1 INTRODUCTION

1.1 Definition of a Traffic Impact Assessment

A traffic impact study (TIA) is a technical appraisal of the traffic and safety implications relating to a specific development. The information provided in the study report should enable the relevant authorities (i.e. Ministry of Works & Housing) to assess the traffic impact of a development.

It is particularly important that the TIA remains an objective assessment of the traffic impact of the development and not merely an avenue for a developer getting planning and building approval. If there will be future traffic problems resulting from the proposed development (either directly caused by the development or by the level of detail in the area) then this needs to be objectively presented in the TIA. Also the TIA should investigate ways of mitigating this impact.

Similarly the TIA should address all issues related to on-site parking and internal circulation. Also the interface between the development and the surrounding road network is important, as is adequate provision for service vehicles.

A TIA should follow the standard format and structure that is listed in the relevant Sections of these Guidelines. This format covers the key issues to be addressed in determining the impact on traffic of a development.

1.2 When is a Traffic Impact Assessment Required

The Roads Planning and Design Directorate requires that planning applications for developments which are of a size or type that would generate significant additional traffic are accompanied by a Traffic Impact assessment (TIA). The TIA study would determine whether the development necessitates changes in the existing or planned road infrastructure or public transportation services.

A TIA is required where traffic to and from the development exceeds 10% of the two way traffic flows on the adjoining road network or 5% of the two way traffic flows on the adjoining road network where traffic congestion exists or will exist within the assessment period or in other sensitive locations.
Further there will be some development that will be so significant in size that TIAs should be undertaken as a matter of course. As a guide, proposals exceeding the following parameters may attract sufficient additional traffic to warrant a TIA.

- Residential developments in excess of 100 units (apartments etc.).
- Business in excess of 5,000m².
- Warehousing in excess of 10,000m².
- Retail Gross Floor Area (GFA) in excess of 1,000 m².
- 100 trips in and out in the peak hour.
- 100 on site parking spaces.

1.3 Issues to Be Covered in a Traffic Impact Assessment

The following outlines issues to be addressed in traffic impact studies. The issues to be looked at in the TIA are presented more fully in the following sections of these guidelines:

1. The scale of the proposed development and its compliance with the relevant landuse zoning guidelines.
2. existing proposals for improvements to the study area road network and hierarchy
3. impact on road safety
4. impact of traffic noise (particularly in residential areas)
5. peak period traffic volumes and congestion levels at intersections in the study area
6. existing parking supply and demand in the vicinity of the proposed development
7. existing and proposed public transport services in the vicinity of the proposed development
8. parking provisions appropriate to the development (in relation to demand and statutory requirements)
9. traffic generation / attraction and trip distribution of the proposed development
10. safety and efficiency of internal road layout, including service and parking areas
11. impact of generated traffic on the streets in the study area
12. safety and efficiency of access between the site and the study area road network
1.4  Steps Required When Undertaking A Traffic Impact Assessment
When a TIA is being undertaken the following process will be followed.

1.4.1  Approaches To Government Agencies
Initial approaches should be made to the relevant Government agencies by the Consultant proposing to undertake the TIA. These approaches should be made to the relevant officers within the Government Agencies. As a minimum approaches should be made to the Roads Planning & Design Directorate of the MOWH and the Structural Planning Directorate of the MOMA.

In these approaches should be accompanied by concept plans for the development. On their part the Government agencies will provide relevant transport and planning information to the Consultants.

As well it is expected that the following information if available can be provided to the Consultant.

- Proposed road and transport plans for the area
- Current transport model for the area
- Accident data
- Existing traffic information (automatic classifier counts, intersection movement counts)
- Current information on the expected traffic and parking generation of similar types of development in Bahrain
- Current or proposed landuse zoning in the area
- Proposed road network for the area
- Road strategies for the area (including restricted access roads)
- Previous TIA's for other developments in the vicinity of the proposed development;
- Other relevant traffic information in electronic format. This could include previous VISSIM and SIDRA models already used for roads in the proposed study area.

The relevant contact persons are:

Kadhim Latif MOWH

Firas Ameen MOMA

1.4.2  Determination Of Development Planning Status
The Consultant should consider the relationship between the scale and type of development and the current (or proposed) landuse zoning of the subject site.
Furthermore the Consultant should consider the landuse zoning and current development of areas adjoining the development.

The Consultant should at an early stage confirm that the proposed development represents an allowable development, given the current landuse zoning. If the development seems not to be allowable, then documentation should be obtained from the MOMA which demonstrates that the proposed development is acceptable from a planning perspective.

The Consultant should also obtain information on the corridor and road widths on the access roads to the development.

### 1.4.3 Determination of Required Study Area

The Consultant should make a determination of the required study area (that is the road network to be objectively assessed).

The study area will be determined by the scale of the development, the likely scale of other development in the area and the road network. As a rule the study area will include the following.

- The access street from which the development gets access;
- The streets by which traffic from the development will get to the nearest Collector or Major Distributor Road. In the absence of a defined road hierarchy this will be the first road with a corridor width of 20 metres or greater;
- All streets and intersections for which the development will contribute 5% or more of the future traffic. This figure of 5% will be arrived at by modelling of the area for assumptions of ultimate development (2030) of the area according to the current landuse plans for the area. Where the area is already more or less fully developed existing traffic counts can also be used for this purpose.

### 1.4.4 Production And Approval Of Scoping Statement

The Consultants will prepare a scoping statement. This statement will be forwarded to the relevant officer in the MOWH.

The scoping statement is intended to be a short document and will provide the following:

- Brief description of the development;
- Summary of the information obtained from relevant agencies;
- Verification that the development complies with current zoning requirements;
- The predicted traffic generation of the development including working;
- Traffic surveys intended to be carried out, including traffic movement counts on existing roads and existing similar developments;
- The intended study area with supporting analysis of how this was derived;
- Whether the analysis of traffic accident histories will be included in the TIA;
• The approach intended to assess the traffic impact. This will include the intended modelling approach, including software to be used;
• Any other information relevant to the planned study approach.

Upon review of the TIA by the relevant government agencies approval will be given for the TIA to precede as per the scoping statement. Alternatively further discussions can be undertaken until an agreed approach and study area is arrived at.

1.4.5 Submittal Of Draft Traffic Impact Assessment
The Consultant will submit a Draft TIA to the MOWH. The Draft TIA will comply with the requirements set out in these guidelines. As well the scope of the study will be as defined in the approved scoping statement.

Spreadsheets or database files containing the traffic & parking generation calculations and any surveys conducted should also be provided with the draft TIA.

The Consultant is required to submit electronic copies of the relevant software files used in the traffic impact analysis (eg VISUM, VISEM, VISSIM, SIDRA files etc).

After review by the appropriate authorities, comments on the Draft TIA will be forwarded to the Consultant.

If there are issues with the Draft TIA, these will be put in writing by the MOWH.

If necessary, a meeting shall be arranged between those responsible for the preparation of the TIA and the relevant officers from the Government Agencies. At this meeting the issues with the Draft TIA will be discussed and a way forward agreed upon. The Consultant will submit in writing the results of this meeting, in which they will detail what changes will be made to the Draft TIA.

1.4.6 Submittal Of Final Traffic Impact Assessment
A final TIA will be submitted. Two hard copies of the TIA will be required.

As well as the hard copies of the TIA, the Consultant should also provide a copy of the TIA, together with its Appendices in PDF format.

Along with the TIA the Consultant is required to submit electronic copies of the relevant software files used in the traffic impact analysis. This will include the modified VISUM strategic model.

Spreadsheets or database files containing the traffic & parking generation calculations and any surveys conducted should also be provided.

If this TIA meets the requirements of the relevant authorities it will be approved.
2 STRUCTURE OF A TRAFFIC IMPACT ASSESSMENT

A TIA will have the following structure. The

2.1 A Non-Technical Summary [Executive Summary]

This will be a brief non technical summary of the expected impact of the development. This summary is designed to be read by those not familiar with the technical side of traffic engineering and planning.

The Executive summary will contain the following information:

- A description of the development, including relevant floor areas;
- The expected peak hour trip generation of the development;
- The recommended and provided parking for the development;
- A brief description of the surrounding road network with any road hierarchy – traffic capacity issues outlined;
- A brief summary of the access strategy for the development;
- A brief summary of the problems and recommended solutions resulting from the technical analysis.

2.2 Description of Existing Conditions [Chapter 3 of TIA Guidelines]

- Background discussion, with reference to existing and proposed developments, road hierarchy as well as to the masterplan for the area. This should serve as a foundation for the rest of the study.
- Existing traffic volumes on links and junctions on the network that may be affected.
- Pedestrian counts if appropriate.
- Brief review of accident records (if accident assessment included in the TIA)
- Definition of study area with identification of critical links and intersections.
- Committed highway works in the area.
- Landuse zoning, proposed and existing development of the site and surrounding areas.

2.3 Proposed Development [Chapter 4 of TIA Guidelines]

- Description of current use of site.
- Planning policy or zoning for the site.
- Description of proposed development by usage.
- Full set of architectural plans for proposed development.
2.4 Trip Generation [Chapter 5 of TIA Guidelines]

- Current trip generation.
- Trip generation surveys of other similar developments in Bahrain.
- Proposed development trip generation by peak hours
  - AM Peak (07:00 to 08:00)
  - PM Peak (13:00 to 14:00)
  - Evening Peak (16:00 to 19:00)
  - 24 Hour.
- Specification of trip generation during different future periods (if a staged development).
- Trip generation of service vehicles.
- Comparison of with and without development scenarios.
- Trip generation of committed developments in the area.
- Trip generation of the study area if fully developed according to approved zoning.
- Identification of times when impact is greatest.
- Evaluation of linked trips.
- Identification of routing to and from the site.
- Electronic copies of analysis used.

