A FOUR LEVEL ROAD HIERARCHY FOR NETWORK PLANNING AND MANAGEMENT

V.A.T. Eppell, J.M. Bunker and B.A. McClurg

Eppell Olsen & Partners

Eppell Olsen & Partners has been at the forefront of developing and applying road hierarchy concepts throughout Queensland. One of the objectives of such application is to assist with the management of the road network. Tony Eppell is a director of the firm and has been instrumental in the development of road hierarchy concepts and the application of such in diverse areas. He has presented numerous papers on the subject since 1980. Jon Bunker and Brett McClurg are associates within the firm and have both been involved in the development and application of road hierarchy principles to areas such as Ipswich, Maroochydore and Mackay.

ABSTRACT

A road hierarchy has, for some time, been accepted as one of the important tools used for road network and land use planning. It is a means of defining each roadway in terms of its function such that appropriate objectives for that roadway can be set and appropriate design criteria can be implemented. These objectives and design criteria are aimed at achieving an efficient road system whereby conflicts between the roadway and the adjacent land use are minimised and the appropriate level of interaction between the roadway and land use is permitted. The introduction of a four level road hierarchy, as presented herein, expands the use of the road hierarchy as a tool for a broad spread of uses ranging from network/land use planning to asset management.

This four level road hierarchy has been developed by Eppell Olsen & Partners and adopted by a number of planning agencies in Queensland. The paper outlines the road hierarchy framework, the desirable criteria to achieve the hierarchy objectives and the benefits of the four level system.
INTRODUCTION

A key component of the built environment is the transport system that serves the land uses contained within the urban fabric, whether they be residential, commercial, educational or other. The road hierarchy has been used as a tool to assist in planning the interface between land use and the road system, and the appropriate linkage of roadways in the road system. This paper introduces a “four level road hierarchy” philosophy that manages the interface and guides system planning and management. Application of this road hierarchy to the various aspects of road system planning and management is then discussed.

WHAT IS A ROAD HIERARCHY?

Roadways serve a variety of functions, including but not limited to the provision of direct access to properties, pedestrian and bicycle paths, bus routes and catering for through traffic that is not related to immediate land uses. Many roads serve more than one function and to varying degrees, but it is clear that the mixing of incompatible functions can lead to problems.

A road hierarchy is a means of defining each roadway in terms of its function such that appropriate objectives for that roadway can be set and appropriate design criteria can be implemented. These objectives and design criteria are aimed at achieving an efficient road system whereby conflicts between the roadway and the adjacent land use are minimised and the appropriate level of interaction between the roadway and land use is permitted. The road hierarchy can then form the basis of ongoing planning and system management aimed at reducing the mixing of incompatible functions.

A four level road hierarchy has been developed by Eppell Olsen & Partners and adopted by a number of planning agencies in Queensland. This paper outlines the basis behind this road hierarchy and how it can be used to assist in areas of transport/land use planning and asset management.

ROAD HIERARCHY OBJECTIVES

The key objective of a road hierarchy is to ensure the orderly grouping of roadways in a framework around which state and local governments can plan and implement various construction, maintenance, and management schemes and projects. It should also assist local and state governments with the adoption of appropriate standards for roadway construction.

A well formed road hierarchy will reduce overall impact of traffic by:-

- concentrating longer distance flow onto routes in less sensitive locations;
- ensuring land uses and activities that are incompatible with traffic flow are restricted from routes where traffic movement should predominate;
- preserving areas where through traffic is discouraged;
- ensuring activities most closely related to frontage development, including social interaction and parking, can be given more space within precincts where environmental and access functions should predominate.
The road hierarchy principles will assist planning agencies with:-

- orderly planning of heavy vehicle and dangerous goods routes;
- planning and provision of public transport routes;
- planning and provision of pedestrian and bicycle routes;
- identifying the effects of development decisions in and on surrounding areas and roadways within the hierarchy;
- development design that facilitates urban design principles such as accessibility, connectivity, efficiency, amenity and safety;
- assigning control over access onto traffic carrying roads to ensure safe and efficient operation for traffic;
- identifying treatments such as barriers, buffers and landscaping to preserve amenity for adjacent land uses.

