Abu Dhabi Urban Street Design Manual

رؤية أبوظبي 2030
Abu Dhabi Vision 2030

مجلس أبوظبي للتخطيط العمراني
ABU DHABI URBAN PLANNING COUNCIL

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Chapter 1 – Foundation

1.1 Introduction

The Abu Dhabi Urban Street Design Manual has been commissioned by the Abu Dhabi Urban Planning Council (UPC) to address the needs of the growing population and a desire to improve pedestrian facilities to create more walkable communities. This Manual has been developed to address the following needs:

- To accommodate existing driver behavior which is unique to the Emirate of Abu Dhabi due to the diverse population.
- To design streets that create a safe environment for all users, recognizing varying levels of driver education and cultural differences.
- To act as a tool for the transition of Abu Dhabi from a vehicle trip based society to a multi-modal society and supporting the Abu Dhabi Department of Transport's long term public transport plan.
- To introduce fine-grained street networks that allow greater route choice for pedestrians and improve the capacity and efficiency of the Emirate's urban streets.

The Manual introduces to Abu Dhabi the concept of the pedestrian realm as an integral part of the overall street composition and shows how this and the traveled way are combined to provide an overall balanced street network for all modes of transport.

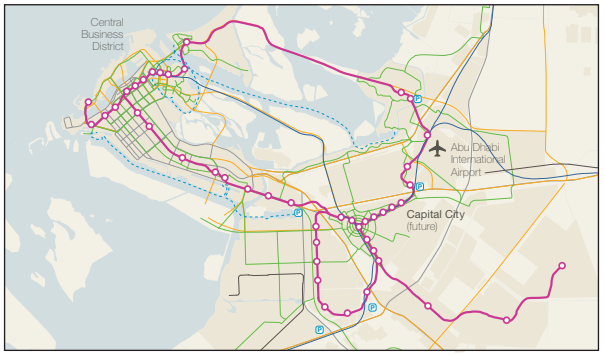
The Manual shall be used by all agencies in the design and approval of all urban street and network designs in the Emirate of Abu Dhabi, and shall take precedence over existing design manuals.

1.2 Manual Intent

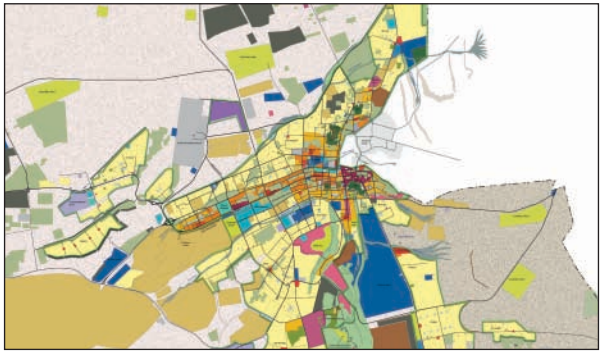
The Abu Dhabi Urban Planning Council (UPC) and the Department of Transport (DOT), in conjunction with the municipalities of Abu Dhabi, Al Ain, and Al Gharbia, as well as the Abu Dhabi Police (ADP), have developed the Abu Dhabi Urban Street Design Manual as a tool for the continuing implementation of the 2030 Plans for all three municipalities making up the emirate of Abu Dhabi. It is part of the DOT's mandate to deliver an effective, multi-modal transport system that contributes to the quality of life and sustainability of the Emirate.

This Manual is part of the UPC's development regulations and is approved by the Executive Council for use in all urban streets in the Emirate, as defined by this Manual or otherwise by the UPC. This Manual constitutes one of many related design initiatives in the Emirate. It shall be used in conjunction with other adopted standards and guidelines as applicable. The street design process integrates the needs of different agencies, including the Department of Municipal Affairs (DMA), UPC, DOT, ADP, and Civil Defense, and shall be undertaken by multiple professionals, including urban planners and designers, traffic engineers, civil engineers, and landscape architects.

The Abu Dhabi Urban Street Design Manual will be updated regularly as new data and experience with best practices become available. Please check the UPC and DOT websites for the latest version before using this Manual.



Abu Dhabi 2030 Transportation Framework



Al Ain 2030 Land Use Framework

Al Gharbia 2030 Settlement Areas

1.3 Manual Jurisdiction

For the purpose of this Manual, urban streets are all streets within the existing and planned urban areas of the Emirate, except for rural roads and urban freeways (as shown in the Abu Dhabi Surface Transport Master Plan). Urban areas are defined in the maps contained in the *Plan Abu Dhabi 2030*, *Plan Al Ain 2030,* and *Plan Al Gharbia 2030* plans. Refer to separate DOT guidelines for the design of rural roads and urban freeways. Where ambiguity arises regarding the jurisdiction of a particular street, consult with the UPC.

1.4 Key Design Principles

The standards and guidelines in this Manual are based upon the following key design principles:

- The best transport plan is a good land use plan.
- Good street design starts with pedestrians.
- A well designed street network provides safety for all modes of transport.
- Street connectivity enhances capacity and allows smooth traffic flow.
- Street design reflects Plan 2030 goals for Abu Dhabi Emirate.
- Street design supports Estidama principles.

The street design process within the Manual balances all of the above principles through integrated design and multiple, quantitative measures of success. Designers, urban planners, civil and traffic engineers, and others will work together to enhance the quality of streets throughout the Emirate.

1.4.1 The Best Transport Plan Is a Good Land Use Plan

Streets are not just for movement, but for supporting the land uses along them, including space for café seating, social exchange, children playing, and public plazas. Streets are for the enjoyment of residents and visitors and the economic success of businesses along them.

1.4.2 Good Street Design Starts with Pedestrians

The world's great cities are delightful and safe for walking, resulting not only in reduced rates of driving, but also improved public health. Streets throughout the Emirate will be designed to emphasize family, hospitality, inclusiveness, and pedestrian access to neighborhood facilities, including mosques and schools. Shading and cooling methods will be developed to ensure comfort. Streets shall also feel secure for all users, including women and children, at all times of day and night.

1.4.3 A Well Designed Street Network Provides Safety for All Modes of Transport

The design process in this Manual creates safe, comfortable, and aesthetic street environments that provide a genuine choice of movement. All streets should be designed to accommodate pedestrians, cyclists, transit riders, and motorists so that all modes offer an attractive choice. Safety is achieved through speed management and enforcement. Application of Universal Design principles (see 6.2) also ensures safe and easy access to enhance the social function of streets as public spaces.

1.4.4 Street Connectivity Enhances Capacity and Allows Smooth Traffic Flow

By creating a network of many connected streets, wide streets can be avoided and vehicle flow can be improved while simultaneously increasing pedestrian comfort and safety. A connected street network reduces the amount of vehicle kilometers traveled by providing direct linkages. When coupled with an effective multi-modal transport system, it can decrease congestion and idling rates at junctions and improve overall capacity.

1.4.5 Street Design Reflects Plan 2030 Goals for Abu Dhabi Emirate

The Abu Dhabi Urban Street Design Manual reinforces the Abu Dhabi vision established by the 2030 Plans for three municipalities: Abu Dhabi City, Al Ain, and Al Gharbia. The guiding principles of these documents require the conservation and protection of the natural environment, conscious and deliberate design of the public realm, especially streets, and a proper land use program that enhances and reinforces Abu Dhabi's unique cultural identity.

1.4.6 Street Design Supports Estidama Principles

By designing streets to accommodate all modes of transport, using landscaping and associated irrigation thoughtfully, and enhancing pedestrian comfort, a significant reduction to Abu Dhabi's carbon emissions, urban heat gain effect, and water consumption can be made.

1.5 Manual Goals

The goal of this Manual is to change the priorities of street design from the current focus on motor vehicle traffic to an integrated process that accounts for the needs of pedestrians, transit riders, and bicyclists as well as motorists. This integrated approach will address the following key areas.

1.5.1 Land Use Context

The street design process will closely respond to the land use context and accommodate the particular needs of individual places and neighborhoods.

- The Manual will accommodate all modes of transport according to the land use context.
- The land use context dictates the types of activities taking place along a street and will strongly influence the pedestrian realm design.

1.5.2 Safety

Abu Dhabi's streets will be safe for all users at all times of the day, especially for pedestrians, and with a particular emphasis on children, older adults, and people with impaired mobility. Safety will be achieved in the following ways:

- The reduction in total crashes, injuries, and fatalities by targeting speed, network design, and prioritization of vulnerable users.
- Application of this Manual, educational campaigns for all users, monitoring and effective enforcement of existing laws, and the introduction of strengthened laws and regulations.

Provide well designed public seating areas.

Provide a continuous pedestrian network and adequate accommodation to ensure pedestrian safety.

Provide undisrupted pedestrian pathways.

1.5.3 Efficiency

Abu Dhabi's streets will be designed for the efficient movement of all modes of transport.

- There will be an increase in person capacity of transport networks through investment in transit, bicycling, and walking.
- There will be an increase in connectivity between superblocks in order to provide shorter driving distances and a reduction in congestion at junctions.

1.5.4 Sustainability

Abu Dhabi's streets will contribute toward meeting Estidama principles, as well as achieving thriving natural/environmental, economic, and social systems.

- There will be an increase in rates of walking, bicycling, and transit use to steadily reduce per capita carbon emissions from transport.
- There will be an increase in efficiency of the transport network through a decrease in vehicle idling and vehicle kilometers traveled to reduce Abu Dhabi's carbon footprint and protect natural resources.
- There will be a reduction in irrigation requirements and in the use of groundwater and desalinated water along streets until only treated wastewater and other sustainable sources are used.
- There will be provision of shade in the public realm to reduce ambient temperatures.

1.5.5 Public Health

Abu Dhabi's streets will be designed to accommodate walking and bicycling year round for most residents.

- Good street design will lead to an increase in rates of walking and bicycling.
- Good street design and improved public health will lead to a decrease in obesity, heart disease, and diabetes.

1.5.6 Public Enjoyment

Abu Dhabi's streets will be a pleasure for all users, particularly pedestrians.

- Good street design will lead to an increase in tourism.
- Good street design will lead to an increase in rates of non-utilitarian walking to levels comparable with other urban destinations around the world.

1.5.7 Economic Development & Tourism

Abu Dhabi's streets will enhance the value of all properties along them and will support the Emirate's long-range development strategies.

- Good street design will support an increase in property values and retail success.
- Good street design will support economic development. High quality provisions for all modes will attract investment and tourism.

1.5.8 Culture & Image

Streets will define the image of Abu Dhabi as a gracious, Arab, world class Emirate through attention to detail and imageability, from its quiet residential streets to its grand ceremonial boulevards.

- Design will emphasize privacy and security for women and the creation of family-oriented neighborhoods.
- The public realm will preserve and express local traditions.
- Street infrastructure will be maintained to the highest international standards, consistent with the image of a modern, high amenity Arab city.
- The Emirate's image will be welcoming and multicultural.

The design of the public realm should respect local culture and traditions.

Standards vs. Guidelines

Design guidelines that are presented throughout this Manual are the preferred design approaches for streets in the Abu Dhabi Emirate. However, some design provisions are mandatory, some are strongly encouraged, and some are optional. Look for these language usages to understand the degree of flexibility in design:

- **Standard:** Look for the words "shall" or "shall not," and "must" or "must not." Also look for the words "is required" or "are required."
- **Guideline:** Look for the words "should" or "should not." The words "preferred," "encouraged," or "recommended" may also be used.
- **Optional:** Prescribed options or optional treatments use the words "may" or "may not."

1.6 Design Flexibility

This Manual provides a combination of standards and guidelines that allows for flexible and innovative street design. Standards are required and either mandate or prohibit specific practices, while guidelines are more flexible.

In all cases, the Manual must be applied in conjunction with supporting documents from the UPC, DOT, DMA, and other agencies. Where the standard design process is insufficient, an exceptions process is provided for approval by an approving agency. Chapter 4 of the Manual provides the requirements for the design process.

Priority to pedestrians for a walkable community.

Good street design is vital to the safety and quality of life for all residents of the Abu Dhabi Emirate.

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Chapter 2 – Manual Approach

2.1 Introduction

Drawing from current best practices in the United States, Canada, United Kingdom, Germany, Australia, and other European and Asian countries, this Manual is a significant departure from previous street design practices in the Emirate. Previous design guidance in Abu Dhabi was influenced by documents such as the US Association of State Highway Transportation Officials' *Policy on Geometric Design of Highways and Streets*, which remains a useful document for rural highways, but is inappropriate for urban streets where modes of transport other than the automobile are present.

The mobility functions of urban streets in the Emirate of Abu Dhabi must be balanced with the streets' roles in creating economically vibrant commercial areas, livable neighborhoods, safe and healthy citizens, and a sustainable ecology.

2.2 Conventional Approach

In automobile-oriented cities, street typologies are typically defined by traffic priority – the degree to which streets emphasize through movement for vehicles. This is known as "functional classification." In this conventional approach, streets with the purpose of accommodating a high level of through movement are "arterials," whereas streets that primarily provide access are "locals," and those in between are "collectors" (see Figure 2.1).

2.3 Emerging Practices

Context Sensitive Solutions (CSS) in designing streets is an interdisciplinary approach that involves balancing all stakeholders to design a transport facility that fits its applicable setting and preserves scenic, aesthetic, historic, and environmental resources while maintaining safety and mobility. It also offers flexible design guidelines and standards to design streets that are safe for all users, regardless of their mode of travel.

CSS-inspired design uses a collaborative approach that includes all stakeholders to balance needs between vehicular and pedestrian levels of service, environmental considerations, historic preservation, economic development, and similar community objectives.

Streets in the Emirate of Abu Dhabi serve many functions, and street classifications must reflect more than the simple balance between automobile movement and access. Abu Dhabi's urban street design starts not with automobile throughput, but with the pedestrian, making walkability and livability of foremost importance. Moreover, many streets in Abu Dhabi must accommodate both a high degree of automobile movement and a high degree of accessibility.

