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Roads General Authority

كـود الطرق السعـودي
SAUDI HIGHWAY CODE

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SHC 201 – Planning Process

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KINGDOM OF SAUDI ARABIA

كود الطرق السعودي

SAUDI HIGHWAY CODE

Key list of the Saudi Highway Codes

No.	Thematic Category	Code	Title
1	Introduction	SHC 101	General
2	Planning and Preliminary Studies	SHC 201	Planning Process
3		SHC 202	Surveying and Mapping
4		SHC 203	Preliminary Studies
5	Design of Highways, Bridges and Tunnels	SHC 301	Highway Geometric Design
6		SHC 302	Highway Facilities and Utilities Design - Hydrology and Hydraulic Design
7		SHC 303	Highway Facilities and Utilities Design Rest Areas, Truck Inspection Stations, Parking & Garage Facilities
8		SHC 304	Highway Facilities and Utilities Design - Passive Safety Systems Design
9		SHC 305	Highway Facilities and Utilities Design - Work Zone Design
10		SHC 306	Highway Facilities and Utilities Design - Public Utilities, Highway and Street Lighting, Control and Monitoring Devices
11		SHC 307	Highway Facilities and Utilities Design - Landscape Planting, Outdoor Advertising
12		SHC 308	Pavement Design
13		SHC 309	Material Specifications and Standardized Testing
14		SHC 310	Bridges and Tunnels Design
15	Construction of Highways, Bridges and Tunnels	SHC 401	Construction of Highways
16		SHC 402	Construction of Bridges and Tunnels
17		SHC 403	Construction of Highway Facilities
18	Highways, Bridges and Tunnels Maintenance and Management Systems	SHC 501	Pavement Maintenance Management Systems
19		SHC 502	Bridges and Tunnels Maintenance and Management Systems
20		SHC 503	Highway Facilities Maintenance and Management Systems
21	Traffic Engineering and Road Safety	SHC 601	Traffic Engineering
22		SHC 602	Manual on Uniform Traffic Control Devices
23		SHC 603	Road Safety
24	Environmental Aspects of Highways	SHC 701	Environmental Aspects of Highways
25	Autonomous Vehicles Requirements	SHC 801	Autonomous Vehicles Requirements

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1. Introduction

1.1. Summary of Chapters

Volume SHC 201 - Planning Process is divided into 7 chapters. A brief outline of these chapters is given below:

Chapter 1. Introduction - This chapter provides an overview of the chapters, the scope of the volume, and a full list of the standards referenced within the volume.

Chapter 2. Highway Planning Process Overview - This chapter provides a brief overview of transportation planning for roads and highways.

Chapter 3. Highway Network Planning and Functional Classification - This chapter describes the functional classification for roads and highways and the related requirements for highway network planning.

Chapter 4. Urban and Social Traffic Concepts - This chapter provides key traffic organization planning guidance for urban streets.

Chapter 5. Public Transport Considerations - This chapter provides planning and recommended policy considerations for on-road public transport.

Chapter 6. Traffic Planning for Non-Motorized Users - This chapter discusses requirements related to the planning for pedestrian and bicycle facilities along streets and highways, inside the public right-of-way.

Chapter 7. Highway Capacity - This chapter discusses key traffic engineering issues, related to traffic flow, capacity and level of service.

1.2. Scope

This volume includes fundamental planning aspects and considerations related to the Highway Planning Process, Highway Network Planning, Urban Traffic Organization, Public Transportation, Non-Motorized Users and the Right-of-Way (ROW), and Highway Capacity.

1.3. Reference Standards and Codes

Codes for all procedures related to the content of the volume at hand shall be as specified in these guidelines, and in the Contract documents, if any. In special cases, where supplementary guidance is deemed appropriate, the latest edition of the following documents may be used, unless otherwise directed by the Roads General Authority (RGA) and/or the Client's Organization.

- Transportation Research Board (TRB) Highway Capacity Manual (TRB, 2022).
- Transit Capacity and Quality of Service Manual - Transit Cooperative Research Program TCRP Report 165 (TRB, 2013).

Standards for materials are not applicable for SHC 201 - Planning Process.

2. Highway Planning Process Overview

2.1. Introduction

2.1.1. Scope

This chapter shall apply to the overall framework for the highway planning process, both at rural and urban context. This framework is further defined and analyzed in the remaining Chapters of the present volume SHC 201 - Planning Process, as well as in part of SHC 203 (Preliminary Studies) of Highways.

2.1.2. Standards and Guidelines

For specific design considerations the reader should refer to SHC Volumes 301 to 308 and 310.

For administrative and funding procedures and requirements and asset management procedures the EXPRO's (Government Expenditure & Projects Efficiency Authority) White Book (EXPRO, 2020) and the EXPRO's National Manual of Assets and Facilities Management - Blue Book (EXPRO, 2021) are valid, where applicable.

The sections of this chapter shall not be read in isolation, but in the context of all chapters of this volume and volume SHC 203 (Preliminary Studies) as a whole.

2.1.3. Summary of Sections

Section 2.1 (this section) is providing initial information and context.

Section 2.2 provides an overview of the transportation planning process as a whole.

Section 2.3 defines requirements for specific highway planning considerations along with appropriate references to relevant volumes and chapters of the SHC.

Appendix A provides an indicative list of potential stakeholders for infrastructure related projects within the KSA.

2.1.4. Interpretation and Commentary

Highway planning is about mobility and accessibility. Patterns of growth and activity for people and goods across the Kingdom of Saudi Arabia (KSA) are fundamentally driven by how well the highway transportation system delivers mobility and accessibility. The performance of the highway system also affects public policy concerns, such as air quality, environmental resource consumption, social equity, climate change, land-use, urban growth, economic development, safety, and security. Highway planning recognizes the critical links between transportation needs and other societal goals and includes strategies for operating, managing, maintaining, and financing the transportation system to advance an area's long-term goals and the regional community's shared vision for the future.

This chapter provides an overview of the highway planning process, covering key requirements and concepts of metropolitan, regional and nationwide highway planning, along with references for additional information. The chapter does not cover the topic of urban and land-use planning; for this topic, existing guidelines and manuals (e.g., by Royal Commissions, MODON, MoMRAH, etc.) shall remain in force.

The principles, guidance, requirements and standards set out in this chapter are intended for use by suitably qualified, licensed and experienced transportation planners and traffic engineers.

It is finally noted, that besides the requirements of the present Volume of SHC, transportation planners and engineering consultants must be aware of and comply fully with the applicable local legislation related to transport and roads in the KSA.

2.2. The Transportation Planning Process

2.2.1. Overview

Transportation planning typically follows the following steps (ITE, 2016):

- Understanding of the socio-demographic, land-use, and economic context within which a transportation system operates.
- Developing a community or study area vision.
- Acquiring more specific information and defining goals and objectives.
- Identification of system performance measures.
- Collecting and analyzing data on existing and anticipated future conditions (forecasting).
- Evaluate various alternative improvement strategies and their related tradeoffs using detailed planning studies.
- Programming the implementation of the most desirable actions with the available funds, through the development of long-range plans and short-range programs of alternative capital improvement, management, and operational strategies for moving people and goods.
- Refining the design and operation of programmed projects for implementation (project development).
- Monitoring the transportation planning system to provide feedback to the definition of goals and objectives and the use of performance measures.

However, the planning and project development process commonly does not follow the above steps in an orderly and rational manner, but instead is a complex procedure, often with many different activities occurring concurrently (Figure 2-1). Also, in many cases, several of these steps may have already occurred and therefore are not relevant to a particular planning effort. For example, Royal Commissions, MODON, etc. have been developing transportation plans for years, and as a result, a typical planning effort might simply be updating an existing transportation plan.

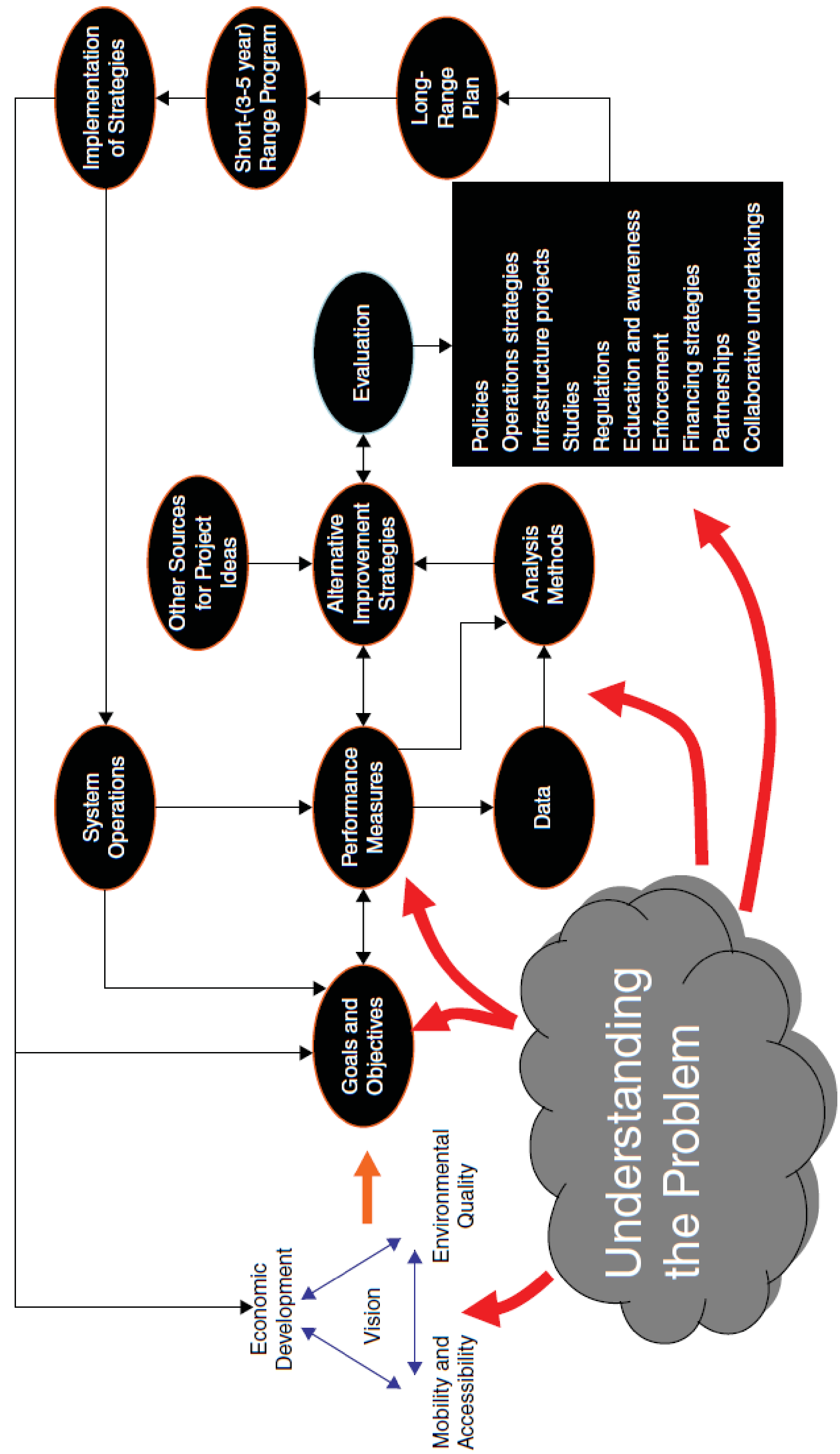

Figure 2-1 Conceptual Framework for Highway Planning (ITE, 2016)

2.2.2. Major Steps in Transportation Planning

The planning process begins with an **understanding of the socio-demographic, land-use, and economic context** within which a transportation system operates. This is followed by becoming aware of the problems, challenges, opportunities, and deficiencies of transportation system performance within this context, be it Kingdom-wide, a province, a governorate, or a small community. Analysis and assessment of the changing context of transportation system performance and an examination of both the existing and expected challenges facing the transportation system should be performed, to understand the nature of these challenges.

The next step is **developing a community or study area vision**. The dimensions of the vision portrayed in Figure 2-1 reflect the interaction among desired states of economic prosperity, environmental quality, and mobility/accessibility. The vision can consist of general statements of desired end states or can be as specific as a defined land-use and transport scenario. The visioning process often relies on extensive stakeholder outreach and is considered one of the most community-interactive steps of the planning process.

Once a vision has been defined, the next step is to **acquire more specific information** about what the vision means. What is the desired performance of the transportation system? What characteristics of community life can be most positively affected by transportation improvements? This more specific definition of a community's future should be accomplished by defining goals and objectives that provide overall direction to the planning process. These goals and objectives not only help define the purposes of the planning process for the public, but also identify criteria to evaluate different transportation system options and alternatives.

Goals and objectives should lead to the **identification of system performance measures**. The primary purpose of collecting data on key system performance characteristics is to provide information to decision makers on the aspects of performance that are most important to them. Performance measures should be used to monitor whether congestion, average speeds, system reliability, and mobility options have changed over time.

Collecting and analyzing data, the next step of the planning process, is key to understanding the problems and potential challenges facing the transportation system and the surrounding community. Requirements for data collection for highway planning purposes are defined in SHC 202 (Surveying and Mapping), SHC 203 (Preliminary Studies) and SHC 601 (Traffic Engineering). Requirements for data analysis are defined in Chapter 7. This analysis process primarily focuses on understanding how a transportation system and its components work and how changes to the system will alter its performance. A large part of the analysis step is identifying the current status of system performance. Analysis also includes identifying alternative strategies or projects that meet the objectives of the study. Analysis tools, ranging from simple data analysis to more complex simulation models, are used to produce the information that feeds the next step of the process, which is evaluation.

The step of **evaluation** involves synthesizing the information produced during the analysis step (for example, the benefits, costs, and impacts of different alternatives) so that judgments can be made concerning the relative merits of different actions. The process of alternatives development is defined in Section 3.6 of SHC 203 (Preliminary Studies) and the evaluation process in Chapter 4 of SHC 203 (Preliminary Studies).

The actual program of actions (implementation - short term plan) is connected to the overall plan through a process called **programming**. Programming matches the most desirable actions that have surfaced through the evaluation process with available funds. Priorities must be set when there are insufficient funds to satisfy all of the funding needs. This process can take many forms, ranging from political considerations to the use of systems analysis tools to assign priorities to different projects or alternatives. Further details and specific requirements for various planning and programming procedures are presented in Section 2.3 of the present chapter.

Once a project or action has been programmed for implementation, its design and operation must be further refined, and likely impacts further explored. This process of refinement is called **project development**. Project development takes various forms, depending on the scope and magnitude of the project and the expected effects. Two major steps in project development include: developing project concepts, planning the project in finer detail than typically occurs within the engineering design process (see SHC Volumes 301 to 308 and 310). When significant environmental impacts are expected, the project development process will include an environmental analysis process, as defined in Chapter 6 of SHC 203 (Preliminary Studies) and further detailed in SHC 701 (Environmental Aspects of Highways).

The final component of the framework is **system monitoring**, which provides feedback to the definition of goals and objectives and the use of performance measures. Poor system performance can lead to further planning analysis to better understand the dynamics of the underlying problem, or it might very well lead to the identification of new goals and objectives (ITE, 2016).

2.3. Highway Planning Considerations

Systems of interconnected, well-designed, and well-maintained highways and streets are critical to the economic well-being and quality of life. Such systems also represent a massive public investment in infrastructure and must be planned with care and detailed consideration to ensure efficient fund allocation.

The present section focuses on specific highway planning considerations, defining related SCH requirements and providing, where appropriate, relevant references to specific volumes and chapters of the SHC.

2.3.1. Road and Highway Planning for Urban Areas

The following planning principles apply for urban highway systems in newly developing areas, where new highway systems are being superimposed on existing development, as well as for modifying existing facilities (ITE, 2016).

2.3.1.1. Multimodal planning

Urban highway systems should consist of a multimodal network of streets and highways that serves automobiles, trucks, transit, bicyclists, and pedestrians. Transportation planners and traffic engineers should:

- Define the highway network to handle traffic volumes safely and efficiently – providing convenient routes around the area for through traffic and routes within the area for traffic moving between major land-uses. Refer to Chapter 7 of the present volume and SHC 601 (Traffic Engineering) for detailed requirements and guidance.

- Define vehicular mobility appropriately in dense urban areas where multiple modes of transportation are served, to ensure that the plan will not result in speeds that threaten the safety of pedestrians or have negative environmental and aesthetic impacts due to noise from motorized traffic. For this purpose, engineers should design the physical form of the highway (geometry, lane width, etc.) within the context of the highway's surroundings. Refer to Chapter 6 of SHC 603 (Road Safety) for traffic calming and speed management detailed requirements and guidance.
- Develop the highway system in such a manner that there are sufficient interconnections and a degree of redundancy. No single highway should have an overwhelming volume of traffic and most highways can maintain a smaller scale and therefore provide a multimodal environment for pedestrians, bicyclists, and transit users.
- Provide reasonably direct access for emergency and service vehicles.
- Arrange parking facilities, vehicular and pedestrian circulation routes, bicycle routes, and buildings to minimize conflicts between non-motorized and vehicular movements.
- Provide a system of bicycle facilities and routes. Consider the most likely bicycle users, which may include commuters, students, or recreational bicyclists. See Chapter 6 of the present volume for relevant requirements.
- Integrate transit service efficiently within the highway network; ensure easy access for pedestrians, cyclists, and motorists accessing bus stops, terminals, or train stations. Also, develop a hierarchy of transit services that includes primary transit access on exclusive bus lanes, secondary transit access on other major highways in mixed traffic, and a feeder transit network on collector and local streets. See Chapter 5 of the present volume for relevant requirements.

2.3.1.2. Functional classification

Urban highway systems should be planned so that individual highways and streets serve different functions within the network (functional classification), serving all modes of passenger and freight/ goods movement. Transportation planners and traffic engineers should:

- Balance the highway system plan to meet the need for all modes of transportation, including private vehicles, commercial vehicles, transit, bicycles, and pedestrians. While each facility does not need to serve every mode, the system as a whole should provide a good level of service for each mode. Some individual highways and streets may have priority for specific modes.
- Consider the land-use context and urban form in determining the relative importance of each mode on various streets in the network. Areas that are intended to be walkable and transit-oriented should have street networks that will support these modes.

2.3.1.3. Planning for connectivity

Urban highway systems should have a high degree of connectivity to help provide multiple routing options for all user groups. Transportation planners and traffic engineers should:

- Favor a highway system that includes redundancy in the network to offer more than one direct route between points in the area.
- Identify layered and of necessity, overlapping, networks for pedestrians, bicyclists, transit, autos, and trucks so that each network has an appropriate level of connectivity and redundancy.
- Prefer networks with more frequently spaced highways of lower functional classification, as opposed to sparse networks of higher classification highways.
- Consider emergency vehicle access as part of the network planning. Emergency vehicles will often operate more effectively within a dense network, where alternative routes are available in the case of severe crashes or emergency highway closures.
- Provide direct access to the regional transportation system for industrial sites.
- Avoid having a concentration of vehicular traffic at bottleneck intersections and rely on connectivity improvements to reduce congestion.
- Provide high levels of highway network connectivity to afford more options for local trips and less dependence on arterials for short trips.
- Provide multiple connections throughout neighborhoods to provide alternative routing, improve emergency response times, reduce travel costs for school buses and reduce the demand on the arterial system.

2.3.1.4. Integration with land-use planning

Urban highway systems should have a network density appropriate to the land-use patterns and urban form that are served. Transportation planners and traffic engineers should:

- Size the highway network to complement the design and character of the surrounding community.
- Integrate the planned highway system with the area's land-use plan so that it serves as a total and integrated multimodal system rather than as a series of loosely related highway improvements.
- Provide appropriate density, walkable, mixed-use development along major transit corridors to maximize the opportunity for transit.
- Provide a highway network conducive to pedestrians by planning small block sizes, high highway connectivity (especially for local streets), and complete sidewalk systems. Pedestrian crossings are safer in a denser network of two-lane to four-lane highways as opposed to a sparser network of multi-lane highways.

Also, urban highway systems should recognize the role of highways as public spaces and in shaping urban environments. Transportation planners and traffic engineers should:

- Recognize the multiple roles of major urban highways in access, place making, and economic development. See also Chapter 4 of the present volume for relevant requirements.
- Include an assessment of the context zones within the planning area. Plan the highway network system to be compatible with the appropriate context zones such a modal balance, connectivity, and scale of highways. See also Chapter 4 of the present volume for relevant requirements.
- Plan the transportation facilities to be aesthetically attractive and, to the extent possible, to blend in with or highlight the surroundings and topographic features through which they pass.

2.3.1.5. Integrated planning considerations

Urban highway network systems should be planned with consideration of environmental, social, economic, and financial issues. Transportation planners and traffic engineers should:

- Plan the highway network system to be sufficiently flexible so that it can be adapted over time to meet future challenges in travel patterns not foreseen at the time of the plan's formulation. Examples include preservation of corridor rights of way to facilitate network expansion as growth occurs or designation of flexible highway cross sections to accommodate dedicated transit lanes or wider sidewalks.
- Plan for a highway network system that minimizes the length of vehicle trips to reduce vehicle-kilometers traveled.
- Plan the highway network system to encourage development that reduces average trip lengths and is conducive to travel by transit, bicycle, or foot.
- Plan a highway network system that does not create barriers for pedestrians as this will unnecessarily create a dependence on cars.
- Bring origins and destinations closer together through higher densities and appropriately mixed land-use.
- Develop a financing plan over the long term to ensure implementation of the urban highway network system, and plan the highway network system to be within the reasonable financial capabilities of the community. Refer to Chapter 4 of SHC 203 (Preliminary Studies) for detailed requirements and guidance on economic analyses.
- Plan the highway network system to consider the safety of all users and seek to minimize conflicts. See SHC 603 (Road Safety) for detailed requirements and guidance on road safety, as well as Section 2.3.6 for road safety implications in the planning process.

2.3.2. Strategic (Long Term) Planning

The Strategic (Long Term) planning, also known as Long-Range Transportation Plan (LRTP), identifies the most cost-effective and appropriate transportation strategies to achieve a desired level of system performance for a country's transportation system, for a planning horizon of at least 20 years (ITE, 2016).

LRTPs may be either policy-oriented strategic plans, or project-focused investment plans that include lists of recommended projects.

The LRTPs address (FHWA & FTA, 2018):

- Policies and strategies, or future projects.
- Projected demand for transportation services for 20 or more years.
- A systems-level approach that considers highways, transit, non-motorized transportation, and intermodal connections.
- National and regional land-use, development, housing, natural environmental resources, freight movement, and employment goals and plans.
- Cost estimates and reasonably available financial sources for operation, maintenance, and capital investments.
- Ways to preserve existing highways and facilities and make more efficient use of the existing system.

Performance goals for LRTPs shall be the following:

- **Safety:** Achieve a significant reduction in traffic fatalities and serious injuries on all highways.
- **Infrastructure Condition:** Maintain the highway infrastructure asset system in a state of good repair.
- **Congestion Reduction:** Achieve a significant reduction in congestion on highway network of freeways and expressways, both in rural and urban areas.
- **System Reliability:** Improve the efficiency of the surface transportation system.
- **Freight Movement and Economic Vitality:** Improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development.
- **Environmental Sustainability:** Enhance the performance of the transportation system while protecting and enhancing the natural environment.
- **Reduced Project Delivery Delays:** Reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices.

The basic steps in strategic (long term) planning process include (ITE, 2016):

1. Define the focus and boundaries of the planning effort.
2. Identify issues and opportunities.
3. Define vision and goals.
4. Identifying and using system performance measures. Performance measures are different from goals, objectives, and evaluation criteria in that they represent a small number of selected indicators monitored over time to determine changes in system performance.
5. Collect and analyze system performance and condition data, leading to a needs assessment.
6. Analyze individual transportation system alternatives for targeted performance characteristics.
7. Evaluate transportation system alternatives to compare relative benefits and costs.
8. Prioritize programs and projects.
9. Monitor system and program performance.

The LRTPs shall be updated every 5 years at the latest.

2.3.3. Implementation (Short Term) Planning

While the LRTP articulates the overall region's vision and identifies possible improvement strategies, the Implementation (Short Term) planning, also known as Transportation Improvement Program (TIP), details how the highest priority projects will advance over the next 5 years (i.e., the typical lifespan of the LRTP, before it is updated).