2.5 Parking Generation & Parking Provision [Chapter 6 of TIA Guidelines]

- Parking requirements based on Bahrain and UAE recommendations and Bahrain requirements.
- Identification of times when impact is greatest.
- Parking provision proposed.
- Scaled drawings giving inventory of parking provision.
- Parking provision for service vehicles.
- Parking for other vehicle types, e.g. bicycles.

2.6 Future Background Traffic Volumes [Chapter 7 of TIA Guidelines]

- Description of modelling undertaken to obtain background traffic volumes for the years 2011, 2021 and 2030 (ultimate).
- Definition of study area, based on the background traffic volumes and expected traffic generation of the development.
- Diagram showing future background traffic volumes.
- Electronic copies of modelling undertaken.
2.7 Site Access, Internal Circulation & Parking [Chapter 8 of TIA Guidelines]

- Scaled drawings (minimum 1:250 scale) of internal circulation and parking.
- Assessment of parking, internal circulation and interface with the access road network with reference to the Draft Bahrain Guidelines For Off-Street Car Parking Facilities.
- Tracking analysis using CAD based software where appropriate.
- Micro-simulation modelling of car park where necessary.
- Service vehicle access and parking, including provision for garbage collection.

2.8 Traffic Impact On Internal Road Network [Chapter 9 of TIA Guidelines]

- Proposed site access with justification.
- Traffic assessment of links and intersections in the study area with and without the development traffic for the years 2011, 2021 and 2030.
- Identification of V/C ratios, Delays, Level of Service, Queues as required (using SIDRA or VISSIM).
- Existing and proposed road designs and improvements to cater for the future traffic predicted.
- Scaled concept drawings of any proposed changes to road elements.
- Diagrams showing existing and future stage plans of traffic signals in the study area.
- Cost estimation tables for proposed mitigation and improvement measures (where required).
- Consideration of the existing and future environment capacity of study area roads, where they occur in residential and shopping areas.
- Electronic copies of analysis undertaken.

2.9 External Pedestrian Access To The Development [Chapter 10 of TIA Guidelines].

- Estimation of future pedestrian routes and road crossing points.
- Evaluation of safety of pedestrian crossing points.
- Pedestrian level of service on walkways and road crossings.

2.10 Public Transport Assessment [Chapter 11 of TIA Guidelines]

- Assessment of existing and proposed public transport routes.
- Opportunities for improvements to public transport services to serve the development.
- Layout of new areas to facilitate public transport.
2.11 Determination of Developer Contribution to Required Traffic Facilities – [No Necessarily Required] [Chapter 12 of TIA Guidelines]

- Calculation of developer contribution to road and traffic facilities if appropriate.

2.12 Conclusions & Summary [Chapter 13 of TIA Guidelines]

- As per the Executive Summary
- Objective assessment of any future problems expected on the external road network.
- Objective assessment of internal circulation and parking layout.
- Objective assessment of on-site parking provision.
- Recommendations for the improvements of roads in the study area.
- Recommendations on improvements to internal circulation and parking layout.
- Recommendations on proposed on-site parking provision.

3 EXISTING TRAFFIC & LANDUSE CONDITIONS

3.1 Description of Study Area Road Environment

The TIA will describe the road network in the study area as defined in the Scoping Statement. This will include specific reference to existing and proposed road carriageway widths and alignments.

One or more diagrams should be provided which show the following information (existing or proposed):

- available road corridor widths in the study area.
- the assumed road hierarchy
- types of intersection control
- provision of turning lanes
- pedestrian facilities including footpaths and crossing points
- formal and informal on-street parking facilities.

This should serve as a foundation for the rest of the study

3.2 Existing traffic volumes on links and junctions on the Study Area Network

All traffic information in the study area will be summarised on a suitable diagram.

Typically AADT (weekday and weekend) 24 hour traffic volumes and weekday peak hour traffic movements will be the most relevant when conducting TIA studies.
Normally three weekday peak hours periods will be examined. In Bahrain these peak periods are as follows:

- AM Peak (07:00 to 08:00)
- PM Peak (13:00 to 14:00)
- Evening Peak (16:00 to 19:00)

For TIA's in areas where substantial development already exists, traffic counts are almost an essential part of any TIA.

However in areas which are only partially developed traffic counts may not necessarily be appropriate. Since the future traffic situation as the area developments will in no way reflect the existing traffic situation.

There will also be occasions where the TIA will need to be prepared during times when non typical traffic conditions exist (i.e. during the summer period of June, July & August or during Ramadan). During these times traffic volumes would not represent typical levels in Bahrain. In these cases traffic counts may be dispensed with, or if conducted, modified in an appropriate fashion so that they represent normal traffic conditions.

The need for traffic counts would have been established at the Scoping Statement stage of the TIA process.

Where additional traffic counts have been undertaken as part of the TIA study, these will be presented in tables included in the TIA as an Appendix. These tables will tabulate traffic volumes by 15 minute intervals.

Any traffic counts undertaken at intersections should include U-turns as separate movements. They should also include heavy vehicles and public transport vehicles separately.

### 3.3 Pedestrian counts if appropriate

If pedestrian counts have been undertaken as part of the agreed study approach, then these should be summarised on a suitable diagram.

Detailed results of these pedestrian counts will be presented in tables included in the TIA as an Appendix. These tables will tabulate pedestrian volumes by 15 minute intervals.

### 3.4 Brief review of accident record

Five year accident histories of the study area will be reviewed for developments where this is considered relevant.

The examination of accident histories will be particularly relevant for developments in existing developed areas. In areas which are largely undeveloped the examination of existing accidents may not be of much benefit (since there may be few existing
accidents). In these cases it will be particularly relevant to ensure that the road access scenarios developed provide for a safe future road environment.

Developments which gain access more or less directly from high design standard roads (for example arterial or collector roads) may not need a detailed examination of existing accidents, since the high design standard of the road would most likely mean that the accidents recorded primarily result from behavioural rather than road design issues.

Additionally in some locations the road network in the vicinity of a proposed development may have just been substantially modified or improved. In these circumstances the recorded accident histories would refer to a previous situation.

These accident histories should identify the types of accidents, the total number of accidents, and make note of any vehicle / pedestrian accidents. Particular attention should be paid to the impact of increased traffic volumes at intersections which already have accident problems.

Where the accident history of a proposed transport route is presented, accident details (such as the type of conflict and vehicle involved) must be provided. Accident numbers alone are not sufficient for safety appraisal. It should be noted that existing accident rates are merely indicators of safety.

If accident rates are high, the situation requires further investigation. Similarly, if the proposed development is likely to have a significant effect on the volume, direction or composition of traffic (including interaction with non-motorised traffic) then further investigation of the safety potential is required. Use of the road safety audit approach is recommended here.

3.5 Committed Or Planned Road Network Improvements In The Area

The committed or proposed road network improvements in the study area should be summarised. These should be illustrated on a plan of the study area. Where available, plans for the upgrading should be included in suitable Appendices.

In undeveloped areas this should include those roads which, while not yet constructed, are included in the area Master plan.

3.6 Landuse Zoning, Proposed & Existing Development of the Site And Surrounding Areas

The TIA will include the approved (or draft) landuse zoning plan for the development site and its surrounding areas.

The TIA will summarise on a suitable plan the existing and proposed landuse in the study area. This should show proposed developments, where this information is available from previous TIA's.
4 DESCRIPTION OF PROPOSED DEVELOPMENT

In the TIA a detailed description of the proposed development will be provided. This description will provide the following information.

4.1 Description of current use of site
Where the site is occupied by existing landuse, the area of the landuse and its usage should be described. The existing access to the site should be described.

4.2 Description of proposed development by usage
Full details in tabular form of the proposed development should be provided.

This should provide full details of the gross and nett floor areas of the different landuse proposed for the development. This should include parking areas.

This description should as far as possible categorise the different uses of the components of the development. For example the following should be provided:

- Residential Development
  The number dwelling units proposed according to the number of bedrooms & net area
  The intended use of these dwelling units (ie private dwellings, rental properties, furnished apartments, apartments owned by other GCC nationals (holiday homes)).
  The size of ancillary activities, (eg health club etc)

- Retail Development
  The type of retail intended by floor area (eg supermarket, hypermarket, speciality shops, fast food restaurants, food halls, normal restaurants etc)

- Office Development
  The type of office development by floor area (eg normal private office, investment banks, government departments etc)

- Commercial Development
  The type of commercial development by floor area (ie service station, retail bank, insurance company, travel agency, movie theatres etc)

- Accommodation Development (Hotels)
Describe the type of accommodation to be provided. In particular, whether the intended clientele for the development will be GCC nationals arriving by private vehicle or business travellers/tourists arriving primarily by air.

Also the size and likely use of ancillary development associated with the accommodation. This will include club and conference facilities. It will be particularly important for the TIA to specify whether these ancillary developments will be intended for persons other than hotel patrons.