Thus, in order for road hierarchy to be effective, it needs to be much more than just a map of coloured lines. This paper presents road hierarchy principles that can be applied to produce a powerful planning tool.

**LAND USE/ROAD HIERARCHY RELATIONSHIP**

Eppell and Zwart (1997) revealed that the notion of hierarchy is deeply embedded within the planning of transport networks. One of the key aims of the hierarchy is to optimise accessibility, connectivity, amenity and safety for all road users including motor vehicles, bicycles pedestrians, and public transport patrons. To do so, the relationship between hierarchy and the land uses it serves needs to be considered.

The road hierarchy philosophy begins with consideration of the local area needs in what is termed a “specific area” or “environment cell”. A specific area is a part of the urban fabric that is contained within a “block” bordered by traffic carrying roads or other physical boundaries (refer to Figure 1). **Arterial roads** carry through traffic external to the specific area, and **sub arterial roads** carry through traffic between multiple specific areas and the arterial roads.

**Collector streets** are located within the specific area, providing indirect and direct access for land uses within the specific area to the road network. These streets should carry no traffic external to the specific area. The environmental cells within the specific area are bounded by the collector streets, and contain **local streets** with low speed environments and pedestrian priority. Their function is to provide direct property access. Within environmental cells, considerations of amenity and environment dominate.
Whilst the size and shape of a specific area is commonly constrained by fixed elements such as topography and property boundaries, the idealised form is of the order of 1km x 1km. This size would typically encompass four environmental cells, each 0.5km x 0.5km. It is these typical areas which generally satisfy the following desirable criteria for livable residential areas:

- people tend to regard an area within 500m of their residence as their “home area”;
- this distance accords well within the principles of desirable spacing of accesses from the cell to the traffic carrying roads, bus route spacing, and acceptable walking distances;
- the desirable maximum traffic volume on a residential street to satisfy amenity considerations is 2,000vpd – 3,000vpd.

Traffic should be distributed appropriately amongst the collector streets to ensure that amenity levels are not exceeded and adequate connectivity is maintained. References such as Queensland Streets (1993) provide appropriate guidance on street network layout consistent with this aim.
ROAD HIERARCHY FRAMEWORK

Table 1 presents a four level road hierarchy framework which has been developed by Eppell Olsen & Partners in a manner that identifies the functional objectives of each element within each level of the hierarchy. The use of four levels is an innovation which has been developed from the experiences learned in the extensive application of hierarchy principles and schemes over a number of years.

The four levels have been arranged in terms of an increasing degree of detail with respect to functional objectives and are defined as follows:-

- **Level 1. Purpose** relates to the primary objective of the element, whether to carry through traffic or provide direct property access;
- **Level 2. Function** relates to the relationship between the roadway and the land use it serves (i.e. how the roadway serves the land use);
- **Level 3. Management** relates to the emplacement of policies to achieve the envisaged function based upon the attributes of the element and of the adjacent land uses; and
- **Level 4. Design** relates to specification of the form of the element in order to achieve its functional objectives.

PURPOSE

In general terms, traffic volume on a roadway is proportional to the number of properties served. Figure 2 identifies the relationships between the importance of the access function, and the traffic carrying function, and the number of properties served. The greater number of properties served, the greater need there is for a roadway to serve a traffic carrying purpose.