The TIP also programs public funds over the short-range to reflect investment priorities. Priorities must be set when there are insufficient funds to satisfy all of the funding needs. This process can take many forms, ranging from political considerations to the use of systems analysis tools to assign priorities to different projects or alternatives (ITE, 2016). Criteria to be typically considered for project prioritization include:

- Safety.
- Security.
- Congestion reduction.
- Environmental Sustainability.
- System Reliability.
- Freight Movement and Economic Vitality.

The Implementation planning (i.e., the Transportation Improvement Program - TIP) focuses on allocating the region's transportation resources among the various capital, management, and operating investment needs of the area. The TIP is based on a clear set of short-term transportation priorities prepared through a performance-driven process.

TIPs shall (FHWA & FTA, 2018):

- Cover at least 5 years of investment.
- Be updated at least every 5 years.
- Remain fiscally constrained so that projects are only included if their full funding can reasonably be anticipated and may include a financial plan.
- Report on anticipated progress in meeting performance targets.

2.3.4. Corridor Planning

Corridor plans determine the need for facilities or services among activity centers or other logical termini, as well as identify transportation investments to complement existing or planned land-use. Corridor planning may focus on many different characteristics of corridor system performance (e.g., high-crash locations, increasing levels of congestion, restricted freight movements, changing land-use patterns etc.). Decisions resulting from a corridor plan may lead directly to project definitions, design, and environmental analyses requiring a degree of detail that may be absent from a broader planning process. Corridor planning shall be accomplished using a long-range outlook (at least 20 years).

Reasons for carrying out a corridor study are (ITE, 2016):

- Developing a strategy to address current or future transportation problems.
- Relating a corridor strategy to a larger system plan.
- Identifying land-use strategies that complement transportation investments.
- Identifying improvements to include within a local or regional plan.
- Setting the conditions for setting aside right-of-way within the corridor.
- Allowing more detailed cost estimates to be prepared.

The minimum contents of a Corridor Planning Study shall be the following (ITE, 2016):

- Executive Summary:
    - Primary function of the corridor.
    - The 20-year vision for the corridor.
    - The goals for the corridor.
    - The study process and public involvement.
    - Prioritized recommendations.
    - Summary of the next steps.

- Introduction:
  - Purpose of study.
  - Study area or corridor, including function, classification, and distinguishing characteristics.
  - History of the corridor.
  - Corridor location, including base map of the corridor.
  - Stakeholders.
  - The 20-year vision for the corridor.
  - Plan contents.
  - Goals of the study.
- Basic Information - Existing Conditions:
  - Current issues present in the corridor.
  - Preservation.
  - Safety.
  - Mobility.
  - Environment.
  - Stewardship.
- Data Analysis for the 20-year Planning Horizon:
  - How will the existing conditions change?
  - Modeling.
  - Forecasting.
- Fiscal Constraints - List of Financial Assumptions.
- Recommendations:
  - Preliminary recommendations based on goals.
  - Screening criteria.
  - The Action Plan - Implementation Action Matrix.
  - Next Steps for Monitoring Implementation.

Furthermore, special considerations during highway studies at the corridor planning level will be required for Gas or Oil Pipelines intersecting the highway alignment or pipelines with Right-of-Way boundaries within 50 m of the highway Right-of-Way boundaries. Further details are defined in Section 2.1.2 of SHC 306 (Highway Facilities and Utilities Design – Public Utilities, Highway and Street Lighting, Control and Monitoring Devices).

Further details on the specific process and requirements for highway studies at the corridor planning level are defined in Chapter 3.7 of SHC 301 (Highway Geometric Design).

2.3.5. Sustainable Transport Planning

Environmental factors are related to transportation planning at two levels. The first is the broader transportation planning occurring at the strategic (long term), implementation (short term) or corridor level. This planning is often not project-specific (except for some corridor studies), and thus limited engineering analysis is performed to identify the types of environmental impacts likely to occur. The second type of planning, which is more closely related to project development, provides a much more detailed analysis of the likely consequences of project alignment and operating decisions. This planning usually includes sufficient conceptual engineering detail to determine the types and magnitudes of environmental impacts likely to be encountered during project construction and operation, as well as what might be needed to mitigate them (ITE, 2016).

See Chapter 6 of SHC 203 (Preliminary Studies) and SHC 701 (Environmental Aspects of Highways), for detailed requirements and guidance on environmental considerations on both aforementioned levels.

2.3.6. Planning for Safety

Road safety is affected by how the transportation system is designed, constructed, operated, and maintained. Given that transportation planning leads to changes in this transportation system, safety should be thoroughly integrated into the planning process (ITE, 2016).

Transportation planners and traffic engineers shall incorporate safety considerations by identifying high-crash locations and the most effective strategies for reducing crashes at these locations. Crash data helps identify which focus areas should receive funding priority for improving safety in the region (FHWA & FTA, 2018). Detailed guidance and requirements on road safety analysis, management and procedures is provided in SHC 603 (Road Safety).

Safety concerns shall be incorporated into the following major steps of the planning process (as described in Section 2.2.2) (ITE, 2016):

- Establish multidisciplinary coordination with safety stakeholders.
- Incorporate safety into the vision, goals, and objectives of the planning process. There should be at least one goal, several objectives, and system performance measures that address safety in the transportation planning process. Performance measures are most often related to reduction in crashes, fatalities, and injuries, as well as the monetary savings associated with these reductions.
- Apply safety performance measures and targets, also known as Safety Performance Indicators (SPIs), in the planning process. Specific SPIs for use in the KSA are defined in Section 3.2 of SHC 603 (Road Safety). Further information on recommended SPIs (theoretical framework, justification for selection, guidance for data collection and analysis and limitations) can be found in Appendix D of SHC 603 (Road Safety).
- Collect and analyze crash data. Guidance and requirements for crash data are provided in Chapter 2 of SHC 603 (Road Safety).
- Analyze and evaluate road safety and identify safety countermeasures, where applicable. See also Chapter 3 of SHC 603 (Road Safety).
- Make safety a decision factor at the planning level (i.e., by conducting a benefit/cost analysis and assign points to each project according to the safety benefits that are likely to accrue).

2.3.7. Collaborative Planning and Stakeholder Engagement

2.3.7.1. Stakeholder identification

The cooperation of agencies and stakeholders for highway transportation planning improves decision-making, saves time and money through shared resources, and helps agencies achieve more by working together. Stakeholder engagement improves freight and congestion management coordination across jurisdictional boundaries and supports ways to address common issues (FHWA & FTA, 2018).

During the highway planning process, transportation planners and traffic engineers shall reach the following entities, authorities and stakeholders, as primarily identified based on the geographic area of the study (ITE, 2016):

- Local government staff.
- Transportation agencies (port, airports, transit, etc.).
- Law enforcement and emergency services management, emergency operations centers and economic development agencies.
- Agencies responsible for land-use management, natural resources, environmental protection, conservation and historic preservation and other environmental issues.
- Providers of freight transportation services.
- Private providers of transportation.
- Other key organizations could include health authorities, colleges and universities, educational directorates, major employers, and recreation providers.
- Other parties that would have an interest in the planning and development of the transportation network, including affected public agencies in the transportation planning area.
- Special interest groups (other interested parties).

An indicative list of potential stakeholders for infrastructure related projects within the KSA is provided in Appendix A.

2.3.7.2. Stakeholder engagement plan

At the project planning stage, the project management team shall prepare the project's Stakeholder Engagement Plan to identify the project’s stakeholders, define the interfaces between the stakeholders and the project and describe how the stakeholders and interfaces will be managed. A project external stakeholder is any party external to the project organization, impacted by, has an influence on or an interest in, the project. This procedure does not cover internal project stakeholders such as the project authority itself or any parties directly engaged in the delivery of the project (e.g., consultants, specialist sub-consultants, contractors or sub-contractors, etc.).

2.3.8. Planning for Road Freight Transport

The efficient movement of freight and goods is a fundamental prerequisite for a strong and vibrant economy. Government agencies responsible for transportation planning should promote integrated modal systems by supplying highway infrastructure that can support responsive, reliable and safe freight transportation.

Although much of the freight and goods movement is the responsibility of private firms, a large portion of this movement occurs on the highway network and thus has implications to those responsible for planning, building, and managing the highway network. Transportation planners and traffic engineers need to know how much freight and what type of goods are moving on the highway network, and from which distribution/ warehouse centers these flows are originating. These and other data about the mode of transportation, vehicle characteristics, and types of facilities used are needed to track and monitor system conditions and performance to assess the many ways freight affects the transportation system (ITE, 2016).

2.3.8.1. Freight considerations in strategic (long term) planning

Freight transport should be considered at several levels of transportation and highway planning. At the most general level are the long-range transportation planning (LRTP) studies conducted periodically at national, provincial or metropolitan area level (see also Section 2.3.2). The challenge in these studies is to incorporate freight considerations in a proportionate way to the freight problems faced at the national, provincial or the metropolitan level.

The following elements shall be considered for the successful integration of freight issues in the national and metropolitan long range transportation planning process (NCHRP, 2007; ITE, 2016):

1. Developing a freight stakeholder engagement plan (see also Section 2.3.7).
2. Understanding the national or regional freight system.
3. Developing links between freight planning activities and the transportation planning and programming process.
4. Freight data needs assessment and collection.
5. Consideration of incompatibilities in providing major goods movement mobility with other uses. For example, major truck routes should not cross major pedestrian corridors.
6. Taking advantage of training and education opportunities for freight transport providers.

2.3.8.2. Freight-specific planning studies

Freight-specific planning studies focus exclusively on freight movements in and through a study area. In such studies, the following aspects/steps shall be included (ITE, 2016):

Goals, Objectives, and Performance Measures

As in other planning processes, freight planning studies shall start with the identification of broader goals and more specific objectives. Freight Performance Measures that should be taken into account are (ITE, 2016):

- Reducing travel time - Annual hours of delay, defined as travel time above the congestion threshold.
- Reducing direct truck operating cost.
- Reducing truck engine emissions.
- Improving economic output - Defined as employment, and regional economic output.
- Improving network resiliency - Defined as the ability to reduce closures of the national/ regional truck routes that are due to severe weather or natural disasters and lasting 24 hours or more.
- Improving reliability.

System Designation

This step involves the identification of facilities, services, and/or market areas that serve freight movements. This entails designating those portions of the highway network used by substantial numbers of freight movements (for example, major roads with large volumes of trucks). In addition, this system designation can also identify locations where freight movements intersect with passenger movements, creating the potential for crashes.

Although freight planning studies begin with some sense of the major freight systems and networks in their study area, these systems are often refined as the planning study progresses, because the designated networks may be outdated or major new areas of growth have occurred.

Data Collection and Analysis

As with most types of planning, freight studies depend on the collection and analysis of data. Such data can relate to statistics on inbound and outbound freight flows and commodity types as well as survey information from shippers, carriers, and other handlers of freight, and should consider external-internal freight movements (i.e., which have one end inside and the other end outside of the study area), through movements and internal movements.

Needs Analysis and Models

Identifying current and future system needs is an important step in freight planning. Determining current needs is usually undertaken by examining system performance data, such as congested areas, areas of slow freight operations, or locations with high truck crash rates. At the next stage is to forecast future freight movements, by examining these topics from the perspective of future conditions and demands.

The reader should refer to Section 2.2 of SHC 203 (Preliminary Studies) for guidance on traffic forecasting models.

Evaluation and Prioritization of Freight Strategies

The needs analysis and traffic forecasting lead to a set of strategies or projects to improve the freight transportation system of the study area. The range of feasible solutions / project types can be quite large, and may include the following examples:

- Mitigate interchange bottlenecks.
- Maintain and enhance intermodal connectors.
- Use intelligent transportation systems (ITS) technologies.
- Implement management and operations strategies, such as: (1) public-sector operational techniques to optimize freight travel (traffic signal timing, signage, and geometric design restrictions on weight or clearance), and/or (2) private-sector operational techniques to optimize freight travel (off-peak operations, consolidated deliveries).
- Preserve lands for freight uses.
- Enhance freight network safety.
- Improve data and analytical methods.
- Enhance public awareness of freight transportation.
- Expand highway infrastructure.

A cost-benefit analysis approach should be applied for prioritization between different alternatives. See also Chapter 4 of SHC 203 (Preliminary Studies).

Regarding Freight Transport Management as part of the highway traffic engineering process, the reader should refer to Chapter 5 of SHC 601 (Traffic Engineering).

2.3.9. Planning for Special Events

Special events may temporarily overwhelm the local transportation system in cities of all sizes. In order to effectively plan required activities, three phases are recognized (FHWA, 2011):

- **Before the event:** Planning should begin as early in the process as possible. This phase involves identification of resources and funding; lead agency collaboration with other partners and stakeholders; regular meetings with team members, partners, and stakeholders; development of detailed transportation and communication plans; training; and outreach.
- **During the event:** Thorough and continuous communication, staffing, coordination, monitoring, and reporting are critical during the actual execution of the event. This involves keeping police and staff on extended stays, sending media alerts and using intelligent transportation system (ITS) devices to distribute information on road closures, having agency staff or field technicians conduct on-site observations to ensure key operational areas are functioning properly, credentialing, and more. It also involves tracking time and finances.
- **After the event:** Post-event activities involve coordination, clean-up, reopening closures, and after-action review.

Transportation planning for special events refers to activities during the first phase, i.e., before the event. The following principles shall apply for the development of transportation plans for special events (ITE, 2016; FHWA, 2008; FHWA, 2011):

- An **event transportation committee** shall be established from staff of relevant authorities that will be responsible for the management of all transport issues related to the event.
- Regular **coordination meetings** should be held in advance among stakeholders. Coordination meetings provide the opportunity not only to coordinate upcoming events, but also to build relationships among the agencies and groups that participate in the meetings.
- A **contingency plan for evacuation** of the event venue or area (if applicable) should be developed before the event. Pre-planning evacuation-related messages for dynamic message signs are components of this plan. It is also important to know the chain of command and plan for communication among emergency responders in the event that contingency measures need to be implemented.
- **Security zones and road closures:** Special events may require a secure perimeter, or zones, that require road closures. In addition to road closure, closures of subway, light rail, bus stops and sidewalks may be required. Committee members shall discuss these requests and develop alternatives that suit all parties involved. While considering the alternatives, transportation professionals also need to consider road and transit alternatives that can handle the increased usage and that are accessible to the elderly and persons with disabilities.

Multi-day or large events may require long-term road or lane closures, which can have a substantial effect on metropolitan traffic flow. To minimize the effects to road users, advance warning shall be provided to users and, if necessary, route alternatives. Clear messaging and well-planned alternatives are essential to a transportation plan's overall success.

- **Traffic detours:** Providing traffic detours is a major part of planning for a special event. Traffic management devices shall be used to support the event operations, including traffic control devices (e.g., cones, lane striping, fixed and dynamic parking/route signage, etc.) and pedestrian control devices (e.g., metal fencing, fixed and dynamic route signage). Detailed guidance on such devices can be found in Appendix A of SHC 305 (Work Zone Design).
- **Emergency routes:** During special events, emergency concerns include access to hospitals and evacuation routes. Security perimeters can affect response time; therefore the coordination by the event transportation committee will need to include emergency services (Fire Department, EMS) so that they are able to prepare accordingly. It may be required to clear routes by closing additional roads, restricting parking on key routes to provide more road space, or establishing a more extensive traffic detour program.
- **People with disabilities and elderly:** During planning for road closures, transit station closures, and sidewalk closures, transportation planners and traffic engineers must consider how the elderly and people with disabilities will be served. Accommodations (e.g., shuttle bus services) may need to be made for these segments of the population.
- **Parking:** Before the event, an estimation of attendance is required to help determine parking requirements (if applicable). Additionally, the event itself will require parking as will support personnel, police, Fire/EMS, etc. Determination of parking areas for support vehicles, such as ambulances, or vehicles with equipment, must occur in advance. In cases where equipment is necessary within a security zone, the equipment may not be permitted to move in and out of that zone. In this case, the vehicle will not be available to provide service outside the zone.

  Another important planning issue for the event transport committee is to arrange for quickly removing illegally parked or disabled vehicles. This may require coordination with the police or contracting with one or more private towing companies.
- **Public notification and the media:** Messaging through transportation resources (i.e., overhead highway messaging, VMS, detour signs, and transportation agency websites) are all part of a complete transportation plan for a special event. Public messaging via media outlets, such as the Internet, print media, television, and radio interviews, are also a positive way to have the message about the event reach the widest possible audience. The event transport committee shall review any messaging related to transport during the event to ensure the messages are consistent.
- **Road construction work zones:** Road construction work zones present a unique transport challenge to a special event. Completing or stopping and then securing ongoing road projects that affect traffic detours, road closures, and key transportation routes will be necessary prior to the event. Securing a road construction work zone can consist of removal of equipment, supplies, and debris or installation of barriers and fences. Road construction work zone concerns must be coordinated with the event transport committee at the onset of the event planning process since a longer lead time makes it easier to accommodate any changes to permitting and contracts.

- When planning for an event, the **needs of local citizens** should also be considered as well as of event attendees. The importance of keeping event participants out of local neighborhoods should be recognized, and streets in residential areas may be closed for this purpose. It is also important to remember that local citizens may need to move around the event area. The needs of both event attendees and local residents should be considered when adjusting signal timing plans.

3. Highway Network Planning and Functional Classification

3.1. Introduction

3.1.1. Scope

This chapter shall apply to the planning of the highway network and to the functional classification of highways and roads in the KSA. It focuses on combining the goals of spatial highway planning for the accessibility of places and derives the functional structure of the highway network to achieve a uniform spatial planning approach and a coordinated highway network development.

3.1.2. Standards and Guidelines

No other standards for highway network planning are applicable in the SHC other than the contents of the present chapter. The current chapter shall be used for planning purposes only; for specific geometric design considerations the reader should refer to SHC 301 (Highway Geometric Design).

3.1.3. Summary of Sections

Section 3.1 (this section) provides initial information and context.

Section 3.2 describes the functional classification of highways and streets within the national highway network.

Section 3.3 defines the requirements for developing a functional classification of highway network in a given area, i.e., assigning appropriate functional classifications to highways.

Appendix B provides fundamental context and guidance on functional classification.

3.1.4. Interpretation and Commentary

The present chapter provides the binding requirements for highway network planning and functional classification of highways in the KSA. For further theoretical considerations for the integration of spatial planning and transport network planning, as well as for the required balance between accessibility and mobility needs related to the various functional classes of highways and streets, the reader may refer to Appendix B. For specific design considerations the reader should refer to SHC 301 (Highway Geometric Design).

The principles, guidance, requirements and standards set out in this chapter are intended for use by suitably licensed and experienced transportation planners and traffic engineers.

3.2. Functional Classification of Highways

All highways in KSA shall be classified into one of five broad highway categories: freeways, principal (or major) arterials (expressways), minor arterials, collectors (major and minor), and local streets.

Functional categories differ for urban and rural areas, as there are fundamental differences in urban and rural areas with respect to density of highway and street networks, density and types of land-use, nature of travel patterns, and the relationship of these elements.

For the purpose of highway functional classification, places inside urban boundaries (developed areas) where the population is greater than 5,000 persons are considered "urban areas" (AASHTO, 2018). These areas are further subdivided into large urban areas with more than 50,000 population and small urban areas with populations between 5,000 and 50,000. Places outside urban areas are considered "rural areas".

3.2.1. Functional System for Rural Areas

Rural highways consist of facilities outside of urban areas, although they may pass through built-up areas and small towns or villages. The functional classification for rural highways includes:

1. rural freeways,
2. rural principal arterials (expressways),
3. rural minor arterials,
4. rural (major and minor) collectors, and
5. rural local roads (locals).

Definitions and functional system of all rural highway networks are described in Section 3.2.4.

3.2.2. Functional System for Urban Areas

The functional classification for urban highways includes:

1. urban freeways,
2. urban principal arterials (expressways),
3. urban minor arterial streets,
4. urban collector streets, and
5. urban local streets.

Definition and functional system of all urban street networks are described in Section 3.2.4.

3.2.3. Functional Classification Considerations

Most travel occurs through a network of interdependent highways, with each highway segment moving traffic through the system towards destinations. The concept of functional classification defines the role that a particular highway segment plays in serving this flow of traffic through the network. Highways are assigned to one of several possible functional classifications within a hierarchy according to the character of travel service each highway provides. Transportation planners and traffic engineers use this hierarchy of highways to properly channel transportation movements through a highway network efficiently and cost effectively (FHWA, 2013).

3.2.4. Characteristics and Description of Functional Classes

Based on the operational features each highway is providing to the highway network, all highways in KSA are assigned to the aforementioned ten functional classes, separate for rural and urban areas. The functional classes are in direct correspondence with the highway categories defined in Section 2.4 of SHC 301 (Highway Geometric Design); therefore, the functional classification also defines the design requirements of a highway.

An exception is noted in the case of the (special purpose) highway category of industrial collector highways, which, in terms of functional classification, meet the general characteristics of collectors in most cases, or in specific cases of locals, either in rural or urban areas.

3.2.4.1. Rural functional classes

3.2.4.1.1. Rural freeways

Rural freeways are mainly connecting heavily populated regions and large cities. They are designed and constructed to maximize their mobility function, and abutting land-uses are not directly served by them. Freeways are therefore fully controlled-access highways that provide an unhindered flow of traffic, with no traffic signals, intersections, or property access. They are free of any at-grade crossings with other highways, railways, or pedestrian paths, which are instead carried by overpasses and underpasses. Entrances and exits to the freeway are provided at interchanges by ramps, which allow for speed changes. On freeways, opposing directions of travel are always separated by a median strip or central reservation containing a traffic barrier or ditch. Elimination of conflicts with other directions of traffic dramatically improves safety, capacity, speed and traffic flow for everyone and time taken to reach the destination.

- Rural freeways are multilane, divided highways and are designed to move large volumes of traffic at high speeds under free-flow conditions. Freeways have full control of access with grade-separated interchanges.
- Annual Average Daily Traffic (AADT) generally exceeds 15,000 veh/d (both directions).
- Traffic flow on freeways shall be uninterrupted. Grade separations shall be used at rail-highway crossings and with other highways. Access is at interchanges or slip-ramps. Only emergency parking is permitted along freeways.
- Freeways connect to other rural freeways, rural expressways, rural arterials, rural collectors, urban expressways, or urban arterials.

3.2.4.1.2. Rural principal arterials (expressways)

Rural principal arterials (expressways) serve corridor movements with trip length and traffic volume characteristics indicative of substantial province-wide or inter-province travel, and they should provide an integrated network of continuous routes without dead ends.

The main difference between an expressway and a freeway is that an expressway is a limited-access highway whereas a freeway is a fully controlled-access highway; i.e., an expressway is a divided highway with partial control of access. An expressway may have interchanges or at-grade intersections, and it does not allow direct access to adjacent properties. There are no pedestrians and slow-moving vehicles in expressways. Usually, they are constructed over completely new routes. They should not pass through largely populated areas but only near them. The main traffic objectives of expressways are high speed, safety, comfort, and convenience for both the drivers and passengers, combined with low vehicle operating costs. Expressways can generally handle large traffic volumes.

- Rural expressways are multilane, divided highways and are designed to move large volumes of traffic at high speeds under free-flow conditions. Expressways have limited access by grade-separated interchanges and at-grade intersections.
- AADT generally exceeds 15,000 veh/d (both directions).
- Only emergency parking is permitted along expressways.
- Expressways connect to other rural expressways, rural arterials, rural collectors, urban expressways, or urban arterials.

3.2.4.1.3. Rural minor arterials

Rural minor arterials provide service for trips of moderate length, serve geographic areas that are smaller than their higher arterial counterparts and offer connectivity to the higher arterial system. They normally consist of two lanes in the cross section, one for each direction of travel, although occasionally, passing lanes may be added to one or two sides of the highway extending the cross section to three or four lanes at those locations.

- Rural arterial highways are intended to move large volumes of traffic at high speeds.
- AADT varies from 2,000 to 15,000 veh/d (both directions).
- Arterial highways generally have uninterrupted flow of traffic except for at-grade intersections. Intersections are controlled either by traffic signals or stop signs on side highways.
- Rural arterials generally connect to collectors, other arterials, or expressways.

3.2.4.1.4. Rural collectors

Rural collector highways collect traffic from local roads and distribute it to arterials and vice versa. In the rural environment, collectors generally serve primarily intra-governorate travel (rather than province-wide) and constitute those routes on which (independent of traffic volume) predominant travel distances are shorter than on arterial routes. Rural collectors provide for both movement of traffic and limited access to adjacent land, with safety mitigation measures if required.