- **Educational Development**

The level of education being catered for by the development will need to be established. Also whether it will be a private or public institution will affect the distribution and modal split of trips. The gender of the users should also be specified.

- **Healthcare Development**

Important factors will be whether the facility will cater for public or private patients. Also, whether the facility is a medical centre, private medical suites (doctor or dentist) or a hospital.

- **Industrial Development**

The expected size and type of each of the expected users of the industrial areas. Uses could be as diverse as factories, concrete plants or labour camps.

**4.3 Compliance With Zoning Conditions**

The TIA should demonstrate the proposed development complies with the current landuse zoning for the site.

Where the site does not seem to comply with the current zoning, documentation from the MOMA which clearly states that over zone development has been approved should be included in the TIA.

Where no such documentation exists, the TIA for a seemingly non complying development will not be considered further by the MOWH.

**4.4 Full set of architectural plans for proposed development**

A full set of architectural plans for the proposed development will be provided. This will be of a scale which can be readily interpreted.

A particular requirement are full scale plans of the proposed parking areas, showing the layout of parking spaces, column footprint, circulation aisles and driveways.

The minimum scale for the plans of parking and driveway areas is 1:250.
5 TRIP GENERATION

5.1 Appropriate Trip Generation Rates For Bahrain

At present the basis for calculating development trip generation of developments in Bahrain is the Dubai Trip Generation & Parking Rates Manual (DTGPRM).

Complete reliance on the Dubai Trip Generation and Parking Rates Manual is not necessarily appropriate for Bahrain as the structure of the population, times of work and tourist industry is quite different in Bahrain than Dubai.

It is anticipated that a manual for trip and parking generation rates for Bahrain will be progressively developed.

To check the appropriateness of the DM trip generation figures used, additional surveys of similar developments to the ones which of the subject of the TIA should be undertaken as part of the preparation of the TIA. The surveys to be undertaken would have been defined when the Scoping Statement is approved.

As a database of trip generation surveys of various development in Bahrain is developed, this will become a resource which can be provided to Consultants at the commencement of each TIA.

These existing Bahrain traffic generation surveys can then be combined with the trip generation surveys undertaken as part of TIA and compared with the results of the DTGPRM to arrive at an acceptable rate to be used in the TIA.

5.2 Trip Generation Times

As a minimum the TIA should calculate 24 hour and normal peak hour traffic generation. For Bahrain the following weekday peak times should be examined in each TIA.

- AM Peak (07:00 to 08:00)
- PM Peak (13:00 to 14:00)
- Evening Peak (16:00 to 19:00)

Depending on the type of development, other peak times may need to be specifically considered in the TIA.

5.3 Surveys Of Trip Generation In Bahrain

Each TIA will undertake one or more trip generation surveys of existing landuse in Bahrain.

The landuse selected will as far possible coincide with that being examined in the TIA. Where the TIA is for a development with multiple landuse types, then two or more traffic generation surveys may be specified.
When undertaking the traffic generation surveys care should be taken to determine whether the development being surveyed is being fully utilised. For example, if a block of flats is being surveyed, then the current flat occupancy should be established.

As a minimum, the surveys will determine person and vehicle trips entering a development during the three peak hours previously defined. Where necessary the timing of these surveys will be extended.

The trips will be divided where possible into person, small vehicle (divide into car & motorcycle) and service vehicle (divide into vans and trucks) trips.

The TIA will relate the trips measured into trip rates (per dwelling, per employee, per pupil, per bed or per 100 m²) depending on the type of landuse surveyed.

### 5.4 Calculation of Development Trip Generation

The 24 hour hour, peak hour and other relevant hours trip generation for the development should be calculated.

In documenting the trip generation process in the TIA, a table illustrating the development units and traffic generation rates used for each development component should be provided.

One important point is the landuse variable on which trip generation rate is based. The DTGPRM makes a clear distinction between the Gross Floor Area (GFA) and the Gross Leasable Area (GLA). The definitions of GFA and GLA are as follows:

- **GFA [Gross Floor Area]**

  The GFA is the gross floor area of a building (in square metres) of each floor level, including basements, mezzanines, corridors, lobbies, stores and offices that are within the principal outside faces of exterior walls. If ground level area or part thereof, within the principal outside faces of the exterior walls is not enclosed, this GFA is considered part of the overall area of the building. However un-roofed areas and un-enclosed roofed-over areas, except those contained within the principal outside faces of exterior walls, should be excluded from the area calculations. For purposes of the trip generation calculation, the GFA of any parking garages within the building should not be included with the GFA of the entire building. With the exception of buildings containing enclosed mall or atriums, gross floor area is equal to gross leasable area.

- **GLA [Gross Leasable Area]**

  The GLA is the floor area designed for tenant occupancy and exclusive use, including basements, mezzanines or upper floors. The GLA, expressed in square metres, is measured from the centre line of joint partitions and from outside wall faces. For purposes of the trip generation calculation, the floor area of any parking garages with
the building should not included within the GLA of the entire building. In addition, consideration should given to any leasable space that is unoccupied, the GLA should be adjusted accordingly. GLA is the area for which tenants pay rent, it is the area that produces income. For smaller self-standing retail stores and smaller shopping centres, GLA usually equals GFA.

Where the development has multiple access points, the expected traffic generation should be distributed to these access points where appropriate.

Where possible, service and visitor trips (for residential developments) should be listed separately.

It is expected that the traffic generation calculation will be undertaken using Excel or Access. When submitting the draft or final TIA reports electronic copies of these calculations will be provided to ensure transparency.

5.5 Trip Generation Phasing

Some developments will be staged.

In this case the traffic generation for each stage of the development should be calculated separately. The expected timing of each stage and consequently the traffic generation should be clearly documented.

5.6 Assessment of Linked Trips

The incidence of linked and multi-purpose trips can reduce overall trip generation rates, for certain developments.

A **linked trip** is a trip taken as a side-track from another trip, for example, a person calling in to the centre on the way home from work.

A **multi-purpose trip** is where more than one shop or facility is visited. Any trip discounts would apply differently in new free-standing centres and for new shops within existing centres.

Discounts for linked trips vary depending on the nature of the adjacent road network.

With multi purpose trips for shopping centres, an average discount of about 20% is suggested, with this figure reducing with increasing centre size, with rates of 25% (less than 10,000 m$^2$ GLA), 20% (10,000-30,000 m$^2$ GLA) and 15% (over 30,000 m$^2$ GLA) indicative.

The existence of combined residential, office and retail developments may also result in a reduction in overall trip generation rates.

Note that these discounts apply to trip generation but not to parking demand.
Discounts of this nature should not apply without adequate substantiation.

### 5.7 Trip Generation of Service Vehicles

For residential and commercial developments service vehicles will be generated. The service vehicles will typically use different access and parking areas from the normally generated traffic.

The number of service vehicles expected will be an important consideration when the design and adequacy of the service facilities is being assessed in the TIA.

Accordingly the TIA should make a prediction of the expected service vehicle generation. This will include the type of service vehicles.

### 5.8 Traffic Generation of Other Committed Developments In The Study Area

Where TIA’s exist for other committed developments in the study area, the predicted traffic generations for these developments should be included in the TIA. It is expected that these traffic generations will be incorporated into the traffic impact assessment process.

### 6 PARKING GENERATION & PARKING PROVISION

#### 6.1 Importance of Adequate Parking Provision

Adequate off-street parking is the main criterion in the assessment of development parking. Adequate provision of off-street parking discourages on-street parking, thereby maintaining the existing levels of service and safety of the road network.

As adequate parking also contributes to the economic viability of a development, it is recommended that adequate parking facilities be provided for the following types of vehicles:

- Private cars
- Courier vehicles
- Delivery / service vehicles
- Bicycles

The importance of parking must be kept in perspective in the overall planning assessment. There may be situations where it may not be physically possible to provide parking, but the potential planning benefits of the proposal are significant.

A shortage of parking (both on-site and off-site) is not necessarily detrimental to the success of a proposed development. It is but one of many issues that need to be considered in determining development proposals.
Ultimately it is the responsibility of the applicant to prove that either the proposed level of parking provision is adequate, or that the overall planning benefits of the proposed development outweigh these needs.

6.2 Car Parking Requirements In Bahrain

The statutory car park requirements for development in Bahrain are defined in the Bahrain Building Regulations.

These requirements are very simplistic with typically one parking space being required for each dwelling and one parking space for each 100 m$^2$ of GFA for other landuse.

Clearly the numbers of car parking spaces to be provided for each land use type are not based on any surveys or research.

It is envisaged in the future that the Bahrain Building Regulations will be revised to have car parking requirements which reflect actual parking characteristics in Bahrain. In the meantime the MOWH has proposed recommended parking provisions for a variety of landuse types.

In conducting a TIA, although Consultants can compare the on-site parking provision with that required in the Building Regulations, unless specific surveys are conducted, the TIA should not state that compliance with the Bahrain Building Regulations in itself represents satisfactory parking.

Unless it can be demonstrated by relevant parking surveys, satisfactory on-site parking provision should be determined by the MOWH recommended parking rates, provided in the following table.

When calculating the required parking for a development the Consultant should ensure that the appropriate distinction is made between GFA and GLA. It is noted that most rates in the following table refer to parking per 100 m$^2$ of GFA (Gross Floor Area).