*Roadway Function and Scale*  
*Figure 2*
Eppell Olsen & Partners
A Four Level Road Hierarchy for Network Planning and Management

### LEVEL 1: PURPOSE

<table>
<thead>
<tr>
<th>ROAD</th>
<th>STREET</th>
</tr>
</thead>
<tbody>
<tr>
<td>• to carry through traffic</td>
<td>• to provide local property access</td>
</tr>
<tr>
<td>• to provide local property access</td>
<td>• to collect local traffic</td>
</tr>
</tbody>
</table>

### LEVEL 2: FUNCTION

<table>
<thead>
<tr>
<th>ARTERIAL ROAD</th>
<th>SUB ARTERIAL ROAD</th>
<th>COLLECTOR STREET</th>
<th>LOCAL STREET</th>
</tr>
</thead>
<tbody>
<tr>
<td>• through traffic movements</td>
<td>• connections between local areas and arterial roads</td>
<td>• carry traffic having a trip end within the specific area</td>
<td>• direct access to properties</td>
</tr>
<tr>
<td>• longer distance traffic movements</td>
<td>• connections for through traffic between arterial roads</td>
<td></td>
<td>• pedestrian movements</td>
</tr>
<tr>
<td>• line haul public transport task</td>
<td>• access to public transport</td>
<td></td>
<td>• local cycle movements</td>
</tr>
<tr>
<td>• primary freight and dangerous goods routes</td>
<td>• through movement of public transport</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• regional cycle movements (off road)</td>
<td>• regional – local cycle movements (off road)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• pedestrian movements</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### LEVEL 3: MANAGEMENT

<table>
<thead>
<tr>
<th>Highway</th>
<th>Arterial</th>
<th>Arterial Main Street</th>
<th>Traffic Distributor</th>
<th>Controlled Distributor</th>
<th>Sub Arterial Main Street</th>
<th>Major Collector</th>
<th>Minor Collector</th>
<th>Access Street</th>
<th>Access Place</th>
</tr>
</thead>
<tbody>
<tr>
<td>• longer distance traffic movements</td>
<td>• longer distance traffic movements</td>
<td>• longer distance traffic movements</td>
<td>• connection of local areas to arterial roads</td>
<td>• connection of local areas to arterial roads</td>
<td>• connection of residential streets with traffic carrying roads</td>
<td>• connection of residential streets with traffic carrying roads</td>
<td>• access to individual adjacent properties</td>
<td>• access to individual adjacent properties</td>
<td></td>
</tr>
<tr>
<td>• regionally and nationally significant movements</td>
<td>• access to commercial properties</td>
<td>• access to commercial properties (certain existing cases). Treatment may control some aspects of traffic operation to ameliorate impacts</td>
<td>• access to commercial properties</td>
<td>• access to commercial properties. Treatment may involve preservation of aspects of local amenity in balance with traffic operation</td>
<td>• access to grouped/ commercial properties and community facilities</td>
<td>• access to grouped/ commercial properties and community facilities</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### LEVEL 4: DESIGN

• according to relevant guidelines and codes including Council subdivision guidelines, AUSTROADS Guides, Queensland Streets, AMCORD, Australian Standards
In level 1 of the hierarchy we are able to define the basic purposes as follow:-

- **roads** – to carry through traffic, serving a longer distance purpose;
- **streets** – to provide access to properties and local areas.

**FUNCTION**

Within the two broad groups of roads and streets, the functions of roadways vary in how land use is served. This has necessitated the identification of four functional categories as level 2 of the hierarchy framework. This level of the hierarchy framework corresponds most closely to the traditional, widely used single level road hierarchy frameworks.

The four functional categories in level 2 of the hierarchy are defined as:-

- **arterial roads** – to carry long distance through traffic external to specific areas;
- **sub arterial roads** – to carry through traffic between specific areas and arterial roads on a supporting role to the latter;
- **collector streets** – to provide connectivity between the environmental cells and the traffic carrying road and serve property access; and
- **local streets** – to provide direct property access.

**MANAGEMENT**

Road hierarchy plans form the basis for the roadway management and planning initiatives of government and are embodied as powerful planning instruments in the legislation. The designation of a roadway in a particular category is useful only when there are complementary management policies to implement the designation. In other words, there must be a means to achieve the road hierarchy plan. These management policies form the third level of the hierarchy.

