1983) made a significant contribution to reassessing the amount of road space required to serve residential areas. It is suggested that this article has added to the rationale that questions the notion of standardized road reserve widths. It is conceded that the access collector and local distributor act as corridors for movement and that a standardized road width could be applicable. However, the access roads which can account for 80 per cent of the roads in a residential area should be designed individually. This will ensure that access roads are visibly different to roads for movement and that they have individuality (Rapoport; 1977).

The functional design approach will allow the designer to allocate the specific amount of land required for circulation where it is required rather than providing road space to generalized standards.

7.3 Pedestrians and cyclists.

Although the motive for the design approach has been to provide an environment suitable for people, little attention has been paid in this article to the pedestrian and the cyclist. This aspect is implicit in the design of the access roads; where these road users will be adequately provided for by the low vehicle speeds and volumes. Part of the overall plan should be a circulation plan for pedestrians and cyclists. This would indicate the trip generators and the routes to these. Traffic control measures could then be introduced to provide safe crossing facilities for pedestrians and cyclists where necessary.

7.4 Optimization of the design.

One could compare alternative residential road layouts in terms of the space allocated for circulation. It is suggested that while this might be one component of a measure of the efficiency of the design, it does not consider the need of the urban designer to select the road reserve width to achieve design objectives. The length of roadway within the residential area would be a more accurate measure for comparison, especially if the size of erven can be taken into account.

Del Mistro (1987) has shown that the size of erf can be taken into account as follows:

$$\text{Road length index} = \frac{\text{Road length/erf}}{\sqrt{\text{Area of erf}}}$$

He has also shown that his value should be less than 0,52 and 0,68 for residential areas with low and high trip generation

rates respectively, if the cost of the network is not to exceed the minimum cost by more that 15 per cent.

This index would take account of the cost of internal travel, which amounts to less than 35 per cent of the total cost of the residential road network. The cost of internal travel is affected by two factors; namely the directionality of the trips and the number and location of the access points to the surrounding road network. These aspects are considered beyond the scope of this article and are discussed elsewhere (Del Mistro; 1987).

8. CONCLUSIONS.

Residential streets serve four major functions; namely:

1. To provide access to abutting properties.
2. To facilitate social activity.
3. To provide a corridor for the movement of vehicles.
4. To accommodate engineering services.

Each function has its own design requirements. Historically attempts have been made to reconcile the access and mobility requirements. In this article it has been shown that it is possible to identify which of the two functions a residential street section should serve. This obviates the need to compromise the design, improves the environmental conditions in access roads from which residential erven gain access and provides a means whereby the designer allocates land for circulation where it is necessary.

The functional approach to the design of residential road networks suggests that two types of roads should be designed for. The first type is the access road which provides access to abutting residential properties and facilitates social activity in the road space. This road is designed as an urban place. The second type includes the access collectors and local distributors which serve to move vehicles within the residential area, and to which residential properties should not be permitted direct access. These roads are designed using highway engineering requirements. Both types of roadways can accommodate the engineering services.

Finally, alternative designs can be compared in terms of costs by using the road length index. This index is calculated by dividing the average length of roadway per erf by the square root of the average erf size. The total cost of a residential road layout will not exceed the minimum cost by more that 15 per cent if the index is less that 0,52 and 0,68 for residential areas with low and high trip generation rates respectively.

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