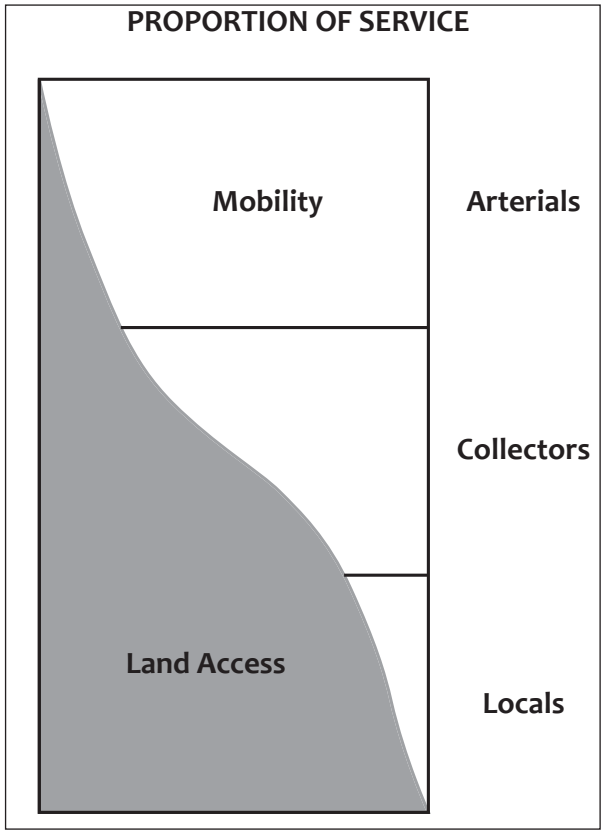


Figure 2.1 Conventional Approach No Longer Used in the Emirate of Abu Dhabi

2.4 Emirate Approach

In order to provide a high quality urban street environment two basic influencing factors need to be considered and balanced. These factors are:

- Land use context
- Transport capacity

Only when both of these factors are given appropriate consideration can a truly urban street design be achieved. It is with this fundamental approach that the design concepts contained within this Manual have been developed.

2.4.1 Changing Land Use Context

The land use context will, in many cases, change along the same street. This change needs to be reflected in the design of the street as it adapts to meet the needs of its surroundings. More intensive land uses may require greater provisions for transit, wider sidewalks, greater network connectivity, and in some cases, more travel lanes.

Liwa Road in Madinat Zayed, Al Gharbia, provides an example of a single street that passes through a series of different land use contexts (Figure 2.2).

As the street progresses, it changes in nature and performs different functions for all the existing modes of transport - pedestrians, bicyclists, and motor vehicles - in the different urban settings.

Khaleej Al Arabi in Abu Dhabi City also provides an example of a street passing through a variety of land uses and changes in density. Figure 2.3 illustrates this change as Khaleej Al Arabi moves from a predominantly residential neighborhood near Al Saada Street, through a mix of community facilities and park space, to finally meet the Corniche road with its surrounding high density mixed land use.

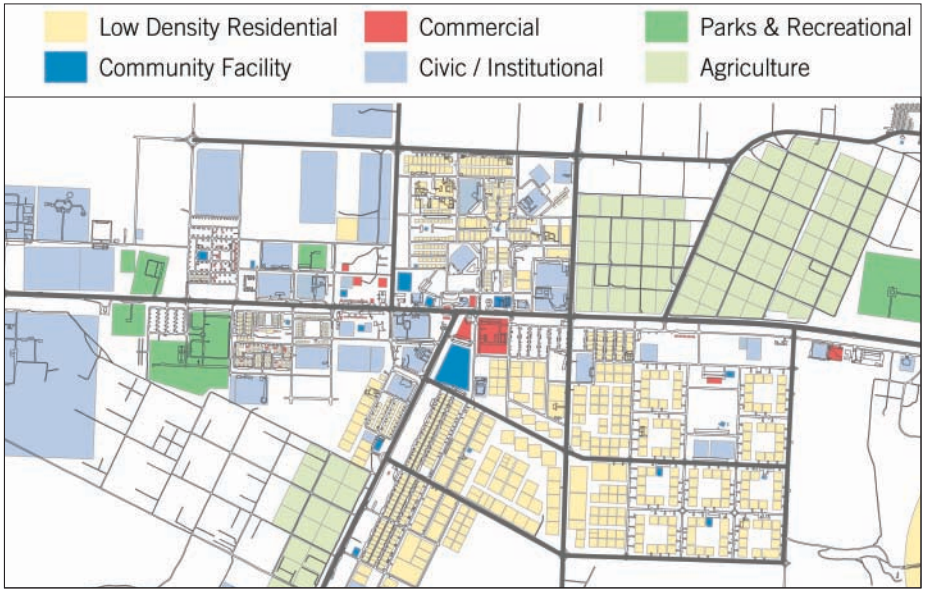


Figure 2.2 Liwa Road in Madinat Zayed

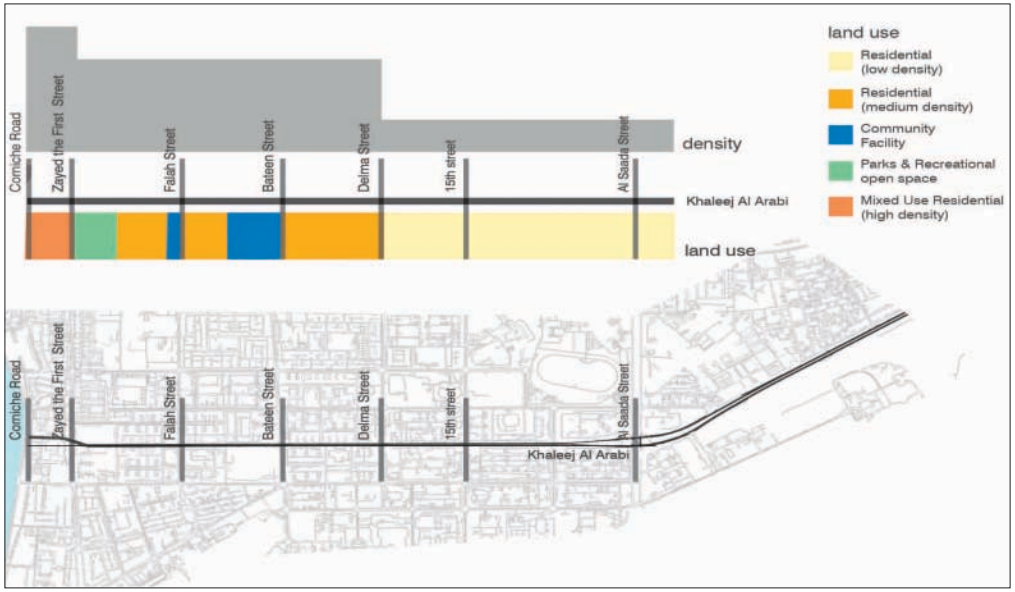


Figure 2.3 Khaleej Al Arabi Land Use Context

2.4.2 Street Typology

The Manual defines streets with a two name convention. The first name, the "Context name," is based on the urban land use, such as "Residential" or "Commercial". The second name, the "Street Family name," refers to the transport capacity of the street.

Context names are defined in detail in Chapter 5 and summarized below:

- City – Mixed use Central Business Districts (CBD) and high density neighborhoods with high levels of pedestrian activity, where buildings are typically seven stories and higher.
- Town – Mixed use areas with medium levels of pedestrian activity, where buildings are typically three to six stories.
- Commercial – Areas throughout the city intended to provide a variety of working, shopping, and service options and convenience.
- Residential – Areas that provide a variety of housing opportunities, allowing for densities varying from villa to multi-dwelling residential buildings.
- Industrial – Areas for businesses that have potential to create adverse visual, noise, or other impacts to adjoining public and residential properties. Uses include warehousing and distribution with support commercial services, ancillary office space, and labor camps.
- No Active Frontage – Places where no buildings or land uses front onto the street, such as a perimeter wall around a palace or residential neighborhood. These areas experience low levels of pedestrian activity.

Street family names are:

- Boulevard: a high vehicle priority 3+3 street (three lanes in each direction).
- Avenue: a medium vehicle priority 2+2 street (two lanes in each direction).
- Street: a low vehicle priority 1+1 street (one lane in each direction).
- Access Lane: a very low vehicle priority 1+1 street (one lane in each direction). This could also be a one-lane shared street.

Note that the terminology used to define the street typology (i.e. Boulevard, Avenue, etc.) is for professional use; it is possible that the public naming of the streets will follow different conventions.

Table 2.1 illustrates the 24 potential combinations of standard street types. Using this table it is possible to define a high capacity street in a high density mixed use area as a City Boulevard. A medium capacity street in an industrial area becomes an Industrial Avenue. Dimensions for each of these street types, including sample cross sections, are found in Chapter 5.

In cases where there is a dedicated transit lane on the street, the transit lane will not be counted in the definition of the street family name. For example, a 2+2 street with one lane of transit in either direction in a mixed use city context will be referred to as a City Transit Avenue.

Urban streets should not exceed 3+3 lanes unless otherwise approved through the exceptions process described in Chapter 4. Higher projected volumes of traffic should be accommodated in the street network layout through the addition in the number of streets and the distribution of traffic over a larger area, or by providing enhancements to other modes of travel.

Street Family	Transport Capacity		Land Use Context					
	Vehicle Priority	Travel Lanes	City (7stories +)	Town (3-6 stories)	Commercial (1-3 stories)	Residential (1-3 stories)	Industrial	No Active Frontage
Boulevard	High	3+3	City Boulevard	Town Boulevard	Commercial Boulevard	Residential Boulevard	Industrial Boulevard	General Boulevard
Avenue	Medium	2+2	City Avenue	Town Avenue	Commercial Avenue	Residential Avenue	Industrial Avenue	General Avenue
Street	Low	1+1	City Street	Town Street	Commercial Street	Residential Street	Industrial Street	General Street
Access Lane	Very Low	1+1 1 shared	City Access	Town Access	Commercial Access	Residential Access	Industrial Access	General Access

Table 2.1 Naming Combinations

Table 2.2 Street Typology Examples

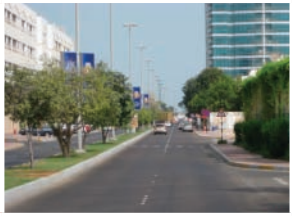
Street Family	Land Use Context				
	City (7 stories +)	Town (3-6 stories)	Commercial (1-3 stories)	Residential (1-3 stories)	Industrial
Boulevard					
Avenue					
Street					
Access Lane					

Table 2.2 provides examples of streets as classified with the new street typology.

2.5 Applying the Manual

The 2030 Plans guide the Emirate's transition toward more sustainable land use planning. In the same fashion, this Manual guides the transition of the Emirate's streets toward a more multi-modal, walkable, low-carbon future. Changing from Abu Dhabi's current auto-oriented streets and driving behaviors, however, will present certain challenges.

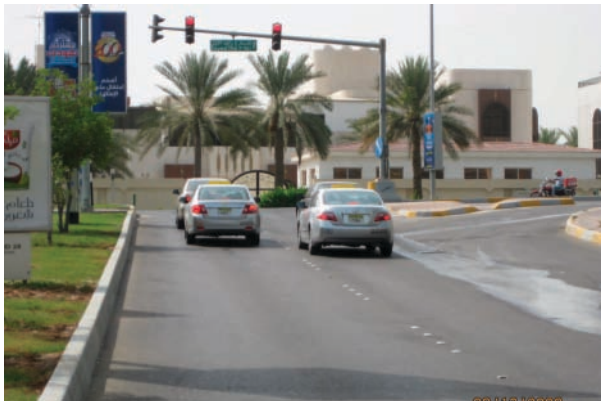
To be effective, the new street designs presented here should be supplemented with ongoing enforcement of laws regarding safe driving behavior – particularly reduced vehicle speeds and yielding to pedestrians in urban areas. In addition, new streets require a public education campaign aimed at changing the culture of transport in the Emirate. The educational campaign should address the Emirate's great diversity, ensuring that there is a common understanding of the rules of the road. Beyond improving compliance with traffic laws, however, the education effort should also provide encouragement of more walking, bicycling, and transit use, even as the networks for these modes are being developed.

While this Manual represents a significant departure from past practice, it remains a "transitional" document, recognizing that driver behavior and rates of walking in the Emirate are different from Europe and North America. While moving the Emirate's streets toward the future envisioned in the 2030 Plan, the Manual acknowledges current conditions in many ways, including the following:

- Abu Dhabi drivers are noted for their high rate of compliance with traffic signals. As a result, the Manual tends to emphasize use of signalized junctions and pedestrian crossings in order to maximize safety, rather than assuming motorists will yield to pedestrians. Similarly, to enhance pedestrian safety, the Manual restricts the use of unprotected left- and U-turns on larger streets.
- Modern European concepts of "shared" roadway space, including removal of all curbs, junction controls, and signage from major junctions, are not included in this Manual except on very low volume, low speed streets. As motorists become more accustomed to the presence of pedestrians and more aware of pedestrian right-of-way, shared space concepts may be introduced.

This Manual prescribes a typical design process, provided in Chapter 4, but also recognizes that some streets require flexibility when the typical standards may not be appropriate. Chapter 5 defines standard dimensions and cross sections for streets throughout the Emirate. The majority of the Emirate's urban streets fall under these standards while others require a customized approach.

As the Emirate continues to develop and change, these and other considerations should be revisited continually through local data collection and analysis, and consideration of the world's best practices.



The Manual will emphasize the use of signalized junctions and pedestrian crossings in order to maximize safety.

The Emirate of Abu Dhabi will shift its focus from a vehicle-dependent society to adopt an integrated multi-modal transport system.

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Chapter 3 – Design Priorities & Parameters

3.1 Introduction

The best urban streets are exciting public spaces where pedestrians, transit users, bicyclists, and vehicles all mix. A multi-modal integrated design process that considers all users is necessary for street networks to function safely and efficiently.

To achieve a context-driven urban street design process, a number of parameters must be taken into consideration before the initiation of the process. Significant to Abu Dhabi, urban street design must consider local parameters including cultural, climatic, and geographic conditions.