- AADT varies from 200 to 4,000 veh/d (both directions).
- Traffic flow is interrupted at intersections with arterials or other collector highways by either stop signs or traffic signals. Flow may be interrupted by vehicles leaving and entering from adjacent land.
- Collectors generally connect to locals, other collectors, or arterial highways.

3.2.4.1.5. Rural locals (low volume roads)

Rural locals are mainly low-volume roads that are located outside of built-up areas of cities, towns, and communities and have a traffic volume of less than 400 veh/d AADT. They are not intended for use in long distance travel, except at the origin or destination end of the trip, due to their provision of direct access to abutting land.

- The main function of rural local roads is to provide land access. Of minor importance is movement of traffic to allow vehicles to reach other collectors or arterials.
- Traffic volumes are generally low, depending upon the density of the development along the sides of the road.
- Traffic flow on rural local roads is interrupted by stop conditions at all intersecting highways and is affected by traffic moving to and from adjacent properties.
- Local roads connect with collectors and sometimes with arterials.

3.2.4.2. Urban functional classes

3.2.4.2.1. Urban freeways

Urban freeways are limited-access, multi-lane divided highways in populated areas. They are designed to move motorized traffic over long distances at high speeds. Some urban freeways run through city centers while others encircle the urban core.

- Freeways carry large volumes of traffic at high speeds under free-flow operation.
- They connect to other freeways, expressways and arterials.
- All freeways have full control of access.
- Only emergency parking is permitted.
- All freeways are multilane, divided highways with grade-separated rail-highway and other highways crossings (interchanges).
- AADT exceeds 20,000 veh/d (both directions).

3.2.4.2.2. Urban principal arterials (expressways)

Urban expressways (major or principal arterials) are intra-city expressways and controlled-access, multi-lane divided highways in populated areas.

- Expressways carry large volumes of traffic at high speeds under free-flow operation.
- Expressways connect to other expressways and arterials.
- All expressways have limited access.
- Only emergency parking is permitted.
- All expressways are multilane, divided highways with grade-separated rail-highway and other highway crossings (interchanges).
- Urban expressways serve major activity centers, high traffic volume corridors and long trip length demands.
- Urban expressways interconnect and provide continuity for major rural corridors to accommodate trips entering and leaving urban area and movements through the urban area.
- Urban expressways serve demand for intra-area travel between the central business district and outlying residential areas in a city.
- AADT exceeds 20,000 veh/d (both directions).

3.2.4.2.3. Urban minor arterials

An urban minor arterial is a high-capacity urban highway that is hierarchically lower than freeways/expressways in terms of traffic flow and speed. The primary function of a minor arterial is to deliver traffic from urban collectors to freeways or expressways, and between urban centers at the highest level of service possible. As such, many arterials are limited-access highways, or feature restrictions on private access. Because of their relatively high accessibility, many major highways face large amounts of land-use and urban development, making them significant urban places.

- Arterials carry large volumes of traffic at medium speed.
- Access to abutting land shall be minimized.
- Arterials may have more than one lane per direction and may be divided, depending upon traffic volumes.
- Access to abutting property and connection to intersecting streets is usually provided using parallel frontage highways (or service roads).
- Traffic movements between frontage roads and arterials are by slip-ramps or at intersections.
- Arterials may have grade-separated interchanges at connections with other streets having high traffic volumes.
- Urban minor arterials provide more land access than principal arterials (expressways) without, however, penetrating identifiable neighborhoods.
- AADT varies from 5,000 to 30,000 veh/d (both directions).
- Traffic flow is uninterrupted except at signalized intersections.
- Only emergency parking is permitted along arterials.

3.2.4.2.4. Urban collectors

A collector highway or distributor highway is a low-to-moderate-capacity highway which serves to move traffic from local streets to arterials. Unlike arterials, urban collectors are designed to provide both land access service and traffic circulation within residential neighborhoods and commercial and industrial areas.

- Collectors carry traffic from local streets to arterials and provide access to abutting land.
- Collectors may have more than one lane per direction and may be divided.
- Urban collectors serve both land access and traffic circulation in higher density residential, and commercial/industrial areas.
- They distribute and channel trips between local streets and arterials.
- AADT ranges between 1,000 and 12,000 veh/d (both directions).
- Traffic flow may be interrupted by stop, yield, or signalized controls, and by traffic entering and exiting from abutting land.

3.2.4.2.5. Urban local streets

Urban locals provide access to a specific destination, as to a main highway or to a property that lies within another property. It is often used to provide access to private driveways, shops, houses, or industries. Residential streets mean a subdivision street adjacent to property that is anticipated to develop as single-family residences or multi-family blocks, apartment buildings, or other similar dwelling structures.

- Urban locals provide land access, carry low volume, and are not intended to carry through traffic. May be located in residential, commercial, or industrial areas. Also, may be multilane facilities but are seldom divided.
- AADT ranges from 100 to 1,000 veh/d (both directions).
- Traffic flow is interrupted by stop, yield, or signalized control. Also, flow is restricted by vehicles entering and exiting abutting land, and vehicles parked along the street.
- Local streets connect to other locals and to collectors. In industrial and commercial areas, local streets may connect directly to urban arterials.

Table 3-1 and Table 3-2 summarize the characteristics of the aforementioned functional classes of highways. For details on design requirements and design concepts related to each class, the reader is referred to SHC 301 (Highway Geometric Design).

Table 3-1 Summary of Functional Classes in Rural Areas

	Locals	**Collectors**	**Arterials**	**Expressways**	**Freeways**
Traffic Service	Traffic movement secondary consideration	Traffic movement and land access of equal importance	Traffic movement primary consideration	Optimum mobility	Optimum mobility
Land Service	Land access primary consideration		Land access secondary consideration	Limited control of access-no direct land access	Full control of access-no direct land access
AADT	400 max.	200 - 4,000	2,000 - 15,000	Over 15,000	Over 15,000
Traffic Flow Characteristics	Interrupted flow	Interrupted flow	Uninterrupted except at intersections	Generally free flow; limited number of at-grade intersections	Free flow
Average Running Speed for Off-Peak Conditions	40 (30 as exception)-60 km/h	50 - 90 km/h	60 - 110 km/h	80 - 120 km/h	90 - 130 (140) km/h
Vehicle Type	Predominantly passenger cars & light to medium trucks with occasional heavy trucks	All types; up to 30 % heavy trucks	All types; up to 40 % heavy trucks	All types; heavy trucks average 20 - 40 %	All types with > 60 km/h; heavy trucks average 20 - 40 %
Connects to	Arterials Collectors Locals	Locals Arterials	Collectors Arterials Locals Expressways	Expressways Freeways Arterials	Expressways Freeways

Connection Type for Public Highways	At-grade intersection	At-grade intersection	At-grade intersection or interchanges	At-grade & Rail-highway grade separations & interchanges	Rail-highway grade separations & interchanges
Direct Access to Private and Commercial Land-uses	Permitted	Permitted or limited	Limited or Not permitted	Not permitted	Not permitted
Non-Motorized Users (pedestrians, bicyclists)	Permitted	Limited (separated preferably)	Not permitted	Not permitted	Not permitted

Table 3-2 Summary of Functional Classes in Urban Areas

	Locals	Collectors	Arterials	Expressways	Freeways
Traffic Service	Traffic movement secondary consideration	Traffic movement and land access of equal importance	Traffic movement primary consideration	Optimum mobility	Optimum mobility
Land Service	Land access primary consideration		Land access secondary consideration	Limited control of access-no direct land access	Full control of access-no direct land access
ADT	100 - 1,000	1,000 - 12,000	5,000 - 30,000	Over 20,000	Over 20,000
Traffic Flow Characteristics	Interrupted flow	Interrupted flow	Uninterrupted flow except at intersections	Generally free flow; limited number of at-grade intersections	Free flow
Average Running Speed for Off-Peak Conditions	30 - 40 km/h	30 - 50 km/h	50 - 80 km/h	70 - 90 km/h	80 - 100 km/h
Vehicle Type	Passenger & service vehicles	All types	All types; up to 20 percent heavy trucks	All types; up to 20 percent heavy trucks	All types with > 60 km/h; up to 20 percent heavy trucks
Connects to	Collectors Locals	Arterials Collectors Locals	Expressways Arterials Collectors	Expressways Freeways Arterials	Expressways Freeways
Connection Type for Public Highways	At-grade intersection	At-grade intersection	At-grade intersections, interchanges, or slip-ramps	At-grade, Rail-highway grade separations & interchanges	Rail-highway grade separations & interchanges
Direct Access to Private and	Permitted	Permitted	None or limited	Not permitted	Not permitted

Commercial Land-uses					
Non-Motorized Users (pedestrians, bicyclists)	Permitted	Limited (separated preferably)	Not permitted	Not permitted	Not permitted

3.3. Defining the Functional Classification of a Highway Network

A primary objective of the functional classification system is to connect traffic generators (population centers, industrial areas, business districts, schools, shopping areas, etc.) with a highway network that channelizes trips logically and efficiently. As classification proceeds from identifying arterials to collectors and to locals, the perspective (and size) of traffic generators also moves from a larger to a smaller scale.

When developing a functional classification network in a given area, the same basic procedures should be followed, whether the functional classification is applied in a rural or an urban area. However, due to the differences in population and land development intensity between rural and urban areas, the process and considerations used to classify highways may be different. Because functional classification is part art and part science, these procedures are a blend of detailed, task-oriented steps and qualitative guidelines. These procedures do not eliminate judgment from the classification process, but when used as a guide, they help to apply judgment in a sound and orderly fashion (FHWA, 2013).

In order to define the functional classification of a highway network, the following procedure should be followed (FHWA, 2013):

1. Step 1 - Identify traffic generators.
2. Step 2 - Rank traffic generators.
3. Step 3 - Map traffic generators.
4. Step 4 - Determine appropriate functional classification to connect traffic generators.

3.3.1. Identify Traffic Generators

In rural areas, traffic generators may be population centers (cities and towns), industrial areas, military facilities, consolidated schools, and logistic facilities/warehouses. In urban areas, traffic generators may be business districts, air, rail, bus and truck terminals, regional shopping centers, school complexes and universities; hospital complexes; military bases; industrial and commercial centers, and parks. Regional traffic generators adjacent, but outside of the area of interest, should also be identified.

3.3.2. Rank Traffic Generators

Traffic generators should be categorized based on their relative ability to generate trips and be first stratified into urban and rural groupings. Traffic generators that are significant enough to be served by a collector or higher-class highway should be categorized into five to eight groups (it is better to have too many groups than to have too few, especially toward the lower end of the scale). Traffic generators with similar significance should be placed in the same group. These groups will be used to identify the functional classification of connecting highways.

Travel demand models should be used, where applicable, to produce estimates of the number of trips that travel between traffic generators as well as the flows of travel on highway segments. For details on the use of travel demand (traffic forecasting) models, refer to Section 2.2 of SHC 203 (Preliminary Studies).

3.3.3. Map Traffic Generators

Traffic generators should be mapped using graduated symbols of varying sizes and/ or colors according to the group to which the generator belongs. This will produce a visual representation of the ranking. For example, the group of generators ranked highest should all be symbolized with the largest symbol.

3.3.4. Determine Appropriate Functional Classification to Connect Traffic Generators

To determine the functional classification system of the highway network, engineers should start from the highest mobility facilities first by identifying freeways, expressways, then minor arterials and collectors (major, then minor). Then, by definition, local streets will be all of the highways that were not classified as either arterials or collectors. In other words, begin with a wide, regional perspective to identify freeways and expressways, then gradually move to smaller, more localized perspectives as minor arterials, and collectors are identified. In this process, the size of the traffic generators connected should be considered along with the predominant travel distances and the general area served, from which most travelers originate.

Specific considerations for designating highways to specific functional classes (also considering their characteristics as presented in Section 3.2.4, while also preserving the continuity of the functional classification system - see Section 3.3.5) are as follows (FHWA, 2013).

3.3.4.1. Arterial considerations (also including freeways and expressways)

Arterials serve a wide range of functions across the accessibility-mobility spectrum. Considerations for designating highways as arterials (freeways, expressways and minor arterials) include:

- Analysis should start with the distinction between freeways and expressways. Engineers should first examine control of access, as it is the most straightforward criterion to apply. Highways with full access control are classified as freeways, whereas highways with partial control of access will be classified as arterials or collectors. It is therefore advantageous to identify these highways first, providing a convenient starting point in defining the arterial system.
- The continuity of freeways and principal arterials should be preserved. Continuity of principal arterial routes traveling from rural areas, then into and through urban areas, should also be preserved.

- Arterials should avoid neighborhoods. They often serve as buffers between incompatible land-uses and should avoid penetration of residential neighborhoods.
- Most high-volume highways in urban areas function as arterials. Notable exceptions to this rule in intensely developed area exist in cases where high volume highways actually function as collectors that serve traffic movements between locals and arterials or provide a high degree of direct access service to abutting land-uses. For example, urban highways that border on high-activity, low-land area generators may carry proportionally high volumes of traffic while functioning as collectors.
- The network of minor arterial highways will usually intersect highways in all other classifications.
- Freeways and expressways cannot be designed as one-way highways. Urban minor arterials may be designed as one-way highways, although it is not common.
- In urban areas, the following should be considered for distinguishing between principal arterials (expressways) and minor arterials:
    - Principal arterials typically serve:
        - activity centers, from Central Business Districts (CBDs) to larger town centers,
        - important air, rail, bus and truck terminals,
        - regional shopping centers,
        - large schools and universities, medical complexes, military bases and other institutional facilities,
        - major industrial and commercial centers,
        - important recreational areas,
        - important religious areas.
    - Principal arterials provide more mobility, while minor arterials provide more accessibility. The land access function of principal arterials is subordinate to their primary function of providing mobility for traffic not destined to land adjacent to the highway. Minor arterials on the other hand, have a slightly more important land access function (although even for this classification category, this is a secondary consideration).
    - In general, the spacing between principal arterials should be greater than the spacing between minor arterials. In most cases, minor arterials will be located between principal arterials.
    - Minor arterials in urban areas should provide service to all remaining major traffic generators not served by a principal arterial, and they provide adequate area-wide circulation.
    - Location matters when assigning functional classification. Because traffic volumes in the outlying portions of an urban area are generally lower than in the more densely populated central areas, the traffic volume on a minor arterial in the central city may be greater than the volume on a principal arterial in a suburban area.

3.3.4.2. Collector considerations

Collectors, which may have an important land access function, serve primarily to funnel traffic from local roads and streets to arterials. In order to bridge this gap, collectors provide access to residential neighborhoods.

To identify collectors, the following guidelines should be considered:

- A highway that is not designated as an arterial but that connects larger traffic generators to the arterial network can be classified as a (major) collector. Such collectors generally are busier, have more signal-controlled intersections (inside urban areas) and serve more commercial development.
- After major collectors have been identified, minor collectors should be identified for clustered residential areas that have yet to be served by a highway within higher classification categories.
- In rural areas, collectors should have approximately equal distance between arterial routes for equal population densities, such that equitable service is provided to all rural areas.
- Service roads of access-controlled highways (freeways, expressways) should be classified as collectors.

3.3.4.3. Considerations for the system as a whole

The following principles for the whole functional classification system should also be considered:

- Highways that connect to and allow for the interchange of traffic with principal arterials (expressways) are most likely other principal arterials, minor arterials or collectors.
- Assignment of the same functional classification to parallel routes should be avoided, if possible. In the event that parallel routes are determined to provide identical functions, a decision should be made as to which of the routes is more important (as perhaps indicated by traffic volumes); the other parallel route(s) should be assigned the next lower functional classification.
- In general, the more intense the development, the closer the spacing of highways within the same functional classification category. In less dense suburban locations, neighborhoods tend to be larger than in the more dense central parts of cities. These less dense areas generally do not require the same close spacing of highway facilities to serve traffic, as the areas closer to the Central Business District (CBD).
- In most cases, a single connection between two traffic generators is all that is required. However, in some instances, an additional alternative route might be included if:
    - Two apparently alternative routes are separated by geographic barriers and each is needed for connection to another intermediate generator or another intersecting route within the same classification category.
    - One highway excludes Heavy Goods Vehicles (HGVs) or vehicles transporting hazardous materials.
    - Total traffic volume is not adequately handled by one of the routes.
- Each route should terminate at a route of the same or higher functional classification. As each subsequent category in the functional classification hierarchy is identified and added to the system, the continuity of the system must be maintained (see also Section 3.3.5).
- In rural, sparsely developed areas, the spacing of various functional classification categories is often not a helpful criterion in determining functional classification. In such cases, the most direct, most improved and most heavily traveled route should be chosen as the main option for connecting medium and small size traffic generators.

3.3.5. Continuity of the Functional Classification System

Since the highway system is an interconnected network of facilities channeling traffic in both directions from arterials to collectors, then to locals and back again, the concept of continuity of routes is important to recognize. A basic principle of the functional classification network is **continuity** - a highway of a higher classification should normally not connect to a single highway of a lower classification. However, there are exceptions to this rule. A higher functionally classified highway may “split” its traffic between two lower-level highways, with different levels of accessibility and mobility. Also, arterials may end or link to very large regional traffic generators or can connect to multiple parallel highways of lower functional classification that, together, provide the same function and capacity as an arterial (FHWA, 2013).

Further requirements for maintaining the continuity of functional classification are defined in Section 2.3.1 of SHC 301 (Highway Geometric Design).

3.3.6. Permanency of Classification

Requirements with regard to the permanency of classification designation and reviews of class assignment in a region are defined in Section 2.3.1 of SHC 301 (Highway Geometric Design).

3.3.7. Route Designation and Numbering

Definition of the system of route designations and route numbering on the highway network of KSA is included in Section 2.6 of SHC 301 (Highway Geometric Design).

3.3.8. Access Control and Limitations

Requirements and limitations related to access control, according to the highway class and the area type, are defined in Section 4.5 of SHC 301 (Highway Geometric Design).

4. Urban and Social Traffic Concepts

4.1. Introduction

4.1.1. Scope

This chapter shall apply to the provision of guiding principles and major considerations in the context of traffic in urban areas.

4.1.2. Standards and Guidelines

For specific design considerations the reader should refer to SHC 301 (Highway Geometric Design). The sections of this chapter shall not be read in isolation, but in the context of other chapters of this volume, and especially of the Highway Planning Process Overview chapter (Chapter 2).

For additional guidance on safety considerations the user should refer to SHC 603 (Road Safety).

4.1.3. Summary of Sections

Section 4.1 (this section) provides initial information and context.

Section 4.2 identifies aspects that shall be considered in the process of urban highway network planning.

Section 4.3 provides planning considerations for parking in urban areas.

Appendix C provides fundamental context and guidance on Transit-Oriented Development (TOD).

4.1.4. Interpretation and Commentary

The present chapter provides fundamental urban traffic guidance and principles, for transportation planners and traffic engineers aiming to create a comprehensive approach in balancing the movement of people and goods in urban streets, while at the same time preserving their safe, accessible and economically sustainable character.

The principles and guidance set out in this chapter are intended for use by suitably licensed and experienced transportation planners and traffic engineers.

In this chapter, a clear distinction is drawn between highways and streets. Highways' main function is to accommodate the movement of motor traffic, whereas streets, while they maintain movement as a key function, they include several others (e.g., the "public place" function discussed later in the chapter).

4.2. Urban Highway Networks

4.2.1. Introduction

This section provides general principles for the planning of urban highway networks.

KSA cities will benefit from established and modern approaches to planning of urban traffic, aiming to reduce costs of public services, increase urban environment attractiveness and the offer of services and activities in various communities.

4.2.2. Key Objectives

The key objectives for urban highway networks, which should principally be determined within a planning decision environment require that:

1. Urban highway networks should respect and integrate with existing land-use patterns and urban forms. Individual highways and streets should serve the different functions within the network (see Table 3-2). A high degree of connectivity should be ensured while planning urban highway networks to facilitate the provision of multiple routing options for all users (ITE, 2016).
2. Priority should be given to coordination of land-use and transport plans in order to minimize traffic generation and travel distances, by adopting sustainable means of mobility, and Transit-Oriented Development (TOD) principles where applicable. Adopting mixed use development densification around nodes and corridors of public transit will also be a requirement while reviewing existing local plans (refer to Appendix C).
3. Urban streets and highway networks should not be evaluated in isolation or as transportation projects alone. They should also be safe and livable spaces and balance the needs of all users (vehicles and non-motorized users). They should promote public health and safety, quality of life, economic and environmental sustainability and inclusion.
4. Urban highway networks and streets should be designed to serve different modes (i.e., vehicles, trucks, public transportation, pedestrians and bicyclists), provide multiple mobility options for its users, and at the same time prioritize walkability and micromobility where possible.
5. KSA urban highway networks planning should build upon and reinforce the objectives of National Spatial Strategy (NSS 2030) Charter.

4.3. Traffic Planning

4.3.1. Introduction

Proper traffic planning and traffic management are of the utmost importance and requisites in urban areas. Conflicting objectives such as economic sustainability, ease of access and movement, safety requirements for all highway users and various land-uses, and environmental amenities can make this process challenging.

4.3.2. Traffic Plan

A traffic plan for urban areas, should be an integrated part of the transportation planning process. Its main priority should be the optimal use of existing assets (traffic management), and it should include the following features:

- Have a maximum 5-year horizon (and be updated every 5 years).
- Be compatible with existing land-use and cities' development plans.
- Preserve its multimodal characteristics.
- Be based on thoroughly selected objectives.

4.3.2.1. Traffic management

Traffic management for urban areas (which is a part of a traffic plan) involves the routine management of traffic network and the development of programs and projects. Traffic management techniques should involve:

- Network traffic control.
- Provision of facilities for all street users (with prioritization of non-motorized users).
- Network monitoring and enforcement.
- Traffic calming and speed management.
- Parking provision.
- Freight/servicing/emergency vehicles facilities.
- Prioritization of objectives, and assessment based on established performance measures.

For guidance on network traffic control and network monitoring the user should refer to Chapter 6 of SHC 601 (Traffic Engineering). For procedures and measures for the management of speed in rural and urban highways and for traffic calming inside urban areas, the user should refer to Chapter 6 of SHC 603 (Road Safety). For requirements concerning the selection and design of appropriate traffic calming measures the user should refer to Section 6.8 of SHC 301 (Highway Geometric Design).

4.3.2.2. Traffic study

In order to develop short- and medium-term solutions for the improvement of traffic circulation and highway facilities for all modes of travel, and the improvement of the livability of the cities (predominantly city centers), a traffic study is required that shall examine existing traffic management policies and propose new ones where appropriate.

For urban areas under examination, and based on their population, the development of traffic simulations and predictive models may be needed. However, a traffic study should include, as a minimum, the following parts:

- Traffic volumes (mid-sections & intersections) and turning counts.
- Non-motorized users and micromobility counts.
- Parking surveys.
- Loading/Servicing surveys.
- Traffic control assessment.
- Survey of public transport facilities and needs.

- Maps indicating networks for each of the above.

Traffic study proposals and deliverables:

- Alternative traffic plan scenarios (at least 2) with comparative assessment.
- Proposed traffic plan with corresponding schematics and considerations for phased implementation of the proposed interventions.
- Cost analysis and estimation for scenarios’ requirements.
- Traffic/Population growth estimates.
- An assessment report on the existing development plans and conditions.
- Identification of future transport needs.

For guidance on the implementation of traffic studies, and the conduct of traffic analysis and modelling the user should refer to SHC 601 (Traffic Engineering). For guidance on traffic forecasting the user should refer to Section 2.2 of SHC 203 (Preliminary Studies).

Ideally a traffic plan should be carried out following a land-use/transportation study/plan for the urban area under examination. In such a case the traffic plan would serve as a short-term implementation with a view to the longer-term objectives set out by the land-use/transportation study, which is strategic in nature and has a longer horizon.

4.4. Parking Considerations

4.4.1. Introduction

Parking is a necessary component in an urban transport network as it allows for the safe storage of vehicles, while they are not used, and supports local activities, forming an interface between the urban highway network and the adjacent land-uses.

Parking can be provided in the two following basic forms:

- **On-Street Parking** refers to the parking of a vehicle on a street, at the curbside and in designated areas.
- **Off-Street Parking** refers to the parking of a vehicle in any place other than the highway or the roadside.