The recommended minimum number of off-street visitor parking spaces is one space for every 5 to 7 dwellings. In the future this requirement may be reduced for buildings located in close proximity to public transport, or where short term unit leasing is expected.
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<thead>
<tr>
<th>LANDUSE</th>
<th>PER</th>
<th>BAHRAIN REGULATIONS*</th>
<th>UAE</th>
<th>BAHRAIN RECOMMENDED</th>
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<td>Post Office</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>3.18</td>
<td>5.00</td>
</tr>
<tr>
<td>Retail Shops General</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>2.15</td>
<td>2.15</td>
</tr>
<tr>
<td>Supermarket</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>2.22</td>
<td>4.00</td>
</tr>
<tr>
<td>Electronics Store</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>1.73</td>
<td>2.00</td>
</tr>
<tr>
<td>Furniture Store</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>0.58</td>
<td>2.00</td>
</tr>
<tr>
<td>Petrol Station</td>
<td>100 m² GFA</td>
<td>1.27</td>
<td>1.27</td>
<td>1.27</td>
</tr>
<tr>
<td>Fast Food Outlet</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>7.08</td>
<td>7.08</td>
</tr>
<tr>
<td>Restaurant</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>12.00</td>
<td>12.00</td>
</tr>
<tr>
<td>Hotel</td>
<td>Room</td>
<td>1.00</td>
<td>1.20</td>
<td>1.20</td>
</tr>
<tr>
<td>Shopping Centre</td>
<td>100 m² GLA</td>
<td>1.00</td>
<td>3.16</td>
<td>5.00</td>
</tr>
<tr>
<td>Car Dealer</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>2.26</td>
<td>4.00</td>
</tr>
<tr>
<td>Friday Mosque</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>6.30</td>
<td>10.00</td>
</tr>
<tr>
<td>Cinema</td>
<td>100 m² GLA</td>
<td>1.00</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>or Seat</td>
<td>or 1.00</td>
<td>or 0.60</td>
<td>or 0.60</td>
<td></td>
</tr>
<tr>
<td>Theatre Concert Hall</td>
<td>100 m² GLA</td>
<td>1.00</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>or Seat</td>
<td>or 1.00</td>
<td>or 0.16</td>
<td>or 0.16</td>
<td></td>
</tr>
<tr>
<td>Gymnasium</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>5.50</td>
<td>5.00</td>
</tr>
<tr>
<td>Sport &amp; Recreation (Spa etc)</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>9.00</td>
<td>9.00</td>
</tr>
<tr>
<td>Sports Hall</td>
<td>Court</td>
<td>2.50</td>
<td>2.18</td>
<td>2.50</td>
</tr>
<tr>
<td>Squash Court</td>
<td>Court</td>
<td>1.50</td>
<td>2.50</td>
<td>1.50</td>
</tr>
<tr>
<td>Tennis Court</td>
<td>Court</td>
<td>3.00</td>
<td>1.50</td>
<td>3.00</td>
</tr>
<tr>
<td>Club or Associated Building</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>3.00</td>
<td>4.00</td>
</tr>
<tr>
<td>Museum</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>3.00</td>
<td>5.00</td>
</tr>
<tr>
<td>Medical Centre</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>5.00</td>
<td>8.00</td>
</tr>
<tr>
<td>Hospital</td>
<td>Bed</td>
<td>1.00</td>
<td>8.3-18</td>
<td>5.00</td>
</tr>
<tr>
<td>Nursery</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>1.50</td>
<td>1.50</td>
</tr>
<tr>
<td>Social Centre</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>0.25-1.00</td>
<td>0.50</td>
</tr>
<tr>
<td>Schools</td>
<td>Student</td>
<td>1.00</td>
<td>0.01</td>
<td>0.12</td>
</tr>
<tr>
<td>Colleges - Universities</td>
<td>Student</td>
<td>1.00</td>
<td>0.22</td>
<td>0.25</td>
</tr>
<tr>
<td>Light Industry</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>0.14</td>
<td>3.30</td>
</tr>
<tr>
<td>Medium &amp; Heavy Industry</td>
<td>100 m² GFA</td>
<td>1.00</td>
<td>0.09</td>
<td>0.90</td>
</tr>
</tbody>
</table>

* Note: Provision of parking as per the requirements of the Building Regulations does not in any way mean that the parking provision is satisfactory.

### 6.3 Requirements For Delivery & Service Vehicles

Provision must be made for service and delivery vehicles. The spaces should be at a convenient location and appropriate for the type of delivery service vehicles expected to generated.

The number of service bays required for a development depends on the size and nature of the development. As a guide the following table gives the required service vehicle provision.
Because of the general nature of these recommendations, the TIA's for major
developments should ideally quantify their service vehicle requirements through surveys
of similar developments.

When dealing with a combination of different types of developments, the total spaces
required should be determined by adding the individual components and rounding
upwards to the nearest space.

For residential flat buildings, the total spaces required is determined by adding the
individual components and rounding upwards to the nearest space. Service area
requirements for residential flat buildings may be waived in cases where visitor parking
spaces are available to trucks and delivery vans.

### Provision of areas for delivery and service vehicles

<table>
<thead>
<tr>
<th>Type of Development</th>
<th>Minimum Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Commercial premises</td>
<td>One space per 4,000 m$^2$ GFA up to 20,000 m$^2$ GFA plus one space per 8,000 m$^2$ thereafter (50% of spaces adequate for trucks)</td>
</tr>
<tr>
<td>Shopping Centres</td>
<td>One space per 1,500 m$^2$ GLA up to 6,000 m$^2$ GLA plus one space per 3,000 m$^2$ thereafter (all spaces adequate for trucks)</td>
</tr>
<tr>
<td>Supermarkets, shops and restaurants</td>
<td>One space per 400 m$^2$ GFA up to 2,000 m$^2$ GFA plus one space per 1,000 m$^2$ thereafter (all spaces adequate for trucks)</td>
</tr>
<tr>
<td>Wholesale, Industrial</td>
<td>One space per 800 m$^2$ GFA up to 8,000 m$^2$ GFA plus one space per 1,000 m$^2$ thereafter (all spaces adequate for trucks)</td>
</tr>
<tr>
<td>Hotels</td>
<td>One space per 50 bedrooms or bedroom suites up to 200 plus one per 100 thereafter plus one space per 1,000 m$^2$ of public area set aside for clubs, lounge and restaurant, (50% of spaces adequate for trucks)</td>
</tr>
<tr>
<td>Residential flat buildings</td>
<td>One space per 50 flats or home units up to 200 plus one per 100 thereafter plus one space per 1,000 m$^2$ of public area set aside for club, lounge and restaurant, (50% of spaces adequate for trucks)</td>
</tr>
<tr>
<td>Other uses</td>
<td>One space per 2,000 m$^2$ GFA (50% of spaces adequate for trucks)</td>
</tr>
</tbody>
</table>

There is also a requirement that spaces should be provided for taxis to stand while
waiting for passengers from hotels, shopping centres or residential flat buildings.

Service area spaces may be sufficient for this purpose if they are accessible to taxis. If
service area space is not sufficient, the requirement is for the provision for taxi spaces at
the rate of one space per 100 bedrooms or part thereof for hotels, and one space per 100 flats or home units or part thereof in the case of residential flat buildings. Visitor parking spaces are acceptable to use for this purpose.

6.3 Bicycle Parking

The security and protection of bicycles parked within or near a development must be provided for in the parking design. It is recommended that cyclists are able to secure the frame and two wheels of a bicycle to a fixed, secure stand, preferably with the cyclist's own lock and chain. The parking facility must cater for all types of bicycles.

6.4 Calculation & Assessment Of Parking Requirements

The TIA will contain a table showing the calculation of the required and provided off-street parking. This table should list in parallel columns the parking requirement according the Bahrain Building Regulations, the MOWH recommended parking requirements and the UAE parking requirements. The table should also show the parking spaces intended to be provided as part of the development.

When calculating parking requirements the Consultant should make it clear whether GFA or GLA is being used. In all cases, except for major shopping centres GFA is the variable on which parking spaces provision is calculated, not GLA.

Where stacked parking spaces are proposed, these will generally not be considered as contributing to the required parking.

In residential developments a stacked parking space can only be considered to be providing an additional parking space for a dwelling unit. The space in front of the stacked parking space being the primary space for that unit.

For hotel developments stacked parking spaces can only be considered where it is demonstrated that a valet parking system will be used. Care must be taken in this case to ensure that satisfactory pick up and drop off areas are provided for the valet service.

The TIA should clearly state if the development is not providing an adequate parking spaces. It needs to be acknowledged that providing parking which complies with the Bahrain Building Regulations does not necessarily result in an adequate parking provision.

Where the on-site parking provision is deemed to be inadequate, alternatives, such as contributions for off-site parking provision elsewhere must be explored.

Also if the on-site parking provision is deemed to be inadequate, then in routing of traffic movements to and from the development, the actual traffic generation of the site itself may be reduced and traffic generation to areas of remote parking may be increased.
The TIA should provide a plan at a minimum of 1:250 showing the off-street parking layout. To ease the task of checking the parking provision, this plan should progressively number the parking spaces provided.

7 FUTURE BACKGROUND TRAFFIC VOLUMES

7.1 Background Traffic Volumes

The background traffic volumes refer to those traffic volumes on the TIA study area road network which occur at present or are expected to occur in the future, not including those volumes from the site which is the subject of the TIA.