3.2 Cultural Inspiration

The Emirate of Abu Dhabi has a rich cultural context, with traditions stretching back thousands of years. More recently, people from all over the world have made the Emirate of Abu Dhabi their home. This blend of old and new is a major asset at the foundation of Abu Dhabi's world class status. As a cosmopolitan center, the Emirate possesses a unique blend of local culture while sharing common characteristics with other global destinations. These characteristics require the consideration of the following factors.

3.2.1 Hospitality

Emirati culture honors its visitors from around the globe, and its streets should be welcoming and safe for everyone and for every mode of transport. It should be easy for everyone to navigate the Emirate's multi-modal transport networks.

3.2.2 Family

Emiratis place a high value on families. Streets in all neighborhoods must accommodate safe walking and bicycling for people of all ages, especially children. They should also provide pleasant environments for extended Emirati families to socialize together in a traditional neighborhood environment.

3.2.3 Diverse Population

The Emirate of Abu Dhabi possesses a diverse population as it attracts people from around the world. Street design should consider this unique cultural composition and accommodate drivers with different, or little, past experience. A shift in policies and infrastructure from private motor vehicles to alternative modes provides more accessible means of transport.

3.3 Climate & Geography

While pleasant most of the year, summer in the Emirate of Abu Dhabi tends to be very hot and, in the coastal areas, humid. In much of the Emirate, blowing sand can be a concern for safe driving and comfortable walking. In other locations, heat and sand may be mitigated by landscaping, however the use of natural water resources for irrigation purposes is a significant environmental and sustainability issue.

3.3.1 Estidama

Environmental policies rooted in Estidama principles guide the development of the Emirate at every stage, from the creation of development regulations, to the development of neighborhood master plans, to the improvements of the public realm and street design. Guiding policies that address climatic and geographic concerns pertinent to the Manual include the following:

- Community network and street design standards that encourage walking and urban vitality by making streetscapes more attractive and pedestrian oriented.
- Provisions for a shaded and comfortable public realm, while considering water conservation as part of landscaping.
- Water recycling and high efficiency irrigation that includes the use of drought tolerant and low water use plants while retaining moisture in the soil.
- Sustainable materials that are appropriate for the climate and setting.
- Methods that harness prevailing winds for cooling purposes for humidity mitigation.
- Dark sky strategies that include street lighting that minimizes upward glare.

Streets in the Emirate will be responsive to their unique culture and environment.

3.4 Design Considerations

When undertaking the design of urban streets in the Emirate of Abu Dhabi it is imperative to balance the needs of all travelers:

- Pedestrians
- Transit riders
- Bicyclists
- Motor vehicle drivers

In order to design a successful street incorporating an attractive and welcoming pedestrian environment, it is important to establish standard design criteria for all users. The following design dimensions and parameters shall be considered and used where appropriate for street design.

3.4.1 Pedestrians

Pedestrians in Abu Dhabi have unique needs and characteristics that shall be considered as part of every street design project. These include:

- Shelter, shade, protection, and comfort to address extreme temperatures and solar exposure, particularly during the humid summer months.
- Cultural needs, such as privacy for women and accessibility to mosques from the public realm.

Pedestrians walk at speeds ranging from 0.8 to 1.8 meters per second. For safety in critical situations, such as estimating pedestrian crossing times at junctions, designers shall accommodate a walking speed of 1.0 meter per second. Figure 3.1 provides the design dimensions for pedestrians.

Mobility Considerations

In November 2006, the United Arab Emirates Federal Government passed the UAE Disability Act (Federal Law No. 29/2006). The law was enacted to protect the rights of people with special needs. In accordance with this law, equitable access and related facilities must be accommodated in all aspects of design. Special consideration should be given to older adults as they may use wheelchairs or motorized carts to

Design Priorities

In line with the Plan 2030 goals that promote walking and the creation of a sustainable city environment, the user priorities governing the design of all urban streets throughout the Emirate shall be:

1ST Priority - Pedestrians
All streets must be safe and pleasant for pedestrians of all ages and abilities.

2ND Priority - Transit Users
Transit riders are among the most efficient users of street space.

3RD Priority - Bicyclists
Bicycle riders are vulnerable users, and their safety must be considered during design. They are also among the most efficient users of street space.

4TH Priority - Motor Vehicles
The accommodation of motor vehicle traffic is important to the continuing growth of the Emirate of Abu Dhabi. However, when considering traffic accommodation on urban streets, it is essential that the non-driving options be at least as attractive as those that involve the use of private motor vehicles.

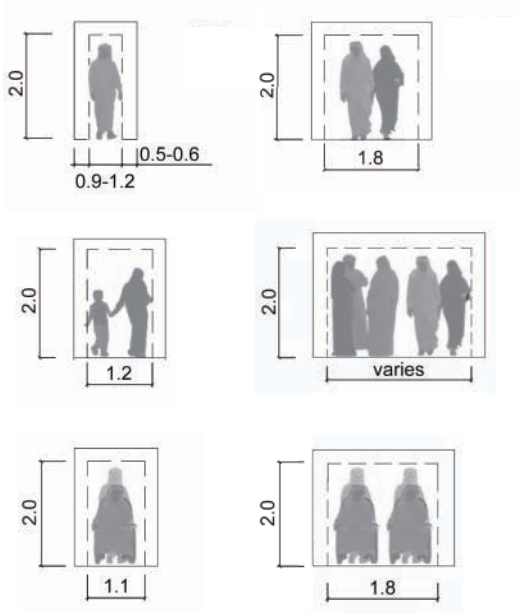


Figure 3.1 Pedestrian Design Dimensions (meters)

travel along pedestrian routes. When walking, they may travel at slower rates and have less mobility, or they may have sight and hearing impairments.

Design parameters for all pedestrians include:

- A maximum pedestrian crossing distance of 13 meters. See Chapter 5 for techniques on shortening pedestrian crossing distances and providing median refuges.
- Smooth, slip resistant surfaces and unobstructed travel ways.
- Multi-sensory warnings such as audible warnings and message systems, tactile warnings, and raised and Braille letters for communication.

Refer to Chapter 6 for additional design details related to accessibility within the pedestrian realm.

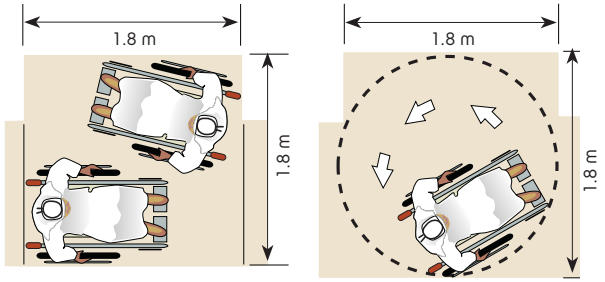


Figure 3.2 Wheelchair User Passing and Turning Dimensions

Accommodating Women and Children

Specific accommodation should be provided to address the safety and security of women and children in street design. Separated waiting areas and visual buffers should be installed in locations that women frequent.

Children are expected to walk along and cross all urban streets in the Emirate, and they may use many residential streets and access lanes for playing. Special care should be taken to ensure the safety of children, especially near schools, playgrounds, mosques, community centers, and neighborhood stores. Children are less visible to drivers and they are limited in their judgment of speed, sound direction, and distance of oncoming vehicles.

The Pedestrian Realm

Pedestrians are mainly accommodated in the space between a building or lot line and the curb within the street right-of-way. Throughout this Manual, this space is referred to as the pedestrian realm and is composed of four zones:

- The frontage zone provides room for activities along building frontages.
- The through zone is an unobstructed pedestrian path of travel.
- The furnishings zone is used for placement of shade structure, landscaping, signing, and other facilities.
- The edge zone provides a buffer between the pedestrian realm and the traveled way.

3.4.2 Transit

Transit patrons have basic needs such as safety, security, and comfort at waiting areas. They also need to be able to cross streets efficiently and conveniently to access transit stops. Some transit riders have mobility, sight, or other impairments that limit their ability to drive, walk, or bicycle, so they rely on transit as their primary mode of transport.

Design parameters for transit are covered by various documents available from the DOT. Figure 3.3 provides simple spatial dimensions for buses and trams.

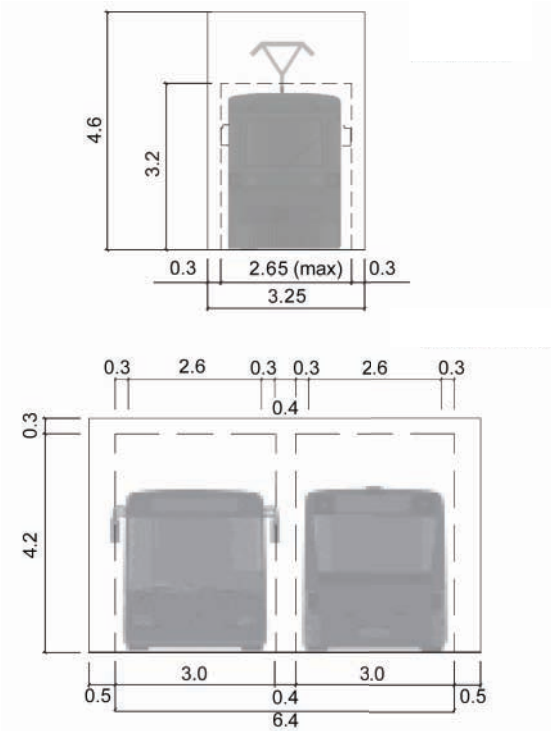


Figure 3.3 Transit Design Dimensions (meters)

3.4.3 Bicycles

Bicycles provide an extremely efficient means of transport. All urban street design for new and reconstructed streets in the Emirate of Abu Dhabi shall accommodate bicyclists in accordance with the provisions in Chapter 5 and DOT's requirements.

Typical bicycling speed is 15–20 km/h. However, bicyclists can travel as slow as 5 km/h or up to 30 km/h. Figure 3.4 provides design dimensions for bicyclists.

Bicycle facilities may be provided in the pedestrian realm in the form of cycle tracks, or within the traveled way as bicycle lanes or yield lanes. Cycle tracks and bicycle lanes are dedicated bicycle paths, whereas yield lanes are not delineated and share motor vehicle travel lanes.

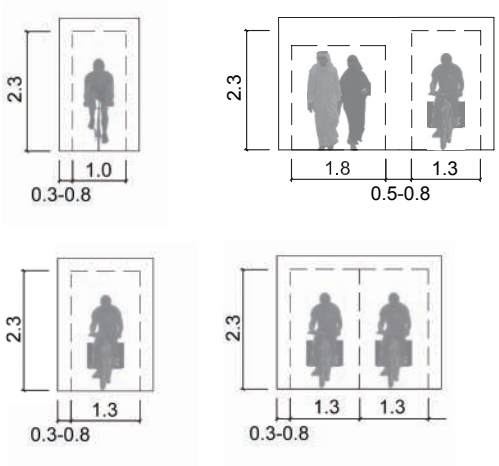


Figure 3.4 Bicycle Design Dimensions (meters)

3.4.4 Motor Vehicles

Details on design parameters for motor vehicles are found throughout this Manual, including parking standards, street cross sections, and junction design details.

Design speed is a speed selected to determine the various design dimensions of the traveled way, and sometimes the timing of signals. On streets in Abu Dhabi, the vehicular design speed shall directly correlate with the desired travel speed of the motor vehicles, or "target" speed.

Target speed ranges from 15 to 60 km/h for the street types described in this Manual. The lower end of this speed range is a key characteristic of a safe and walkable world class city. Dimensions for motor vehicles are illustrated in Figure 3.5.

The following design factors contribute to speed management and should be incorporated into the street design process as suitable in urban areas:

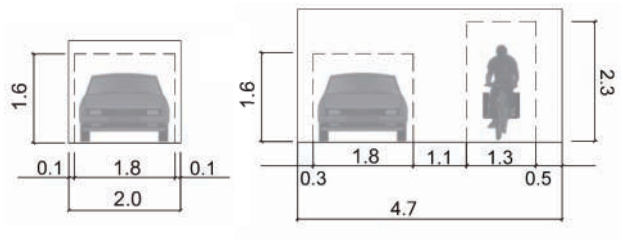


Figure 3.5 Motor Vehicle Design Dimensions (meters)

- Lanes of appropriate width without excess
- No "shy" areas or shoulders between travel lanes and curbs
- No super-elevation
- On-street parking
- Tight curb return radii at junctions and elimination or reconfiguration of high-speed channelized right turns
- Spacing of signalized junctions and synchronization of signals to the desired speed
- Paving materials with texture (crosswalks, junctions) detectable by drivers as a notification of the possible presence of pedestrians
- Vertical shifts, such as raised pedestrian crossings and junctions where appropriate
- "Gateway" elements and other appropriate devices to reduce speeds at urban settings
- Curb extensions
- Bicycle facilities

At the lower end of target speeds, this Manual includes shared access lanes and frontage lanes on which vehicles will occasionally pause to await the passage of an oncoming vehicle to drive around a parked vehicle or bulbout. In such cases, target speed will be equivalent to pedestrian speeds.

3.4.5 Emergency Vehicles

The general principle concerning emergency service vehicles is to design streets so that they may use more of the street than automobiles may legally and properly use. This principle is important, because if the occasional large emergency vehicle becomes the design vehicle for a street, the result will be excessively large streets that encourage speeding, putting traffic safety at odds with fire safety.

Emergency service vehicles shall be allowed to:

- Use transitways, bicycle lanes, and bicycle paths
- Mount sidewalk curbs as necessary to turn corners
- Complete turns by crossing over centerlines into opposing traffic
- Cross raised medians as necessary to bypass traffic queues by using opposing lanes of traffic
- Control traffic lights to clear queues and avoid delay
- Reverse in traffic in order to complete turns or maneuver around obstacles

Street designers must demonstrate that the design of their streets and networks meets Civil Service's objectives. For this reason the initial layout needs to be discussed with Civil Defense during the start of the design and approval process.