In general, off-street parking should be the preferred option for the mass storage of vehicles. The type of parking strategy to implement (on-street or off-street parking) should be based on the overall parking supply and demand of the urban area under examination.

For specific requirements concerning parking for Autonomous Vehicles the user should refer to Section 2.2 of SHC 801 (Autonomous Vehicles Requirements).

4.4.2. On-Street Parking

The curbside use priorities should essentially be established in the public interest.

Major traffic routes and arterial highways should prioritize the movement of traffic, hence curbside parking in high volume or high-speed highways (≥ 60 km/h) should be avoided for traffic and safety reasons (unless adequate clearance between the parking spaces and the trafficable lane is justified).

Collector and local streets may permit parking, especially in areas where available off-street parking space is limited. The following factors should be considered to determine whether parking should be permitted:

- Safety.
- Function of the highway.
- Highway location.
- Type of land-use pattern.
- Traffic flow characteristics.
- Public transport and cycling requirements.
- Availability of off-street parking.
- Potential visual impact.
- Requirements for emergency & service vehicles and driveways.

4.4.2.1. Priorities for the allocation of parking space

On-street parking provision should support the primary activities and land-uses in a street and consider the following priorities:

- When considering parking and stopping of vehicles, safety of all highway users should be the top priority at all times.
- On-street parking, especially in urban centers, should be used to service the needs for a higher level of access, with priority to public transport, government and supply vehicles, emergency services, taxis and people with disabilities.
- Public transport stops, loading and unloading zones and parking spaces for people with disabilities should be provided where necessary.
- Alternative transport modes such as walking, cycling and transit should be encouraged.

4.4.3. Off-Street Parking

Off-street parking facilities form an interface between the highway network and other land-uses and should be ideally located between the main access route to the highway network and the land-use served.

In the context of traffic planning, the following general principles should be followed:

- Car parks should not be located in Central Business Districts or city centers when vehicle flows associated with them would be likely to cause congestion on the center's street network.
- Off-street parking should be provided in city centers (principally near important transport hubs) only when it is deemed necessary and for the purpose of reducing on-street parking.

For the selection of the location of off-street parking facilities, the following factors should be considered:

- Impact from the increased traffic flow to the performance of the surrounding highways and intersections.
- Potential interactions of entry/exit traffic with non-motorized users' paths.

- The location of the parking facility in order to avoid arterial highway crossings by pedestrians.
- Grade separation or pedestrian treatments (e.g., signalized and marked pedestrian crossings) where heavy pedestrian movements occur across highways with significant traffic.
- Parking facilities proximity and good accessibility to arterial highways in order to minimize traffic intrusion into local streets.

5. Public Transport Considerations

5.1. Introduction

5.1.1. Scope

This chapter shall apply to the planning of On-Road Public Transport (ORPT) network and facilities throughout the highway network.

5.1.2. Standards and Guidelines

No other guidelines on public transport planning considerations for on-road public transport are applicable in the SHC other than the contents of the present chapter. The current chapter of SCH shall be used for planning purposes only.

5.1.3. Summary of Sections

Section 5.1 (this section) provides initial information and context.

Section 5.2 provides general public transport planning requirements and guidelines.

Section 5.3 provides a set of general public transport policy considerations.

Appendix D provides public transport network planning fundamentals.

5.1.4. Interpretation and Commentary

This chapter intends to provide to planners and designers general planning guidelines and considerations on on-road public transport networks (ORPT). Public transport network planning process is an integral part of the overall transport network planning process covered in Highway Planning Process Overview chapter (Chapter 2). Specific design aspects of public transportation facilities are not covered by the current volume. For multimodal considerations for urban areas, including public transportation as a function, and considerations on transit-oriented-development the reader should refer to Chapter 4 of this volume. For measures of Quality of Service that apply principally for on-road fixed-route transit services (e.g., buses, streetcars etc.) and methods for conducting public transportation studies for the purposes of monitoring the system performance or addressing specific issues, the reader should refer to Section 2.12 of SHC 601 (Traffic Engineering). Furthermore, for issues related to intersection signals and operations for transit (including active transit signal priority) and freight movement, the reader should refer to Section E.4 and Chapter 5 of SHC 601 (Traffic Engineering) respectively. Finally, for public transport considerations concerning new developments the reader should refer to Section 2.3 of SHC 203 (Preliminary Studies).

In this chapter, terms *public transport* and *transit* are used interchangeably.

5.2. Public Transport Planning Considerations

5.2.1. Introduction

The continuous demographic and geographic expansion of major cities in KSA results in an ever-increasing congestion of the metropolitan highway networks since private automobiles remain the preferable option for commuting. This development necessitates solid urban transportation plans which can integrate multimodal public transport systems with all available planned public transport modes (e.g., conventional bus and Bus Rapid Transit (BRT), Light Rail Transit (LRT) etc.) and ITS systems.

Cities should prioritize highly productive modes, like transit, as the key to efficient, sustainable mobility for growing urban populations. Transit agencies and Municipalities should work together to create streets that not only keep buses and other means of public transportation moving, but at the same time they are great places to be. Transportation authorities should rethink their networks to serve neighborhoods and city centers at a high level all day, not just at peak times, while active mobility can reduce/substitute driving. Public transportation is the key that can unlock street space, bringing new opportunities to create streets that can move a tremendous number of people and be enjoyed as public spaces at the same time.

A framework of key principles that should govern urban public transport planning and design is presented in Table 5-1.

Table 5-1 Public Transport Planning and Design Key Principles (NACTO, 2016b)

Key Principle	**Planning/Design Features**
Design Better Streets Offering Better Services	• Create dedicated lanes and transitways. • Design comfortable stops and stations. • Coordinate action with transit agencies on intersections and signals.
Public Transport Creates Urban Places	• Walkable urban places host many people/activities that rely on transit connections to other places. • Transit served walkable areas increase the competitiveness.
Mobility Service for the Whole Society	• Provide prompt, seamless and safe connections to service peoples' needs and desires. • Transit system open to people of all ages and abilities.
Growth without Congestion	• Design streets for rapid transit (especially on streets with high travel demand).
Safe Movement at a Large Scale	• Benefit from public transport's order-of-magnitude safety advantage.

	• Design transit streets with better pedestrian access and safer crossings. Higher top speeds have little benefit for transit on urban areas.
Permanent Economic Benefits	• Transit supports higher-value, more compact development and is more fiscally sustainable than highway infrastructure. • Public transport provides savings for businesses and residents along a transit corridor and far beyond.

Within this context, this section discusses planning for public transport and its relationship to other transportation planning activities.

5.2.2. Quality of Service and Performance Measures

Quality of Service (QOS) reflects a passenger's perception of transit performance. QOS depends to a great extent on the operating decisions made by a public transport agency within the constraints of its budget, particularly decisions on where transit service should be provided, how often and how long it is provided, and how it is provided.

QOS reflects how well a public transport service meets the needs of its customers, however, a balance should be kept between the quality of service passengers would ideally expect and the quality a transport agency can afford to provide and would reasonably provide, given a base demand for the service.

5.2.2.1. Quality of service framework of performance

A QOS framework of performance includes aspects of transit availability and transit comfort that are important to passengers and are relatively easy to quantify and forecast.

In Tables 5-2 and 5-3, two frameworks – one for fixed-route services and the other for demand-responsive services – are presented, which include key performance measures that transit agencies should use to evaluate the quality of service they provide to their passengers.

Table 5-2 Quality of Service Framework: Fixed – Route Transit ((TRB, 2013) – Exhibit 4-10)

Availability	Comfort and Convenience
Frequency	Passenger Load
Service Span	Reliability
Access	Travel Time

Table 5-3 Quality of Service Framework: Demand-Responsive Transit ((TRB, 2013) – Exhibit 4-11)

Availability	Comfort and Convenience
Response Time	Reliability
Service Span	Travel Time
Service Coverage	No-shows

Performance measures for fixed-route transit are further discussed in SHC 601 (Traffic Engineering), in the section concerned with Public Transportation Studies (Section 2.12). Descriptions of performance measures are provided in Appendix G.

5.2.3. Classification of Transit Modes

Public transport (transit) modes can be defined both in terms of right-of-way and their operational characteristics (AUSTROADS, 2020a):

5.2.3.1. Right-of-way

The three broad categories of right-of-way include:

- Category A – Fully controlled with no at-grade crossings and no legal access by other vehicles.
- Category B – Longitudinally separated from other traffic by curbs, barriers, etc., but with at-grade crossings for other vehicles and pedestrians.
- Category C – On streets with mixed traffic, where public transport vehicles may travel with other vehicles. This may include some allocation of priority to public transport (e.g., bus lanes, transit signal priority etc.) but without physical segregation.

Planners and traffic engineers, with respect to the scope of the current chapter, shall be generally concerned with common types of usage operating in Category B and Category C right of way conditions.

5.2.3.2. Operational characteristics

Public transport services may vary by the type of lines, trips and stop patterns. In Table 5-4, the main types, respective applications and main features are presented.

Table 5-4 Transit Route Types (NACTO, 2016b)

Route Type	Route Application	Route Features
Downtown Local	• Serve areas with high demand for short trips	• Stop Frequency: 3 or more per km

Route Type	Route Application	Route Features
	• Can operate parallel to longer local or rapid routes. • Can be used to connect a highway capacity node (e.g., commuter rail terminal) with a broader destination area. • Can provide extra capacity where dense residential areas are close to major commercial and other traffic generation centers.	• Service Area: Compact/Dense
Local	• Appropriate for all urban contexts. • Can serve trips within and between neighborhoods, downtowns and other hubs. • Balance access with speed. Can provide modest increases in stop distance, to reduce delay on local routes.	• Stop Frequency: 2 - 3 per km • Service Frequency: Moderate to high, depending on context • Service Area: Compact/Dense
Rapid	• Use less frequent stops and higher capacity vehicles to provide a transit service for longer trips and busy lines (high-demand transit routes) such as those connecting downtowns to dense neighborhoods. • Can run along the same route as a local service. • Can be used on routes that intersect many other transit routes.	• Stop Frequency: 1 - 2 per km • Service Frequency: Moderate to high
Express	• Can provide point-to-point service with few stops using limited-access routes, sometimes in dedicated or HOV lanes, to reach destinations quickly. • Ability to connect neighborhoods with peak-period ridership directly to downtown or other destinations such as airports or ports. • Primarily serve long-distance commuter routes.	• Stop Frequency: Non-stop between service areas that have more frequent stops. • Service Frequency: Scheduled, often infrequent and concentrated at peak periods.
Coverage	• Serve as connectors of less densely populated areas to regional hubs and destinations, and to the full transit network.	• Stop Frequency: 1 - 5 per km • Service Frequency: Low • Service Area: Low density, feeder to intermodal hubs

5.2.3.3. On-road transit modes

Main transit modes distinguished primarily by right-of-way (ROW) category comprise the following (ITE, 2016):

Street transit – Transit modes using ROW category C. Includes buses, trolleybuses, streetcars/tramways, shuttles etc.

Semi-rapid transit – Transit modes that mainly utilize ROW category B, and on occasion, ROW A or C. For this reason, these modes usually exhibit a higher performance than street transit modes. Semi-rapid transit includes medium capacity and medium performance transit modes such as light rail transit (LRT), most forms of bus rapid transit (BRT), and a number of automated guided transit modes.

Demand Responsive Transit (DRT) services – Transit mode using ROW category C. Also known as paratransit, typically uses small vehicles with low to medium capacity. They differ from regular transit because of variable schedules and routings to accommodate individual user's demand.

Descriptions of public transport vehicles are provided in Appendix G.

5.2.4. Strategic Public Transport Planning

Planning departments should manage all strategic planning, create long term strategic master plans and monitor for performance changes that may require plan adjustments.

The long-term vision should include planning to achieve central government priorities and at the same time should take into account municipal or regional needs in the same context.

The successful implementation of a public transport strategic plan requires that:

- The strategic plan is linked to an agency's operating and capital budgeting process to ensure that financial investments are being made consistently with the objectives of the plan.
- A formal tracking mechanism should be in place to determine to what extent an agency is achieving its goals.
- A periodic renewal process of the plan should be in place (e.g., every four years)

Strategic decisions that transport authorities' planning departments should help to make also may include:

- Ensuring that residential, industrial, commercial and shopping areas are built to create a focus on user demand.
- Providing businesses incentives to reduce car use.
- Allocating a part of existing highway capacity to public transport use.
- Delegating to public transport departments the operation, oversight and gathering of public transport planning information.
- Establishing requirements for traffic managers and engineers concerning the use of Intelligent Transport Systems (ITS) which can provide real-time information that allows users to make decisions, and which can keep systems running efficiently.
- Promoting the use of integrated transport solutions instead of simple traffic impact studies in new developments.

- Selecting car parking locations that benefit public transport use and ensure enforcement.
- Redirecting freight/goods movements to reduce operational and safety conflicts with public transport.

5.2.5. Public Transport Network Planning

Public transport networks in general, should be designed to achieve the following three basic goals:

- *Maximize transit ridership*, as measured in either unlinked trips or passenger-kilometers served, through providing attractive services to passengers such as good area coverage, short access to stations, high frequency services and high-speed reliable services between trip generators.
- *Achieve maximum operating efficiency*, through attaining high output per unit costs, labor and resources, integrated and convenient transfers with other modes of transport and balance between the network system's investment and operating costs.
- *Maximize positive regional and urban impacts*, such as short-term increases in transit's modal split and long-term promotion of urban livability and sustainability, while reducing traffic congestion, noise and air pollution.

Planning an on-road public transport network (ORPT) for a given area should consider the role of public transport with the network. Large cities (in terms of population and geographical area) generally demand both line-haul and feeder functions. While the relatively lower capacity shorter distance feeder services are usually provided by on-road means of public transport, high capacity, longer distance line-haul services often can be served by LRT or commuter rail systems along with busways operating in exclusive ROW (i.e., BRT).

The general overall form of the public transport network should be largely determined by the urban form and structure of the city, particularly the shape of the city and the number and locations of its major activity centers. Other factors that should be considered include the presence or absence of natural barriers (e.g., steep ridges) and the form of the highway network. Typical urban highway network forms such as linear, radial, multicentered, ring-radial and their implications are described in Appendix D. In real urban situations, combinations of elements of these or other basic types (e.g., rectilinear grid) may be used to provide a public transport network that most appropriately matches the city form and structure, socio-economic objectives, prevailing constraints and resources and other factors.

The planning process should start with an analysis of the strengths and weaknesses of the existing network that will take into account the current situation as viewed by different groups of public transport users and operators. Subsequently, the target network should be identified for the long term so the planning process may begin considering the proposed planning considerations of the following section. Before the planning process begins, it is advised that short-term solutions should be worked out with respect to potential existing infrastructure issues and high-demand corridors.

5.2.5.1. General network planning considerations

1. Planning should aim at creating an integrated network of all public transport modes providing for convenient and easy transfers at several stops across the agglomeration.
2. Networks for ORPT are constrained by the existing highway network. An ORPT with a line-haul function will usually operate on the arterial network. Complementary feeder services may operate on both the arterial and local street networks.
3. On a network that offers many alternative routes between two points (e.g., a grid highway network) the form of the ORPT network is less constrained.
4. Line-haul ORPT services should ideally operate on routes that are as straight and direct as possible. Radial or ring-radial networks generally facilitate this directness unlike grid networks (Figure 5-1) that do so only in the primary direction of the grid.
5. Where a straight line between the origin and destination is diagonal to the highway grid, travel distance is necessarily longer, but travel time can be reduced by minimizing the number of left and right turns, consistent with the travel demands to be served along the way.
6. A grid street network is a very efficient layout for bus operations. It enables maximum permeability and decreased concentrations of congestion, as it is effective in spreading traffic loads throughout the network.

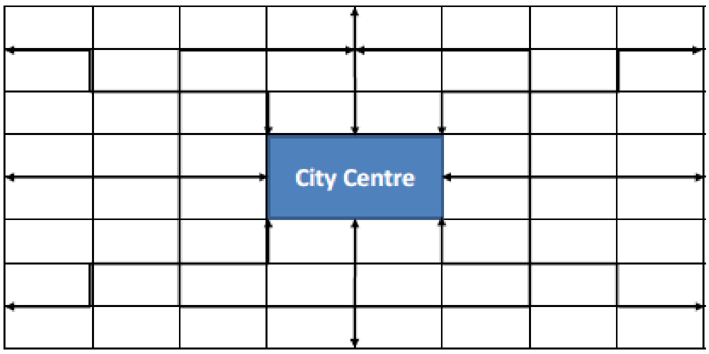

Figure 5-1 Grid Highway Network ((AUSTROADS, 2020a) – Figure 4.3)

7. Where parallel ORPT routes are provided on a grid network, their spacing should be such as to provide reasonable walking distances to ORPT stops from all residences.
8. During ORPT network planning, consideration should be given to the type of vehicles used, in relation to their potential to access a specific highway, their impact on broader traffic management (e.g., double decker buses with increased dwell times), route served demand and frequency of services.

5.2.6. Public Transport Route Planning

Following the determination of the basic features of the on-road public transport network, the next step should be to plan the specific routes to be assigned to various services. Typically, the following issues should be considered during the route planning process:

- For the purpose of reducing total travel time to a minimum, bus routes should be as short and direct as possible. A simple route network with a clear structure of lines makes it easy for each user to understand and remember.
- In order to reduce operational costs and maximize usage, routes should be chosen taking into consideration land-use factors and associated travel demands, passing through land-use cells (e.g., residential blocks, commercial areas) and thus maximizing catchment areas, rather than going around them.
- Local and collectors and/or distributor roads should be considered for ORPT routes, as their use will facilitate penetration of residential areas and coverage optimization.
- Stopping patterns should be determined based on the primary function of each route, different requirements should apply to different types of services (e.g., commuting, shopping, recreational and intercity trips).
- To the extent possible, ORPT stops should be positioned closer to major trip attractors (e.g., regional centers, educational institutions etc.) than vehicle parking facilities, to prioritize the use of public transport.
- When planning to establish transit routes into arterial highway sections, the scope for the use of traffic signals and/or roundabouts should be assessed, along with pedestrian movements, to assist public transport operations.

5.2.7. Passenger Transfer Points

Public transport passenger transfer points which can be called “stations” should be provided on high-demand line haul routes or with “stops” provided on lower volume feeder routes. These transfer points have a variety of roles (e.g., terminal, interchange, standard stop, park-and-ride etc.). Table 5-5 summarizes the basic roles and their respective characteristics.

Table 5-5 Public Transport Transfer Points ((AUSTROADS, 2020a) – Table 4.5)

Transfer Point Role	Basic Features
Terminals	• Stations at the beginning or end of a transit route. • Require longer dwell times (for drivers to take breaks, obtain change-of-destination information etc.). • Parking for buses preparing to enter service may be a requirement.
Interchange	• Stations where passenger movements between vehicles of the same or different modes take place. • Vehicle dwell times may be longer to ensure passenger connectivity
Standard Station/Stop	• Typically, they serve local residential areas where the bulk of passengers walk to the station.

Minor Station/Stop	• Minor stations/stops with minimal infrastructure for passenger pick-up and set-down (e.g., curb-mounted, with shelter, seat, bus-stop sign and passenger information).
	• Can be classified as:
	  ○ Standard stop for pick-up/set-down purposes.
	  ○ Part-time – Peak stop only (e.g., school days).
	  ○ Special use (e.g., high activity sites such as religious sites, stadiums).
	  ○ Set-down – where passengers are set down (e.g., at the end of a service run).

Park-and-Ride	• Can be provided at any of the transfer points listed above. • Suited to stations/stops with limited interchange facilities and in fringe metropolitan areas.
Operational Stop	• Serve as schedule timing points, layovers, driver or vehicle changeover points. • Vehicles dwell longer even if the stop or dwell time is not associated with passenger volumes. • May require additional bus stands with independent pull-in/pull-out capabilities for bypass by other ORPT vehicles. • May require driver parking in the adjacent area (driver changeover points).

5.2.7.1. Passenger stations planning considerations

Among the most important features of a public transport network system are the locations where passengers access transit services, transfer among routes or interchange with another mode. These transfer points can be key typical trip bottlenecks, creating negative experiences for passengers.

For complex facilities due to institutional and financial requirements a series of factors should be taken into consideration during the planning process, including:

- The number of alternatives to select from.
- Current and forecasted amount of travel to accommodate.
- Facilities construction and operating costs.
- Fares collection methods, parking fees, rental fees or tariffs.

For larger stations, a vision should be established for the station concerning the role it is intended to play in the public transport system and the community, that should address issues such as (California High-Speed Train Authority, 2011):

- How the physical size and architecture of the station will affect the surrounding environment (including considerations for land-use, streets design, public space etc.).
- How the station will accommodate intermodal connections to buses, shuttles, taxis, cars and non-motorized users, become integrated with other modes of transportation and connect to the community.
- The location and configuration of parking so that it addresses the needs of both the station and the community.
- Considerations about the developments, activities and growth in the communities the station will serve.

In the next sections, a series of additional specific planning considerations for various public transport transfer facilities are provided.

5.2.7.1.1. Life-cycle planning

Development plans for new public transport stations or for major improvements of existing ones should consider, apart from the initial construction costs, the estimated operating, maintenance and rehabilitation capital expenditures needs during the projected life of the facility.

5.2.7.2. Bus stops on streets

The main compromise in the planning process for bus stops is between shorter access times (stops closely spaced) and higher operating speeds (stops farther apart). Bus stations stop spacing should reflect the location of expected passenger origins and destinations.

Average stop spacing for buses should vary so that buses can stop at distances of 400 - 600 m, and in exceptional cases somewhat closer, taking into consideration possible degradation in service quality, including speed and comfort.

The three possible locations for bus stops along streets include:

- The nearside of an intersection (location before crossing a cross street).
- The far-side of an intersection (location after crossing a cross street).
- Midblock (away from the intersection).

Variations among stop locations (especially nearside and far-side) can often return considerable advantages in terms of higher bus speeds and passenger comfort.

Factors to be considered during the selection of bus stop locations should include traffic signals operation, passenger access, vehicular and non-motorized traffic conditions at intersections and the geometry of bus turning and stopping.

5.2.7.3. Bus stops on urban freeways

Bus stops on freeways, primarily for express public transport routes, may reduce bus operating speeds, however, they are essential to provide the expected service level. They should be preferably included in the original freeway design.

The selection of the location of freeway bus stops should consider:

- Population density in the adjacent area of influence.
- Potential transit users' accessibility.
- Nearby major trip generators.
- Potential development growth and estimated future demand.
- Major intersecting transfer routes and outlying parking facilities.

5.2.7.4. At-grade LRT stations

At-grade LRT stations generally can be located: in the street right-of-way, in a reserved street median, on the side of the street, in an exclusive right-of-way (LRT stops can also be placed in pedestrian areas such as squares, shopping centers etc.). Where LRT vehicles operate at moderate speeds crossing the tracks can be allowed.

Major LRT transfer stations for surface transit should be located in large pedestrian areas, separated from automobile traffic, and short walking distances between different routes should be ensured.

5.2.7.5. Bus terminals

Terminal Planning, location and design should embody a variety of considerations concerning traffic circulation, transit operations and site planning principles. A decisive factor for the positioning of bus terminals is the routes that have to be serviced. Consequently, relevant bus terminal planning factors also include:

- Line-haul transit routes (e.g., rail and bus).
- Passenger interchange needs.
- Passenger arrival and departure patterns.
- Bus distribution opportunities and constraints.
- Land requirements and availability.
- Impacts and costs.

Stations in medium-sized communities can be a part of transportation centers in which intercity bus services and parking facilities are basic components. Alternatively, they can be located at outlying parking lots serving express bus lines.

Central area stations on the other hand, that consolidate bus operations at a single location, can facilitate passenger interchange among bus lines, reduce journey times and improve overall traffic flow.

Downtown bus stations should be considered wherever the complementary services and development potential exceeds the costs involved. They are appropriate where downtown curb loading capacity is limited, large volumes of express buses are expected, and bus routing is slow, unattractive, unreliable and cannot be improved through bus priority measures.

Central business district (CBD) bus stations should provide direct connections to expressway, be located between the expressway and the CBD core, be at an appropriate distance from points of peak land value and be within a reasonable distance from blocks of major commercial activities.

5.2.7.6. Park-and-ride facilities

Park-and-Ride (P&R) facilities are usually designed to intercept automobiles at outlying locations commonly along express public transport lines.