Existing background traffic volumes can be obtained by surveys or with reference to the current base year transport model available from the MOWH. Where the proposed development site is already generating traffic, this traffic should be subtracted from these existing traffic volumes, to give the base year background traffic.

Future base year traffic volumes should be arrived at by using the MOWH/MOMA VISUM/VISEM model of Bahrain, with suitable local modifications to take into consideration network and landuse characteristics of the TIA study area. This process is described in Section 7.3 below.

7.2 Future Year Scenarios For Background Traffic Volumes

The VISUM/VISEM multi-modal transportation model developed as a component of the Integrated Transport Study will form the primary tool to calculate future background traffic volumes.

This model will have trip and traffic projections for the years 2011, 2021 and 2030. Accordingly when assessing the traffic impact of a development in the TIA, these three future years will be used.

7.3 Calculation of Background Traffic Volumes

The VISUM/VISEM multi-modal transportation model developed as a component of the Integrated Transport Study will form the primary tool to calculate future background traffic volumes.

The full Bahrain wide model can be provided to the Consultant for the conduct of each TIA. Alternatively a sub-area model can be provided to cover the study area of the TIA.

It is expected that the VISUM model will be modified by the Consultant undertaking the TIA to include the entire road network which makes up the study area.
Where necessary, additional zones will be added to the model. As a minimum it is expected that the number of connectors from the existing zones will be expanded to provide a rational loading of the expanded road network. It is normally expected that an additional zone will be added to account for the development which is the subject of the TIA. Depending on the expected phasing of the project, only partial development traffic generation may be incorporated into the model for the 2011 and 2021 years. However full generation will always be assumed for 2030.

So that future population and employment projections in the Bahrain Transport model are reasonable, the 2030 model has not necessarily assumed that development has occurred to anything like the density allowed by the current landuse zoning in some areas. However in a dynamic growing area like Bahrain it is unwise to assume that growth in one particular area in the future will not actually reflect the allowed zoning.

Thus when considering the potential traffic impact of a development, it is desirable if it is assumed that in 2030 the surrounding area is developed to a level which is consistent with the zoning. This will ensure that future problems with the study area road network area are fully defined, so that the necessary planning can take place to minimise future problems.

Accordingly the traffic model zones within the study area will be assessed to determine whether in 2030 full development according to the allowed zoning has been assumed. If the modelled development appears to be substantially less than the future allowed zoning potential, then the trip generation of these zones should be increased to reflect full development of the allowed zoning. In this way the 2030 traffic volumes in the study area will in fact be representing an ‘ultimate’ development scenario.

As VISEM bases the future trips on residential population in Bahrain, an area which in the future could have substantial non-residential landuse could have trip generation suppressed by the future assumptions of population in Bahrain. Accordingly when developing the 2030 ‘ultimate’ background traffic projections in the study area, the trips of non-residential landuse in the study area may have to factored up to account for the full traffic generation of this landuse.

The TIA should clearly detail how the 2030 trip generation of the zones in the study area have been modified to account for an ultimate development scenario.

As can be seen the process for arriving at the future Bahrain traffic volumes assumes the use of the Bahrain VISEM/VISUM model. Thus it is expected that those Consultants undertaking the TIA will use this software.
The revised VISEM/VISUM models will provided electronically to the MOWH at the
time the draft and final TIA reports are submitted. This will allow the Bahrain wide
model to be enhanced as appropriate.

7.4 Background Traffic Volumes For Entire New Areas
Where the TIA refers to an entire new area (not proposed development within an existing
Master planned area) the background traffic volumes will be calculated by extending the
Bahrain VISUM/VISEM traffic model to include the new area. An example of such area
area is the New Northern Town. The upgraded VISUM within the proposed new area
will include a detailed network model of the proposed area. The zone layout of the new
area will include separate zones to cover the main landuse types in the study area. For
example separated zones will be incorporated into the model to represent areas of
residential, commercial, retail and educational landuse, etc.

The trip characteristics for the study area will be calculated by incorporating the study
area into the VISEM model for Bahrain. However for the ultimate development scenario
(2030) adjustments for the trip matrices may have to be made to ensure that the non-
residential traffic generation balances the scale of landuse which is proposed.

In calculating the future vehicle trip matrices for the new area particular attention should
be given for the opportunity for high standard public transport corridors to the area.

8 SITE ACCESS, INTERNAL CIRCULATION & PARKING
 LAYOUT

8.1 Compliance With Bahrain Guidelines For Off-Street Car
Parking Facilities
The Ministry of Municipalities & Agriculture has produced draft comprehensive
guidelines for the design of off-street car parking areas.

These guidelines provide full details on the design of car parking spaces, internal
circulation roads and the interface between the car parking area and the surrounding road
network. It is expected that the design of off-street car parking facilities will comply
with these guidelines.

It should be stressed that these guidelines assume that, with the exception of single
dwelling developments, all off-street car parking spaces will be accessed by vehicles
leaving and entering public roads in a forward direction. That is off-street parking
facilities will be accessed by means of dedicated driveways.

The previous practice in Bahrain of allowing vehicles to reverse out of parking spaces
across footpaths into public streets from multi-storey buildings (as shown in the
photograph below) is no longer considered acceptable and will be prohibited wherever
possible. This practice has resulted in an unsatisfactory and hazardous road environment for pedestrians and motorists.

The TIA should provide a plan of the proposed car parking and internal circulation with a minimum scale of 1:250. This plan should indicate the number of car parking spaces provided, by numbering the car parking spaces sequentially from 1 to the total off-street parking provision.

8.2 Micro-Simulation of Parking Area Operation

A VISSIM micro-simulation will be required for those off-street car parking areas where it is anticipated that problems may occur with internal circulation and queuing.

Typical instances of where micro-simulation may be expected are as follows:

- Where the traffic between parking modules is restricted to one circulation roadway and this roadway is subject to one way flow (controlled either by traffic signals or priority signs);

- Where entry or exit from the car park is restricted by boom gates, security checks etc;

- Where stops are required on entry to an off-street facility, for example at an ATM, parcel pick-up facility or valet parking
8.3 Service Vehicle Access & Parking
The TIA needs to demonstrate that service vehicles are able to access the proposed off-street service facilities in a satisfactory manner.

This will normally be verified by using CAD vehicle tracking software. The TIA should clearly indicate and justify the size of the service vehicles selected for this tracking curve analysis.

Reversing trucks are particularly hazardous for pedestrians due to the poor visibility afforded to the rear of trucks. Accordingly it is a priority that trucks are able to enter and leave the service facilities in a forward direction.

Attention also needs to be given to height clearances for trucks underneath structures.

8.4 Garbage Collection Provision
Provision for garbage collection is an important consideration. In many existing developments large wheeled garbage bins are simply wheeled into the street and compete with the existing traffic and parking for space.
The TIA should explicitly consider the issue of garbage collection.

For the scale of development requiring a TIA communal garbage facilities will be required. This will require internal and or external bins.

The TIA should determine whether these bins will be placed inside the development or adjacent to a public street for mechanical collection.

Where bins are proposed to be placed on-street for collection then they should be placed adjacent to straight sections of road, or at a cul-de-sac head. Bins should not be placed in private drives but placed at the edge of the drive. Specific spaces should be allocated for bins to be placed for collection. These spaces should not be on the outside of parking spaces or use space which would otherwise be designated as on-street parking spaces.

The bins should be placed close to where the collection vehicles will be able to stop.
The turning circle on public roads to accommodate waste collection vehicles shall be a minimum 17 metres.

All access roads should be able to withstand a gross vehicle weight of up to 30 tonnes. Manholes, gratings and so forth must also be built to withstand the weight of collection vehicles.

Access roads should allow the vehicles the ability to move in a forward direction, collect waste and then leave in a forward direction. Adequate turning facilities should also be provided. Turning circle considerations should allow for steering errors and overhangs (allowance of 1 metre being acceptable).

Refuse collection vehicles should not reverse more than 12 metres inside a property, due to the increased risk which arises from reversing vehicles.

9 TRAFFIC IMPACT ON EXTERNAL ROAD NETWORK

9.1 Assessment Of Traffic Impact

9.1.1 Impact of Traffic

Traffic can have an impact in a number of ways eg:
- impact on traffic efficiency
- impact on amenity
- impact on safety
- impact on road pavement life

In addition, the traffic impact assessment needs to take into account implications on public transport and pedestrian movement. Private vehicle movements must be viewed in the context of the overall transport task.

Each of these effects is discussed in the following sections. Where appropriate, impacts should be assessed against appropriate performance standards. The assessment needs to take into account the function of roads within the road hierarchy.

Traffic efficiency primarily involves the performance of major roads.

Amenity is primarily a concern of minor roads. Safety is a concern affecting all roads. Safety is arguably the most important, although its assessment does not necessarily lend itself to quantitative review.

Finally, road pavement effects can occur on all classes of road. However assessment is only required when substantial numbers of heavy vehicle movements are proposed. Car traffic has little impact on road pavements.
9.1.2 Measures of Traffic Efficiency For Midblock Locations

An important consideration in determining the impact of a development proposal on the road system is to assess the effect on traffic efficiency, the objective of which is to maintain the existing level of service. Adverse effects must be identified and corrective measures designed.

The level of service is used as the performance standard. This is a qualitative assessment of the quantitative effect of factors such as speed, volume of traffic, geometric features, traffic interruptions, delays and freedom to manoeuvre. There are six levels of service (LOS), as described below. These descriptions characterise levels of service for uninterrupted flow conditions, i.e. no interruption to traffic occurs because of factors external to the traffic stream, such as intersection controls.