When proposing narrow, single-lane streets, designers shall work closely with Emergency Services to ensure adequate emergency vehicle access while maintaining high levels of traffic safety. Consideration should be given to:

- Locating fire stations and providing adequate staffing so that smaller, more specialized emergency service vehicles that are compatible with narrow streets can be used.
- Providing frequent fire hydrants with a sufficiently high level of water pressure in order to reduce fire truck size and the need for added on-truck water storage and pumping.
- Creating connected street networks that allow emergency vehicle access to all buildings, and providing alternate routes should one street be blocked.
- Providing staging areas on narrow streets to accommodate stabilizers and access to onboard equipment.

Figure 3.6 provides spatial dimensions for Emergency Vehicles.

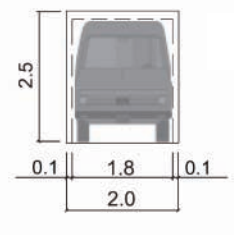


Figure 3.6 Emergency Vehicle Design Dimensions (meters)

3.4.6 Freight & Servicing

Developments that attract heavy goods vehicles will require areas where trucks may be turned safely and conveniently, parked securely when not in use, and loaded easily and efficiently without disrupting other traffic. New developments that require this type of facility must accommodate movement and turning maneuvers within their site boundary and not create larger than necessary streets to accommodate this activity (refer to site design requirements from the UPC). See Figure 3.7 for design dimensions for Freight Vehicles.

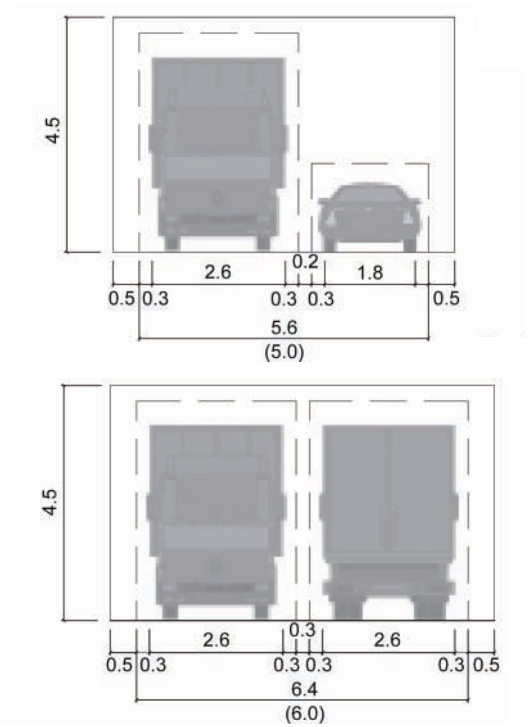


Figure 3.7 Freight Vehicle Design Dimensions (meters)

3.5 Design Methods

The Manual applies some fundamental design concepts that shall be applied at all locations and in all cases. Additional detail on these concepts can be found in Chapter 6.

3.5.1 Universal Design

Universal Design accommodates all potential users in the design process. This type of design includes people with special needs, such as those with mobility and visual impairments, and more vulnerable users such as older adults and children. Universal Design goes beyond accessible design by promoting approaches and solutions that can benefit everyone.

Urban Braille is a tactile system that corresponds to Universal Design principles by providing visually impaired users with information to allow them to navigate through public space as easily as the rest of the population.

Signing and wayfinding methods that are understandable to the international population also form an essential component of Universal Design. The Emirate of Abu Dhabi is made up of diverse nationalities and people reading and speaking many different languages; their ability to navigate the public realm should not be compromised.

3.5.2 Vertical Separation

Pedestrian- and vehicle-dominant spaces across the street right-of-way will be separated vertically, such that pedestrians are elevated above motor vehicles. This discrepancy in vertical elevation, as illustrated in Figure 3.8, provides users with a clearer definition of space.

- As pedestrians cross a vehicle-dominant space (such as the traveled way), they must transition down the curb to a lower level, therefore being made aware that they have entered another space that requires more cautious and considered movement.
- Conversely, when a vehicle crosses a pedestrian-dominant space, such as a side access lane, the vehicle will be elevated to the level of the pedestrian and must give priority to the pedestrian.
- Curb heights are maintained at 150 mm in part to discourage motorists from driving and parking on sidewalks.
- Similar treatment applies to transit and bicycle facilities, depending on their location within the street right-of-way.

The inclusion of additional separation measures such as bollards will need to be considered on a case by case basis.

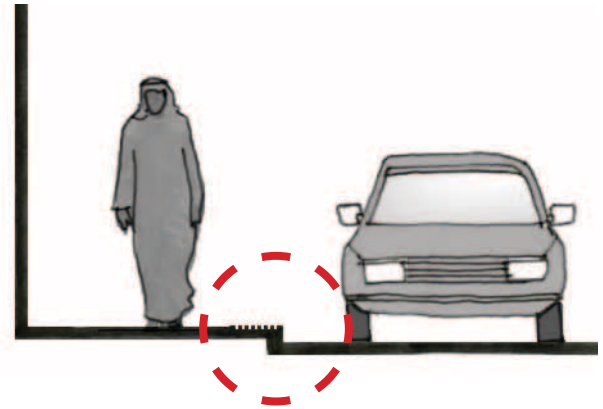


Figure 3.8 Pedestrian and Vehicle Vertical Separation

Streets shall be safe for children.

3.5.3 Vehicle Speeds

Due to the high pedestrian volumes in urban environments, vehicle speeds need to be maintained through safe street design, education, and the enforcement of policy. Operating vehicle speeds must therefore reflect the needs of all street types. The actual, physical posting of speed limits on specific streets is the responsibility of the local municipalities and Abu Dhabi Police to direct.

Table 3.1 illustrates recommended vehicle operating speeds for all street types in the Emirate of Abu Dhabi.

Ideally, a "progression" or network speed approach can be adopted in urban areas with suitable traffic control devices such as signal control junctions. For example, if signals are linked to provide a progression speed of 40 km/h through a network, then posting a speed limit of 60 km/h encourages drivers to travel faster than the network can accommodate, in turn leading to extended delays at junctions and an increase in driver frustration (and subsequent speed).

Table 3.1 Recommended Operating Speeds

Street Family	Land Use Context				
	City (7stories +)	Town (3-6 stories)	Commercial (1-3 stories)	Residential (1-3 stories)	Industrial
Boulevard	40 km/h	40 km/h	60 km/h	40 km/h	60 km/h
Avenue	40 km/h	40 km/h	60 km/h	40 km/h	60 km/h
Street	30 km/h	30 km/h	30 km/h	30 km/h	30 km/h
Access Lane	20 km/h	20 km/h	20 km/h	20 km/h	20 km/h

Reduced speeds for increased safety.

مجلس أبوظبـــي للتخطيط العمراني
ABU DHABI URBAN PLANNING COUNCIL

Chapter 4 - Design Process

4.1 Introduction

The planning, design, and approval process within the Manual shall be used for the development of all new and retrofit street design and the development of all street networks, new and existing. For all designs, connectivity and safety must be addressed in the design process.

A fine-grained network of small, interconnected streets and short block lengths provides an inviting environment for walking, bicycling, and transit use, thereby reducing vehicle trip generation. By distributing traffic across many streets, designers can avoid building wide streets that will be difficult and potentially dangerous for pedestrians to cross. A strong network of streets can also decrease the number of vehicle kilometers traveled by increasing route choice and providing multiple alternatives. This network, in turn, has the positive impact of reducing vehicle idling at junctions.

Considerations for Street Design

When constructing streets or street networks, the following issues shall be considered:

- Safety and accessibility for all users
- Interconnected networks for all modes of transport
- Legibility and efficiency
- Speed management
- Environmental conditions
- Consideration of landmarks, views, vistas, and gateways

4.1.1 Integrating the Street Network Layout & Street Design Process

No matter the scenario, street network, new street, or retrofit, the design process is essentially the same. Land use directs design for streets and networks, and the design must cater to pedestrians, transit, bicycles, and motor vehicles in their priority order as established in Chapter 3. This rationale allows for one process to guide all aspects of street design, whether it is for new streets, retrofit streets within fixed rights-of-way, or street network layout.

4.1.2 Phases of the Design Process

The design process applies to all street design scenarios and entails four phases:

- Phase I: Gather and present information
- Phase II: Develop conceptual design
- Phase III: Evaluate and review design
- Phase IV: Finalize design

Figure 4.1 provides a brief overview of the design process as it follows these four phases. At the completion of Phase I, II and III a formal submission shall be made to the relevant authority and approval obtained before progressing to the following phase.

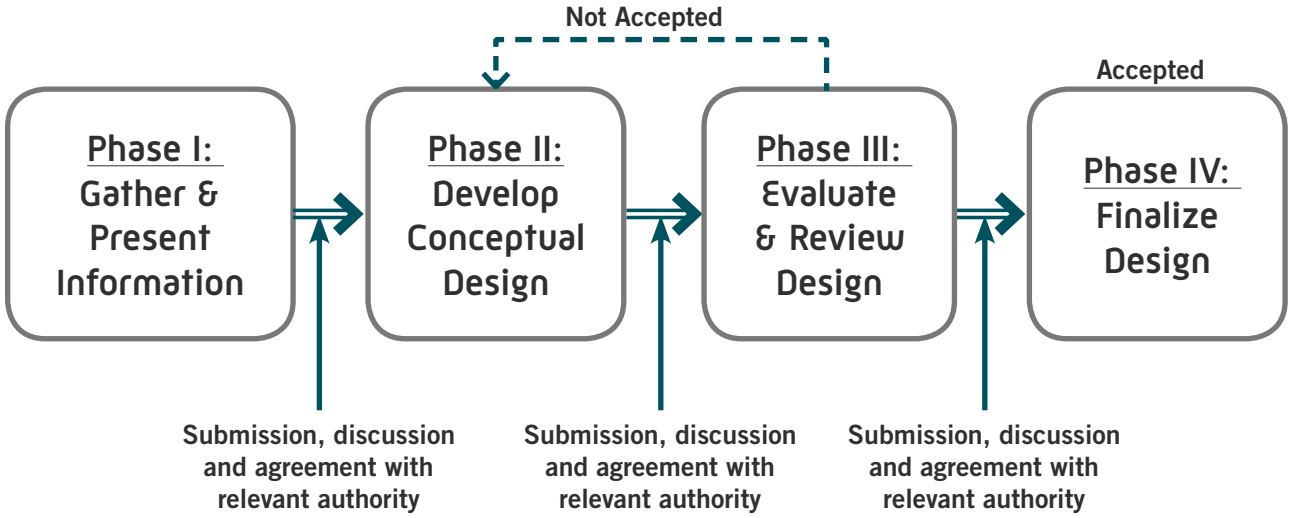


Figure 4.1 Design Process

4.2 Phase I: Gather & Present Information

At the beginning of the design process, the UPC, DOT, and local municipality must be approached in order to compile information relating to the existing and planned conditions. Based on discussions with these organizations, the designer must determine if there are other design requirements that must be met by other agencies.

Figure 4.2 provides a list of information that needs to be collated and presented during this phase. This list is intended as a guide and is considered to be the minimum required. Additional information as deemed necessary by any of the approving agencies should be included.

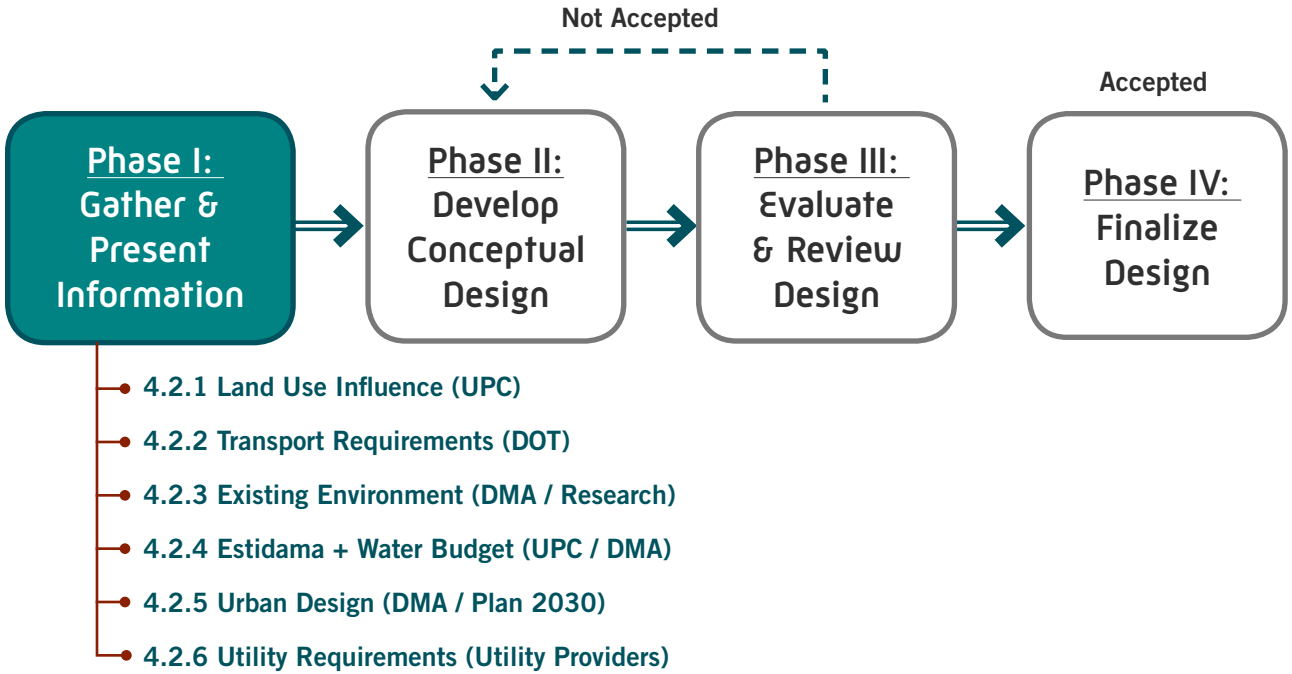
Once compiled, all of the gathered information must be illustrated in a Context Plan as illustrated in section 4.3.