The optimum distance of these facilities from the city center depends on locations of major topographic barriers, street convergence patterns, line-haul express transit system configuration, land development intensities, land availability and value and parking costs.

Typical locations for park-and-ride facilities are at the stations near the end of line-haul lines. Supplementary planning considerations include:

- Express bus travel from the park-and-ride facility to the CBD or activity center of choice, should be quick and reliable.
- Park-and-ride facilities should strive to achieve intermodal integration by including parking and good connections for non-motorized users.
- Sites for park-and-ride facilities should be compatible with adjacent land-uses, have minimum environmental impact and achieve a reasonable level of use in relation to development costs.
- Park-and-ride facilities should have good access to freeways and expressways, intercepting motorists prior to points of major route convergence and congestion.
- Outlying park-and-ride facilities should take into account growth patterns and constraints in metropolitan areas, and proposed and underway public transport projects.

6. Traffic Planning for Non-Motorized Users

6.1. Introduction

6.1.1. Scope

This chapter shall apply to the planning of pedestrian and bicycle facilities along streets and highways, inside the public right-of-way.

6.1.2. Standards and Guidelines

No other standards for transportation planning for non-motorized users are applicable in the SHC other than the contents of the present chapter. It is clarified, however, that the present chapter applies for the planning process only; for specific design considerations of non-motorized users' infrastructure and relevant guidance, the reader should refer to Section 4.8.2 of SHC 301 (Highway Geometric Design).

6.1.3. Summary of Sections

Section 6.1 (this section) provides initial information and context.

Section 6.2 describes planning requirements for pedestrians.

Section 6.3 describes planning requirements for bicyclists.

Appendix E gives guidance on pedestrian improvements schemes.

6.1.4. Interpretation and Commentary

The chapter is intended to present sound planning requirements that result in facilities that meet the needs of pedestrians and cyclists, as well as other highway users. Sufficient flexibility is permitted to encourage planning that is sensitive to local context and collectively incorporates the needs of bicyclists, pedestrians, and motorists.

With regards to planning for public transport users (i.e., besides pedestrians and bicyclists), the reader is referenced to Chapter 5 of the present Volume.

The purpose of this chapter is to provide planning requirements initially for new projects. The fact that new requirements for pedestrian and bicycle facilities is presented in the SHC does not imply that existing facilities in KSA that differ from the prescribed approach are by default inadequate or unsafe, nor does it necessarily mandate the initiation of improvement projects. Good design practice involves engineering cost-effective solutions that balance safety and mobility for all transportation modes, along with preservation of scenic, aesthetic, historic, cultural, and environmental resources.

6.2. Planning for Pedestrians

This section discusses transportation planning for pedestrians and its relationship to other transportation planning activities.

6.2.1. Walkability

Nearly all highways, except some freeways and expressways that are not open to pedestrian traffic, provide some level of pedestrian accommodation. At the other end of the spectrum from freeways and expressways are pedestrian malls or plazas, which exclude most motor vehicle traffic (allowing for emergency vehicles and possibly for delivery vehicles). Between the two extremes are highways that provide varying levels of pedestrian and vehicular priority.

To describe these varying levels, Figure 6-1 depicts the interrelation between the functional classification of highways and their potential use by pedestrians. Features promoting pedestrian mobility are not required on freeways that prohibit pedestrians. Along rural highways and suburban highways, provision of pedestrian facilities may be considered, where needed. As the functional classification trends toward rural town, suburban, and urban land-uses, greater accommodation for pedestrian mobility, i.e., better facilities and linkages, is increasingly likely to be needed.

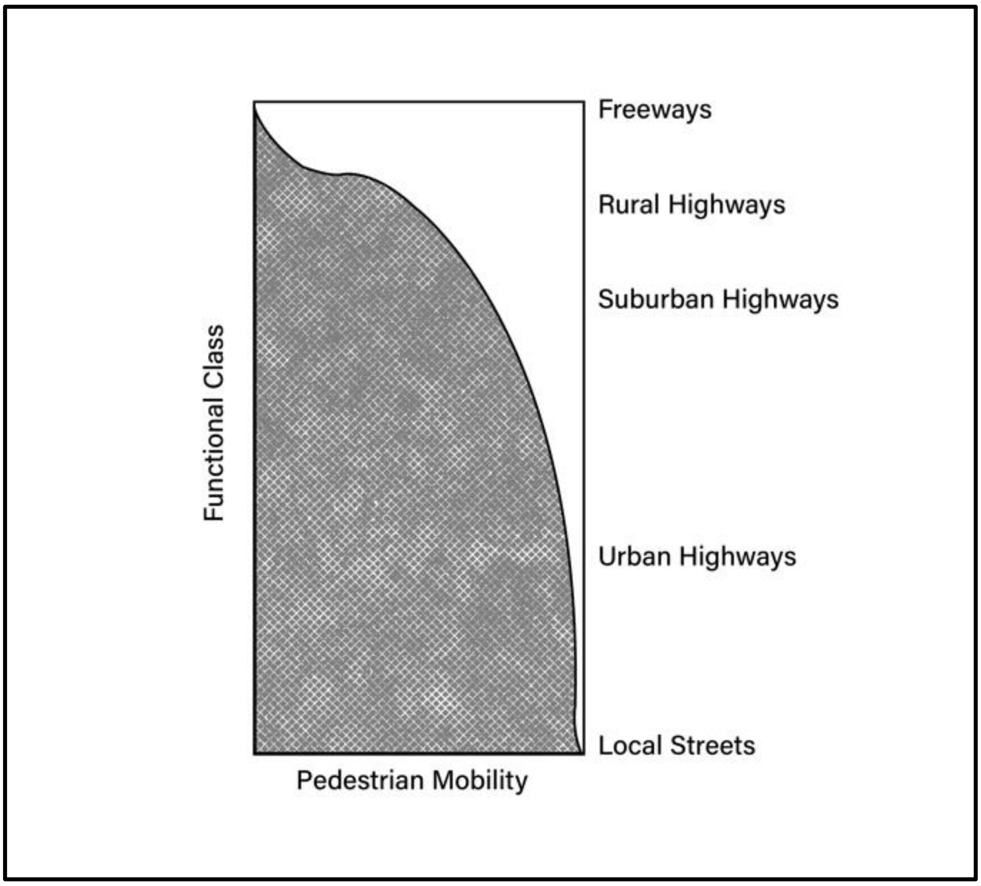

Figure 6-1 Pedestrian Mobility with Respect to Highway Type (AASHTO, 2021)

Individuals are more likely to choose to walk or cycle if they see the environment as being walkable / walk-and-cycle-friendly (i.e., convenient, safe and pleasant, with direct routes that minimize travel time). The nine primary characteristics shown in Table 6-1 should be considered by highway planners to achieve a walkable community.

Table 6-1 Primary Characteristics of Walkable Communities (NZTA, 2009)

Characteristic	Definition
Connected	The network should provide direct access for pedestrians to the places they wish to reach. Paths should connect well to public transport and to surrounding networks.
Legible	Walking networks should be clearly signposted and published in local maps. Users should intuitively sense how to use the facilities.
Comfortable	Shade from the sun should be provided. Routes should be protected from severe weather conditions (e.g., sandstorms), and unpolluted by excessive noise and fumes. Paths should be wide enough with even surfaces and gentle gradients. Places to rest should be provided.
Convenient	Routes should be continuous, efficient, unimpeded by obstacles, and not delayed by other path users and highway traffic.
Pleasant	Pedestrian spaces should be enjoyable, interesting, quiet and clean, with qualities encouraging lingering and social interaction.
Safe	Crossing places and driveway crossings should be safe from traffic danger and all surfaces should provide a good grip when wet and be free from trip hazards. The potential presence of sand on route surface should be properly addressed.
Secure	The walking environment should discourage antisocial and criminal behavior due to the application of the principles of crime prevention through environmental design (e.g., lighting, places for social interaction).
Universal	Facilities should be suitable for mobility and vision-impaired pedestrians through gentle gradients, visual contrast, audible and tactile features.
Accessible	Popular destinations should be located within easy walking distance.

6.2.2. Pedestrians in Transportation Plans

This section defines the requirements for pedestrian master plans (Section 6.2.2.1), as well as requirements for the integration of pedestrians into different types of transportation planning procedures (Section 6.2.2.2).

6.2.2.1. Pedestrian master plans

Pedestrian master plans shall include a long-term vision for providing pedestrian facilities in the community, identify project and program needs, and prioritize improvements for implementation. Pedestrian needs should be incorporated in master plans:

- either as in long-range transportation plans that include both a pedestrian and a bicycle element, or
- as stand-alone pedestrian plans that address a range of issues, provide planning guidance, identify capital projects for implementation, and may also include design criteria or other topics.

Pedestrian master plans may or may not be combined with a bicycle master plan. Among the benefits of a combined pedestrian and bicycle transportation master plan are increased efficiency in data inventory and analysis for both modes, access to additional funding sources, improved partnership between the area's pedestrian and bicycle communities, and the ability to reach a broader audience.

A pedestrian master plan shall include the following elements:

Introduction

The introduction to a pedestrian master plan sets the stage for what the reader is about to encounter. It should include a description of the background and setting of the plan, summarizing prior pedestrian plans and any related planning efforts. The introduction should then briefly describe the ensuing plan elements.

Goals and Objectives

A "Goals and Objectives" element establishes the purpose of the plan. Goals and objectives may be governed by a plan's Vision Statement, which may consist of general statements of desired end states or can be as specific as a defined land-use scenario (ITE, 2016). The visioning process often relies on extensive stakeholders' consultation.

Goals are high-level aspirations on specific subjects that the plan can help achieve. Objectives are quantitatively measurable aims that support a particular goal. If all the objectives associated with a goal are met, the goal will likely be achieved as well. Many plans, also, include specific benchmarks and performance measures for each objective; because objectives by definition are measurable, establishing the measure by which progress will be monitored adds guidance and specificity to the planning process.

Existing conditions

Prior to identifying needs and improvements, pedestrian master plans should provide a thorough evaluation of existing conditions in the community. The conditions analyzed should be tied to the anticipated needs and may include sections on:

- pedestrian-related education, enforcement, and encouragement programs;
- pedestrian-related codes and regulations;
- pedestrian Level of Service (LOS) provided by the area's highways; and
- observed or latent pedestrian demand.

As with goals and objectives, it can be helpful for the existing conditions element to include specific benchmarks and performance measures to monitor progress. For example, pedestrian LOS may be established as the performance measure for tracking walking conditions, and the benchmark may be to achieve a particular LOS on an established percentage of arterial and collector streets.

Stakeholders' involvement

Pedestrian master plans benefit from sustained involvement and active participation by stakeholders and members of the public. Stakeholder involvement can occur during all stages of development of the pedestrian master plan. Plans should include a section documenting the stakeholders involvement activities and feedback that was received and incorporated into the planning process.

Recommended improvements

The existing conditions evaluation frequently identifies "gaps" in the pedestrian network. Gaps may consist of missing sidewalks, intersection-related elements, crossing needs, or highways that otherwise provide inadequate pedestrian facilities. Once established, these gaps should form the basis for the plan's recommended improvements. Recommended improvements should encompass all identified infrastructure needs regardless of cost.

Recommended policies and design guidelines

Recommended policies and design guidelines provide the framework for future development and construction of pedestrian facilities in ways that meet the community's expectations. Policies tend to govern pedestrian-related aspects of new development (e.g., the need for sidewalks, internal pedestrian connections between sites, pedestrian lighting, shade trees, and other pedestrian amenities), while a set of comprehensive pedestrian design guidelines establish a protocol for the design and construction of new facilities used by pedestrians.

Recommended education, enforcement, and encouragement activities

Pedestrian master plans should identify non-infrastructure (education, enforcement, and encouragement) programs and their potential benefits. Education programs improve public (motorist and pedestrian) awareness of safe operating behaviors. Enforcement programs target specific unlawful operations by motorists and pedestrians. Encouragement programs provide incentives for increased walking activity among members of the community and include incentives for motorists to be more cognizant of, and courteous to, pedestrians.

Implementation plan

Plans should prioritize identified pedestrian-related projects and programs based on various qualitative and/or quantitative evaluation criteria. The prioritization results constitute an implementation plan and serve as a guide for future application of the plan's recommendations.

More details for potential prioritization criteria are presented in Appendix E.

Evaluation

The final component of a pedestrian master plan should be to monitor or evaluate progress, or both. Evaluation methods will vary, but may include elements such as development of an annual performance report; updates to pedestrian infrastructure or count databases, or both; and assessments of new facilities. Through the evaluation, an agency can assess if it is achieving the goals and objectives of the pedestrian master plan and update the plan as necessary.

6.2.2.2. Integration of pedestrians into other planning studies

In addition to pedestrian master plans, basic requirements of planning for pedestrians shall also be considered into the following types of studies, as further defined below:

6.2.2.2.1. Traffic impact studies (TIS)

SHC requirements for Traffic Impact Studies are defined in Section 2.3 of SHC 203 (Preliminary Studies).

With regard to pedestrian planning, traffic impact studies shall examine: (1) the need for direct, convenient, accessible pedestrian paths and (2) street crossings and the need to connect from the transportation network to the site and on-site. Planned highway modifications should include appropriate pedestrian facilities. Traffic signal analyses should include analysis of pedestrian movements and how delay for all modes can be minimized.

6.2.2.2.2. Corridor and area-wide studies

Corridor and area-wide studies shall address the needs of all users, including pedestrians. When such studies are used to select a preferred alternative for a project, pedestrian considerations should be included as an evaluation measure. Level of Service (LOS), crossing difficulty, access to transit, and safety are appropriate evaluation metrics that should be used (see also Appendix E).

Area-wide studies should include a pedestrian wayfinding component, towards important destinations (e.g., shopping districts, government buildings, educational institutions, quasi-public destinations (such as museums, aquariums, or zoos), historic sites, mosques, parks and recreational areas, hospital and health care facilities, cultural sites, and major transit hubs). The development of pedestrian way-finding plans should include walking audits of the facilities being considered for inclusion in the wayfinding routes.

6.2.2.2.3. Evacuation route studies

Evacuation plans should be developed for orderly evacuation of people from an urban area or an element of the highway system (i.e., tunnel, bridge, bus lane) in the event of an emergency or potential disaster. In urban areas with a relatively high use of mass transit for people commuting to work, any such evacuation would involve a large number of people on foot. Consequently, in dense urban areas, transportation agencies should develop pedestrian evacuation plans.

The operational element of a pedestrian-related disaster preparedness and emergency action plan is a "walk-out plan", which should include the following components as a minimum:

- Establishment of a cordon area where walking is the fastest primary mode. The size and configuration of this area can be determined through appropriate evacuation modeling and engineering judgment, considering unique geographic features.
- Assessment and designation of priority pedestrian evacuation routes (portions of the existing sidewalk/crosswalk network, walking paths, and travel or bridge lanes for catastrophic events) within the "walk-out zone".
- Identification of safety zone shelters or terminals at the fringe of the "walk-out zone" that will provide a pick-up point to access high-occupancy vehicles, public transit, commuter rail, ferry, and other modes of transportation.
- Identification of how pedestrians with disabilities will be accommodated.

6.2.2.2.4. Freight route plans

SHC requirements for freight management are defined in Chapter 5 of SHC 601 (Traffic Engineering).

Freight route plans should address the effects of identified truck routes and potential facility modifications on pedestrian movements. Pedestrian mobility and safety should not be compromised to improve freight movement. Pedestrian access should be maintained to transit stations and between pedestrian traffic generators. Sidewalk and intersection operations for pedestrian traffic should not be degraded.

6.2.3. Documenting Pedestrian Activity

Pedestrian monitoring programs that collect pedestrian data should be regularly implemented by responsible or concerned authorities, as they provide agencies with information to support policy and planning decisions, investment decisions, design of facilities and infrastructure, operation/maintenance activities, and measuring performance and progress towards overall agency missions and goals.

Requirements and relevant guidance are provided in Section 2.11 of SHC 601 (Traffic Engineering).

6.3. Planning for Bicyclists

6.3.1. Bicyclists in Transportation Plans

This section discusses transportation planning for bicyclists and its relationship to other transportation planning activities.

6.3.1.1. Bicycle master plans

The purpose of a stand-alone bicycle plan is to identify the projects, policies, and programs that are needed in order to fully integrate bicycling as a viable mode of transportation within a community. Bicycle plans prepared by the highest authority (e.g., a Ministry) may be more focused on policy issues, while bicycle plans that are completed by local or regional agencies may focus on bicycle network planning, as well as policies and design practices that support bicycling.

Bicycle plans should reflect local communities' characteristics and needs. Bicycle plans for municipalities, governorates, provinces, and Kingdom-wide all differ significantly, depending on many factors including span of control (e.g., which highways or corridors are controlled or managed by the government entity), political support, available funding, and level of community engagement. Bicycle plans are relevant to any type of community: urban, suburban, rural, mountain, and resort.

6.3.1.1.1. Coordination with other documents and planning processes

The plan should be coordinated with regional and national transportation plans (such as modal plans or corridor plans). While bicycle transportation may not always be the primary focus of these plans, the bicycle mode should be taken into consideration and should be addressed in an appropriate level of detail. Coordination is also needed with funding programs, and planning documents of other agencies (related for example to transit, parks and recreation).

6.3.1.1.2. Phasing of infrastructure improvements

A phasing plan sets forward a strategy for improving conditions for bicycling over time, reflecting political realities, future development, funding opportunities, corridor constraints, and technical challenges. By identifying projects to be implemented in the short-, medium- and long-term, authorities can focus initially on projects that are low-cost or need minimal infrastructure work, while simultaneously starting to plan, design, and seek funding and support for longer-term, more complex projects.

Short-term projects

Short-term projects can help to create early success and show significant progress in plan implementation. These projects are generally low-cost and easy to implement. Examples include traffic signal timing and/or detection adjustments; shared lanes; adjusting lane widths when restriping existing streets to create wide right lanes or bike lanes; removing travel lanes or parking and redistributing space to accommodate bike lanes; highway repaving that includes bike lanes or paved shoulders; or installation of wayfinding signage or shared lane markings.

Medium-term projects

Medium-term projects may include major street repaving, facility reconstruction, such as moving curbs, or funding as part of other capital improvement programs. These projects generally undergo a detailed infrastructure design study, are more complex to implement, and need time to secure funding and potentially right-of-way. Medium-term projects may, also, be those that only occur with new facility construction or old facility rehabilitation.

Long-term projects

Long-term projects generally represent investments of major capital funds; these projects are complex from a design or political standpoint. Examples can include bicycle bridges, elevated crossings, or underpass-style tunnels. These projects can be developed through new facility construction or facility rehabilitation.

6.3.1.1.3. Bicycle master plan contents

A bicycle plan should be comprehensive and cover the following topics:

Introduction

The introduction of the plan should provide a brief overview of the history and current status of bicycling in the jurisdiction, discuss any previous or current planning efforts that support bicycling, provide data on current levels of bicycling (along with historical data if available), and any other information that is needed to lay a foundation for the plan.

Vision, goals, and objectives

The vision statement should describe the desired future state, once the goals and objectives have been fulfilled. Goals should be broad statements that address key focus areas, such as mobility, health, and the environment. Objectives identify more specific strategies for accomplishing the vision and goals.

Benchmarks or performance indicators

Benchmarks should be set in such a way that results can be measured. In order to set a baseline for performance measures, collection of initial data may be needed. Performance measures should be as simple as practical, and should be fairly easy to measure. In some cases, existing data collection processes (such as highway inventories) can be adjusted to collect data relevant to bicycle performance measures (i.e., shoulder width and pavement condition). Examples of benchmarks include the number of bikeway kilometers implemented, mode share percentage, rate of bicycle-motor vehicle crashes as compared to the number of bicycle trips, total number of bicycle-motor vehicle crashes, number of bike parking spaces, bike usage on a particular corridor, percentage of children bicycling to school, and others. Inclusion of outcome-oriented performance measures (such as usage counts and crash rates) is desirable to check effectiveness of current programs, purely inventory-oriented performance measures may not detect issues that need to be addressed.

Existing conditions

The overview of existing conditions should take stock of the transportation infrastructure. The existing conditions analysis should include a general assessment of streets, highways, and highways by function, type, ownership, traffic volumes and speeds, width, and pavement/surface conditions, as well as an inventory of existing bikeways, including shared use paths and trails outside the street system. Other items include bicycle parking conditions (quality, quantity, and location); crash data; proposed developments that may have a significant impact on bicycling; bike-transit integration (availability of bicycle racks on buses and policies regarding bicycles on transit vehicles); and education, encouragement, and enforcement efforts.

Recommended bicycle facilities

Recommendations should reflect the community's needs, as well as the feasibility of projects in specific highway corridors. An opportunistic approach is wise - the majority of bike plans recommend new facilities in locations where other highway projects (such as repaving and shoulder widening) offer opportunities to implement bikeways less expensively. Projects should be identified in sufficient detail such that they can be integrated into a local capital improvement plan or advanced to a design phase. The provided level of detail should include, as a minimum, highway name, beginning and end points, bikeway or improvement type, a description of the work needed, and the estimated cost. Bicycle parking needs can also be identified, as well as standards for placing bicycle parking facilities.

Recommended policies / design guidelines

Recommendations for policy changes are a standard component of most bicycle master plans. This includes zoning and land development policies that support bicycling (such as higher densities of mixed-use development, neighborhood design that provides a high level of bicycle connectivity, bicycle parking ordinances, the need for commuter support facilities such as showers, etc.). Some bicycle plans also include design guidance that clarifies the jurisdiction's expectations in terms of bicycle facility design.

Recommended education and encouragement programs

The education component should address issues such as bicycling-related information on appropriate websites; improvements in driver education programs and driver handbooks; routine inclusion of bicycle-related questions on driver license exams; safety information messages for motorists and bicyclists; and bicyclist training programs for children, youth, and adults. Education programs can help dispel myths, encourage courteous and lawful behavior among motorists and bicyclists of all ages, enhance the skill level of bicyclists, and improve motorist awareness. Education programs can be administered through a number of different agencies and interest groups, such as police departments, schools, libraries, parks and recreation departments. The encouragement component can include commuter support programs and incentives, promotional activities oriented to neighborhoods and local business districts (e.g., a "shop by bike" program), campaigns to promote use of bicycles with transit, rides organized to introduce (or publicize benefits of) bicycling to a wider audience, and other activities to promote the more widespread practical application of bicycling (e.g., a "bike to work" program).

Enforcement programs

This section of the plan should provide an overview or summary of enforcement of motorist and bicyclist violations and assess the need for improved enforcement of violations. This section should also address training of enforcement personnel to improve their understanding of the rights and responsibilities of bicyclists and duties of motorists towards bicyclists.

Implementation plan

This section should address short-, medium- and long-term recommendations, and should provide a phasing plan, as described above. Short-term projects should include planning-level cost estimates for budgetary purposes. Potential funding sources should be identified at this stage. All types of projects, both infrastructure and non-infrastructure (such as education and encouragement programs), should be included in the phasing plan. For some plans, it may also be desirable to identify the specific agencies that are responsible for implementing the recommendations, and after project implementation it is also important to evaluate improvements to determine if they achieved their desired results.

6.3.1.2. Integration of bicyclists into other planning studies

This section defines the requirements to incorporate bicyclists into other types of transportation planning procedures (in addition to dedicated bicycle master plans) both large and small scale, including urban, suburban, and rural areas. The following types of planning processes are examined:

- Comprehensive Transportation Plans.
- Traffic Impact Studies.
- Small-Area and Corridor-Level Planning.

6.3.1.2.1. Comprehensive (long-range) transportation plans

Comprehensive (long-range or master) transportation plans should include a bicycling component. The bicycle component of these plans should be of a similar level of detail as the motor vehicle components; for example, identifying specific short-term and long-term improvements, establishing funding priorities, and addressing policy issues. Stakeholder meetings for these plans should be designed to solicit input on bicyclists' needs and priorities, as well as input on all other modes. These plans should also provide recommendations for improving bicycle/transit connections and integration.

The bicycle element of the master transportation plan may be a condensed version of a separate bicycle master plan (see below) and/or may incorporate the separate bicycle master plan by reference. Where this is the case, the bicycle component of the planning process should provide the same level of detail as the other modal elements.

6.3.1.2.2. Traffic impact studies (TIS)

SHC requirements for Traffic Impact Studies are defined in Section 2.3 of SHC 203 (Preliminary Studies).