Levels 1 and 2 of the hierarchy framework derive purely from functional considerations. It is these levels of the road hierarchy that are traditionally used to assist in planning the road network and the land use that is serves.

Ideally, within each category of level 2, all roadways would be treated in the same manner. Whilst this may be achievable in a new design, often an existing situation or other constraint may dictate that a variety of treatments may need to be available. 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 roadways.

Level 3 includes management sub categories within each of the four classifications of function which relate to more particular attributes of the roadway. It is this level of the hierarchy that fulfills the road management role. For each sub category, Table 1 addresses objectives that are more specific than level 2.

Section 6 discusses this most innovative level of the hierarchy in detail.
DESIGN

The fourth level of the hierarchy framework relates to specific design criteria that are applicable to each road/street category in level 3. These design criteria should be developed using relevant documents, including local government development guidelines, state guidelines (e.g. Queensland Streets) and national guidelines (e.g. AUSTROADS, AMCORD and Australian Standards).

ROAD MANAGEMENT UNDER THE HIERARCHY

The preceding section and Table 1 identify individual road hierarchy categories and their functional objectives. In order for the hierarchy to be an effective planning tool, means of achieving these objectives need to be identified. This has been done by specifying desirable performance criteria for each classification in level 3 of the hierarchy framework.

These desirable performance criteria are subdivided into three groups:

- **Functional** characteristics required of a roadway element to achieve its objectives;
- **Frictional** characteristics, which relate to the way roadside activity affects traffic use; and
- **Impact** characteristics, which relate to the relationship between a roadway element and amenity to adjacent land use.

Once the appropriate level 3 classification is established for a roadway element, the desirable performance criteria provide guidance on how that element should be managed. It is recognised that individual circumstances may preclude some of the criteria from being met, but the structure of the hierarchy provides sufficient flexibility that all cases can be accommodated. Separate sets of criteria have been developed for rural and urban settings.

FUNCTIONAL CHARACTERISTICS

For each level 3 classification, the desirable performance criterion is specified for each of the following roadway **functional** characteristics:

- dominant linkage – what type of areas should the roadway provide service to/from;
- traffic carrying function – whilst volumes are not intended to define the category into which the roadway falls, this criterion provides some guidance as to the maximum traffic volumes anticipated;
- residential, commercial, industrial access – what degree of direct access to each of the land use types is appropriate;
- traffic speed environment – the typical speed environment anticipated. This is not intended to define the maximum speed limit, which should be done in accordance with state regulation;
- heavy vehicle movement – whether the roadway is appropriate for heavy vehicles (other than for local access);
dangerous goods movement – whether the roadway is appropriate for the passage of dangerous goods vehicles (other than for local access);

• public transport facilities – what role should the roadway serve for public transport (consistent with any public transport network planning);
• cycle facilities – what type of bicycle facilities should be provided (consistent with any bikeway network planning);
• pedestrian movement facilities – what type of pedestrian movement facilities should be provided along the roadway.

The desirable performance criteria for these functional characteristics are set to ensure the network operates effectively, efficiently and safely for its users.

**FRICIONAL CHARACTERISTICS**

Roadway frictional characteristics for which desirable performance criteria are specified are as follows:

• access control – constraints imposed on direct access to adjacent developments;
• parking provision – what provision for parking within the road reserve is appropriate;
• bus stopping provision – what provision for bus stopping within the road reserve should be made;
• pedestrian crossings – what types of facilities should be provided to allow pedestrians and cyclists to cross the roadway. Note that state regulation prevails;
• intersection spacing – the typical distance between successive intersections along the roadway;
• intersection treatments – what form of intersection control is appropriate where the roadway intersects another of equal or higher classification;
• cross section – typical cross sections in terms of divided or undivided carriageways and number of lanes. Note that further details on cross section would be identified in level 4 (design) of the hierarchy framework.