4.2.1 Land Use Influence

Information on the existing and proposed land use(s) must be presented on the Context Plan. Land use influences all aspects of street design, including the general layout of streets within communities, the activities taking place along the street, and the volumes of pedestrian activity, bicycle activity, transit usage, and traffic to be accommodated. In line with this Manual's approach, land use dictates the street "context name" (see Table 2.1).

To determine the overall land use context, consult with the UPC for the relevant Plan 2030, land use maps, and site plans for any planned or existing nearby developments.

Figure 4.2 Phase I: Gather & Present Information



4.2.2 Transport Requirements

For all street design projects, contact the DOT for guidance on the expected volume of traffic. Designers should also consult with the DOT to determine priorities for bicycles, buses, trams, and metro, noting special treatment as needed for these modes. Lane capacity and initial traffic volumes shall be addressed in line with DOT's latest requirements.

Determining the transport capacity provides the information necessary to determine the street "family name" (see Table 2.1). Information on transport requirements, along with land use influence, is essential in determining street type.

4.2.3 Existing Environment

Gathering information on key environmental factors is necessary for developing a sustainable design. Such information includes topography, wind direction, sun patterns, key views of the natural context such as a shoreline or hill, and natural or landscape features such as unusual soil type, adjacent oasis, or wadi.

New streets in an existing development area will also need to respect existing built environment features such as landmarks, existing community areas, and open spaces.

4.2.4 Estidama

The UPC or municipality can provide details on how Estidama principles apply to urban streets, particularly with regard to the provision of shade, the allocation of irrigation for landscaped areas, and the minimization of urban heat effect. Since a water budget will be provided, the designer will need to concentrate available landscape water in locations that most benefit pedestrians.

4.2.5 Urban Design

Streets are an expression of a place's identity. Consult with the municipalities, the local 2030 Plans, and any detailed area plans for guidance on potential or proposed unique urban design objectives for the area.

An analysis of potential views and vistas should also direct some design elements. For example, mosques may be made more prominent within a community if they are placed at the end of "T" junctions to create terminating vistas. Design consideration may also be given to streets that act as gateways into special districts.

4.2.6 Utility Requirements

It is important that utility requirements are identified and agreed upon in the early stages of design, and that communication and coordination with the utility providers is maintained throughout the design process. Right-of-way restrictions may arise at this stage and must be addressed during the design process by using flexible provisions outlined in section 4.6.

Approvals will be required from each of the utility providers before street design may move into construction.

4.2.7 Context Plan

Using the information gathered on land use, transport requirements, and natural and built environmental conditions, develop a context plan that shows the planned and proposed conditions of the network or street within its surrounding context. Note strengths and opportunities during this stage of the design process.

Remaining information that was collected in this phase of the design process should be presented in a separate report noting transport needs, Estidama direction from the UPC, urban design direction from local municipalities, and utility requirements as prescribed by utility providers.

Figure 4.3 provides an example of the information to be provided in the context plan.

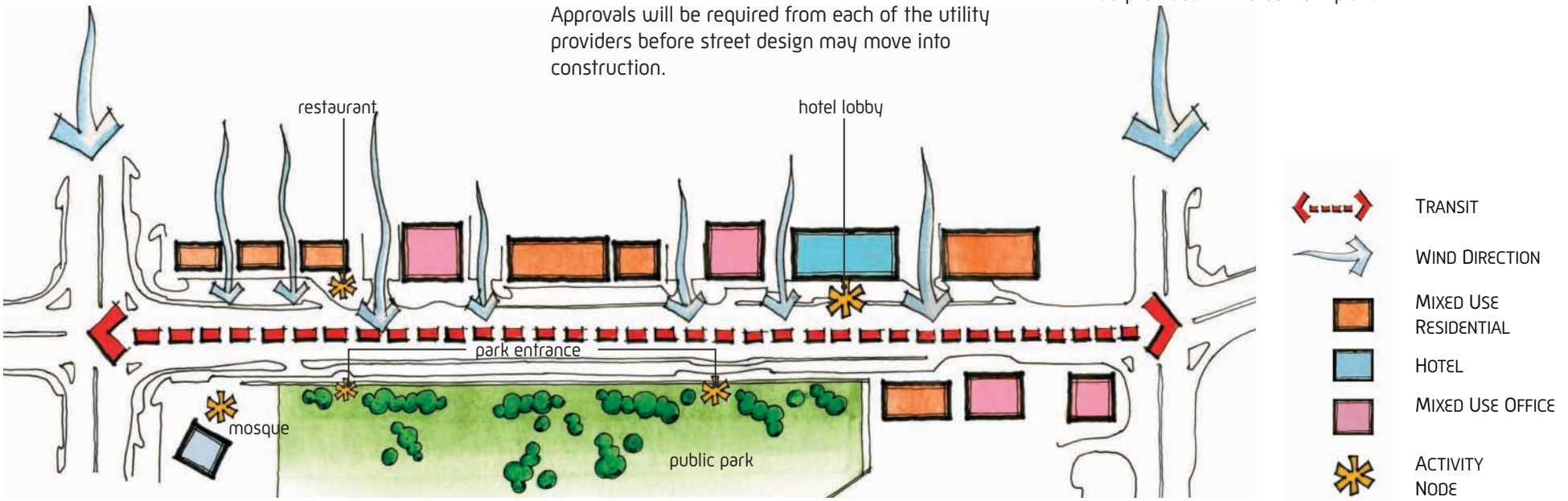


Figure 4.3 Context Plan

4.3 Phase II: Develop Conceptual Design

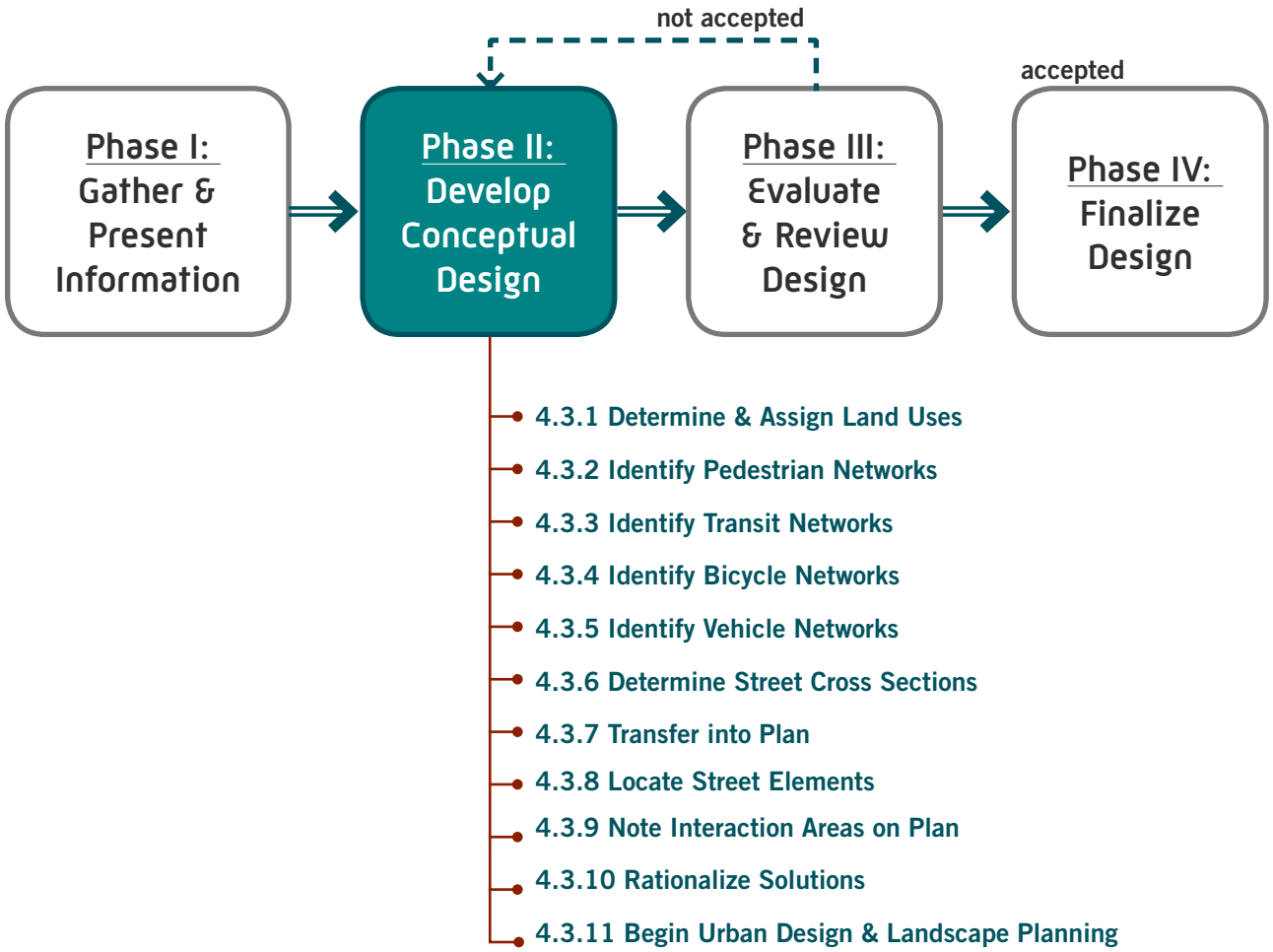
Once all the necessary information has been gathered and presented to the appropriate authority in a context plan with supporting documentation, the conceptual design may be developed. In this phase of the process, the information gathered must be analyzed to develop a design that best demonstrates the principles and goals of this Manual. The level of detail within which the design must be executed depends on whether it is a street network layout process or a single street design process. The street network process must adhere to these steps and proceed with the street design process to provide sample cross sections of typical streets within the development. Figure 4.4 provides an outline of the steps required for Phase II. The steps below focus on the design of individual streets or a network of a few streets. For supplemental guidance on the design of larger networks, see Chapter 7.

4.3.1 Determine & Assign Land Uses

In the design of new street networks, designers should ensure that most residents and employees will be within a comfortable walking distance of transit stops, local retail, schools, mosques, and other community services. The street network must ensure a high level of street connectivity by providing alternative routes to major destinations. For example, regional centers should be planned around transit stops proposed for the site; regional centers should typically be located at important junctions such as those where one Avenue meets another.

On the street level, as the land use density and mix alongside a street change, so do the space requirements in the pedestrian realm. Streets with high ground floor retail activity, for example, may require wider through zones to accommodate

Figure 4.4 Phase II: Develop Conceptual Design



higher pedestrian volumes. In the traveled way, wider medians provide refuge for a larger volume of pedestrians at crossings. Active land uses that generate high levels of pedestrian activity may be determined, and the location of schools, restaurants, mosques, and other specialized uses should be considered. This level of detail informs the next steps of the street design process.

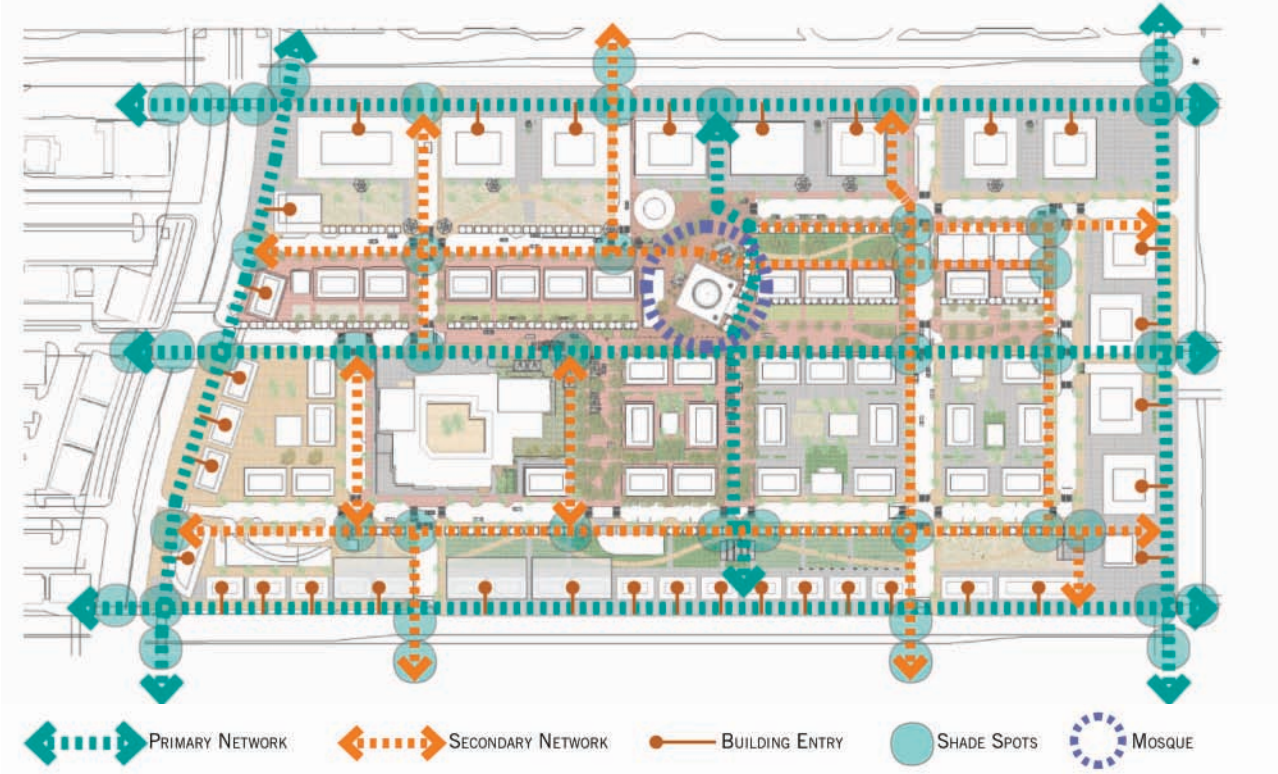
4.3.2 Identify Pedestrian Networks

The analysis of land uses and specialized activity areas provide information on pedestrian destination and flows. Consider which routes will require the greatest provision of shade at different times of the day. Ensure that median transit stops have safe pedestrian crossings at both ends of the platform and that pedestrian through zones accommodate the projected volumes of pedestrian flow. Using the pedestrian crossing guidelines in Chapter 5, lay out a preferred pedestrian network considering pedestrian volume, junction and mid-block crossings, refuge accommodation, and connections into adjacent blocks; see Figure 4.5.