Traffic impact studies evaluate impacts to all modes, including pedestrians, bicyclists, and transit, in addition to a discussion of on-site circulation and support facilities. Impacts to bicyclists should be explicitly considered in traffic impact studies if any of the following criteria is met:

- A project disrupts existing bicycle facilities. This can include adding new vehicular or bicycle traffic to an area experiencing safety concerns or a new development adjacent to an existing sensitive use (e.g., a school or park). Particular attention should be paid to on-street bicycle facilities on highways with proposed driveways, and highway widening or intersection improvements intended to augment motor vehicle capacity, which may reduce or eliminate shoulders or bike lanes.
- A project interferes with proposed bicycle facilities. This includes failure to dedicate right-of-way for planned on- and off-street bicycle facilities included in an adopted bicycle master plan, or failure to contribute toward construction of planned bicycle facilities along the project's frontage.
- A project conflicts with adopted bicycle system plans, guidelines, policies, or standards. This can include project designs that are in conflict with policy language, such as bicycle directness, connectivity, and network completeness.

6.3.1.2.3. Small-area and corridor-level planning

Transportation plans that focus on specific highway corridors should incorporate the needs of bicyclists along with all other users. The presumption in preparing these plans is that the needs of bicyclists will be included as a routine matter, and the decision to not accommodate them should be the exception rather than the rule.

During the development of small-area plans and corridor plans, bicycle access along and across highways should be planned. A practical approach should be used to incorporate improvements with the potential to reduce crashes for bicyclists along with other planned highway improvements. In some cases, a highway corridor or bridge replacement/ reconstruction plan may create an opportunity to provide a new bicycle facility that does not necessarily connect to bikeways on either end of the corridor. However, bicycle accommodations should still be provided and should be designed with logical boundaries, because all bicycle networks begin with incremental improvements that eventually result in a connected network and transportation system that meet bicyclists' travel needs.

6.3.2. Planning Bicycle Transportation Networks

The core element of any type of bicycle plan is the bicycle transportation network, composed of a connected, comprehensive system of paved shoulders, bike lanes, shared lanes, bicycle boulevards, bike routes, and shared use paths. This section describes how to develop a bicycle network plan.

6.3.2.1. Deciding where improvements are needed

All highways should be accessible by bicycle, except where bicycle travel is specifically prohibited. Whenever highways are reconstructed or constructed, appropriate bikeways should be included to accommodate bicyclists' needs.

Factors to consider when deciding where improvements are needed to develop a connected bicycle transportation network include (AASHTO, 2012):

- **User Needs:** Balancing the full range of needs of current and future bicyclists.
- **Traffic Volumes, Vehicle Mix, and Speeds:** Motor vehicle traffic volumes, vehicle mix, speeds, and driveways should be considered along with the highway width. Some bicyclists will avoid highways with high speeds and high volumes of traffic and many drive-ways unless they are provided with a facility that offers some degree of separation from traffic.
- **Overcoming Barriers:** Overcoming constraints and physical barriers such as freeways or waterways should be a top priority when developing a bicycle network.
- **Connection to Land-Uses:** Bikeways should allow bicyclists to access key destinations. They should connect to employment zones, parks, schools, shopping, restaurants, coffee and ice cream shops, sports facilities, community centers, major transit connections, and other land-uses that form the fabric of a community.
- **Directness of Route:** A bikeway should connect to desirable locations with as few detours as practical. For example, does a bicyclist have to travel out of his or her way on a route with many turns to reach a freeway overpass? Multiple turns can disorient a rider and unnecessarily complicate and lengthen a trip.
- **Logical Route:** A network should include facilities that bicyclists already use or have expressed interest in using.
- **Intersections:** Bikeways should be planned to allow for as few stops as practical, as bicycling efficiency is greatly reduced by stops and starts. If bicyclists are required to make frequent stops, for example, along streets with stop signs every block, they may avoid the route or disregard traffic control devices. Signalized intersections with very short green times (such as those on low-priority streets) can lead to disregard for traffic control. At major streets, crossings should be carefully planned and managed to reduce crashes and improve operations for all travelers and modes. Each additional intersection can present a potential for additional crashes.
- **Aesthetics:** Scenery is an important consideration along a facility, particularly for a facility that will serve a primarily recreational purpose. Trees can also provide cooler riding conditions in summer and can provide a windbreak. Bicyclists tend to favor highways with adjacent land-uses that are attractive such as campuses, shopping districts, and those with scenic views.

- **Spacing or Density of Bikeways:** A bicycle network should be planned for maximum use and comfort, and thus should provide an appropriate density relative to local conditions.
- **Safety:** Analysis of crash data and reviews of crash reports may also aid in identifying where improvements to the bicycle transportation network are recommended based upon safety experience.
- **Security:** Security issues are important to consider especially for sections of shared use paths that are not visible from highways and neighboring buildings.
- **Overall Feasibility:** Decisions regarding the location of new bikeways may also include an overall assessment of feasibility given physical or right-of-way constraints, as well as other factors that may impact the cost of the project. While funding availability may influence decisions, it is essential that a lack of funds not result in a poorly-designed or constructed facility. The decision to implement a bicycle network plan should also be made with a conscious, long-term commitment to a proper level of maintenance. Facility selection should seek to maximize user benefit per Saudi Riyal funded.

While every street will serve as a bicycle facility to some extent, concentrating bicycle trips along specially treated corridors can help to attract new bicyclists and reduce crashes for all modes. A context sensitive design approach is important in all aspects of highway design. Simply applying standards, without understanding how they will function, the local context, or the future design intent, can lead to inappropriate and underused facilities.

6.3.2.2. Selection of bicycle facility type

Appropriate provisions for bicyclists that may be considered when designing or re-designing highway, according to the priorities set by a bicycle plan, are:

- shared lanes,
- marked shared lanes,
- paved shoulders,
- bike lanes,
- bicycle boulevards, and
- shared use paths.

The best application of each of these facilities combines experience with data analysis, engineering judgment, and budget constraints. Therefore, strict rules for selecting the most appropriate type of bicycle facility cannot be provided. Overall, however, a network of bike lanes and shared use paths should form the backbone of a city's bicycle infrastructure.

Selection of an appropriate bikeway type should be based on the following information:

- highway function (arterial, local),
- traffic volume,
- speed,
- traffic mix (e.g., truck percentage),
- expected users (e.g., is one type of user expected to dominate, such as children bicycling to school),
- highway conditions (lane widths, total highway width, conditions at intersections, and parking demand),
- driveways or access points,

- topography,
- existing and proposed adjacent land-uses, and
- cost.

Corridors may combine multiple bicycle facility types, each type being used where appropriate. For example, a shared use path can connect to a bicycle boulevard to create a continuous corridor. A corridor may start with bike lanes, travel along a bicycle boulevard, and then transition back to bike lanes. Throughout the network, transitions between facility types should be functional and intuitive.

6.3.3. Documenting Bicyclist Activity

Guidance provided for documenting pedestrian activity (see Section 6.2.3 of the present Volume) is applicable also for bicyclists. For detailed guidance, the reader should refer to Section 2.11 of SHC 601 (Traffic Engineering).

7. Highway Capacity

7.1. Introduction

7.1.1. Scope

This chapter shall apply to the provision of fundamental context, guiding principles and major considerations in the context of Highway Capacity.

7.1.2. Standards and Guidelines

The sections of this chapter shall not be read in isolation, but in the context of this volume as a whole.

For additional guidance on the application of traffic analysis and modelling the user should refer to Chapter 3 of SHC 601 (Traffic Engineering). For requirements concerning capacity analysis and the resulting level of service (LOS) of affected highways and streets by proposed new developments the user should refer to Section 2.3 of SHC 203 (Preliminary Studies). For guidance on measuring various traffic flow and other parameters related to highway capacity, the user should refer to the Traffic Operations Studies chapter (Chapter 2) of SHC 601 (Traffic Engineering).

Where supplementary guidance is deemed appropriate, not covered from the provisions of SHC, the latest edition of the Highway Capacity Manual (HCM) (TRB, 2022) should be the primary reference on capacity analysis, unless otherwise directed by the competent authority.

7.1.3. Summary of Sections

Section 7.1 (this section) provides initial information and context.

Section 7.2. provides the fundamental context and guidance concerning highway capacity.

Section 7.3. discusses level of service as a design control element.

Appendix F provides highway capacity fundamentals and additional guidance.

7.1.4. Interpretation and Commentary

The present chapter provides fundamental highway capacity guidance and context, for transportation planners and traffic engineers aiming to ensure a degree of consistency in transportation planning, design and traffic analysis.

The principles and guidance set out in this chapter are intended for use by suitably licensed and experienced transportation planners and traffic engineers.

7.2. Highway Capacity Fundamentals

The concepts of capacity analysis and level of service are fundamental to the planning, design and operation of traffic facilities.

7.2.1. Types of Traffic Facilities

Traffic facilities can be classified into two broad categories (TRB, 2022):

1- Uninterrupted-flow facilities.
2- Interrupted-flow facilities.

7.2.1.1. Uninterrupted-flow facilities

Uninterrupted-flow facilities have no fixed causes of delay or interruptions to the traffic stream, such as traffic signals. The traffic stream on uninterrupted-flow facilities is the result of individual vehicles interacting with each other and the facility's geometric and environmental characteristics. However, traffic flow can be influenced by freeway management and operations strategies (e.g., ramp metering, auxiliary lanes, truck lane restrictions, variable speed limits), pavement conditions and the occurrence of traffic incidents. Examples include freeways which operate under the purest form of uninterrupted flow and multilane and two-lane highways which can also operate under uninterrupted flow in long segments.

7.2.1.2. Interrupted-flow facilities

Interrupted-flow facilities have fixed causes of periodic delay or traffic stream interruption, irrespective of the total amount of traffic, such as traffic signals, roundabouts and STOP signs. The traffic flow patterns on an interrupted-flow facility are the result of vehicle interactions, the facility's geometric characteristics, the traffic control used at intersections, and the frequency of access points to the facility. Examples include urban streets, signalized and unsignalized intersections.

Uninterrupted flow and interrupted flow are terms that describe the type of a facility and not the quality of the traffic flow at any given time.

7.2.1.3. Effects of other modes

Each mode that uses a highway (pedestrians, bicycles, trucks and transit vehicles) interacts with the other modal users of that highway. All travel modes must be considered in the highway design and operation analysis process taking into consideration the provisions prescribed herein and in HCM (TRB, 2022).

7.2.2. Level of Service (LOS)

LOS is used to translate complex numerical performance results into a simple A-F system representative of highway user's perception of the quality of service provided by a facility or service (TRB, 2022).

Table 7-1 presents the general operating conditions represented by these levels.

Table 7-1 General Definitions of Levels of Service (HCM 2022 (TRB, 2022))

Level of Service	General Operating Conditions
A	Free Flow
B	Reasonably Free Flow
C	Stable Flow
D	Approaching Unstable Flow
E	Unstable Flow
F	Breakdown Flow

The HCM (TRB, 2022) defines LOS for most combinations of travel mode (i.e., automobile, pedestrian, bicycle, and transit) and highway system element (e.g., freeway, urban street, intersection) addressed by HCM methodologies. For the determination of LOS, the user should refer to HCM (TRB, 2022).

7.2.2.1. LOS considerations

Judgements on the selection or development of a facility should be based on the different modal scores, and additional relevant information (e.g., function intended for the highway concerned, safety performance, etc.). Trade-offs and interactions between the different modes must be considered. Therefore, modal LOS results, should be reported individually where applicable.

Traffic engineers and decision makers should always be mindful that neither LOS nor any other single performance measure tells the full story of highway performance. Depending on the particulars of a given location and analysis, queue lengths, demand-to-capacity ratios, average travel speeds, indicators of safety, and other performance measures may be equally or even more important to consider, regardless of whether they are specifically called out. For additional guidance on traffic analysis performance measures the user should refer to Section 3.8 of SHC 601 (Traffic Engineering). Moreover, HCM (TRB, 2022) provides methods for estimating a variety of useful highway operations performance measures.

As introduced earlier, service measures are specific performance measures that are used to determine LOS. Table 7-2 summarizes the service measures used by HCM (TRB, 2022) for different transportation system elements and travel modes. Additionally, Table 7-2 summarizes the components of traveler perception models used to generate service measures for multimodal studies.

Table 7-2 Service Measures for LOS Determination (adapted from HCM 2022 (TRB, 2022) – Exhibit 8-2)

Transportation System Element	**Service Measure**			
System Element	**Motorized Vehicle**	**Pedestrian**	**Bicycle**	**Transit**
Freeway Facility	Density	--	--	--
Basic Freeway Segment	Density	--	--	--
Freeway Weaving Segment	Density	--	--	--
Ramp Junction	Density	--	--	--
Multilane Highway	Density	--	LOS Score[1]	--
Two-Lane Highway	Follower Density	--	LOS Score[1]	--
Urban Street Facility	Speed	LOS Score[1]	LOS Score[1]	LOS Score[1]
Urban Street Segment	Speed	LOS Score[1]	LOS Score[1]	LOS Score[1]
Signalized Intersection	Delay	LOS Score[1]	LOS Score[1]	--
Two-Way Stop	Delay	Crossing satisfaction[1]	--	--
All-Way Stop	Delay	--	--	--
Roundabout	Delay	--	--	--
Interchange Ramp Terminal	Delay	--	--	--
Alternative Intersection	Delay	--	--	--
NOTE: 1. See Table 7-3 for the LOS score components.				

Table 7-3 Components of Traveler Perception Models Used to Generate Service Measures (adjusted from HCM (TRB, 2022) – Exhibit 8-3)

System Element	Mode	Model Components
Urban street facility	Motorized vehicle[1]	Weighted average of segment motorized vehicle LOS scores.
	Pedestrian	Urban street segment and signalized intersection pedestrian LOS scores.
	Bicycle	Urban street segment and signalized intersection bicycle LOS scores.
	Transit	Weighted average of segment transit LOS scores.
Urban street segment	Motorized vehicle[1]	Stops per mile, left-turn lane presence.
	Pedestrian	Pedestrian density, sidewalk width, perceived separation between pedestrians and motor vehicles, motor vehicle volume and speed, midblock crossing difficulty.
	Bicycle	Perceived separation between bicycles and motor vehicles, pavement quality, automobile and heavy vehicle volume and speed, driveway conflicts.
	Transit	Service frequency, perceived speed, pedestrian LOS.
Signalized intersection	Pedestrian	Street crossing delay, pedestrian exposure to turning vehicle conflicts, crossing distance.
	Bicycle	Perceived separation between bicycles and motor vehicles, crossing distance.
Uncontrolled pedestrian crossing	Pedestrian	Annual average daily traffic (AADT), street crossing delay, pedestrian safety countermeasures at crossing.
	Bicycle	Average meetings/minute, active passings/minute, path width, centerline presence, delayed passings.

NOTE:
1. The motorized vehicle traveler perception model for urban street segments and facilities is not used to determine LOS; however, it is provided as a performance measure to facilitate multimodal analyses.

In order to define LOS F conditions, the v/c ratio should be also taken into consideration (v/c greater than 1.00 results in LOS F in any case).

7.3. Motor Vehicle Level of Service as a Design Control

The LOS targets presented in Table 7-4 should be considered a desirable condition during the peak hour, with significant variance from those targets in either direction an undesirable condition. Every project should have an established design level of service to design all highway elements (corridors, intersections, roundabouts, ramps, weaving sections etc.).

Selection of a design LOS different from that discussed in this section should be in concurrence of the competent authority.

Table 7-4 Guidelines for Selection of Design Levels of Service (adapted from (AASHTO, 2018) – Table 2-3)

Functional Class	Level of Service		
	Rural	Rural Mountainous	Suburban, Urban, and Rural Town
Freeways	B	C	C or D[1]
Expressways	B	C	C or D[1]
Arterials	C	C	C or D[1]
Collectors	C	D	D
Local Roads/Streets	D	D	D

NOTE:

1. Designers should strive to provide the highest level of service practical, consistent with anticipated conditions and system constraints.

Choice of the appropriate level of service for motor vehicles should take into account other factors (e.g., pedestrians, cyclists, transit users, level of development) based on the consideration discussed in Section 7.2.2.1, especially in urban and suburban areas. In such cases, it may be desirable to accept a lower LOS than that prescribed in Table 7-4. This will require sufficient justification and approval by the competent authority.

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Appendix A - List of Stakeholders

A non-exhaustive list of potential stakeholders for infrastructure related projects within the KSA that should be used as an initial check list is as follows (EXPRO, 2020) - in alphabetical order:

- Al Madina Region Development Authority (MDA).
- Al-Ahsa Development Authority.
- AlAhsa Municipality.
- AlBaha Municipality.
- AlJouf Municipality.
- Assir Development Authority.
- Assir Municipality.
- Communications, Space & Technology Commission (CST).
- Development Authorities Support Center (DASC).
- Diriyah Gate Development Authority.
- Eastern Province Municipality.
- Economic Cities and Special Zones Authority (ECZA).
- General Authority for Meteorology and Environmental Protection (GAMEP).
- General Authority of Civil Aviation (GACA).
- General Court for Audit (GCA).
- General Directorate of Civil Defense.
- General Food Security Authority (GFSA).
- General Organization for Social Insurance (GOSI).
- Hafr Al Batin Municipality.
- Hail Municipality.
- Hail Region Development Authority.
- Holy Makkah Municipality.
- Jazan Mountain Regions Development and Reconstruction Authority.
- Jazan Municipality.
- Jeddah Central Development Company (JCDC).
- Jeddah Development Authority.
- Jeddah Municipality.
- Madinah Municipality.
- Makkah Region Development Authority (MRDA).
- Ministry of Human Resource and Social Development (HRSD).
- Ministry of Commerce.
- Ministry of Communications and Information Technology (MCIT).
- Ministry of Culture (MOC).
- Ministry of Defense (MOD).
- Ministry of Economy and Planning (MEP).
- Ministry of Education (MOE).
- Ministry of Energy.
- Ministry of Environment, Water and Agriculture (MEWA).
- Ministry of Finance (MOF).
- Ministry of Foreign Affairs (MOFA).
- Ministry of Hajj and Umrah.

- Ministry of Health (MOH).
- Ministry of Human Resources and Social Development (HRSD).
- Ministry of Industry and Mineral Resources (MIM).
- Ministry of Interior (MOI).
- Ministry of Investment of Saudi Arabia (MISA).
- Ministry of Islamic Affairs, Dawah and Guidance (MOIA).
- Ministry of Municipal, Rural Affairs and Housing (MOMRAH).
- Ministry of National Guard (SANG).
- Ministry of Sport.
- Ministry of Tourism.
- Ministry of Transport and Logistic Services (MoTLS).
- Najran Municipality.
- National Center for Environmental Compliance (NCEC).
- National Center for Meteorology (NCM).
- National Center for Wildlife (NCW).
- National Industrial Development Center (NIDC).
- National Transport Safety Center (NTSC).
- National Water Company (NWC).
- Northern Borders Municipality (Arar).
- Public Investment Fund (PIF).
- Qassim Municipality.
- Real Estate Development Fund (REDF).
- Riyadh Municipality.
- Roads General Authority (RGA).
- Royal Commission for Al Ula (RCU).
- Royal Commission for Jubail and Yanbu (RCJY).
- Royal Commission for Makkah City and Holy Sites (RCMC).
- Royal Commission for Riyadh City (RCRC).
- Saline Water Conversion Corporation (SWCC).
- Saudi Arabia Railways (SAR).
- Saudi Arabian Airlines (Saudia) iSharqia Development Authority.
- Saudi Aramco.
- Saudi Authority for Industrial Cities and Technology Zones (MODON).
- Saudi Central Bank (SAMA).
- Saudi Commission for Health Specialties (SCFHS).
- Saudi Electricity Company (SEC).
- Saudi Geological Survey (SGS).
- Saudi Industrial Development Fund (SIDF).
- Saudi Irrigation Organization.
- Saudi Olympic & Paralympic Committee (SOPC).
- Saudi Organization for Chartered and Professional Accountant (SOCPA).
- Saudi Ports Authority (MAWANI).
- Saudi Post (SPL).
- Saudi Red Crescent Society (SRCA).
- Saudi Shura Council.
- Saudi Standards, Metrology and Quality Organization (SASO).
- Social Development Bank (SDB).

- Tabuk Municipality.
- Taif Development Authority.
- Taif Municipality.
- Technical and Vocational Training Corporation (TVTC).
- Transport General Authority (TGA).
- Water & Electricity Regulatory Authority (WERA).
- Zakat, Tax and Customs Authority (ZATKA).

Stakeholders shall be identified using a combination of the following methods (EXPRO, 2020):

- Feedback from previous projects. The stakeholders that interfaced with previous projects are a good indication of the stakeholders that could interface with the project.
- Review of the Project's scope and requirements. The following shall be considered:
  - Land acquisition, permits or approvals for planning, design, construction and permanent use;
  - Utility provision (e.g., power or water); and
  - Infrastructure requirements (e.g., road or rail links, power connections).
- Cross-check against the list of potential stakeholders.

The Stakeholder Engagement Plan for a project shall include (EXPRO, 2020):

- a list of all relevant stakeholders,
- a mechanism to define interfaces between the different stakeholders within the project,
- assignment of the responsibility for managing stakeholders and interfaces, and
- description of the activities and tools required to manage stakeholders and interfaces.

In order to manage stakeholder interfaces the following activities shall be embedded in the Stakeholder Engagement Plan (EXPRO, 2020):

- **Initial Contact:** A point of contact should be identified for each stakeholder. This is typically achieved by a formal request to the stakeholder's management. A letter describing the project and the envisaged interface should be prepared and it should be requested that the stakeholder formally nominate a point of contact. This letter could also invite the stakeholder to the kick-off meeting.
- **Kick-off Meeting:** A kick-off meeting should be held with each stakeholder to provide a brief on the project and confirm the interfaces. Kick-off meetings can be held with individual stakeholders, groups of stakeholders or with all stakeholders at once.
- **Formal Stakeholder Relationships:** Depending on the criticality of the interface with the project, it may be necessary to enter into a formal relationship with the stakeholder. This provides a basis for managing the interface. Depending on the nature of the interface, this relationship may be a charter, memorandum of understanding or agreement.
- **Keeping Stakeholders Informed:** During the project, regular meetings should be held to keep stakeholders informed of project progress, complete actions and resolve issues related to the stakeholder interfaces. The relevant stakeholders shall be kept informed of any changes to the project that could impact their interfaces and at key milestones.
- **Managing Stakeholder Interfaces:** During the kick-off meeting, at progress update meetings and at other times, actions would be generated by the project team and the stakeholders. Completing these actions are the key to successful stakeholder interface management. The project management team should develop tools to capture, monitor, report and resolve the actions.

Appendix B - Highway Network Planning Fundamentals

B.1. Transport Network Planning Principles

Principles for planning and design of transport systems are derived from socio-political values. This also applies to transport networks which, with their traffic routes and traffic nodes, make public and private spaces accessible and connect them to one another. Accessibility influences the favorable location of spaces and their ability to be developed as residential and/or business locations. The effects of the transport networks on the competition between various locations must be taken into account. Transport systems cannot compensate for the overall conditions that affect potential development, but the accessibility of areas can certainly be improved. Transport network planning is therefore an instrument to support spatial planning and regional planning goals, by assisting at mitigating the development obstacles of areas and thus promote their development opportunities.

The goals of spatial planning and transport network planning are closely interlinked via the system of centroids. Transport networks support the centroids in performing the supply function for their supply area. At the same time, traffic connectors enable the exchange of services between centroids in the sense of an exchange function. The transport networks thus strengthen the concept of "decentralized concentration" and a polycentric development system.

The planning and design of the transport network should also contribute to sustainable transport development. This is characterized by social compatibility, economic efficiency and ecological viability.

The effects of the transport networks on spatial and urban development have significant impact on:

- transport costs,
- road safety,
- environmental sustainability, and
- initial investment and operating costs.

The goals of spatial planning and transport network planning should be achieved with the lowest possible costs and lowest negative consequences for the general public. Therefore, transport network planning should always take an integrative approach. The integration includes the following aspects (FGSV, 2008):

- **Integration of the planning disciplines:** spatial planning, urban development, regional and land-use planning, landscape planning and even scientific knowledge gains are brought together in traffic planning. Spatial and economic development is supported, the consequences on the landscape and with regards to environmental pollution are minimized, traffic is serviced efficiently and shorter travel distances are made possible.
- **Integration of the planning levels:** Different planning levels, i.e., at the Kingdom-wide or central level, at the level of regions and of municipalities (or Royal Commissions), should be coordinated within the framework of the network design.

