

Hierarchy: the Next Step

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Abstract:

The paper will present current research undertaken by Eppell Olsen & Partners on road hierarchies. A major component of the paper will be a recommendation based on this research for hierarchy structure, terminology and standards. The basis of a road hierarchy is the functional grouping of roads and streets so that rational usage occurs. A road hierarchy also provides guidance for the intent of any treatment and appropriate measures. Resolution of the road hierarchy will properly enable and enhance future planning. We have developed a hierarchy which is based on four levels with categorisations in each level related to function in the first level, role in the second level, road treatment and management for the third level and design treatments in the fourth level. Function considerations in existing networks are particularly addressed. For example, existing roads with mixed functions. Alternatives for dealing with amenity versus traffic function, access and land use management of roads and streets are discussed.

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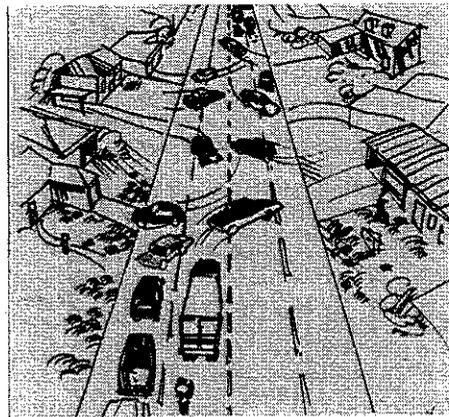
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Introduction

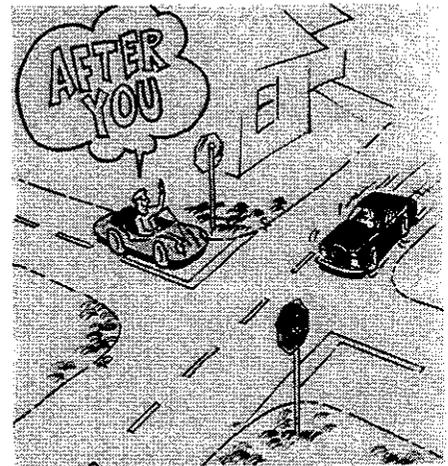
Historically, it has been accepted practice for a road hierarchy to be based on separate functions of roads (traffic carrying) and streets (providing access). Details and terminology may have differed slightly but this principle was agreed by most. More recently, differing ideas have been put forward, including the abandonment of a hierarchy altogether, and these need to be addressed. We have given consideration to the alternative concepts and ideas to develop an updated, best practice, road hierarchy.

The basis of a road hierarchy is the functional grouping of roads and streets so that rational usage occurs. The road hierarchy also provides guidance for the intent of any treatment and appropriate measures.



Amenity issues can be identified and appropriately addressed.

The classification of roads should also provide guidance to the types of works that should occur.



Issues in hierarchy

The function balance

Typically in older suburbs, past planning and land use decisions have, in some cases, resulted in streets with residential and commercial access carrying large volumes of through traffic. A large majority of these types of roads are in the inner city areas. Unfortunately, due to growth, the road is usually in the most convenient location for a through traffic carrying road or there may be no other choice for a route in this location

Strictly speaking if these roads are to continue to carry large volumes of traffic then the two conflicting activities of traffic and access should be separated. However, relocating the road to another location is often impractical and removal of residential and/or commercial premises is often similarly impractical and/or undesirable usually because of historic and/or social reasons. Frequently in these cases, the option of tunnelling the road under the residencies is a popular suggestion which would solve the problems and separate the conflicting activities. Realistically, however, funding for such an option is rarely available.

Due to the more dominant traffic function of these roads, implementing a road hierarchy should require that these be classified as a "road" and therefore be treated in a manner according to their classification, e.g. improved capacity, reduced access provision. However, there are some cases where treatment may differ as it is impractical to implement in the foreseeable future. Varying degrees of access and land use management can be used to manage the difficulties of providing a safe and efficient road whilst at the same time managing the safety and convenience of access to properties.

Brindle (1995), Roads and Traffic Authority of New South Wales (1993), Kaufman and Morris (1996), Loder and Bayley (1978) are just some authors who have considered and suggested solutions to some of these issues. Such have been reviewed and used to assist in developing a preferred hierarchy.

There is another situation where residential or commercial frontage and access occurs on roads which carry volumes over 3,000 vpd (3,000 vpd is frequently adopted as the limit before amenity and safety implications apply to frontage development). Closer examination of these situations indicates that the traffic volumes consist of local traffic, not through traffic, and are often the result of the size of the development catchment.