4.3.3 Identify Transit Networks

It is important to determine the type, frequency, alignment, and expected routes for planned transit. This information should have been gathered in Phase I from the DOT (4.2.2 Transport Requirements). In Phase II of the design process, the type of facility required to accommodate the projected volumes of transit riders must be determined. The location for supporting facilities should also be identified. Special consideration must be given to junction design and stop location at this point.

Figure 4.5 Identifying the Pedestrian Network



4.3.4 Identify Bicycle Networks

During this phase of the street design process, the type of facility and expected volumes need to be estimated in accordance with the information gathered in Phase I from the DOT on the proposed bicycle network. Consider land uses and specialized activity areas, and provide bicycle parking where high volumes of bicycle stops are expected. Ensure that bicycles facilities are safe; do not use bicycle lanes and yield lanes on high priority traffic streets.

4.3.5 Identify Vehicle Networks

Use the information gathered in Phase I of the design process to determine the number of lanes necessary to accommodate projected vehicle volumes and allocate on-street parking where there is demand. Junction design should be given special consideration and expected turning movements should be identified to enhance the capacity of street networks.

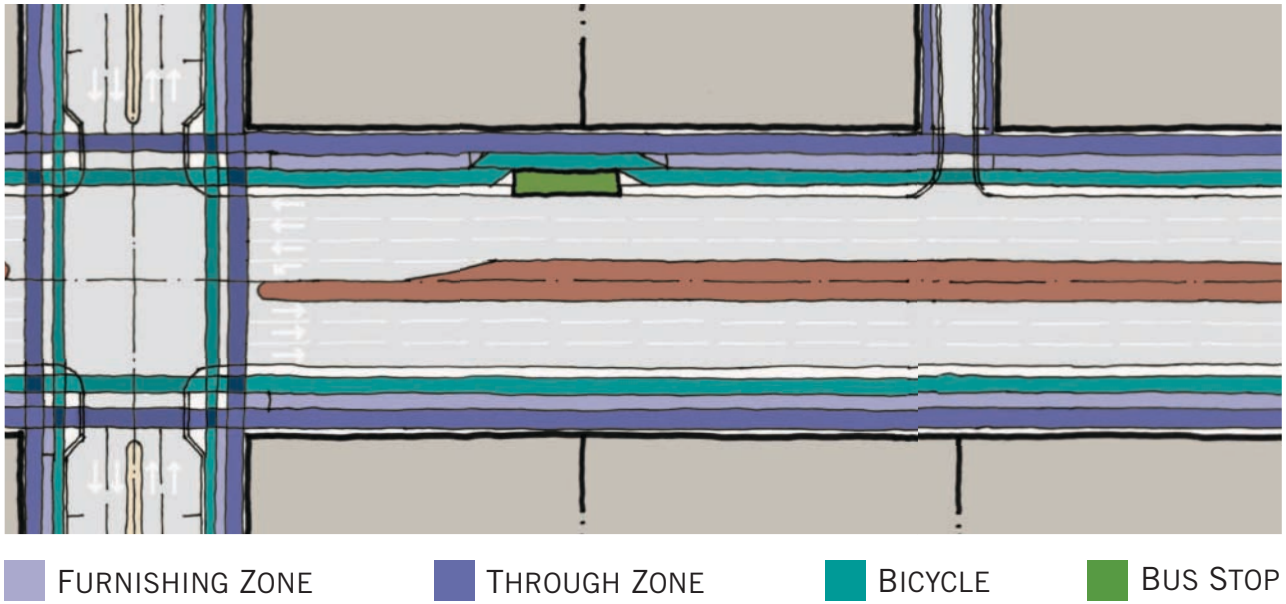
For the efficient design of networks, it is important to ensure that there is sufficient connectivity created by using through streets. The recommended spacing for these are shown in Section 5.10.3. Sufficient route choice shall be provided for all main centers and external connections.

Develop the final proposed street network to create a rich mix of interconnected streets, bicycle facilities, and transit in conformance with the maximum spacing and other criteria of this section.

Significant streets (Boulevards & Avenues) should head in an essentially continuous direction, to aid in way-finding and clarity, but may include curves, provided that any center line tangent does not deflect more than 30° either side of the general direction of the street. Similarly, a curve in one direction should generally be followed by a straight segment and then a curve in the other direction.

Smaller streets, including Streets and Access Lanes, may be designed with short straight lengths connected by deflections of 15° to 30°, or even by turns of 45° or more – sometimes becoming a different street in the process. It is acceptable to design new curved Avenues and Streets in order to celebrate a special feature such as a park, bay, hilltop, etc., in which case such streets are called crescents. Crescents should adopt a regular geometric form such as a semicircle or a segment of an oval.

Figure 4.6 Initial Concept Plan



4.3.6 Determine Cross Sections

Once a street's context name and family name have been determined through an analysis of the land use context and transport capacity, respectively, the street typology as established in Chapter 2 may be applied to further guide the design process. Standard dimensions and cross sections are provided in Chapter 5.

Street type must also be determined for all side and intersecting streets. Transit and bicycle facilities must be included when developing the cross sections. It is recommended that a number of alternative cross sections be developed for each street type to respond to differing land use frontages.

4.3.7 Transfer into Plan

Once the typical cross sections are assigned, the street corridor should be transferred into an initial concept plan. This detail should be added to all existing or planned land uses and natural features in the surrounding context. All of the applicable street facilities should be noted in the Conceptual Plan, including travel lanes, medians, parking, bicycle facilities, and the four zones of the pedestrian realm. Sight distance requirements should be noted at this stage to ensure clear visibility.

The plan should detail the main study street and all side and intersecting streets, including sikkas and other pedestrian passageways. The extent to which the side and intersecting streets should be designed should be confirmed with the UPC, DOT, and the local municipality.

4.3.8 Locate Street Elements

Street elements including tram stops, bus stops, taxi lay-bys, metro station entrances, and major utilities must be incorporated in the Conceptual Plan. Chapters 5 and 6 provide guidance on including these elements in the street design without over-sizing the street right-of-way. Figure 4.6 illustrates the development of a concept plan with street elements.

4.3.9 Note Interaction Areas on Plan

Interaction areas occur where multimodal networks intersect and design elements cause potential obstructions. Figure 4.7 identifies the different user zones. From this identification the user interaction and conflict areas can be shown. These areas will generally include the following:

- Main junctions (all users)
- Secondary access points (all users)
- Transit stop and bicycle parking areas (pedestrian and bicycle)
- Street crossings (pedestrian, transit, bicycle, and vehicle)

It is important to consider the potential flows and volumes of movement for all user groups. This will aid in the next step of the design process: the rationalization of solutions.

4.3.10 Rationalize Solutions

After determining the context and user interactions along a street, apply the priority of street users to rationalize solutions for interaction and conflict areas. The safety of all street users should not be compromised; pedestrians and bicycles are considered most vulnerable. Chapters 5 and 6 provide detailed guidance for this process.

An example of this step is to rationalize interaction areas into junctions using guidelines provided in section 5.10. Optimal locations for signalized crossings should be determined in this step. On Boulevards, minimize driveways and determine where signalized pedestrian-only crossings are necessary to serve the pedestrian network. While the best traffic calming measures are well designed narrow streets, physical traffic calming measures are sometimes required and are therefore to be considered throughout the design process.

Every street will have different user networks and desire lines; the application of standard solutions must be informed by context-driven requirements. All conflicts must be considered in relation to each other, as each potential solution will result in variations in the street design. It may be possible to combine solutions for specific locations; however, these combinations should never be at the expense of pedestrians as they are the most vulnerable street users.

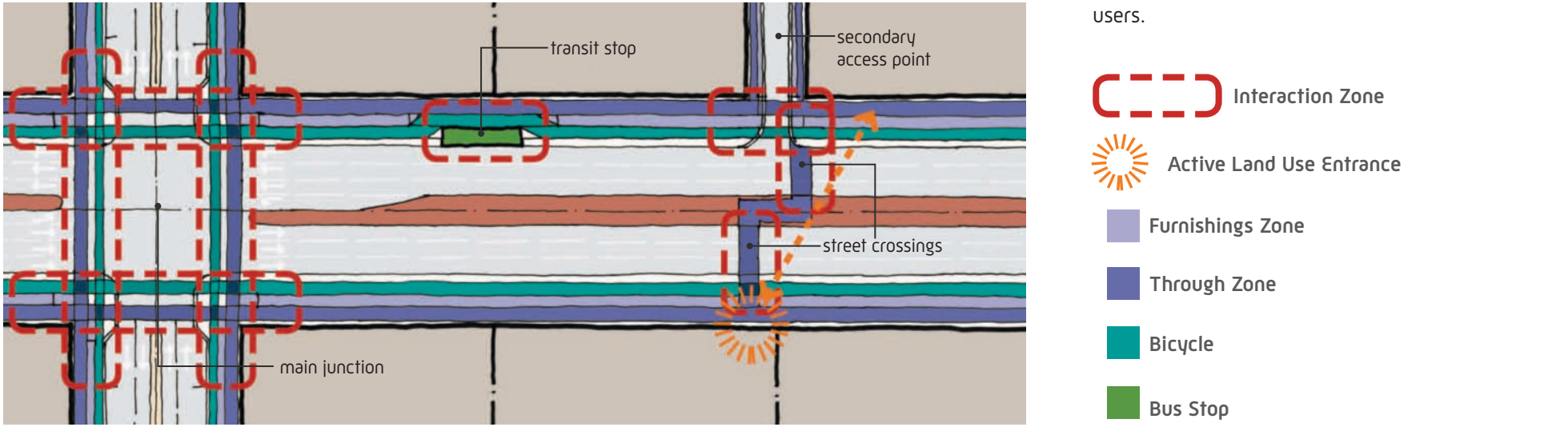


Figure 4.7 Identification of Interaction Zones

4.3.11 Begin Urban Design & Landscape Planning

Determine where to locate the highest level of investment in landscape water and design features. These investments should typically occur where there will be the highest concentration of pedestrians such as at junctions, transit stops, and along pedestrian through zones near major destinations. The design is then detailed and finalized in Phase IV of the process.

4.4 Phase III: Evaluate & Review Design

All designs must undergo evaluation and review by the UPC, DOT, ADP, DMA, and the relevant municipality, along with other approval agencies as required. A design may be finalized only after it demonstrates that it meets the Plan 2030 goals, Estidama principles, and direction from the approval agencies. Figure 4.8 lists types of studies, audits, and performance measures that must be conducted before submitting the Conceptual Plans for approval to the UPC. Where the design needs to be adjusted, review and re-evaluate. The review process may require designers to go back and gather extra information, or simply to adjust the Conceptual Design.

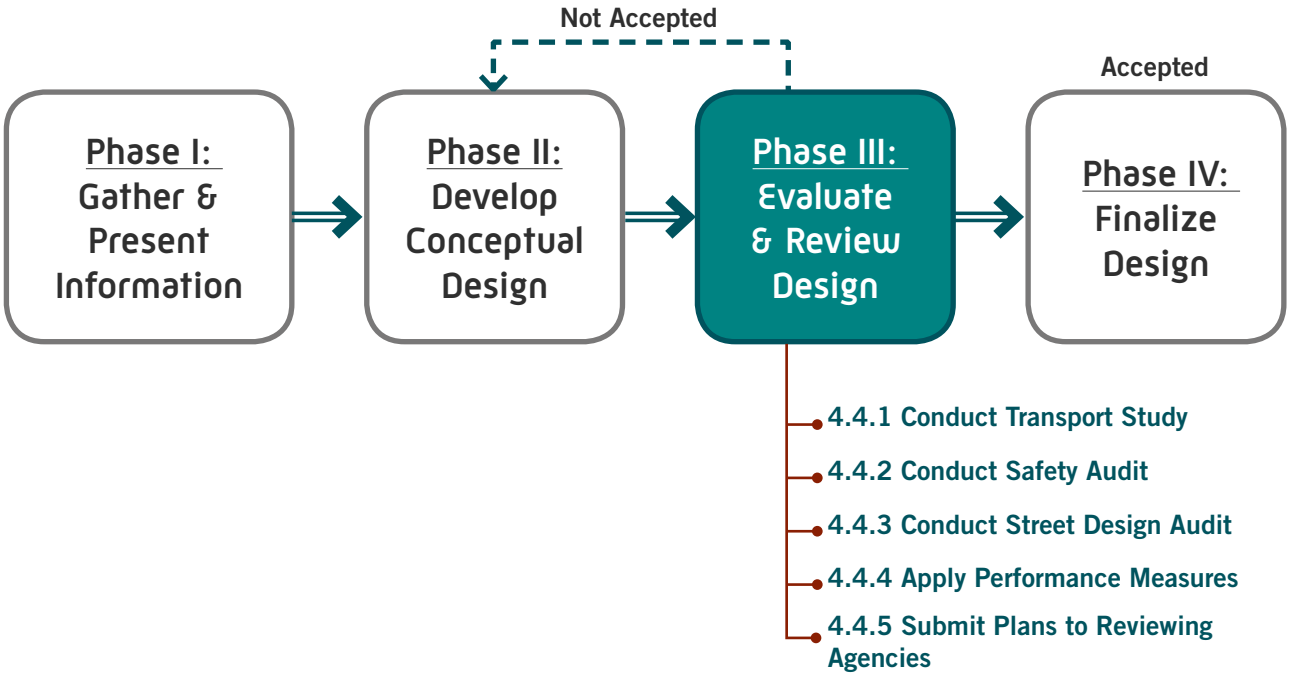
4.4.1 Conduct Transport Study

Using DOT's Transport Impact Study guidelines, evaluate facilities and ensure that the projected volumes of the varying modes are being accommodated in the selected capacity measures.