The desirable performance criteria for these frictional characteristics are set with the intent of improving the efficiency of traffic flow and thus reducing its environmental consequences, in balance with access needs.
IMPACT CHARACTERISTICS

Roadway impact characteristics for which desirable performance criteria are provided are as follows:-

- abutting land use types – in general, what type of land use would be appropriate or compatible with the roadway function;
- land use impact amelioration – in general, what types of measures are appropriate on this roadway to reduce the immediate social and environmental impacts of traffic. Such treatments include barriers (fences, walls), buffers (vegetation), setbacks (distances to property lines and/or building facias), streetscaping and local area traffic management (LATM) devices.

The desirable performance criteria for these impact characteristics are set with the intent of reducing social and environmental impacts of traffic flow on adjacent land uses.

USE OF THE PERFORMANCE CRITERIA

Table 2 provides an example of a matrix of desirable performance criteria developed for level 3 classifications under each of these functional, frictional and impact characteristics for urban areas. An agency such as a local government wishing to use this framework will need to develop its own criteria with care, to ensure that the social, physical, and legislative attributes of the area are given due consideration.

The desirable performance criteria can be used by a roads agency, such as a local government, in all aspects of road network planning, design and management, including the following activities:-

- ongoing management of a section of roadway in a network;
- identifying constraints within the roadway network under existing and projected future conditions;
- identifying capital improvement projects;
- planning for an area capital works program;
- providing direction in local area planning activities;
- developing land use zoning plans and/or local area objectives;
- developing an infrastructure charging Plan (ICP);
- assessing development impact and setting appropriate conditions of development.
### Table 2: Road Hierarchy Desirable Performance Criteria – Urban Areas (Example Only)

<table>
<thead>
<tr>
<th>Criterion</th>
<th>ROAD</th>
<th>SUB ARTERIAL ROAD</th>
<th>COLLECTOR STREET</th>
<th>LOCAL STREET</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ARTERIAL ROAD</td>
<td>Traffic Distributor</td>
<td>Controlled Distributor</td>
<td>Sub Arterial Main Street</td>
</tr>
<tr>
<td></td>
<td>Highway</td>
<td>Arterial Main Street</td>
<td>Traffic</td>
<td>Sub Arterial Main Street</td>
</tr>
<tr>
<td>Functional Characteristics</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Access control</td>
<td>No access</td>
<td>No access</td>
<td>Selective access control</td>
<td>Selective access control</td>
</tr>
<tr>
<td>Parking provision</td>
<td>Nil</td>
<td>Nil</td>
<td>Keep clear of through lanes</td>
<td>Keep clear of through lanes</td>
</tr>
<tr>
<td>Bus stopping provision</td>
<td>None on road</td>
<td>Indented bays where appropriate</td>
<td>Indented bays where appropriate</td>
<td>Indented bays where appropriate</td>
</tr>
<tr>
<td>Pedestrian crossings</td>
<td>Unspecified</td>
<td>Standardised</td>
<td>Controlled points</td>
<td>Controlled points</td>
</tr>
<tr>
<td>Intersection treatments</td>
<td>Grade separated</td>
<td>Grade separated/ roundabout</td>
<td>Signal/roundabout</td>
<td>Signal/roundabout priority T</td>
</tr>
<tr>
<td>Cross section</td>
<td>Volume driven, divided</td>
<td>Volume driven, could be divided</td>
<td>4 or 2 lanes, could be divided</td>
<td>4 or 2 lanes, could be divided</td>
</tr>
</tbody>
</table>