Such streets can occur in new developments as the size of the catchment often may not be restricted to pockets generating traffic volumes less than 3,000 vpd. This is often related to topography and existing constraints.

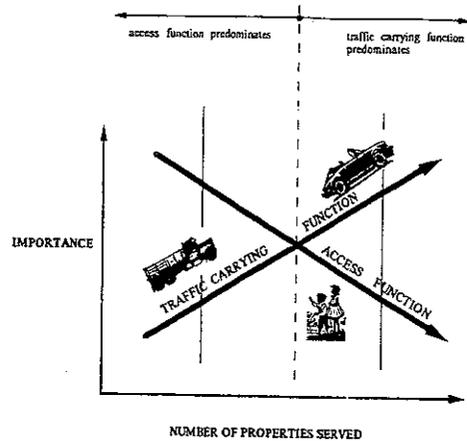
The management of these street types has been addressed in a number of sources and varying solutions have been recommended (AMCORD (1990 and 1995), Queensland Streets (1993) and Brindle (1986)), however it is generally agreed that such streets are not envisaged to carry through traffic but, as they provide a link to the traffic network,

can carry higher volumes Residential access is generally considered inappropriate on this street type unless strict guidelines regarding safety and amenity are met.

Preferred road hierarchy - Function and management

The road hierarchy proposed by Eppell Olsen & Partners as a result of this review process is consistent with the generally accepted philosophy of separating functions in which there are two main functions, access and through traffic movement.

These are the primary functions of a hierarchy and should be all that is required to classify the network However, in reality, the hierarchy needs to be broken into further elements based on issues of management, connectivity, type of traffic and design, together with fronting land use and form.



(Source: Eppell, 1989(a))

A structure has been developed to cater for all these elements. The structure is based on four levels and is illustrated in Table 1.

Table 1 Hierarchy structure

FUNCTION		DESIGN	
Level 1	Level 2	Level 3	Design
Road	Arterial	Highway	Design criteria dependent on form - reference to Queensland Streets, AMCORD, AUSTROADS, LA's subdivision guidelines
		Urban Arterial	
		Main Street	
	Sub Arterial	Sub Arterial	
		Boulevard	
Street	Collector	Major (combined lot access)	
		Minor (individual lot access)	
		Local	
	Local	Access Street	
		Access Place	

Level 1 - Primary function

The separate functions theory stems from early planning philosophy. Such a theory was brought to the forefront with "Traffic in Towns" (Ministry of Transport, 1963), although use of such a theory was evident in British planning well before this. A hierarchy should be based on the designation of specific areas and environmental cells within which considerations of amenity or environment would dominate. Specific areas are then linked by the system of traffic carrying roads whose function is to serve the specific areas. The concept of a hierarchy of roads is used to define the main function of each road which can then form the basis of ongoing planning and system management aimed at reducing the mixing and impact of incompatible functions. The hierarchy can therefore be divided into two groups based on the primary function:-

- 1) STREETS for access to property and collection of local traffic;
- 2) ROADS for through movement

The definition of a road in one particular category serves to indicate a planning intent in relation to the primary functions which will be permitted on that road. Thus, measures are likely to be adopted on access streets which relate to environmental capacity by removal of through traffic. At the other end of the scale, treatments on roads will principally be related to increasing carrying capacity. This would tend to be by removal of some incompatible lower order functions, such as limiting access to properties or reducing the number of intersecting roads

The grouping of roads by primary function forms the first level of the proposed road hierarchy structure in Table 1.

Level 2 - Role

It is necessary to apply a further functional separation within each road group based on the particular role a road should perform in the overall traffic network. This gives rise to the classification shown as Level 2 in Table 1. A definition of each classification is given below.

Arterial Roads cater for longer distance traffic movements to, from and within urban areas. Longer distance traffic requires a more efficient, less interrupted flow, therefore management techniques need to focus on this requirement.

Sub Arterial Roads provide connection between local residential, commercial or industrial areas and arterial roads. These carry through traffic and should be more convenient than using the internal streets, therefore a high level of efficiency and safety should be provided.

Collector Streets provide for circulation of traffic having a trip end within the local area. These streets are within the specific area and do not provide for through traffic. In residential areas particularly, amenity and safety within the residential environment should be the most important consideration.