Evaluation of pedestrian, transit, and bicycle facilities should be conducted to determine that the street design addresses the needs of the projected demands, as dictated by the land use and other previously collected information.

With regard to motor vehicle capacity, if excess capacity is present, reduce the number of lanes such that Boulevards become Avenues and Avenues become Streets, etc. Where additional capacity is needed, break up large blocks by adding through streets until the minimum spacing criteria as provided in Chapter 5 is achieved. Should further capacity require accommodation, increase the number of lanes on a street such that an Avenue becomes a Boulevard, a Street becomes an Avenue, etc. These iterations continue until the needed capacity is achieved. In the network layout process, the fewest number of Boulevards and Avenues should be used to achieve more pleasant, walkable, environments.

Figure 4.8 Phase III: Evaluate & Review Design



4.4.2 Conduct Safety Audit

The Manual recognizes pedestrians and bicyclists as the most vulnerable street users; however, it is essential that safety concerns are addressed for all modes of transport. Conduct a safety audit as per the DOT and ADP's requirements.

Table 4.1 Streets as Places Audit Criteria

Context Design and Connectivity
Does the design include provisions for many types of uses?
Is it easy to get from one use to another?
Does the design contain spaces that will attract people at times other than rush hour?
Does the design have continuity of street level activity?
Are ground floor uses active and welcoming, and does the street have a welcoming character?
Are building front doors noted and well served by the pedestrian realm?
Is the scale of nearby buildings comfortable for pedestrians, with choices of places to sit or use?

Safety Considerations
Are pedestrian crossings safe?
Are junction designs safe for all users?
Does the design contain spaces that children can use independently?

Design Considerations
Do buildings give "life" to the street?
Does the area project a distinctive image from a distance?
Is seating and other street furniture well located?
Is lighting safe and adequate for the different users of the street?
Does the design fit with the image goals of the municipality and the UPC?
Does the design create a unique area?

Pedestrian Provisions
Are pedestrian crossings well designed?
Are crossing distances minimized?
Do signalized crossings have adequate time?
Does the design ensure that pedestrians can easily walk to and through the area?
Are uses easily visible and inviting to pedestrians?
Does the design ensure that vehicles do not detract from the pedestrian experience?
Are protected pedestrian crossings shown at the correct spacing, and do these crossings relate to areas where pedestrians desire to cross?
Is there leftover space in the pedestrian realm, or is there too large a furnishing zone? If so, how can this space be minimized or programmed?

Transit Provisions
Are transit stops and stations easy to find and get to on foot?
Are transit maps and schedules readily available and visible?
Are there sufficient passenger waiting areas at bus stops and taxi lay-bys?

Bicycle Provisions
Are bicycle facilities prominent and well designed?
Are bicycle routes well marked?
Is there adequate bicycle storage?
Do bicycle facilities meet DOT guidelines, and are they continuous across all intersections?

Vehicular Provisions
Is the design vehicle context sensitive (e.g. corner radii not over designed)?
Have all turning movements been checked for vehicle designs?

Climatic and Environmental Considerations
Does landscaping complement the street, and is it sustainable from a water use perspective?
Is there too much landscape area shown given the irrigation budget?
Is the landscaping appropriate for the local environment and soil conditions?
Will the pedestrian realm be shaded during most of the day?
Is shade continuously provided via trees, buildings, canopies, etc.?

Cultural Considerations
Does the design foster people acknowledging one another, as appropriate for Abu Dhabi's culture and gender mix?
Does the design encourage a mix of ages, gender, and ethnic groups that generally reflects the community at large?
Does the design provide private places for women?
Does the design have spaces for groups to gather?

4.4.3 Conduct Street Design Audit

To determine if the Conceptual Design meets the project's larger goals, a qualitative street audit provides designers with a list of questions (see Table 4.1). The criteria are presented in general terms and may not apply to all street design conditions. Note that such a design audit should be applied at all stages of design development. This is intended as an iterative process in order to achieve the highest quality spaces. The final audit will be submitted to the UPC, along with a written discussion by the design team describing what has been done to meet each criterion.

4.4.4 Apply Performance Measures

This part of the evaluation and review phase will be prescribed by the UPC and DOT. Performance measures may test the accessibility, connectivity, and cordon capacity of a street or street network. Details of performance measures are shown in Appendix A.

4.4.5 Submit Plans to Reviewing Agencies

Once an internal review of the street design process is complete and the design is adjusted accordingly, plans and supporting documentation must be submitted to the reviewing agencies. Major design parameters are set at this stage and must be met during Phase IV of the process for approval of the final detailed design.

4.5 Phase IV: Finalize Design

Once the approval agencies accept the Conceptual Design, it must be finalized and prepared for a detailed planning review in accordance with the design parameters established during the conceptual design review. The detail provided in these plans must ensure that the street design is sensitive to adjacent land uses on the street level, and that it complies with Universal Design requirements and Estidama principles. Chapter 6 provides guidelines for this detailed level of design.

4.5.1 Civil Engineering Drawings

These drawings should include details of all geometric elements, including radii and lengths of straights, elevations, and grades to provide suitable longitudinal dimensions and cross falls to ensure positive drainage, avoid standing water, and eliminate obstacles for all users.

4.5.2 Detailed Landscape & Streetscape Design Plans

In the detailed landscape and urban design plans, identify materials, shade structures, plants, water usage, and other necessary elements. Specify locations of signage, lighting structures, and utility works, along with all pavement markings.

This step should result in a series of plans depicting the location of facilities, supported by illustrations and written material that describe the details of the design elements and their facilities. Adherence to the design parameters established by the approval agencies should be demonstrated.

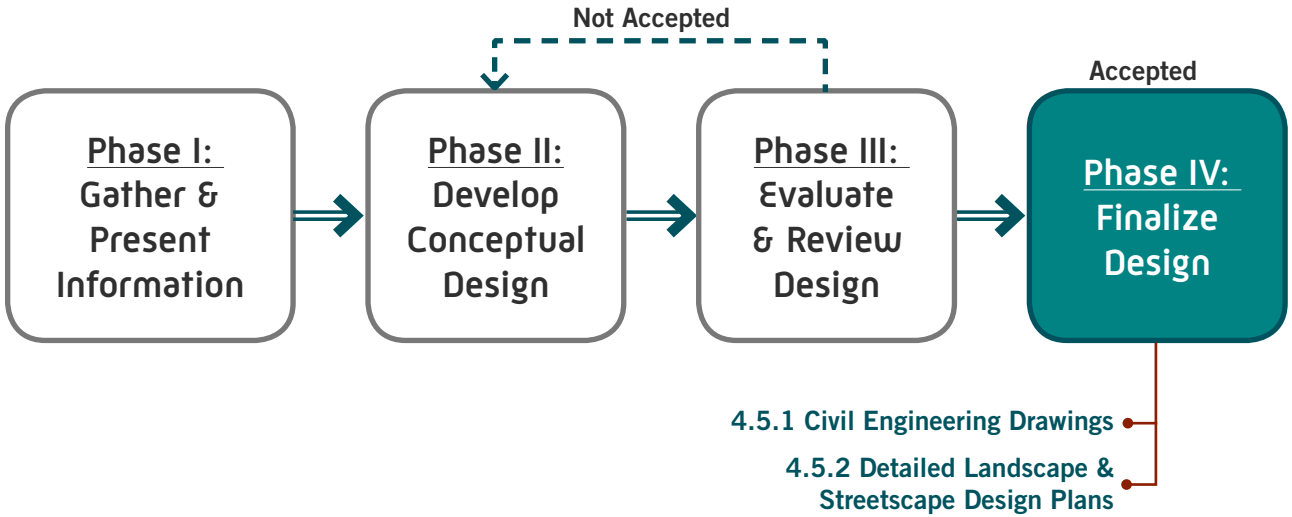


Figure 4.9 Phase IV: Finalize Design

4.6 Design Flexibility for Fixed Right-of-Way Dimensions

Often, when designing streets within existing conditions (retrofit streets) or accommodating utilities for new or existing streets, the total right-of-way is restricted such that there is either too little or too much right-of-way when compared to the preferred street design dimensions. This section offers guidance for such cases, with priorities for shrinking or expanding the street to fit the predetermined right-of-way. Minimum and maximum dimensions provided in Chapter 5 show the allowable ranges. In no case of this flexible design process should the safety of street users be compromised. A safety audit must be conducted to ensure that street design remains safe and accessible for all (see section 4.4.2).

4.6.1 Too Little Right-of-Way

Street design might be restricted with a limited right-of-way in cases where there are existing buildings or utilities that cannot be moved. Once the difference between the preferred and limited right-of-way is determined, the steps outlined in Figure 4.10 must be followed in priority order to guide the street design process.

Design Priorities for Too Little Right-of-Way

1. Reduce median widths to their minimum dimensions. Be mindful of pedestrian volumes at median refuges and transit requirements.
2. Reduce the edge zone in the pedestrian realm to its minimum dimensions.
3. At taxi lay-bys and transit stops, reduce the furnishing zone to minimum dimensions.
4. Reduce the frontage zone in the pedestrian realm to its minimum dimensions, except where the street accommodates outdoor seating areas.
5. Reduce the furnishing zone in the pedestrian realm by installing tree grates and relocating or eliminating benches, utility poles, and other street furniture.
6. Reduce the availability of on-street parking where possible, allowing travel lanes to curve as necessary. Two-sided on-street parking should be reduced to one-side before it is removed completely. On Boulevards, this reduction means assessing the need for a frontage lane. Eliminate frontage lanes if access to buildings is accommodated through other street frontages such as side Access Lanes. On Avenues and Streets where there is ground floor retail, ensure that the projected parking demand is accommodated.
7. Consult with the DOT and, where possible, replace cycle tracks with bicycle lanes, or bicycle lanes with yield lanes.
8. Consult with the DOT and reduce transit lanes and platforms to their minimum possible dimensions while still accommodating projected volumes of transit riders.
9. Repeat steps where insufficient right-of-way remains. Once the previous steps have been exhausted, consult with the DOT and eliminate a motor vehicle lane if possible; mitigate the decrease in traffic capacity through network improvements or mode shift.

Figure 4.10 Too Little Right-of-Way

4.6.2 Too Much Right-of-Way

In cases where utility requirements or existing conditions define a wider right-of-way than the preferred dimensions, consult with the UPC and local municipality to determine if the extra land may be converted to new building sites or public open space. Otherwise, complete the steps outlined in Figure 4.11, in order, until the street fills the available right-of-way.

4.6.3 Development of Alternative Cross Sections

For too much or too little right-of-way, alternative cross sections should be developed to reflect the needs of adjacent land uses, and these alternatives should be discussed with the approving agency prior to the continuation of the design.

Design Priorities for Too Much Right-of-Way

1. Provide on-street parking where there is sufficient demand. On Boulevards, add frontage lanes where possible.
2. Increase the width of the furnishing zone within the pedestrian realm and provide attractive streetscaping to enhance the aesthetic quality of the street.
3. Increase the width of the through zone within the pedestrian realm, making sure that shading requirements are met for the comfort of pedestrians.
4. Increase the width of the edge zone within the pedestrian realm, increasing the width of the buffer between the traveled way and the pedestrian realm.
5. Increase the width of the frontage zone within the pedestrian realm.
6. Consult with the DOT and increase with width of transit lanes and platforms if the street is part of a transit network. Provide attractive streetscaping for stop and lay-by locations to ensure the comfort of transit riders.
7. Consult with the DOT and add or increase the width of cycle tracks and/or bicycle lanes where possible.
8. Consult with the DOT and increase the availability of on-street parking by providing angled parking where possible. Provide two-sided parallel parking on frontage lanes for Boulevards.
9. Increase median dimensions and enhance the quality of the street by providing attractive streetscaping measures.

Figure 4.11 Too Much Right-of-Way

4.7 Exceptions

The typical cross sections in Chapter 5 may not be appropriate for all streets, and designers may apply for a design exception to address unusual conditions. All exceptions will be reviewed by the Review Committee (see section 9.2). The exceptions process allows for innovative design throughout the Emirate, but requires further information during the approvals process. Design exceptions fall into two categories.

4.7.1 Category 1 Exception

In the event that designers wish to vary from the standard cross section dimensions in Chapter 5 but still lie within the allowable ranges of dimensions for retrofit streets, the following additional information is required for the approval process:

- Development of the proposed cross section
- Justification for the desired difference(s)
- Example graphics or photos of the desired condition
- Explanation of why the proposed condition will produce a better result than the preferred street design
- A description of any proposed innovation in street design
- A description of the land use(s) supporting the special condition requested and how the proposed design better serves these uses
- A description of how the proposed street design conforms with the principles and goals in Chapter 1 of this Manual

If, in the opinion of the approval agency, the applicant has presented conformance with sufficient elements of the above, the approval agency may: approve the request, as presented; deny the request; or approve the request with conditions or modifications as the approval agency deems appropriate. Once approved, the exceptions process must continue in the same fashion as the general design process outlined in this chapter, keeping in mind the accepted exceptions. In no case shall the approval agency approve a design it believes will compromise user safety.

4.7.2 Category 2 Exception

In the event that practitioners wish to vary from the minimum and maximum dimensions in Chapter 5, the designer will be required to provide a description of the extraordinary circumstances that justify an exception from the use of the allowed retrofit dimensional ranges.

If, in the opinion of the approval agency, the applicant has presented full and adequate conformance with all of the above, the approval agency may: approve the request, as presented; deny the request; or approve the request with conditions or modifications as the approval agency deems appropriate. Once approved, the exceptions process must continue in the same fashion as the general design process outlined in this chapter, keeping in mind the accepted exceptions. In no case shall the approval agency approve a design it believes will compromise user safety.

4.8 Integration with the Approvals Process

The design of urban streets and networks throughout the Emirate of Abu Dhabi requires approval from a number of agencies throughout the design process. Section 4.4 of the Manual explains the evaluation and review process and provides guidance on the required audits and performance measures. This section provides a timeline of events and lists a non-exhaustive list of deliverables to ensure that the urban street design process is integrated with the UPC's Development Review Process (Figure 4.12).