- **Integration of neighboring planning areas:** Planning for certain areas should be coordinated with the planning of the neighboring areas; this includes determining the effects of network design on neighboring planning areas.
- **Integration of the transport systems:** All transport networks should be planned in a coordinated manner and cross-system connections should be set up with the linking of the transport systems and transport modes.

Furthermore, transport network planning may obtain significant benefits from intelligent transport systems (ITS) applications. ITS draw upon and integrate advanced information processing, telecommunications and electronics technologies, and may contribute to safer and more efficient transportation systems for both travelers and freight, in either urban centers or rural areas. ITS can also provide useful information in real time to motorists and commercial operators as well as road network operators. ITS also have a significant role in demand management by providing a greater quantity and diversity of information, thus allowing users (motorists, commercial operators and public transport customers) to make informed travel decisions based on such factors as traffic conditions, road maintenance or construction work that potentially impact their travel time, and weather conditions that affect the road network and safety. Consequently, ITS solutions, where applicable, should be incorporated in all road network operations and considered in the highway planning process.

B.2. Accessibility versus Mobility

Highways serve two primary travel needs: access to / egress from specific locations and travel mobility. While these two functions lie at opposite ends of the continuum of highway function, most roads provide some combination of each (FHWA, 2013).

- Highway mobility function: Provides few opportunities for entry and exit and therefore low travel friction from vehicle access/egress.
- Highway accessibility function: Provides many opportunities for entry and exit, which creates potentially higher friction from vehicle access/egress.

Freeways provide almost exclusively mobility; arterials provide mostly mobility; locals provide mostly land access; and collectors strike a balance between the two. While most highways offer both "access to property" and "travel mobility" services, it is the highway’s primary purpose that defines the classification category to which a given highway belongs.

B.2.1. Role of Collectors

Collectors “collect” traffic from local streets and connect traffic to arterial highways. Collector routes are typically shorter than arterial routes but longer than local streets. Collectors often provide traffic circulation within residential neighborhoods as well as commercial, industrial or town center districts.

B.2.2. Efficiency of Travel

Drivers will typically seek out highways that allow them to travel to their destinations with as little delay as possible and by the shortest travel time. Arterial highways provide this kind of service, often in the form of fully or partially controlled access highways, with no or very few intersecting highways to hinder traffic flow. Therefore, a high percentage of the length of a long-distance trip will be made on arterials. In contrast, travelers making shorter trips tend to use local and/or collector highways for a much higher proportion of the trip length than arterial roads.

B.2.3. Access Points

Arterials primarily serve long-distance travel and are typically designed as either fully access controlled or partially access controlled facilities with limited locations at which vehicles can enter or exit the highway (typically via on- or off-ramps). In instances where limited or partial access control is not provided, signalized intersections are used to control traffic flow, with the arterial given the majority of the green time.

In contrast, local streets provide direct access to multiple properties.

For further information on access management, the reader should refer to Section 4.6 of SHC 301 (Highway Geometric Design).

B.2.4. Speed Limit

In general, there is a relationship between posted speed limits and functional classification. Arterials typically have higher posted speed limits as vehicles encounter few or no at-grade intersections. The absence of cross-traffic and driveways allows for higher rates of speed, which provides mobility, especially for long-distance travel. In contrast, because their primary role is to provide access, Locals are lined with intersecting access points in the form of driveways, intersecting highways, cross walks and transfer points for buses and other modes. Due to the frequency of traffic turns, speed limits are kept low to promote safe traffic operations. Speed limits on any non-access controlled highways are also influenced by the mix of vehicles and modes that use them.

For further information on speed limits, the reader should refer to Section 4.3 of SHC 301 (Highway Geometric Design).

B.2.5. Route Spacing

The concept of distance (or spacing) between routes is directly related to the channelization of traffic throughout a network. Ideally, regular and logical spacing between routes of different classification level should exist. Arterials are typically spaced at greater intervals than collectors, which are then spaced at much greater intervals than locals. This spacing varies considerably for different areas; in densely populated urban areas, spacing of all routes types is smaller and generally more consistent than the spacing in sparsely developed rural areas. Geographic barriers also greatly influence the layout and spacing of highways.

B.2.6. Traffic Volume

Arterials serve a high share of longer distance trips and daily vehicle kilometers of travel. In rural areas, arterials typically account for approximately half of the daily vehicle miles of travel; in urban areas, this percentage is often higher. Collectors account for the next largest percentage of travel. Lastly, local streets in rural areas typically serve very low density, dispersed developments with relatively low traffic volume. In contrast, the urban local street network, with higher density spacing, serves denser land-uses and therefore accounts for a larger proportion of travel than its rural counterpart.

While there is a general relationship between the functional classification of a highway and its annual average daily traffic volume, two highways that carry the same traffic volume may actually serve very different purposes and therefore have different functional classifications. Conversely, two highways in different parts of the Kingdom may have the same functional classification but carry very different traffic volumes. This is particularly applicable among urban areas with very different populations – an arterial within a remote city with a population of 50,000 is likely to have a much lower traffic volume than an arterial within a city of 1 million people.

AADT should however be considered when determining the proper functional classification of a highway "on the border" of a functional classification group (for example, trying to determine whether a highway should be classified as a collector or local).

B.2.7. Number of Travel Lanes

Highways are designed and constructed according to their expected function. If a highway is expected to function as an arterial, it is designed for high capacity, with multiple travel lanes. In general, arterials are more likely to have a greater number of travel lanes than collectors, and collectors are more likely to have a greater number of travel lanes than locals. It should also be noted that the relationship between functional classification and number of lanes is stronger in urban areas than it is in rural areas.

B.2.8. Regional and National Significance

Highly significant highways connect large activity centers and carry longer-distance travel between and through regions and provinces. Arterials carry the vast majority of trips that travel through a given Province, while local streets are not appropriate for cross-province travel.

B.3. Schematic Example of Highway Network Continuity

An example schematic, illustrating the concept of continuity, is presented in Figure B-1. Arterials (represented by black lines) only connect to other Arterials. Collectors (represented by red lines), only connect to arterials or other collectors. Lastly, local Streets (represented by the green lines) can connect to any type of highway.

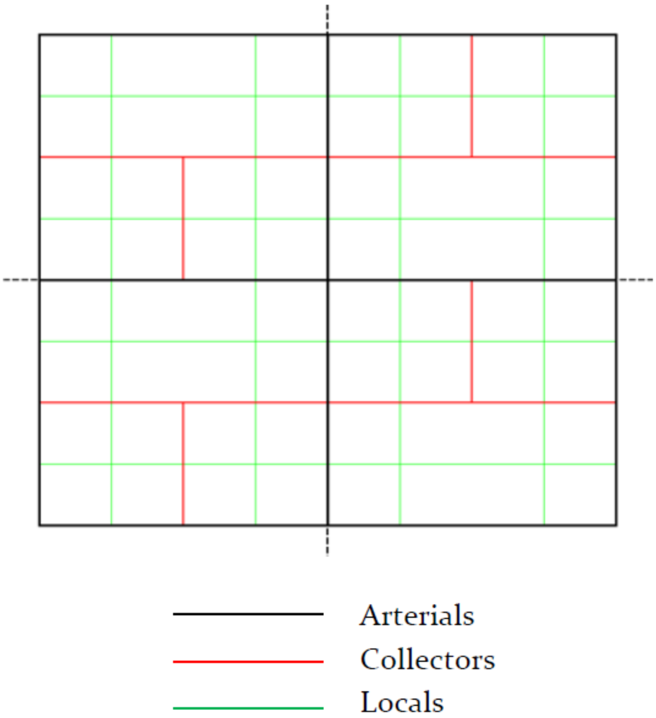


Figure B-1 Schematic Illustrating the Concept of Continuity (FHWA, 2013)

Appendix C - Transit-Oriented Development

C.1. Introduction

Transit-Oriented Development (TOD) is a form of high-density urban development around and providing access to public transport nodes. These developments contain a mix of uses such as housing, business locations, shopping opportunities, restaurants and entertainment. Preference is given to pedestrian comfort and non-motorized means of transportation, without excluding the use of vehicles in moderation (MoMRAH, 2018).

Urban TOD can be implemented as an entirely new urban plan, or as the modification of a building area designed to be easily serviced by public transport.

C.2. TOD and the Public Transport Station

Urban TOD requires that developed spaces are integrated with pedestrian, bicycle and vehicle networks and with the public transport, as presented in Figure C-2 and where:

- **Station Focus is** the area within 200 m from the public transport station containing the uses that generate the most traffic (e.g., retail, offices and commercial uses).
- **Station District** is the area that is not more than 400 - 500 m away from the public transport station. It is critical that major pedestrian traffic generators (70 - 80 % of total) are located within this area (5 - 10 minutes are required to walk a distance of 400 m).
- **Scope of Influence** is the area within 800 m of the public transport station that includes the majority of public transport passengers and affects the characteristics of the station.

Figure C-2 TOD and the Public Transport Station (MoMRAH, 2018)

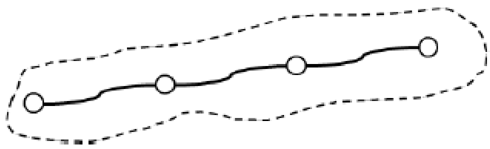
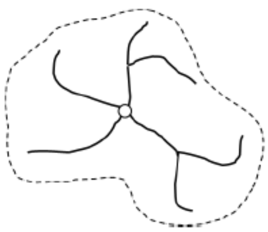
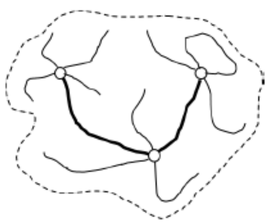
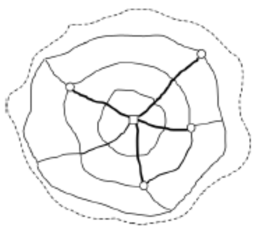
C.3. Principles of Urban TOD

TOD urban developments' planning should be governed by the following principles:

1. **Pedestrian Mobility**: Neighborhoods should be planned in a way that they encourage walkability and provide complete and safe pedestrian facilities so that pedestrian areas are full of vigor and activity.
2. **Non-Motorized Mobility**: Non-motorized transport networks should be prioritized so that a complete network is formed that ensures safety for cyclists and provide sufficient and safe parking places.
3. **Connectivity**: A dense network of streets is required, so that non-motorized users have short, direct and numerous travel options. The aim of planning should be that travel distance for non-motorized users should be shorter than that corresponding to vehicles.
4. **Promotion of Public Transport**: Intensifying development in the vicinity of high-quality public transport lines and stations, so that greater numbers of passengers can reach them on foot.
5. **Land-use Mix**: The focus should be on the creation of mixed-use development areas that include a supportive mix of retail and service amenities within the limits of the station district.
6. **Urban Intensification**: Intensification of land-uses so that the achieved residential and jobs densities ensure the successful operation of high-level public transportation and local services.
7. **Compactness**: Creating areas where the transition between residential and employment areas is short, increasing urban density to the extent possible, and providing walkable and easy access to more than one public transportation stations.
8. **Design Criteria Modification**: Increasing mobility by reducing the spaces used by vehicles and vehicle entrances, and rationing on-road parking spaces.

Appendix D - Typical Urban Highway Network Forms

Table D-1 Typical Urban Highway Network Types and Features ((AUSTROADS, 2020a) Figures C6.1 – C6.4)

Network Type	Network Features
Linear Network (Linear City Form)	
	• Provides the opportunity for a very efficient line-haul public transport service (linear) along a city's spine • This network type (route) passes through or close by all significant activity centers in a city • A large proportion of the population can access the service by walking, and those who access it using other modes will still have relatively short access travel distances
Radial Network (City with a Single, Strong Activity Center (e.g., the CBD))	
	• CBD is the hub towards which all routes are directed, as the primary travel destinations and point of interchange. • The lines represent basic line-haul services, and in a large city, access points along each route would typically be provided with feeder services (especially in outer suburban areas where the separation of line-haul routes is the greatest)
Multi-Centered (Multi-Hub) Network (City with a Number of Major Activity Centers)	
	• Each of the major activity centers is provided with radial, local feeder services • Each of the centers is likely to be the primary location for employment, retail, business, social and recreational activities for its local areas, but ready access to more distant activity centers is facilitated by line-haul services.
Ring Radial Network (City with a Dominant Central Activity District with a Number of other Relatively Strong Activity Areas)	
	• High Connectivity that provides public transport travelers with a number of alternative routes for any trip (often one route will be clearly more efficient than the other options) • Capacity of individual network links will vary according to levels of interaction between different activity centers

Appendix E - Prioritizing Pedestrian Improvement Schemes

E.1. Overview

Prioritizing pedestrian improvement schemes and measures involves a significant number of factors and there is no simple assessment process. The situation is further complicated when also implementing other highway and cycling projects, as these may create the opportunity to bring forward comparatively low-ranked walking schemes, but in a highly cost-effective way.

The following paragraphs present alternative approaches that may be used by authorities to decide which pedestrian schemes should be implemented first. Since all approaches have advantages and weaknesses, it is recommended to use several of the following approaches in parallel and then implement those schemes that perform well overall.

Alternative methods for the prioritization of pedestrian improvement schemes are (NZTA, 2009):

- Pedestrian numbers.
- Trip linkage.
- Barrier/gap removal.
- Proximity.
- Land-use.
- Perceived need.
- Crash records.
- Demonstrable achievement.
- Combined approach taking into account pedestrians' actual and perceived needs.

Each of these methods, along with its strengths and weaknesses, is described below.

E.2. Pedestrian Numbers

The "pedestrian numbers" method is used on routes with existing high pedestrian use.

This method ensures that the greatest number of pedestrians will benefit from the treatment. This method can be useful in the identification of high-profile schemes that help demonstrate a commitment to walking.

On the other hand, it fails to consider areas where flows are suppressed by hazards, physical difficulties or personal safety concerns. Furthermore, it is difficult to compare pedestrian flows, due to their inherent variability.

E.3. Trip Linkage

The "trip linkage" method is preferred on routes used for trips between the greatest number of origins and destinations. Thus, the greatest number of pedestrians benefit from the treatment. This method can be useful in the identification of high-profile schemes that help demonstrate a commitment to walking. Furthermore, it may reflect latent demand.

However, it does not consider pedestrian numbers and it takes no account of whether there are actual or perceived problems.

E.4. Barrier / Gap Removal

The "barrier/gap removal" method is preferred on schemes that remove physical obstacles on routes where the surrounding pedestrian facilities are of high quality.

The "barrier/gap removal" is a valuable method, as it creates continuous routes, it is straightforward on the identification of physical barriers and is especially effective in creating the core of the pedestrian network.

Still, it is difficult to ascertain perceived barriers without considerable data.

E.5. Proximity

The "proximity" method is used on schemes that are geographically closest to a major trip origin or destination.

This method may benefit the maximum number of pedestrians, as the likelihood of walking declines with increasing distance. It may also reflect latent demand. Additionally, trip origins and destinations are straightforward to identify.

On the other hand, it does not consider pedestrian numbers and it takes no account of whether there are actual or perceived problems.

E.6. Land-Use

The "land-use" method works fairly well for schemes in areas likely to be used by vulnerable pedestrian groups, such as in the vicinity of schools and hospitals.

This method is useful as it can have a major effect on crash rates in the area(s) treated. Also, the type of land-use to be treated can easily be changed and it creates a high-quality environment for pedestrians, albeit in a limited area.

However, it disregards longer-distance routes between origins and destinations, it may not support connected networks and may not identify the needs of other pedestrians in areas of different land-uses.

E.7. Perceived Need

The "perceived need" method is used in areas where pedestrians feel there is the greatest need, determined through consultation. This method has the potential to reflect latent demand and it can be useful to demonstrate publicly a commitment to schemes.

Conversely, the actual need may be different from perceived need. Furthermore, it requires a consultation exercise and it only reflects the views of those consulted.

E.8. Crash Records

The "crash records" method is preferred in schemes that generate the greatest potential crash cost savings. This method is useful as crash data is easily available and it can result in cost-effective solutions.

On the other hand, significant under-reporting of pedestrian accidents means that not all locations will be identified. Also, it may not account fully for places that pedestrians may avoid because of poor perceptions and long delays.

E.9. Demonstrable Achievement

The "demonstrable achievement" method is used on schemes that are the cheapest and/or easiest to implement. With this method the maximum number of schemes on the ground are generated.

However, it does not consider the perceived pedestrian need for schemes. Also, the cheapest and easiest solutions may not be the most cost effective or appropriate.

E.10.Combined Approach

The "combined approach" takes into account pedestrians’ actual and perceived needs. It is used on schemes that take into account safety factors and exposure for existing and expected future use. This method is a holistic approach.

Appendix F - Highway Capacity

F.1. Basic Motorized Vehicle Flow Parameters

In this section certain fundamental vehicle flow parameters are presented, used to determine highway capacity and level of service.

F.1.1. Volume and Flow Rate

Volume and flow rate are two measures that quantify the number of vehicles passing a point on a lane or highway during a given time interval.

These terms are defined as follows:

- **Volume** – the total number of vehicles (observed or predicted) passing over a given point or section of a lane or highway during a given time interval; any time interval can be used, but volumes are typically expressed in terms of annual, daily, hourly, or sub hourly periods.
- **Flow Rate** – the equivalent hourly rate at which vehicles pass over a given point or section of a lane or highway during a given time interval of less than 1 h, usually 15 min (but expressed as an equivalent hourly rate).

F.1.1.1 Peak hour traffic and design hour volume

Peak hour traffic volumes are critical in evaluating capacity and other parameters because they represent the most critical time period. It is the period during which demand is at its highest. A key design decision involves determining which hourly volume should be used for design. The selected design hourly volume (DHV) should not be so low that it is often exceeded, or so high that users would rarely be sufficient to make full use of the resulting facility. The selection of an appropriate hour for planning, design, and operational purposes is a compromise between providing an adequate level of service for all users for nearly every hour of the year and providing economic efficiency.

For rural and recreational routes, the 30th highest hour is typically used for the DHV. For urban areas, the 100th highest hour is often used for the DHV. The designer should review the resulting conditions of the selected design hour, to ensure that the design is acceptable (i.e., meets the needs of all highway users).

F.1.1.2 Peak hour factor

The PHF is the ratio of total hourly volume to the peak flow rate within the hour and should be determined according to the provisions of HCM (TRB, 2022). For capacity analysis, the traffic engineer should use the peak 15 min rate of flow during the analysis hour. For this purpose, peak hour factor (PHF) should be used to convert an hourly volume into a peak 15-min flow rate.

F.1.1.3 Directional distribution

For two-lane rural highways, the DHV is the total traffic in both directions of travel. In the design of highways with more than two lanes, on two-lane highways where important intersections are encountered, or where additional lanes are to be provided later, knowledge of the hourly traffic volume for each direction of travel is important.

The directional distribution of traffic volumes during the design hour should be determined by making field measurements on the facility under consideration or on parallel and similar facilities.

In designing intersections and interchanges, the volumes of all movements occurring during the design hour is required. This information is necessary for both the morning and evening peak periods because the traffic pattern may change significantly from one peak hour to the other.

F.1.1.4 Traffic composition

Vehicles of different sizes and weights have different operating characteristics and should be considered in highway design for estimation of demand and the highway capacity needed.

F.1.2. Speed

Speed is defined as a rate of motion expressed as distance per unit of time, generally as kilometers per hour (km/h). To characterize the speed of a traffic stream, a representative value must be used, because a broad distribution of individual speeds is observable in the traffic stream. Basic speed parameters are the average travel speed, time mean speed, free-flow speed, average running speed.

F.1.3. Density

Density is the number of vehicles occupying a given length of a lane or highway at a particular instant and is expressed as vehicles per kilometer (veh/km) or passenger cars per kilometer (pc/km). Density is a critical parameter for uninterrupted-flow facilities because it characterizes the quality of traffic operations.

F.1.4. Headway and Spacing

Headway is the time between successive vehicles as they pass a point on a lane or highway, measured from the same point on each vehicle. Spacing is the distance between successive vehicles in a traffic stream, measured from the same point on each vehicle (e.g., front bumper, front axle).

F.1.5. Additional Interrupted-Flow Parameters

Interrupted flow can be more complex to analyze than uninterrupted flow because of the time dimension involved in allocating space to conflicting traffic streams. On an interrupted-flow facility, flow usually is dominated by points of fixed operation, such as traffic signals and STOP signs. These controls have different impacts on overall flow.

The operational state of traffic on an interrupted-flow facility is defined by the following measures:

- Volume and flow rate.
- Control variables (signal, STOP, or YIELD control), which in turn influence.
- Saturation flow and departure headways.
- Gaps available in the conflicting traffic streams.
- Control delay.

F.2. Capacity

Capacity is the maximum sustainable hourly flow rate at which persons or vehicles reasonably can be expected to traverse a point or a uniform section of a lane or highway during a given time period under prevailing highway, environmental, traffic, and control conditions (TRB, 2022).

The following should be considered with respect to capacity.

- Capacity analyses typically evaluates the peak 15 minutes of an analysis hour (refer to Peak hour factor Section F.1.1.2). A 15-minute analysis period accommodates most variations in flow without producing an excessively conservative estimate of capacity. For additional guidance on traffic analysis the reader should refer to Chapter 3 of SHC 601 (Traffic Engineering).
- Prevailing highway, environmental, traffic, and control conditions should be reasonably uniform for any segment of a facility that is analyzed.
- Highway conditions include the number and width of lanes, shoulder widths and lateral clearances, design speed, horizontal and vertical alignments and the availability of exclusive turn lanes at intersections.
- Traffic conditions include vehicle type (e.g., the proportion of trucks in the traffic stream), the proportion of highway users who are regular users, turning-movement patterns at intersections, and the distribution of vehicles between lanes and directions of a highway.
- Control conditions include the types of traffic control used at intersections (e.g., traffic signals, STOP or YIELD signs), the amount of green time allocated to a particular movement at a traffic signal, as well as restrictions on the use of certain lanes (e.g., truck prohibitions in the left lane of a freeway).

The goal of the designer is to ensure the expected capacity of a highway reasonably meets the demand for all users of the facility (pedestrian, transit users, cyclists, motor vehicular users, trucks).

Vehicle capacity is normally expressed in passenger cars/hour/lane. In the capacity and level of service analysis, heavy vehicles have to be converted to their passenger car equivalents (PCEs). The base capacity represents the capacity of the facility, assuming that there are no heavy vehicles in the traffic stream and that all drivers are regular users of the segment. To determine the actual lane capacity, base capacity and the methodologies presented in HCM (TRB, 2022) should be used.

The results of the capacity analysis for links on arterial or collector highways with signal, stop, give-way, or roundabout control need to be discussed in relation to the relevant intersection analysis results. Free-flow links (e.g., freeways) may also be affected by weaving merging and diverging. Critical results therefore need to be discussed and agreed upon with the competent authorities.

For capacity analyses all default parameters used shall be agreed upon with the competent authority.

F.2.1. Saturation Flow Rate at Signalized Intersections

For signalized intersections, capacity is calculated as the product of saturation flow rate and effective green divided by the cycle length. Saturation flow rate is the maximum flow rate of vehicles that can be sustained across a signal stop line, assuming 100 % green time and is expressed in passenger cars per hour green per lane.

The base saturation flow rate that should be used in the analysis model is 1,900 passenger cars per hour of green (at a traffic signal) per lane. This value should be adjusted for prevailing traffic conditions (e.g., lane width, left turns, right turns, heavy vehicles, grades, parking, area type, bus blockage, left-turn blockage).

To determine the actual lane capacity, base capacity and the methodologies presented in HCM (TRB, 2022) should be used.

F.2.2. Application

Highway capacity serves the following three general purposes (AASHTO, 2018):

- **Transportation Planning Studies:** Highway Capacity Analyses is used in these studies to assess the adequacy of sufficiency of existing highway networks to service current or future traffic volumes and identify the need for potential infrastructure improvements.
- **Highway Design:** Highway capacity is essential to properly fit a planned highway to traffic demands. Highway capacity is used both to select the highway type as well as to determine the dimensions of its elements (e.g., number and type of lanes, minimum lengths for weaving sections etc.)
- **Traffic Operational Analyses:** Highway Capacity Analysis is commonly used for identifying existing or potential bottleneck locations. It is also used to estimate the traffic impact of proposed developments in the transport system as well as to estimate operational improvements that may result from prospective traffic control measures or from spot alterations in the highway geometry.