Local Streets provide access to properties. In residential areas, these should be in a form to encourage a liveable and safe street environment where the motor vehicle is secondary to the pedestrian. Through traffic should be discouraged on these streets.

Arterials and sub arterials stem from the road primary function group whilst collectors and locals stem from the street primary function group.

The four classifications recommended in Level 2 are necessary to enable the function of each road in a network to be clearly defined. However, some road hierarchy schemes have more classifications such as motorway, trunk collector, and access place, resulting in a hierarchy with up to eight separate classifications. The need for these extra classifications appears not to be based on one of function, but rather on treatment and management issues. For example, a hierarchy scheme with both a motorway and arterial classification would generally make the distinction between the two based on a motorway having full access control and grade separated intersections, whilst at grade intersections would be acceptable on arterials. Clearly, this distinction is one of treatment as opposed to function, since both cater for longer distance through traffic movements.

Whilst it is acknowledged there is certainly a need to classify roads in terms of appropriate treatments and management practices, this should not be confused with classifying roads according to function. Realistically, the classification of roads by treatment should only occur after their functions have been clearly defined. It is therefore seen as appropriate to introduce another level to the road hierarchy structure, shown as Level 3 in Table 1.

Level 3 - Road treatment and management

Levels 1 and 2 of the proposed hierarchy structure were derived purely from functional considerations. Ideally, all roads within each functional classification described in Level 2 would be treated with similar criteria and this may be achievable in a new design situation. However, in many cases, the existing situation and/or other constraints dictate that varying degrees of treatment are necessary in different situations. These situations may arise for a number of reasons, not the least of which is the mixture of access and traffic functions already prevalent on many roads. Level 3 of Table 1 shows proposed treatment sub categories within each of the four functional hierarchy classifications. They provide the basis for consideration of such things as road treatments, management practices, surrounding land use, and level of service. Descriptions of the sub categories are provided below.

Arterial Roads : Arterial roads are of varying importance in their traffic carrying function dependent on the service offered to major through traffic flows and the associated level of management, particularly access management, required. Generally, the levels of management range from full access control and grade separation to signalised control. Access restriction should be adopted where possible and route directness and traffic carrying capacity considerations should predominate. They usually form the principal

heavy vehicle routes particularly for longer distance movements. Intersection spacing will generally discourage their use for local movement. In most circumstances, roadside parking should not be permitted and complete access control is a desirable feature to enhance traffic flow.

Arterials are split into three sub categories:-

- *Highway* - serving longer distance movements. It would be expected that frontage access would not occur or, if it does due to historic events, then any works undertaken will enhance the traffic carrying capability of the highway in terms of both volume and speed;
- *Urban Arterial* - which will cater for metropolitan traffic and is likely to be under local authority control. These are generally existing arterials catering for longer distance traffic but, due to past land use decisions, multiple access points, often including residential property access, occur. Any works undertaken will be directed towards enhancing the traffic carrying capability, however interim works could be undertaken aimed at ameliorating traffic impact on adjacent amenity. Longer term, access limitations and land use amalgamation would be pursued so that the traffic carrying role would be progressively enhanced;
- *Main Street* - directed at existing situations where a group of commercial uses exists on both sides of a road. A decision would need to be made, dependent on the value of these uses, that on these stretches of road the access function would be preserved in the long term and therefore management measures would need to occur to facilitate such activity. Such a road is still a traffic carrying road, however the traffic environment is restricted to improve the amenity for pedestrians and users of the adjacent land use. No measures should, however, be taken which are specifically directed at deterring traffic use of the road.

Another distinction in this category of roads is related to administration - that is federal, state or local government control. Such issues are not dealt with here.

Sub Arterial Roads: Sub arterials will normally be the lowest order of road to be traversed by scheduled public transport in performing a line haul function. In most circumstances specific provision for control of pedestrian movements should be provided and roadside parking discouraged. Usually, the prime concern should be the movement of traffic, so the use of traffic management techniques could be expected to be applied.

Levels of management (sub categories), related to constraints and opportunities imposed by existing use within this category are:-

- *Sub Arterial* - These carry through traffic and should be more convenient than using internal streets, therefore a high level of efficiency and safety should be provided. Access should be restricted, however can be managed through, for example, amalgamated entry points or side streets. This treatment would be the treatment pursued as part of any new development;

- *Boulevard* - On roads where access to adjacent land uses is existing, a different sort of management should apply. This would involve a long term aim to reduce the access as the opportunity arises. Management measures would seek to achieve safe operation while retaining the convenience and efficiency of the route. Other measures could include a reduced speed limit, the protection of adjacent parking by indented bays, bicycle paths, on or off street, and landscaping;
- *Main Street* - This category is described in the same way as for arterials.