**Level of Service A**

This, the top level is a condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.

**Level of Service B**

This level is in the zone of stable flow and drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream, although the general level of comfort and convenience is little less than that of the level of Service A.

**Level of Service C**

This service level is also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.

**Level of Service D**

This level is close to the limit of stable flow but is approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems.

**Level of Service E**

This occurs when traffic volumes are at or close to capacity and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause a traffic-jam.
Level of Service F

This service level is in the zone of forced flow. With it, the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow break-down occurs and queuing and delays result.

9.1.3 Measures of Traffic Efficiency For Intersections

The above descriptions characterise levels of service for uninterrupted flow conditions, i.e. no interruption to traffic occurs because of factors external to the traffic stream, such as intersection controls. However, the concept of level of service can also be applied to intersections through different measures of effectiveness, as summarised in the following table.

<table>
<thead>
<tr>
<th>Level of Service</th>
<th>Average Delay per Vehicle (secs/veh)</th>
<th>Traffic Signals, Roundabout</th>
<th>Give Way &amp; Stop Signs</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>14 or less</td>
<td>Good operation</td>
<td>Good operation</td>
</tr>
<tr>
<td>B</td>
<td>15 to 28</td>
<td>Good with acceptable delays &amp; spare capacity</td>
<td>Acceptable delays &amp; spare capacity</td>
</tr>
<tr>
<td>C</td>
<td>29 to 42</td>
<td>Satisfactory</td>
<td>Satisfactory, but accident study required</td>
</tr>
<tr>
<td>D</td>
<td>43 to 56</td>
<td>Operating near capacity</td>
<td>Near capacity &amp; accident study required</td>
</tr>
<tr>
<td>E</td>
<td>57 to 70</td>
<td>At capacity; at signals, incidents will cause excessive delays Roundabouts require other control mode</td>
<td>At capacity, requires other control mode</td>
</tr>
</tbody>
</table>

The effect of differing levels of traffic flow on the operating performance of intersections has traditionally been assessed by considering the intersection volume / capacity ratios (referred to as Y values), and intersection degrees of saturation (referred to as X values). The X value eliminates the variability caused by lost time within an intersection. It does not however always adequately describe operating conditions, such as when minimum phase times are determined by pedestrian facilities.

Computer based intersection assessment programs can be more effective. These programs are not perfect. They rely on accurate input data and interpretation of the output by a skilled user.

The intersection analysis programs VISSIM and SIDRA used by the Government of Bahrain provide as output the measures of effectiveness shown in the above table.
The best indicator of the level of service at an intersection is the average delay experienced by vehicles at that intersection. For traffic signals, the average delay over all movements should be taken.

For roundabouts and priority control intersections (with Stop and Give Way signs or operating under the T-junction rule) the critical movement for level of service assessment should be that with the highest average delay.

With traffic signals, delays per approach tend to be equalised, subject to any over-riding requirements of signal co-ordination as well as to variations within individual movements.

With roundabouts and priority - control intersections, the critical criteria for assessment is the movement with the highest delay per vehicle. With this type of control the volume balance might be such that some movements suffer high levels of delay while other movements have minimal delay. An overall average delay for the intersection of 25 seconds might not be satisfactory if the average delay on one movement is 60 seconds.

The average delay for level of service E should be no more than 70 seconds. The accepted maximum practical cycle length for traffic signals under saturated conditions is 120-140 seconds. Under these conditions 120 seconds is near maximum for two and three phase intersections and 140 seconds near maximum for more complex phase designs. A cycle length of 140 seconds for an intersection which is almost saturated has an average vehicle delay of about 70 seconds, although this can vary. If the average vehicle delay is more than 70 seconds, the intersection is assumed to be at Level of Service F.

The intersection degree of saturation (DS) can also be used to measure the performance of isolated intersections. The DS value can be determined by computer based assessment programs. At intersections controlled by traffic signals, both queue length and delays increase rapidly as DS approaches 1.0. An upper limit of 0.9 is appropriate. When DS exceeds 0.8 - 0.85, overflow queues start to become a problem. Satisfactory intersection operation is generally achieved with a DS of about 0.7 - 0.8. (Note that these figures are based on isolated signalised intersections with cycle lengths of 120 seconds. In co-ordinated signal systems DS might be actively maximised at key intersections).

The previous table sets out average delays for different levels of service. There is no consistent correlation between definitions of levels of service for road links as defined in the previous section, and the ranges set out in the previous table.

The figures in the above table are intended as a guide only. Any particular assessment should take into account site-specific factors including maximum queue lengths (and their effect on lane blocking), the influence of nearby intersections and the sensitivity of the location to delays. In many situations, a comparison of the current and future
average delay provides a better appreciation of the impact of a proposal, and not simply the change in the level of service.

Although in some situations additional traffic does not alter the level of service, particularly where the level of service is E or F, additional capacity may still be required. This is particularly appropriate for service level F, where small increases in flow can cause disproportionately greater increases in delay. In this situation, it is advisable to consider means of control to maintain the existing level of absolute delay.

9.1.4 Capacity of Mid-Block Roads in Urban Locations

The capacity of non freeway urban roads is generally determined by the capacity of the intersections. Where major reconstruction of intersections is proposed, the ability of the approach roads to feed the intersection at appropriate flow rates may need to be reviewed.

As set out in the following table typical one-way mid-block lane capacities on urban arterial roads under interrupted flow conditions are 900-1000 veh/hr/lane. This calculation assumes Clearway conditions. The capacity falls to 600 veh/hr/lane for a kerbside lane with occasional parked vehicles. These capacities at times may increase under ideal conditions to 1200-1400 veh/hr.

<table>
<thead>
<tr>
<th>Type of Road</th>
<th>One-Way Mid-block Lane Capacity (veh/hr)</th>
<th>Capacity PCU per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median or inner lane:</td>
<td>divided road/undivided road</td>
<td>1,000/900</td>
</tr>
<tr>
<td>Outer or kerb lane:</td>
<td>with adjacent parking lane/clearway conditions/occasional parked cars</td>
<td>900/900/600</td>
</tr>
<tr>
<td>4 lane undivided:</td>
<td>occasional parked cars/clearway conditions</td>
<td>1,500/1,800</td>
</tr>
<tr>
<td>4 lane divided:</td>
<td>clearway conditions</td>
<td>1,900</td>
</tr>
</tbody>
</table>

The mid-block level of service on urban roads is assessed on a vehicle's average travel speed. When assessing the mid-block road capacity requirement in a strategic planning study, the traffic flow limits for different levels of service are of value. The following table sets out peak hour flows for one and two lanes of unidirectional travel, based on volume / capacity ratios applicable for rural roads in level terrain with no sight distance restrictions on overtaking. It should be noted that these are indicative figures based on the rural volume / capacity ratios with a lane capacity of 1400 veh/hr. This figure can be achieved under ideal urban interrupted flow conditions. The lower per lane capacity for one-lane carriageways in comparison with two-lane carriageways, reflects the influence of the need to overtake on drivers’ ability to travel at their desired speed.

The figures in the following table are provided for strategic planning purposes only, and are not intended as a substitute for basic exercises in intersection analysis. In summary, when assessing a development application (and road works that may be required as a
result of that application) the intersection upgrading requirements must be determined. If additional capacity is required then additional works which are needed to maintain appropriate levels of traffic flow must be identified.

<table>
<thead>
<tr>
<th>Level of Service</th>
<th>One Lane (veh/hr)</th>
<th>Two Lanes (veh/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>200</td>
<td>900</td>
</tr>
<tr>
<td>B</td>
<td>380</td>
<td>1400</td>
</tr>
<tr>
<td>C</td>
<td>600</td>
<td>1800</td>
</tr>
<tr>
<td>D</td>
<td>900</td>
<td>2200</td>
</tr>
<tr>
<td>E</td>
<td>1400</td>
<td>2800</td>
</tr>
</tbody>
</table>

9.1.5 Impact Of Traffic On Amenity In Urban Areas [Environment Capacity Of Urban Roads]

Traffic on any class of road has an impact on the amenity of an area. Traffic limits such as volumes, speed limits, do not generally apply to major roads, although emphasis should be placed on traffic calming issues on collector and distributor roads in retail areas.

Traffic limits are necessary on minor roads as pedestrian safety here is of primary concern. Environmental capacity considerations are relevant to streets in residential areas, shopping centres and educational precincts.

Meeting the needs of both traffic and pedestrian access is the main objective in accommodating new development. This is achieved in a different manner with new areas compared to the approach of developments in existing areas.

The Environmental Capacity of an area is determined by the impact of traffic, roads and various aspects of the location.

Traffic characteristics:
- traffic volume
- traffic composition, in particular the proportion of heavy vehicles
- vehicle speed

Road characteristics:
- road reserve and carriageway width
- number of traffic lanes
- gradient
- road surface condition

Locality characteristics:
- distance from road carriageway to property boundary
- nature of intervening surfaces
- setback of building from property boundary
- type and design of building
A number of measures can be used to determine the impact that a road will have on Environmental Capacity. In Traffic in Towns (1963), Buchanan uses the pedestrian delay / safety method, taking into account carriageway width and the vulnerability of pedestrians. A 7.5 m wide street in a subdivision road pattern, with high pedestrian vulnerability was found to have an Environmental Capacity of just over 180 pcu/hr.