### Frictional Characteristics

<table>
<thead>
<tr>
<th>Access control</th>
<th>No access</th>
<th>No access</th>
<th>Selective access control</th>
<th>Selective access control</th>
<th>Selective access control</th>
<th>Selective access control</th>
<th>Combined site access</th>
<th>Individual sites</th>
<th>Individual sites</th>
<th>Individual sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking provision</td>
<td>Nil</td>
<td>Nil</td>
<td>Keep clear of through lanes</td>
<td>Keep clear of through lanes</td>
<td>Keep clear of through lanes</td>
<td>Kerb side</td>
<td>Kerb side</td>
<td>No specific provision</td>
<td>No specific provision</td>
<td>No specific provision</td>
</tr>
<tr>
<td>Bus stopping provision</td>
<td>None on road</td>
<td>Indented bays where appropriate</td>
<td>Indented bays where appropriate</td>
<td>Indented bays where appropriate</td>
<td>Indented bays where appropriate</td>
<td>Kerb side</td>
<td>Kerb side</td>
<td>No specific provision</td>
<td>No specific provision</td>
<td>No specific provision</td>
</tr>
<tr>
<td>Pedestrian crossings</td>
<td>Unspecified</td>
<td>Standardised</td>
<td>Controlled points</td>
<td>Controlled points</td>
<td>Controlled points</td>
<td>Some controlled points</td>
<td>No specific provision</td>
<td>No specific provision</td>
<td>No specific provision</td>
<td>No specific provision</td>
</tr>
<tr>
<td>Intersection treatments</td>
<td>Grade separated</td>
<td>Grade separated/ roundabout</td>
<td>Signal/roundabout</td>
<td>Signal/roundabout priority T</td>
<td>Signal/roundabout priority T</td>
<td>Roundabout/ priority</td>
<td>Priority</td>
<td>Priority</td>
<td>Priority</td>
<td>Priority</td>
</tr>
<tr>
<td>Cross section</td>
<td>Volume driven, divided</td>
<td>Volume driven, could be divided</td>
<td>4 or 2 lanes, could be divided</td>
<td>4 or 2 lanes, could be divided</td>
<td>Generally 2 lanes</td>
<td>2 lanes, could be divided</td>
<td>2 lanes</td>
<td>1 or 2 lanes</td>
<td>1 or 2 lanes</td>
<td>1 or 2 lanes</td>
</tr>
</tbody>
</table>

### Impact Characteristics

<table>
<thead>
<tr>
<th>Alighting areas</th>
<th>Non sensitive to traffic</th>
<th>Non sensitive to traffic</th>
<th>Retail/commercial</th>
<th>Non sensitive to traffic</th>
<th>Retail/commercial</th>
<th>As specified under zoning</th>
<th>As specified under zoning</th>
<th>As specified under zoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land use impact assessment</td>
<td>Buses/buses or bus stops</td>
<td>Bus stops</td>
<td>Streetscape</td>
<td>Streetscape</td>
<td>Streetscape</td>
<td>Traffic management streetscape</td>
<td>LATM streetscape</td>
<td>LATM streetscape</td>
</tr>
</tbody>
</table>
APPLICATION OF THE FOUR LEVEL HIERARCHY

The four level road hierarchy is a tool that can be used in a number of areas of transport planning and road network management, including:-

- Planning – in designating for a region a Strategic Transport Network consisting of roadways, as well as other facilities for the movement of goods and people;
- Assess Management – in designating and programming improvements to achieve the desirable performance criteria over time for each element of the road network;
- Environment – in management of the road network to facilitate efficient operation, which will assist in achieving environmental sustainability and improve amenity to the region’s inhabitants;
- Safety – in management of the road network by controlling access onto traffic carrying roads, providing appropriate design standards, and proper use of the network by the vehicle fleet to facilitate safe movement of all road users;
- Congestion Management – in planning and management of the road network to ensure traffic volumes carried are appropriate to roadway functional and management attributes.

CONCLUSIONS

This paper has presented the overall framework for a new four level road hierarchy. It also presents a sample of the desirable criteria suggested for each roadway classification. These criteria and the overall four level framework can be used in a broad range of transport planning and road system management areas. Transport planners and road authorities are encouraged to consider the use of this hierarchy framework to plan and manage their road networks.
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