Treatment options for roads

There are varying measures to treat access and traffic conflicts on roads. Some of these measures are as follows.

Access Management: This could best be described as the process of controlling the interface between a traffic carriageway and the adjacent land use (Brindle, 1995). Access management techniques apply to those roads on which traffic service, efficiency and safety are primary requirements. An ultimate objective on traffic carrying roads is to make them more attractive routes for through traffic (that is, by improving traffic efficiency) than the residential streets.

The techniques of access management can be grouped into seven types: frontage control, driveway control, local widening, intersection control, turn control, median and openings, and traffic management (including parking).

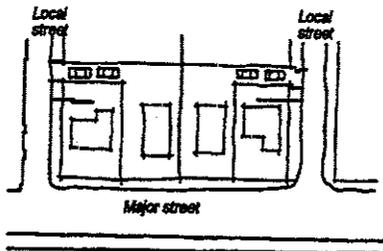
Recently, it has been suggested that access management, and therefore a road hierarchy, is unnecessary if you have a grid network (NCPA, 1995). It is claimed that grid networks allow the dispersal of traffic and turning movements throughout the street system instead of concentrating on the arterials. This therefore reduces the need for "excessively wide arterial roads which are designed to move large volumes of traffic", consequently allowing more street oriented uses along arterial roads (NCPA, 1995,27). It is stated that providing parallel routes to the arterial road, usually one block in, on one or both sides of the arterial, can reduce demand on the one arterial road.

Advocates of the grid network also recommend that subdivisions be designed so that a larger number of local roads intersect directly with the arterial network in order to provide buses better coverage and a more direct service, as well as more direct pedestrian access. It is claimed that this provides a better solution from safety, convenience and efficiency standpoints, particularly when compared to conventional developments where access out of a development is usually restricted to one or two outlets (NCPA, 1995). Although it is acknowledged that special midblock pedestrian or bus only accesses could be provided, it is suggested that the former idea is a better solution. Traditionally, however, such grid designs have encouraged "rat running" traffic through residential areas.

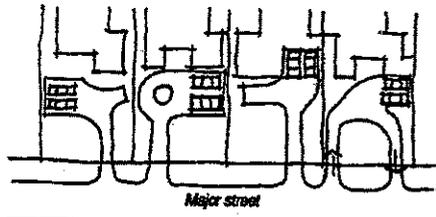
An increase in access to the arterial road reduces the safety of the route by increasing the likelihood of conflict. Efficiency and therefore convenience is also impaired. The resul-

LOT LAYOUT ALTERNATIVES FOR DWELLINGS FRONTING MAJOR STREETS

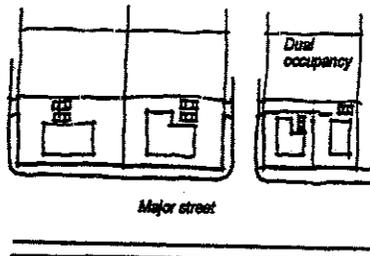
Dwellings fronting major streets such as trunk collectors or traffic routes require layouts to ensure vehicles do not need to reverse out into heavy traffic. Lots should also suit the siting and design of dwellings which can incorporate noise protection measures.



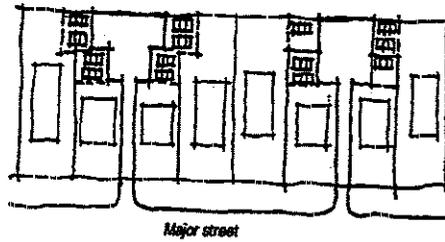
Lots fronting major street with hammerhead car access



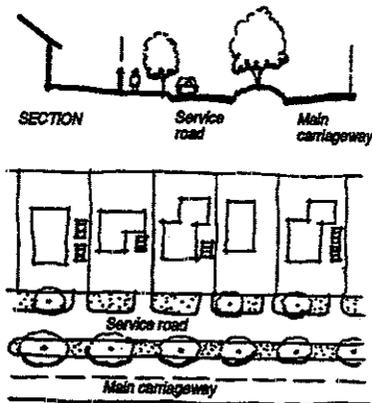
Wide lots allow for large driveways so vehicles can enter and exit forwards



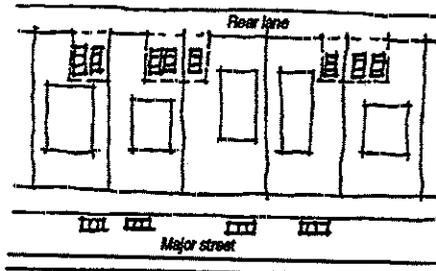
Lots with access from the side street



Car courtyards allow vehicles to enter and exit forwards



Service road enables direct vehicle access to houses fronting street and provides distance for noise reduction.