Additional overseas research has pedestrian safety and delay further. This resulted in the definition of various behavioural thresholds, such as the observation that at 90 veh/hr children tend to stop playing in the street, and a 300 veh/hr limit is required for aged pedestrians to safely cross the average street.

The impact of traffic noise on the Environmental Capacity of an area is also a factor. Issues such as vehicle volume, traffic speed, heavy vehicle percentage and the distance of the noise source should be considered. Environmental Capacity can be defined in terms of the acceptable level of noise at a building or dwelling. Overseas a goal an environmental goal of Leq(24 h) = 55 dBA to 60dBA has been defined. The 55 dBA is more appropriate for minor roads whereas the 60dBA is more appropriate for major roads.

An Leq(24h) of 55 dBA on a street with 5% heavy vehicles and with traffic speeds of 40 km/hr is equivalent to a daily traffic flow of just under 2,100 veh/day. When speed increases to 60 km/hr the threshold reduces to just over 1,400 veh/day.

Overseas research has been undertaken on residents' attitudes to traffic in their streets. This has found sought to define the Environmental Capacity of Residential Streets and a critical range of 3,000-6,000 veh/day was found. This is equivalent to peak hour flows of 250-500 veh/hr.

Overseas guidelines for the design of residential areas cites daily volume maximum of 1,000-2,000 veh/day for different types of local access streets, and 6,000 veh/day for trunk distributor streets.

Environmental Capacity is best estimated by considering a range of differing perceptions and attitudes to traffic impacts in a particular area.

The following Table sets out recommended Environmental Capacity performance standards. This table relates to streets with direct access to residential properties. Trunk collector and spine roads with no direct property access can carry higher traffic flows.
Environmental capacity performance standards on residential streets

<table>
<thead>
<tr>
<th>Road class</th>
<th>Road type</th>
<th>Maximum Speed (km/hr)</th>
<th>Maximum peak hour volume (veh/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>Access way</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>Local</td>
<td>Street</td>
<td>40</td>
<td>200 environmental goal</td>
</tr>
<tr>
<td>Distributor</td>
<td>Street</td>
<td>50</td>
<td>300 maximum environmental goal</td>
</tr>
</tbody>
</table>

Note: Maximum speed relates to the appropriate design maximum speeds in new residential developments. In existing areas maximum speed relates to 85th percentile speed.

In the performance standards set out in the table above, two levels are given - one for the desirable maximum (the environmental goal), and one for the absolute maximum. There may be situations where alterations to these levels might be appropriate, however it is up to the developer to justify a departure from the standards. For example, a road with a wide central-median, and with separate carriageways of approximately 5 metres width would have less impact on pedestrian safety than an undivided road of width 7 metres, and hence could accommodate a higher traffic flow for the same degree of safety.

The above table indicates that the functional classification of the street is important. While two streets may be similar, if one street functions as a distributor street, then local access, safety and amenity are not the only issues to be considered. The movement of traffic along the street from adjoining areas also becomes a planning issue. Since it is still a residential area both traffic movement and planning issues need to be accommodated.

The above table takes into account both amenity and safety considerations. The maximum speeds given are design speeds for new residential areas. They might not be achieved in existing areas without the assistance of traffic calming methods. In assessing a proposed development, the existing average speed (even if over the desirable limit), is the starting point in determining the existing level of hazard. The Environmental Capacity of a street can be increased through a reduction in speed. For example, on an existing residential street where traffic volumes reach the Environmental Capacity maximum (and a proposed development could cope with the volume over the standard), traffic speed may be reduced by the introduction of traffic calming methods.

In general, the distance required by a vehicle to stop when unexpectedly confronting a pedestrian on the road is proportional to the speed of the vehicle squared. Thus a reduction in speed can cause a disproportionate improvement in pedestrian safety. In situations where Environmental Capacity standards are already exceeded, rather than allowing the situation to be made slightly worse with additional traffic, speed reduction measures can be introduced. These may have a positive effect on traffic noise, and ensure that the existing level of pedestrian safety remains the same, or is reduced.
9.1.6 Assessment Of Road Networks In Residential Areas

In existing residential environments, 40km/h is an acceptable speed objective, usually achieved by traffic calming measures e.g. adjusting existing roadways with retrofitted design items such as speed humps and slow points.

A reasonable recommendation for new residential subdivisions is 30 km/h, and this design speed is supported by research which indicates that vehicles travelling at 30km/h or less cause minor levels of injury to passengers, pedestrians, and other vehicles if involved in an accident.

Speed can be limited to 30km/h by the provision of traffic calming measures, and by promoting the concept that each street is a shared environment.

Traffic calming measures often implemented to control the speed of traffic are:
- limiting the distance between intersections to 70m or less
- limiting cul de sacs to 80m or less in length

Care should be taken to ensure that drivers do not need to cross too many controls to access the furthest lot in a subdivision.

Overseas research indicates that many residents prefer to live in a street where the flow of traffic is 2000 vpd or less (where the environmental capacity is 2000 vpd). There is no precise level at which the traffic environment can be said to be acceptable or unacceptable to residents. However, the desirability of a street does not just depend on its traffic characteristics. Often, residents accept a high flow of traffic in a street which is well designed or which offers activities or aspects that are considered important.

Despite the difficulty of arriving at accurate figures, consideration should be given to the level of comfort that may be appropriate for residents. In most cases it is reasonable to require that the flow of traffic passing 85% of households should not exceed 1500 vpd, as a design objective.

The desire to limit traffic volumes in new residential subdivisions is generated by a wish to preserve the amenity of residents by designing street connections to keep traffic volumes on all residential streets within their environmental traffic capacity. The connectivity of a road system determines the flow of traffic on individual streets.

In determining traffic volume objectives, it is advisable to note the following points:
- it is not necessary to create a series of cul de sacs to maintain the flow of traffic at below 1500 vpd
- connective road system serving as many as 1200 households with good access to a collector road system may contain residential streets all with a flow of less than 1000 vpd, and internal collector roads with less than 2000 vpd
- fewer links onto a distributor road results in more traffic on each of the links
• in situations where access to the major road system is restricted (possibly because of the placement of an arterial road), stub roads are an alternative which draw traffic together for access onto the major road. Good connectivity of street, and footpath links for pedestrians reduces the distance travelled, and therefore saves energy and provides incentive for a reduction in car use

Amenity issues depend on the function of the road within the hierarchy. For example, a distributor road has a higher traffic volume limit and therefore can have a lower amenity.

Note that these limits are more accurate when based on maximum hourly flows rather than on maximum daily flows. Further for a given limit, the acceptable volume may vary with the speed of the traffic. In residential design standards a hazard rating concept was developed, where the degree of hazard relates to volume, pedestrian flow and speed squared.

Distance from road to residential properties is also a factor. If traffic calming measures can be introduced to reduce traffic speed then the allowable maximum volume of traffic may be increased. If an additional development is proposed for an existing urban residential road where the current traffic volume is at the environmental limit, the proposal may be considered if traffic calming measures ensure that the hazard rating of the street is not substantially increased.

9.2 Assessment Of Future Road Network Performance

9.2.1 Derivation of Background Traffic
Normally it is expected that the future background traffic volumes for the design years 2011, 2021 and 2030 (ultimate) will be derived by using a suitably modified version of the Bahrain VISUM/VISEM model.

A description of how background traffic volumes should be derived is contained in Section 7.

9.2.2 Derivation of Design Traffic
The design traffic movements on the study area network will be arrived at by combining the development traffic with the background traffic in the VISUM model of the study area.

The future distribution of the traffic generated by the development will be determined from the suitably modified Bahrain VISUM/VISEM model.

As VISEM bases the future trips on residential population, an area which in the future could have substantial non-residential landuse could have trip generation suppressed by the future assumptions of population in Bahrain. Accordingly when developing the trip matrix for the development, the trips of non-residential landuse component of the
development may have to factored up in the VISUM model to account for the full traffic generation of this landuse.

The final assignment of trips in the study area can either be undertaken using VISUM or by using the dynamic assignment capabilities of VISSIM.

9.2.3 Modelling of Future Network

The road network in the study area will be modelled for the combined background and development traffic for the years 2011, 2021 and 2030:

As the Government agencies in Bahrain have elected to use the PTV Vision Suite of transport planning software, supplemented with SIDRA for detailed intersection modelling, it is intended that Consultants undertaken TIA’s in Bahrain will also use these transport planning tools.

If VISSIM is used for the assessment of the study area network, then the proposed layout of roads and junctions used in this assessment can be clearly seen from the micro-simulation model. Accordingly the TIA should contain printouts from the VISSIM model as well as an electronic copy of the model.

If however SIDRA is used to undertake the detailed modelling of intersections, then scaled concept drawings of the junctions modelled by SIDRA should be provided in the TIA. In addition electronic copies of the SIDRA input and output files should also be provided with the draft and final TIA.

The use of network VISSIM networks of the study area dynamically assigning matrices obtained from the local area VISUM model of the area is seen as a particularly robust way of evaluating future network performance.

Master planning of areas in Bahrain has in the past not necessarily considered the transport impact of the landuse provided for in the zoning. Accordingly the road network (including the corridor widths) may not be able to accommodate the fuller development of these areas. Accordingly the TIA may find that the study area road network is unable to accommodate the future predicted traffic (in particular the 2030 traffic). In these cases the TIA should clearly identify the most what can be done and determine the proportion of future traffic which can be reasonably accommodated (eg 80%, 90% etc).