F.3. Quality of Service

Quality of service describes how well a transportation facility or service operates from a traveler’s perspective. Quality of service can be assessed in a number of ways. Among them are direct observation of factors perceivable by and important to travelers (e.g., speed or delay), surveys of travelers, the tracking of complaints and compliments about highway conditions, forecasts of traveler satisfaction on the basis of models derived from past traveler surveys, and observation of things not directly perceived by travelers (e.g., average time to clear a crash) affecting things they can perceive (e.g., speed or arrival time at work) (TRB, 2022).

The traffic engineer shall consider all aspects of quality of service such as, travel time, travel time reliability, speed, delay, ability to maneuver, convenience of travel, safety, user cost, availability of facilities and services, highway aesthetics, and information availability (TRB, 2022)

Quality of service is one dimension of mobility and overall transportation system performance. Other dimensions that the traffic engineer shall consider are the following:

- Quantity of service – such as the number of person kilometers and person-hours provided by the system.
- Capacity utilization – including the amount of congestion experienced by users of the system, the physical length of the congested system, and the number of hours that congestion exists.
- Accessibility – for example, the percentage of the population able to complete a selected trip within a specified time.

Appendix G - Glossary of Terms

Access - Permission, liberty, or ability to enter, approach, or to make use of.

Access (Mode) - A feeder mode to the principal mode of transportation; for example, walking and park-and-ride.

Access Point - An unsignalized intersection, driveway, or opening on either side of a highway.

Accessibility - The percentage of the populace able to complete a selected trip within a specified time.

Agglomeration - Part of a territory, delimited and determined by the KSA as an urbanised area, based on population and population density criteria.

All-Way STOP-Controlled (AWSC) Intersection - An intersection with STOP signs on all approaches. The driver's decision to proceed is based on a consensus of right-of-way governed by the traffic conditions of the other approaches and the rules of the road (e.g., the driver on the right has the right-of-way if two vehicles arrive simultaneously).

Alternative Intersection - An intersection created by rerouting one or more movements (often left turns) from their usual places to secondary junctions.

Arterial - A signalized street that primarily serves through traffic and that secondarily provides access to abutting properties.

Average Travel Speed - The length of the highway segment divided by the average travel time of all vehicles traversing the segment, including all stopped delay times.

Base Capacity - The flow rate achievable under base conditions. Base capacity reflects ideal conditions on a facility with no capacity-reducing effects.

Basic Freeway Segment - A length of freeway facility whose undersaturated operations are unaffected by weaving, diverging, or merging.

Bicycle - Vehicle with two wheels in tandem that is propelled by human power and is usually ridden by one person.

Bus - Self-propelled, rubber-tired road vehicle designed to carry a substantial number of passengers and commonly operated on streets and highways.

Bus Bulb - An extension of the sidewalk into the highway for passenger loading without the buss pulling into the curb, gives priority to buses and eases re-entry into traffic.

Bus Rapid Transit (BRT) - Bus rapid transit is a public transportation strategy where buses travel on exclusive right of way or receive preferential treatment at signalized intersections, with the objective of reducing transit vehicle travel time and increasing reliability.

Collector - Roadways servicing traffic between major and local streets. These are streets primarily used for traffic movements within residential, commercial, and industrial areas. Collector streets may be used for truck or bus movements and give direct service for abutting properties.

Collector-Distributor Highway (C-D Highway) - A continuous highway without local access provided parallel to a freeway mainline through one or more interchanges for the purpose of removing weaving movements or closely spaced merges and diverges from the mainline.

Commute - Regular travel between home and a fixed location (e.g., work, school).

Complete Streets - A transportation design approach that requires streets to be planned, designed, operated and maintained to enable safe, convenient and comfortable travel and access for users of all ages and abilities regardless of their mode of transportation. Complete Streets allow for safe travel by those walking, cycling, driving automobiles, riding public transportation, or delivering goods.

Control Delay - Delay brought about by the presence of a traffic control device, including delay associated with vehicles slowing in advance of an intersection, the time spent stopped on an intersection approach, the time spent as vehicles move up in the queue, and the time needed for vehicles to accelerate to their desired speed.

Corridor - A set of parallel transportation facilities designed to move people between two locations, for example, a freeway and an arterial street.

Coverage - In transit operations, the geographical area that a transit system is considered to serve, normally based on acceptable walking distances (e.g., 0.4 km) from loading points. For suburban rail transit that depends on automobile access (park-and-ride), coverage may extend several kilometers. Coverage is usually computed for transit-supportive areas.

Crosswalk - 1. That part of a roadway at an intersection included within the connections of the lateral lines of the sidewalks on opposite sides of the highway measured from the curbs or in the absence of curbs, from the edges of the traversable roadway, and in the absence of a sidewalk on one side of the roadway, the part of a roadway included within the extension of the lateral lines of the sidewalk at right angles to the center line. 2. Any portion of a roadway at an intersection or elsewhere distinctly indicated as a pedestrian crossing by pavement marking lines on the surface, which might be supplemented by contrasting pavement texture, style, or color.

Curb Extension - Curb extensions visually and physically narrow the highway, creating safer and shorter crossings for pedestrians while increasing the available space for street furniture, benches, plantings, and street trees. They may be implemented on downtown, neighborhood, and residential streets, large and small. Curb extensions have multiple applications and may be segmented into various sub-categories, ranging from traffic calming to bus bulbs and mid-block crossings.

Cycle Length - The duration of a complete sequence of phases in the absence of priority calls. In an actuated controller unit, a complete cycle is dependent on the presence of calls for all non-priority phases. Some indications may be served more than once in a cycle.

Delay - Additional travel time experienced by a driver, passenger, bicyclist, or pedestrian beyond that required to travel at the desired speed.

Demand Responsive Transit (DRT) - Forms of transportation services that are more flexible and personalized than conventional fixed-route, fixed-schedule service. The vehicles for Demand Reponsive Transit service are usually low- or medium-capacity highway vehicles, and the service offered is adjustable in various degrees to individual users' needs.

Demand Volume - The number of vehicles that arrive to use the facility. Under noncongested conditions, demand volume is equal to the observed volume.

Demand-to-Capacity Ratio - The ratio of demand volume to capacity for a system element.

Density - The number of vehicles in a segment at an instant of time divided by the length of the segment expressed in vehicles per kilometer (per lane).

Design Hourly Volume (DHV) - The volume of traffic during one hour (design hour) that is used as an acceptable operating condition for design purposes.

Design Speed - A speed selected for purposes of design and correlation of the geometric features of a highway and a measure of the quality of service offered by the highway.

Distributor Highway - Distributor highways connect highways with a residential function (access streets) and highways with a flow function (through highways).

Double-Decker Bus - A high-capacity bus that has two levels of seating, one over the other, connected by one or two stairways.

Driveway - A defined area used by vehicles travelling between a public highway and a property adjacent or near to the highway.

Dwell Time - Either: 1. The sum of passenger service time and boarding lost time, or 2. The time a transit unit (vehicle or train) spends at a station or stop, measured as the interval between its stopping and starting.

Effective Green Time (G) - The time during which a combination of traffic movements is considered to proceed effectively at the saturation flow rate. Measured in seconds.

Expressway - A high-speed divided arterial highway for through traffic with limited points of access or exit and grade separations at major intersection.

Feeder (Service) - Either: 1. Local transportation service that provides passengers with connections with a major transportation service, or 2. Local transit service that provides passengers with connections to mainline arterial service; an express transit service station; a rail rapid transit, commuter rail, or intercity rail station; or an express bus stop or terminal.

Fixed-Route (Transportation System) - Service provided on a repetitive, fixed-schedule basis along a specific route with vehicles stopping to pick up and deliver passengers to specific locations.

Flow Rate - The equivalent hourly rate at which vehicles or other highway users pass over a given point or section of a lane or highway during a given time interval of less than 1 hour, usually 15 min.

Follower - A vehicle following its leader at a headway of 2.5 seconds or less (TRB, 2022).

Follower Density - The number of followers per kilometer per lane.

Free-Flow Speed (FFS) - The average speed of vehicles on a roadway segment measured under low-volume conditions and in the absence of traffic control devices. FFS can either be estimated using analytical model or based on field measurement.

Freeway - A fully access-controlled, divided highway with a minimum of two lanes (and frequently more) in each direction.

Freeway Facility - An extended length of freeway composed of continuously connected basic freeway, weaving, merge, and diverge segments.

Freeway Weaving Segment - Freeway segments in which two or more traffic streams traveling in the same general direction cross paths along a significant length of freeway without the aid of traffic control devices (except for guide signs).

Freight - Any commodity being transported.

Frequency (Service) - The number of transit units (vehicles or trains) on a given route or line, moving in the same direction, that pass a given point within a specified interval of time, usually 1 hour.

Functional Classification - The grouping of streets and highways into classes, or systems, according to the character of service they are intended to provide.

Gap - The available time in seconds between two successive vehicles at the same point in space, measured from the rear bumper of the lead vehicle to the front bumper of the following vehicle.

High Occupancy Vehicle (HOV) - A motor vehicle carrying more than one person, including carpools, vanpools and buses.

Highway - A general term for denoting a public way for purposes of vehicular travel, including the entire area within the right-of-way.

Hov Lane - Any preferential lane designated for exclusive use by high occupancy vehicles for all or part of a day, including a designated lane on a freeway, other highway, street, or independent highway on a separate right of way.

Intelligent Transportation Systems (ITS) - Include the application of advanced and emerging technologies in fields such as information processing, communications, control and electronics to surface transportation needs.

Interchange - A system of interconnecting highways providing for traffic movement between two or more highways that do not intersect at grade.

Interchange Ramp Terminal - A junction of a ramp with a surface street serving vehicles entering or exiting a freeway.

Intercity (Transportation) - 1. Transportation between cities. 2. Transportation service provided between cities by certificated carriers, usually on a fixed route with a fixed schedule.

Intersection - A point where two or more highways cross or meet at grade, where vehicular travel between the highways is accomplished via turning movements, and where right-of-way is typically regulated through the use of traffic control devices.

Island - A defined area between traffic lanes for control of vehicular movements, for toll collection, or for pedestrian refuge. It includes all end protection and approach treatments. Within an intersection area, a median or an outer separation is considered to be an island.

Layover Time - Time built into a schedule between arrivals and departures, used for the recovery of delays and preparation for the return trip. The term may refer to transit units (also known as vehicle layover) or operators. Note that layover time may include recovery time and operator rest time as two specific components.

Level of Service (LOS) - A quantitative stratification of a performance measure or measures that represent quality of service, measured on an A-F scale, with LOS A representing the best operating conditions from the traveler’s perspective and LOS F the worst.

Light Rail Transit (LRT) - A form of urban rail public transportation characterized by a combination of tram and rapid transit features that usually use electric rail cars operating mostly in private rights-of-way separated from other traffic but sometimes, if necessary, mixed with other traffic in city streets.

Light Rail Vehicle (LRV) - A streetcar or rail vehicle similar to a streetcar, often articulated, operating on light rail systems with substantial amounts of segregated track and higher speeds than traditional on-street streetcar operation.

Limited Access (Controlled Access) - In transportation, to have entry and exit limited to predetermined points, as with rail rapid transit or freeways.

Line-Haul (Service) - 1. Transportation service along a single corridor, without branches, with stops along the way. Usually service is intensive (high capacity) and may use exclusive right-of-way. 2. May also be used to describe express service or even main-line service, as opposed to feeder service.

Link - A directional connection between two areas with an origin - destination relationship.

Link (Model) - The spatial representation of a highway segment in a travel demand model.

Local Street or Local Road - Roadways which provide high access to abutting property, low average traffic volumes, and short average trip lengths. Local roads and streets may include minor county roads, minor urban and suburban subdivision streets, and graded or unimproved roads.

Major Activity Center - A geographical area characterized by a large transient population and heavy traffic volumes and densities; for example, central business district, major air terminal, large university, large shopping center, industrial park, sports arena.

Median - A divider or island placed usually at the centerline of a highway which is meant to separate opposite directions of travel.

Micromobility - Any small, low-speed, human- or electric-powered transportation device, including bicycles, scooters, electric-assist bicycles, electric scooters (e-scooters), and other small, lightweight, wheeled conveyances.

Mid-Block Crossings - Crossings to places that people want to go but that are not well served by the existing traffic network. These pedestrian crossings, which commonly occur at schools, parks, museums, water-fronts, and other destinations.

Mobility - The quality or condition of being mobile by a given mode of transportation or a combination of modes (walking, bicycle, private auto, taxi, bus, light rail, rail rapid transit, airline, private aircraft, or other means) to satisfy personal needs or objectives.

Multilane Highways - Higher-speed facilities, with two or more lanes in each direction, without full access control (i.e., traffic can enter or exit via at-grade intersections, which may or may not be signal controlled).

No-Show - In demand-responsive transit (DRT), a no-show occurs when a passenger fails to show up for a scheduled trip, resulting in a negative impact on other passengers' quality of service on a shared-ride trip, and on DRT performance for the transit agency. When a scheduled rider no-shows a trip, passengers on board the DRT vehicle spend extra time traveling to the pick-up location and waiting for that rider who does not appear.

On-Road Public Transport (ORPT) - Includes on-road public transport means like buses, trams etc.

Park-and-Ride - An access mode to transit in which patrons drive private automobiles or ride bicycles to a transit station, stop, or carpool-vanpool waiting area and park the vehicle in the area provided for that purpose. They then ride the transit system or take a car or van pool to their destinations.

Passenger Car Equivalent (PCE) - The number of passenger cars that will result in the same operational conditions as a single heavy vehicle of a particular type under identical highway, traffic, and control.

Passenger Load - The number of passengers on a transit unit (vehicle or train) at a specified point.

Pedestrian - Any person on foot or who is using a powered wheelchair or mobility scooter or a wheeled means of conveyance propelled by human power, other than a cycle.

Performance Measure - A data element used to quantify a particular aspect of transportation service and used to describe its quality of service. Examples of performance measures include delay, travel time, or emissions.

Quality of Service - An approach of quantifying the travel experience for users of the transportation system.

Queue Length - The length of all vehicles stopped at a traffic control device or delayed at a bottleneck on a freeway.

Rail Rapid Transit (System) (RRT) - Transit system using trains of high performance, electrically powered rail cars operating in exclusive rights-of-way, usually without grade crossings, with high platform stations. The tracks may be in underground tunnels, on elevated structures, in open cuts, at surface level, or any combination thereof.

Ramp - 1. A dedicated highway providing a connection between two other highways; at least one of the highways a ramp connects is typically a high-speed facility such as a freeway, multilane highway, or Collector-Distributor highway. 2. A sloped walkway connecting pedestrian facilities at different elevations.

Ramp-Freeway Junction - The point of connection between a ramp and a high-speed facility, such as a freeway, multilane highway, or Collector-Distributor highway, designed for high-speed merging or diverging without control.

Rapid Transit (System) (RTS) - Transit service that is operated completely separate from all other modes of transportation. The term "rail rapid transit" frequently refers both to operation of light rail transit vehicles over exclusive right-of-way and heavy rail transit vehicles; the term "bus rapid transit" refers to operation of motor buses over exclusive bus roads or busways.

Reliability - A User-Perception measure of traffic performance, indicating relatively stable traffic conditions over multiple days that guide driver expectations.

Response Time - In demand-responsive operations, the time between a passenger's request for service and the passenger pickup.

Ridesharing - A form of transportation, other than public transit, in which more than one person shares in the use of the vehicle, such as a bus, van, or automobile, to make a trip.

Right-of-Way (ROW) - The entire width between the boundaries of a strip of land occupied or intended to be occupied by a road, sidewalk, crosswalk, railroad, electric transmission line, oil or gas pipeline, water line, sanitary storm sewer, or other similar uses.

Roadway - That portion of a highway improved, designed, or ordinarily used for vehicular travel and parking lanes, but exclusive of the sidewalk, berm, or shoulder even though such sidewalk, berm, or shoulder is used by persons riding bicycles or other human-powered vehicles. In the event a highway includes two or more separate roadways, the term roadway as used in this Volume shall refer to any such roadway separately, but not to all such roadways collectively.

Roundabout - An intersection with a generally circular shape, characterized by yield on entry and circulation around a central island.

Route - 1. The geographical path followed by a vehicle or traveler from start to finish of a given trip. 2. A designated, specified path to which a transit unit (vehicle or train) is assigned. Several routes may traverse a single portion of highway or line. 3. In traffic assignments, a continuous group of links that connects two centroids, normally the path that requires the minimum time to traverse. 4. The specified course of a driver traveling through a simulated transportation network. Routes can be permanently defined by the user (static) or can be determined through a path-optimization algorithm by the model (dynamic).

Saturation Flow Rate - Saturation Flow Rate is the equivalent hourly rate at which previously queued vehicles can traverse an intersection approach, assuming the green signal is available at all times and no lost times are experienced.

Service Measure - A performance measure used to define LOS for a transportation system element.

Service Span (Hours of Service) - 1. The number of hours during the day between the start and end of service on a transit route. 2. For calculating transit level of service, the number of hours during a day when service is provided at least hourly on a transit route.

Shared Parking - Shared Parking is a type of parking where spaces are shared by more than one user, which allows parking facilities to be used more efficiently.

Shuttle (Service) - A service provided by vehicles that travel back and forth over a particular route, especially a short one, or one that connects two transportation systems or centers, or one that acts as a feeder to a longer route. Shuttle services usually offer frequent service, often without a published timetable.

Speed - The rate of travel of a motorized or nonmotorized unit, which is defined as the distance traveled over a unit of time, typically expressed in km/hr or meters per second (m/s).

Stopped Delay - The amount of time that a vehicle is stopped. When calculated from vehicle trajectories, it is equal to the time step delay on any step in which the vehicle is in a stopped state. Time step delays accumulated over all time steps in which the vehicle was in the stopped state represent the stopped delay for that vehicle.

Streetcar (Tram) - An electrically powered rail car that is operated singly or in short trains in mixed traffic on track in city centers.

Terminal - 1. The end station or stop on a transit line or route, regardless of whether special facilities exist for reversing the vehicle or handling passengers; also known as a terminus. 2. An assemblage of facilities provided by a railroad or intercity bus service at a terminus or at an intermediate location for the handling of passengers and the receiving, classifying, assembling, and dispatching of trains or dispatching of buses; also known as a depot.

Time Mean Speed - The arithmetic average of speeds of vehicles observed passing a point on a highway; also referred to as the average spot speed. The individual speeds of vehicles passing a point are recorded and averaged arithmetically. The time mean speed is always equal to or higher than the space mean speed. The two are equal only when the speeds of all vehicles in the traffic stream are equal.

Tramway - A street transit system consisting of electrically powered rail vehicles operating in single or multiple-unit, mostly on surface streets with mixed traffic.

Transit (Public) - Passenger transportation service, usually local in scope, that is available to any person who pays a prescribed fare. It operates on established schedules along designated routes or lines with specific stops and is designed to move relatively large numbers of people at one time. Examples include bus, light rail, rapid transit.

Transit Lanes - They are a portion of the street designated for the preferential or exclusive use of transit vehicles, sometimes permitting limited use by other vehicles. They are often repurposed from a general traffic lane, designated by striping, signage, and pavement markings. Transit lanes allow transit vehicles to easily enter and exit the lane to suit their route.

Transit Streets - Streets, often running along commercial corridors, that prioritize the street for pedestrian and transit. Motorists are prohibited beyond limited deliveries and occasional permitted access.

Transit-Oriented Development (TOD) - In urban planning, transit-oriented development (TOD) is a type of urban development that maximizes the amount of residential, business and leisure space within walking distance of public transport.

Transitways - On-street transitways are exclusive transit facilities physically separated from mixed traffic highway by medians or other vertical elements. They are often implemented to ensure reliability of high-frequency/high-capacity transit services such as Bus Rapid Transit (BRT), Light Rail Transit (LRT) or modern tramways.

Travel Time (Total) - In transportation planning, the time duration of a linked trip, that is, from the point of origin to the final destination, including waiting and walking time at transfer points and trip ends.

Travel Time Reliability - 1. The probability of "on-time" arrival (i.e., the probability that a trip is completed below a certain threshold time). 2. The variability in travel time for a given trip due to unforeseen causes such as variations in demand or an incident.

Trip - One-way movement of a person or vehicle between two points for a specific purpose; sometimes called a one-way trip to distinguish it from a round trip. 2. The movement of a transit unit (vehicle or train) in one direction from the beginning of a route to the end of it; also known as a run.

Trip Generation - The estimation of the number of trips generated to and from a site resulting from the land-use activity on that site.

Trip, Unlinked - 1. A trip made in a single vehicle. 2. The boarding of one transit vehicle in revenue service; also known as an unlinked passenger trip. 3. Any segment of a linked trip.

Trolleybus - An electrically propelled bus that obtains power via two trolley poles from a dual (positive and negative) overhead wire system along routes. It may be able to travel a limited distance using battery power or an auxiliary internal combustion engine. The power-collecting apparatus is designed to allow the bus to maneuver in mixed traffic over several lanes.

Two-Lane Highways - Facilities with mostly one lane of travel per direction, with motorists using passing lanes, turnouts, or the opposing lane (where allowed by regulation and opposing traffic) to pass slower vehicles.

Two-Way STOP-Controlled - The type of traffic control at an intersection where drivers on the minor street or drivers turning left from the major street wait for a gap in the major-street traffic to complete a maneuver.

Urban Street - A street with a relatively high density of driveway and cross-street access, located in an urban area, with traffic signals or interrupting STOP or YIELD signs.

Urban Street Facility - A length of highway that is composed of contiguous urban street segments.

Urban Street Segment - A length of urban street from one boundary intersection to the next, including the upstream boundary intersection but not the downstream boundary intersection.

Volume - The number of vehicles, pedestrians, bicycles, heavy vehicles, or other user class of interest that are observed passing a point. Volume is often expressed as volume per hour, in which case a specified period of time would be used to calculate a rate.

Volume-To-Capacity (V/C) Ratio - The ratio of flow rate to capacity for a system element.

Weaving Segment (Freeway) - Freeway segments in which two or more traffic streams traveling in the same general direction cross paths along a significant length of freeway without the aid of traffic control devices (except for guide signs).

Appendix H - Abbreviations, Acronyms

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transportation Officials
BRT	Bus Rapid Transit
CBD	Central Business District
DHV	Design Hourly Volume
DRT	Demand Responsive Transit
EMS	Emergency Medical Services
FHWA	Federal Highway Administration (USA)
HCM	Highway Capacity Manual
HGV	Heavy Goods Vehicles
ITE	Institute of Transportation Engineers
ITS	Intelligent Transport Systems
KSA	Kingdom of Saudi Arabia
LoS	Level of Service
LRT	Light Rail Transit
LRTP	Long Range Transportation Plan
MODON	Saudi Authority for Industrial Cities and Technology Zones
MoMRAH	Ministry of Municipal, Rural Affairs and Housing
MoT	Ministry of Transport (renamed to MoTLS)
MoTLS	Ministry of Transport and Logistic Services
NA	Not Applicable
NACTO	National Association of City Transportation Officials (NACTO)

NASEM	The National Academies of Sciences, Engineering, and Medicine
NCHRP	National Cooperative Highway Research Program (USA)
NHTSA	National Highway Traffic Safety Administration (USA)
NPV	Net Present Value
NRSC	National Road Safety Center (of MoTLS)
ORPT	On Road Public Transport
PCE	Passenger-Car Equivalent
QOS	Quality of Service
ROW	Right-Of-Way
SHC	Saudi Highway Code
SPI(s)	Safety Performance Indicator(s)
TCRP	Transit Cooperative Research Program (TRB)
TIS	Traffic Impact Studies
TOD	Transit-Oriented Development
TRB	Transportation Research Board
UNECE	United Nations Economic Commission for Europe
USA	United States of America

Appendix I - Units

SI Units		Imperial Units	
Length			
m	Meter		
km	Kilometer		
Time			
s	Second		
min	Minute		
h	Hour		
Other			
km/h	Kilometer per hour		
m/s	Meter per second		
Other			
pc/km		Passenger car per kilometer	
veh/d		Vehicle per day	
veh/km		Vehicle per kilometer	

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SAUDI HIGHWAY CODE

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