Adding a rear lane provides vehicle access for houses fronting a major street.

Figure 1 Treatments for lots fronting traffic carrying roads
(Source : Victoria Code for Residential Development, 1992)

tant congestion could increase rat running occurrence in streets not intended to function for through traffic therefore requiring expensive LATM measures to be implemented. Despite the issues raised above it can be concluded that either form of development (i.e. grid or tributary) could be pursued providing the following principles are adhered to:-

- reduce dependence on the motor vehicle;
- reduce penetration by through traffic;
- provide a permeable network for pedestrians and cyclists (not the motor vehicle);
- reduce vehicle speeds in residential areas;
- efficiency on the road network enabled by minimising access points;
- external connections located to allow convenient access.

Land Use Management: Land use based strategies are important tools for long term access management planning. Some examples of such schemes as noted in Eppell Olsen & Partners' reports for Brisbane City Council "Mobility Studies" (1995) are:-

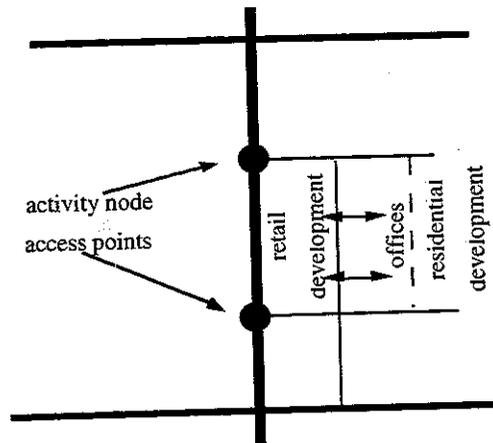


Figure 2 Nodal development to reduce multiple access

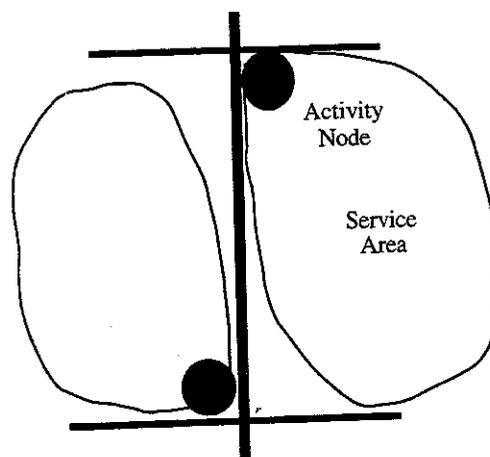


Figure 3 Staggering of nodes

- reduce frontage access along traffic carrying roads by amalgamating entry/ exit points and/or encouraging access from the back or side. Figure 1 illustrates examples of reducing access to major roads;
- encourage nodal or cluster development along traffic carrying roads to further reduce multiple accesses. Figure 2 provides an example of this;
- alternatively, encourage internodal group development along traffic carrying roads to reduce multiple accesses;
- staggering of concentrations of commercial or retail activity along each side of traffic carrying roads to minimise pedestrian crossings. See Figure 3.

The implementation and implementability of such initiatives will vary according to location and opportunity created by land ownership, development and timing thereof (EOP, 1995).

Location of commercial land use in a residential area amongst individual dwellings could encourage the use of the area by inappropriate traffic, creating unnecessary traffic volumes in the residential areas so potentially reducing amenity levels. Therefore, positioning is recommended at the edge of a residential area and generally near a traffic carrying road, ensuring that vehicular access from these roads to the commercial area is minimised, amalgamated or provided from a side street or rear lane as shown on Figure 1.