It is not intended that the TIA will attempt to hide future problems.

9.2.4 Description of Future Network and Identification of Problems

The TIA should provide scaled concept designs of the future road network in the study area. Areas where future problems are expected should be clearly identified.
9.2.5 Impact of Traffic on Residential Streets & Access Roads

Sections 9.1.4 and 9.1.5 have described the impact of traffic on more minor urban roads and residential streets goes beyond just traffic capacity issues.

Accordingly where future additional traffic is assigned to the road network its impact on the amenity and safety on access and residential streets should be assessed from these alternative criteria also.

9.2.6 Modelling of New Areas

Where the TIA refers to an entire new area in Bahrain, then it is expected that a detailed VISUM network of the area will be used to provide the vehicle trip demand for a VISSIM micro-simulation model of the entire area.

VISSIM is particularly appropriate for new areas as it allows the internal road network and intersections to be comprehensively modelled in one package. This will allow the type of junctions to be comprehensively assessed, giving details on the number and length of turning lanes, to ensure that a balanced road network is being planned.

The VISSIM modelling will also allow the overall network efficiency of different types of junction control to be evaluated in an objective fashion.

A VISSIM model can also be used to assess future problems in crossing the study area roads for pedestrians.

9.3 Determination Of Required Road Network Improvements

The TIA should clearly indicate areas of the future road network where problems will occur. Where problems are identified, the TIA should indicate what if anything can be done to increase the capacity of the network. This could include, but not be limited to the following measures:

- Additional lanes at existing or planned junctions (subject to corridor space being available);
- Additional lanes on the links in the study area roads;
- Changes to traffic control, this will include changes to the stage plans of traffic signals;
- Adding or taking away movements at existing or planned junctions, this could including allowing left turns at junctions where they are presently banned;
- Providing additional junctions on the road network.

The TIA should produce scaled concept drawings of all upgrading proposals.

Where it is found that the future predicted traffic cannot be accommodated on the study area road network (even assuming reasonable traffic improvements) then this needs to be clearly stated in the TIA.
9.4 Safety Assessment Of Road Network And Proposed Improvements

Statistics indicate that accident rates increase as the intensity of roadside developments increase (e.g. commercial activities). The amount of traffic generated and attracted by a development depends on the location, the type of land use and the size of the development. One possible outcome of an increase in traffic flow, can be an increase in the number of accidents. Therefore access to the development and the road system must be designed to minimise conflicts between vehicles and pedestrians.

Generally, it is advisable to avoid direct access between developments and major roads. If such access is proposed, the TIA should demonstrate that the resulting situation does not adversely affect safety. Where possible, vehicle access to developments from more major roads should be from service roads / lanes or via dedicated junctions.

10 EXTERNAL PEDESTRIAN ACCESS TO THE DEVELOPMENT

Safe pedestrian access must also be provided to developments. Mid-block crossings of major roads should be avoided. In any new development, a general principle of design is to maintain road safety and, where possible, improve it.

Traffic safety is of primary importance for developments on both minor and major roads. The internal site layout and access to the development should be considered. Vehicle / vehicle and vehicle / pedestrian conflict points should also be reviewed.

Many developments attract pedestrian traffic, particularly commercial developments in retail and CBD areas. It is important that proper assessment is made of pedestrian traffic on footpaths, e.g. the sufficiency of footpath widths. Pedestrian safety also needs to be considered, especially at conflict points such as entry / exit driveways leading to basement and vehicle parking areas. One way of reducing conflict is to divert pedestrian traffic around driveways. In some instances, this may require buildings being set back a considerable distance from the roadway.

Development plans should ensure that the internal circulation system and the external access points are designed for pedestrian safety thereby minimising pedestrian / vehicle conflicts. This plan must cater for access to public transport services as well as to (and within) public parking areas. Pedestrian safety is a critical issue in the design of new residential estates.

Where heavy pedestrian flows are anticipated, levels of service must be evaluated. The following table sets out pedestrian levels of service, based on the Highway Capacity Manual Special Report 209 (1985).
### Pedestrian level of service on walkways

<table>
<thead>
<tr>
<th>Level of Service</th>
<th>Space (m/ped)</th>
<th>Average Speed (m/min)</th>
<th>Flow Rate (ped/min/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>over 12.1</td>
<td>over 79</td>
<td>less than 7</td>
</tr>
<tr>
<td>B</td>
<td>3.7-12.1</td>
<td>76-79</td>
<td>7-23</td>
</tr>
<tr>
<td>C</td>
<td>2.2-3.7</td>
<td>73-76</td>
<td>23-33</td>
</tr>
<tr>
<td>D</td>
<td>1.4-2.2</td>
<td>69-73</td>
<td>33-49</td>
</tr>
<tr>
<td>E</td>
<td>0.6-1.4</td>
<td>46-69</td>
<td>49-82</td>
</tr>
<tr>
<td>F</td>
<td>less than 0.6</td>
<td>less than 46</td>
<td>variable</td>
</tr>
</tbody>
</table>

## 11 PUBLIC TRANSPORT ASSESSMENT

In any new development, opportunities to optimise the use of public transport must be pursued. For large developments and in particular new areas, an evaluation of the question of whether public transport services are necessary and, if so, whether they are available and adequate for that development should be made.

As the public transport infrastructure in Bahrain becomes more mature, the issue of public transport will become a more important issue.

With retail and commercial developments, direct pedestrian routes to bus stops must be taken into account in the design. Wherever possible, the design should encourage the use of public transport.

Residential subdivisions should be located in proximity to existing development when possible, to assist in the design of bus routes. Subdivisions should ideally have at least two entrances to the major road network, to avoid circuitous bus routing.

In subdivisions at least 90% of dwellings should be 400 metres or less safe walking distance from an existing or potential bus route, and not more than 500 metres from the nearest stop or potential stop. With medium density residential developments, opportunities should be developed to ideally reduce walking distances to less than 200 metres of a bus route.

Thus the TIA should be sympathetic to the NPDS recommendations that higher density development should be clustered around future public transport nodes, rather than spread out along road corridors. This is illustrated in the following diagram.
It is advisable to identify bus routes in new residential subdivisions so that appropriate planning measures may be taken. Bus operators seek to minimise operating costs through high operating speed and good connectivity of roads. On a broader front, the success of public transport as competition to the private car, depends on service as well as the availability and convenience of the facility. The location of access points to public transport facilities is another contributing factor in determining the level of success of the facility.

Some sites are suited to running bus services along adjacent collector or sub-arterial roads, resulting in the provision of a service within 400m of most houses. In other instances it is necessary to provide a bus service within a residential area positioned within approximately 400m of the majority of households.

The bus route is therefore usually one of the first traffic considerations shown on a sketch plan of a proposed subdivision.
A convenient through route on its own may attract other traffic, which may be too high for residential amenity. While the provision of a bus-only link may ease this problem, this restrictive arrangement may inconvenience residents who need to drive around the bus only section. (The fact that some residents may drive through the link is not so significant that it should cancel such a proposal. However, a location which is likely to attract regular through traffic may require special treatment.)

Bus operators tend to require two traffic lanes even for low frequency routes and therefore tend to operate on streets where the speed is relatively high. This is often at odds with the overall plan for an estate, and worse still, the bus routes may attract pedestrians onto the most potentially dangerous streets in an estate. One solution to this is to implement traffic slowing measures adjacent to bus stops and allow more free speed between these points. Hence it is better that the bus route should operate generally on 50km/h streets, with 30km/h areas near bus stops.

12 DETERMINATION OF DEVELOPER CONTRIBUTION TO REQUIRED TRAFFIC FACILITIES

It is likely that increasingly in Bahrain contributions for road network improvements will be sought from developers.

A general approach in determining contributions is to:

- Ascertaining vehicle trips generated by a development;
- Establish the existing and future situation by conducting a traffic study (as outlined in these Guidelines);
- Determine existing and future peak traffic movements;
- Establish an appropriate standard for road and intersection level of service;
- Estimate works required to ensure the effective peak hour operation of road(s) adjacent to the site and appropriate approach roads;
- Cost the required works;
- Allocate only the costs associated with the road and intersection improvements required by additional traffic generated by the new development to the developer.

Design standards for traffic efficiency do not always reflect actual capacity. Alternatively, an approach based on levels of service experienced during peak periods may be adopted. With the adoption of a performance standard (such as level of service C or D), some consistency in approach can be maintained. Roads where traffic flows...
have reached these limits will provide a performance standard. Beyond these limits additional traffic lanes are usually required.

In some areas different levels of service may be adopted for different times. For example, level of service C may be most appropriate for weekday peak periods while level of service D may be adopted for weekend recreational peak demands. This approach recognises that the latter occurs less frequently and therefore a lower level of service can be tolerated.

13 CONCLUSIONS & SUMMARY

The conclusions and summary of the TIA should be a non technical statement of the findings of the TIA.

The main findings of the TIA should be summarised according to the components of the TIA defined in these guidelines.

Where the development is predicted to have unsatisfactory traffic impact, this should be outlined in an objective manner.

Broadly speaking the development can be unsatisfactory internally or externally.

Internal impacts could be poor internal circulation or parking or a lack of on-site parking provision. External impacts could be poor level of service on the external road network.