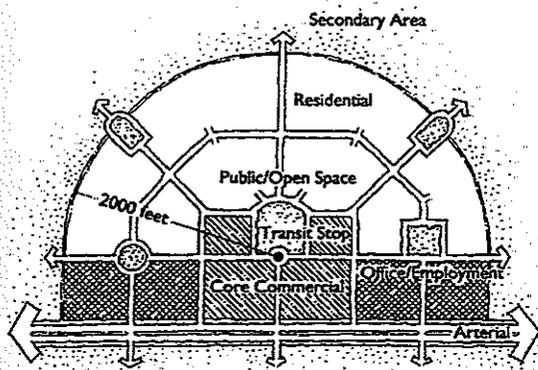


Figure 4 Example of transit oriented development
(Source: Calthorpe, 1983)

Direct pedestrian access should be provided to the commercial area from the residential area and the design should ensure as many residents as possible are within 400m walking distance of the commercial area. Many recent design guidelines suggest that this area be made a community focal point, preferably centred around a transit stop.

Pedestrian activity across an arterial or traffic carrying road should not be encouraged and therefore it may be necessary to ensure commercial development is provided on both sides of a road but in separate locations, as shown on Figure 3 (unless it has been decided that this section of road be treated as a *Main Street*). If pedestrian crossing is unavoidable, this should be provided at selected controlled locations. Underpasses and/or overpasses are usually not favourable to most pedestrians and misuse, even to the extent of the destruction of barriers, has occurred in the past.

Suggestions for locating other particular land uses are discussed in further sections of this paper.

Level 3 - Street treatment and management

Collector Streets: Collector streets will carry public transport operating in a 'sweeper' role although it is necessary to ensure that this does not lead to encouraging penetration by through traffic. Generally, roadside parking is likely to be significant if off road facilities are not provided as part of developments.

There are two sub categories related to management within this category:-

- **Major Collector Street** (combined lot access) - provides a connection between the other residential streets and the traffic carrying roads. Due to the size of some development catchments it is difficult to restrict traffic volumes on such streets to acceptable environmental amenity levels related to frontage residen

tial lots. This category caters for such situations where these volume levels may be exceeded. Strict guidelines for safety and environmental amenity are to be adhered to on such streets. In residential areas, property access should be controlled possibly through alleyways to the back of lots and side street access. Access to multi unit residential development, schools or shopping centres may well relate to major collectors;

- *Minor Collector Street* (individual lot access) - has the same function as above except, due to lower volumes on these streets, property access management is unnecessary. Volumes will be limited to about 3,000 vpd in residential areas.

Local Streets: Local streets can be further categorised into:-

- *Access Street* - access streets are generally streets where the residential environment is dominant, traffic is subservient, speed and volume are low and pedestrian and cycle movements are facilitated;
- *Access Place* - the lowest order of street providing access to sites without any traffic generated by sites in other streets.

In new development, all of the Level 3 categories may not be necessary as these have been developed to cater for both new and retro-fit situations. The preferred categories in a new system or where the opportunity arises could be limited to Highway, Urban Arterial, Sub Arterial, Major and Minor Collectors, Access Streets and Places. The level one and two categories will be unchanged whether in a new or existing situation as these are the functional classifications.

The proposed road hierarchy structure will apply equally to urban, rural and industrial land uses.

For example, a rural arterial road will still have limited access, however particularly where no alternative exists, access will be allowable from individual lots - rural as opposed to rural residential. Due to the size of rural land parcels, the spacing of access points on arterials is unlikely to conflict with the recommended spacing requirements for arterials. If rural land is subdivided, the recommended spacing of the arterial road system should be applied in the development process. Where the arterial road traverses a country town, it may need to be classified as a *Main Street* in this section whether or not a bypass is pursued.

Level 4, design criteria, would allow for varying situations. For example, amenity aspects, which are important in residential areas, do not determine requirements in industrial areas. Higher traffic volumes can therefore be accepted on the access streets. Adopting a flexible approach for industrial subdivisions could similarly lead to economies, both in development costs and ongoing maintenance costs. Current practice is for wide roads in industrial estates. At the same time, development approvals require wide flared crossovers, on site provision for service vehicles and necessary parking. Thus, the roadway can in some instances be significantly wider than necessary.

Relaxation of current requirements could be accepted if the safeguards built into town planning and building approval procedures are adequate. Consideration could, therefore, be given to reducing road widths in cases where road use is largely limited to moving vehicles whilst parking and manoeuvring can be accommodated on site.

Conclusions

The paper presents recommendations for hierarchy structure, terminology and standards based on research undertaken by Eppell Olsen & Partners.

A road hierarchy should provide guidance for the intent of any treatment for roads and streets within a road hierarchy. Such a tool should enhance the future planning of any area. The separation of hierarchy considerations into levels as described here provides a more easily usable base which will facilitate future planning. The structure provides a connection between theory, particularly functional grouping of roads, and reality.

The next stage in the development of the road hierarchy should be the preparation of design criteria for Level 4. It is envisaged that the design criteria would address issues such as:-

- traffic volumes;
- speed environment;
- cyclists;
- pedestrians;
- parking;
- heavy vehicles;
- access management;
- junction treatment;
- public transport;
- cross sections;
- abutting land use;
- junction and median spacing.

The criteria would be based on existing documents such as AMCORD and Queensland Streets.

A further stage would be development of user friendly guidelines. These could include performance based criteria and examples to illustrate how a particular road or street should be managed. Examples of the type of issues that could be addressed in these guidelines are following.

User friendly guideline examples

The road hierarchy concepts may be used to assess specific projects and/or develop guidelines for locating developments. Although not exclusive of other possibilities, appropriate locations consistent with hierarchy concepts for some specific land uses are suggested.

Local shops, Child care centres: These uses should be located such that traffic from the local area has access without requiring to access the through traffic carrying roads (arterial or sub arterial) and such that users from outside the local area do not have to pene-

trate it. An appropriate location is therefore at the interface between the local road system and the through traffic carrying roads. The intersection of a collector and a sub arterial is an appropriate location for a group of local shops and/or a child care centre, as shown on Figure 5.

Regional shopping centres: A principal concern is to ensure that traffic does not penetrate abutting local areas. This can easily be achieved if local areas generally do not have direct access to large shopping centres, however local accessibility is thereby lost. A balance needs to be sought between accessibility and minimising unnecessary penetration.

The centre should not gain access directly to an arterial road. The ideal arrangement as shown on Figure 6 is to develop a specific access road(s) connecting to a sub arterial road. Ramps should be considered as an integral part of the arterial road system and therefore an inappropriate connection point for a regional centre. Pedestrian connections from the local area should also be a requirement.

Service stations: Service stations are grouped into two types - local and through traffic serving. A local service station should be located to readily permit vehicles to enter from and return to the driver's origin. Return trips must be adequately provided for. Figure 7 compares sites for a local service station and an arterial service station.

There are few developments which have a direct relationship to arterial road traffic such that access to/from an arterial is appropriate. A service station is one. It is hard to be sure about others although food outlets on rural arterials would qualify. The essential hierarchy requirement is that access is provided without impacting on arterial road operation or capacity. In heavily trafficked areas, corner sites with frontage to two major roads are rarely large enough for this criterion to be met. It is considered most appropriate for arterial service stations to be mid block. Median provision, resulting in left in/left out access only, is usually a prerequisite for the site.

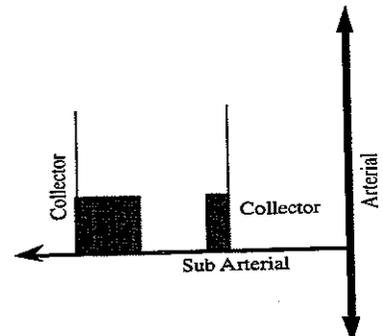


Figure 5 Hierarchic location: Local shop, Child care centre

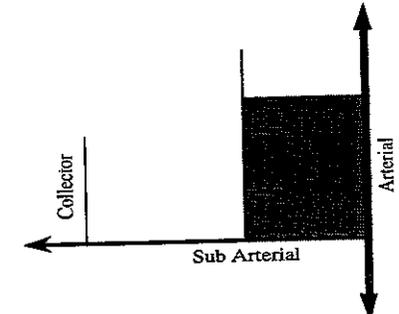


Figure 6 Hierarchic location: Regional shopping centre

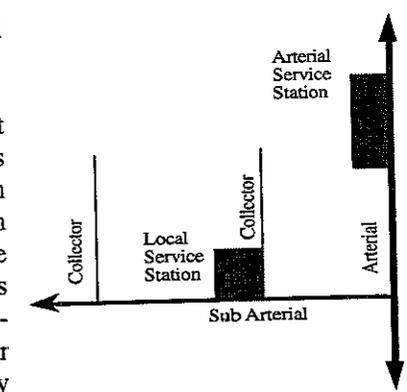


Figure 7 Hierarchic location: Service station

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