4.8.1 Step 1: Enquiry Meeting

This step takes place during the first phase of street design. Consultation with lead agencies ensures all the available information is gathered so that it may be presented on Context Plans.

4.8.2 Step 2: Pre-Concept Stage

Once the first phase of the street design process is complete, the conceptual design must be developed. Consultation is necessary at this step for developing the Conceptual Design and incorporating the required information to ensure safety and quality in design. Internal review of the process occurs at this step until the conceptual plan is ready for Step 3 of the Approvals Process.

4.8.3 Step 3: Concept Planning Review

Prepare and submit a concept planning application with a concept plan(s) to the lead agency to ensure compliance with the Abu Dhabi Urban Street Design Manual. Include materials as directed in Step 1, such as:

- A description of how the conceptual design conforms with the principles and goals outlined in Chapter 1 of this Manual
- Existing and/or proposed land uses, including entrances, driveways, and parking
- Street layout and conceptual cross sections, noting street type
- Pedestrian, transit, and bicycle networks as applicable
- Preliminary junction requirements
- Connectivity and accessibility calculations for new networks as required by approval agencies
- Transport study to determine overall development capacity and transport network in accordance with DOT's latest requirements
- Street safety and quality audits
- Any other special requirements

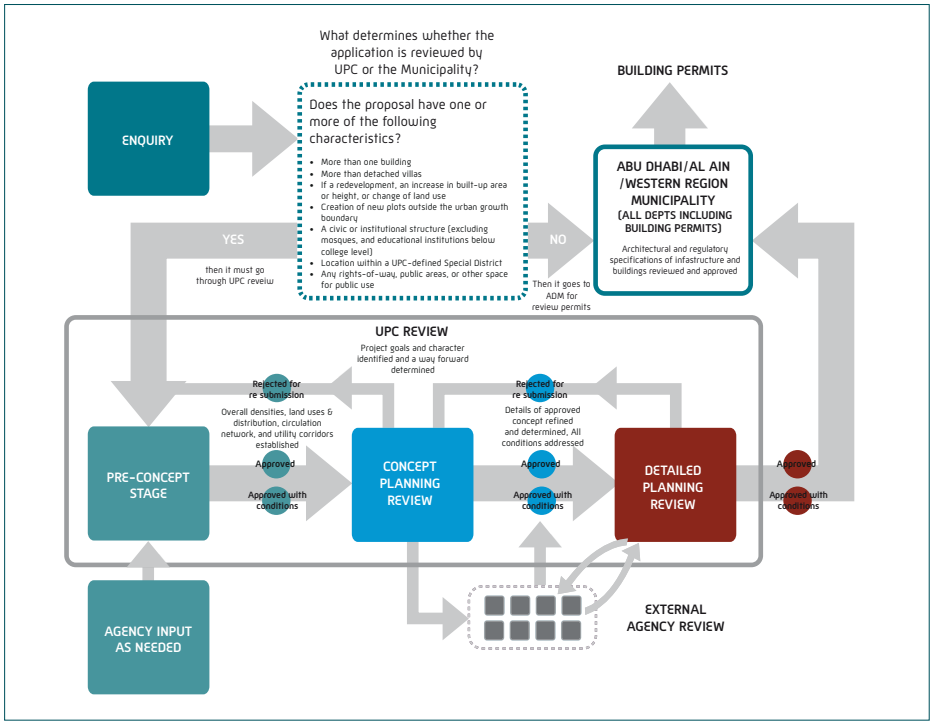


Figure 4.12 Extract from UPC's Development Review Process

4.8.4 Step 4: Detailed Planning Review

Once concept planning approval is granted, applicants must finalize their design in order to apply for detailed planning review. Detailed planning review addresses more specific street design issues, such as:

- A description of how the conceptual design conforms with the principles and goals outlined in Chapter 1 of this Manual (including the application Estidama principles as directed by the UPC and local municipality)
- A Transport Impact Study (in line with the DOT documentation)
- All street cross sections, identifying street type
- Details on pedestrian, bicycle and transit facilities
- Universal Design considerations (see Chapter 6)
- Landscaping and urban design details
- Junction details
- Impact on utilities and planned new utility corridors
- Collation of geotechnical information
- Topographic survey data
- Any other special requirements (especially as prescribed by the exceptions process)

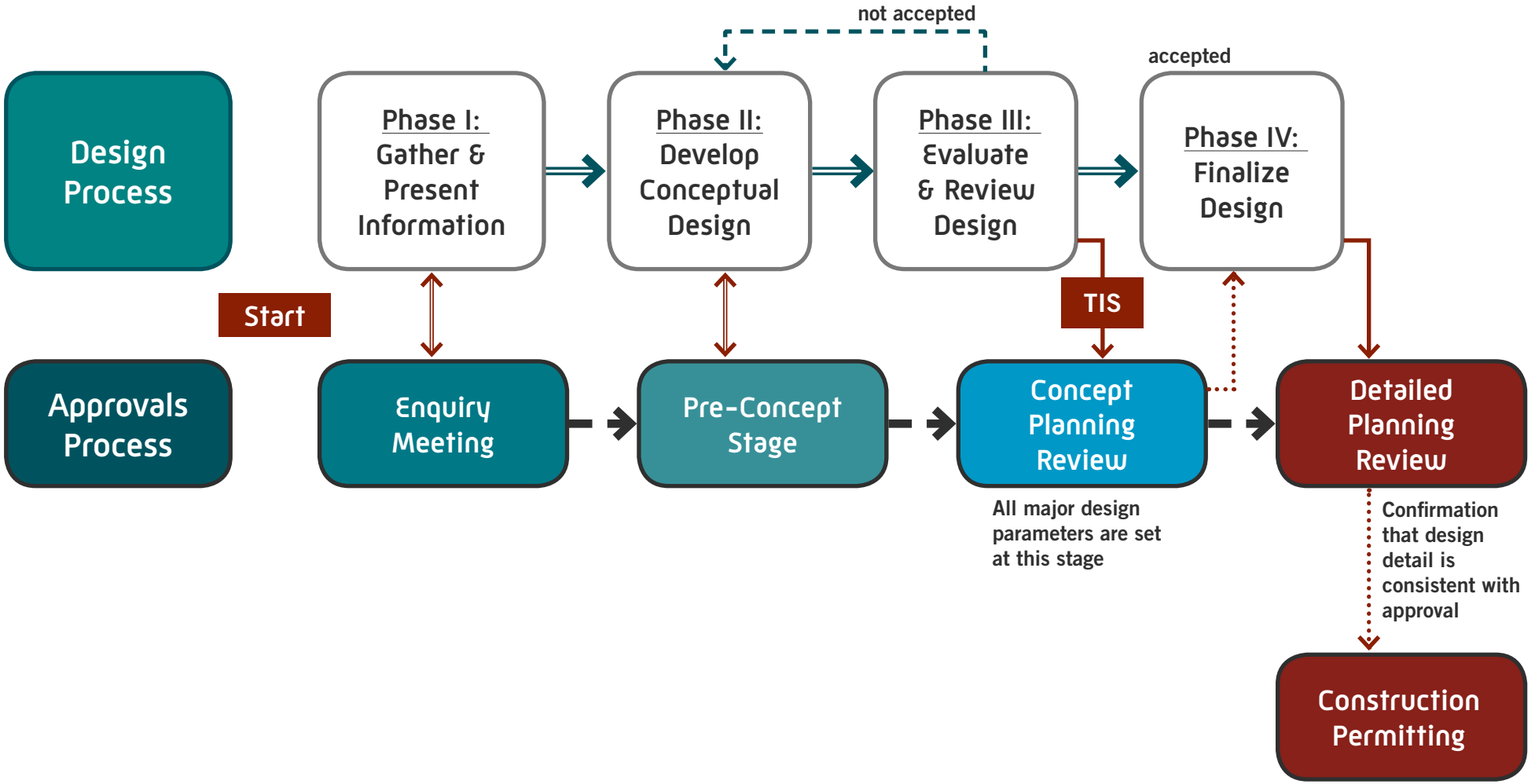


Figure 4.13 Integrating the Design Process with the UPC's Approvals Process

مجلس أبوظبـــي للتخطيط العمراني
ABU DHABI URBAN PLANNING COUNCIL

Chapter 5 – Street Design Elements

5.1 Introduction

This chapter provides a set of standards for street design elements, including junctions and traffic calming. Standard cross sections and dimension tables are followed by flexible ranges for situations with restricted right-of-way. Details on designing for the various elements follow.

Throughout this chapter, reference is made to existing and upcoming municipal and DOT guidelines; however, this Manual takes precedence except as noted. Refer to the UPC, DOT, DMA and the local municipalities for the latest updates on planning and design requirements (typically available on agency websites).

This Manual does not cover street operations such as signal timing, except to state priorities and limit particular operations. Nor does this Manual address street pavement markings, wayfinding, or signage (with the exception of sign placement guidelines related to the pedestrian realm covered in Chapter 6). Operations, signal design, pavement marking, and regulatory signage are addressed in separate DOT documents.

5.2 Street Composition

Dimensions are provided for each of the following elements that compose the pedestrian realm and the traveled way (see Figure 5.1):

1 Pedestrians

The pedestrian realm is the area between the curb and the property or building line. Pedestrian areas are also included at junctions and crossings, as well as bus stops, waiting platforms, and taxi lay-bys. Refer to section 5.6 for pedestrian design considerations.

2 Transit Users

Transit facilities include metro entrances, bus and tram lanes, stops, stations, and associated waiting platforms. Close coordination with the DOT is necessary to determine the type of required transit facilities. Refer to section 5.7 for more information.

3 Bicyclists

Bicycle use can be accomplished through cycle tracks located within the pedestrian realm, bicycle lanes within the traveled way, shared use of frontage lanes, and yield lanes. Consult with the DOT to determine specific bicycle facility requirements. Refer to section 5.8 for more information.

4 Motor Vehicles

Motor vehicle space includes travel lanes, turning pockets, and parking. Refer to section 5.9 for more information. On-street parking is optional on all streets, but preferred on all except boulevards, where parking may only be provided in a frontage lane.

5 Median

Medians shall be provided in the center of boulevards and avenues. They serve various functions, including refuge space for pedestrians, definition of turning lanes and tramways, and space for trees and landscaping. Side medians shall separate frontage lanes from the traveled way. Refer to section 5.9.8 for additional guidance.

5.2.1 Pedestrian Realm Zones

There are four primary zones in the pedestrian realm: frontage, through, furnishings, and edge. Because interaction occurs between these zones, development of a cohesive design for the pedestrian realm is important. Design must consider the unique conditions associated with each zone as well as how the pedestrian realm interacts with other elements of the street, such as bicycle and transit facilities and junctions. Maintaining clear sight lines between pedestrians, bicyclists, and motorists in these areas of interaction is critical.

Refer to Figures 5.2 and 5.3 for an illustration of the pedestrian realm zones. In some cases, a cycle track may be located within the pedestrian realm (see section 5.8 for design of cycle tracks and other bicycle facilities.) Keep in mind that buildings in the Emirate of Abu Dhabi may have more than one frontage.

Frontage Zone

The frontage zone is adjacent to the building or property line. It provides space for door openings,

An example of a building with two fronts.

			Section	Example 1: Avenue with Transit Median	Example 2: Boulevard with Frontage Lane
1	Pedestrians		5.6		
2	Transit Users	Side Bus / Tram Center Bus / Tram	5.7		
3	Bicyclists	Cycle Track Frontage Lane Bicycle Lane Yield Lane	5.8		
4	Motor Vehicles	Travel Lanes On-Street Parking Frontage Lane	5.9		
5	Median	Center Median Side Median Transit Median	5.9.8		

Figure 5.1 Street Design Elements Prioritization

steps, architectural elements, utilities, window shopping, signs, displays, and similar features.

- Keep this space as narrow and clear as possible so that people may walk and stand in the shadow of buildings.
- Vertical changes between the pedestrian realm grade and ground floor levels should be addressed internally within buildings as a last resort in the frontage zone. Do not substitute steps with a low wall or a series of low walls.
- Construct the frontage zone at the same grade and level as the through zone.
- The surface material should be the same as the through zone, but accent paving or color may be used to delineate and distinguish the frontage zone from the through zone.

Through Zone
The through zone is an obstacle-free space for pedestrian movement. It must remain both horizontally and vertically clear and provide a direct connection along pedestrian desire lines.

- Provide a firm, smooth, slip-resistant surface.
- Increase the width of the through zone in places that will attract high volumes of pedestrians, such as near Metro station entrances, malls, and other major destinations.

Furnishings Zone
The furnishings zone is where street furniture, necessary utility equipment, trees, landscaping, transit stops, and other features such as kiosks, sidewalk cafés, and vendors may be located.

- Consolidate and organize furnishings to maximize public use and benefit.
- Break up the furnishings zone to provide pedestrians access to crossings, taxi lay-bys, bus stops, and other facilities.
- Provide screening and buffering of utility fixtures in this zone while maintaining clear access for utility providers for maintenance.
- Refer to Chapter 6 for additional guidance related to streetscape furnishings.

Edge Zone
The edge zone is adjacent to on-street parking or motor vehicle lanes. The edge zone provides space to open a car door. It is where pedestrians wait for taxis or buses. This zone is often where street lights, signals, traffic signs, parking meters, electric car recharge stations, and other street-related infrastructure are placed. These elements may also be placed in the furnishings zone, particularly on narrower streets, or on the side median where there is a frontage lane.

- Provide 4.5 m vertical clearance in the edge zone for tall vehicles.
- Combine furnishings zone and edge zone where necessary for transit stops and taxi lay-bys. If this is not possible, provide a minimum of 1.5 m horizontal clearance where pedestrians are likely to wait for taxis or buses.

Bicycle Facilities
A cycle track may be included in the pedestrian realm, between the furnishings and edge zones, to provide bicyclists with a dedicated right-of-way separate from the traveled way. Coordination is required with the DOT to determine the specific facilities required.

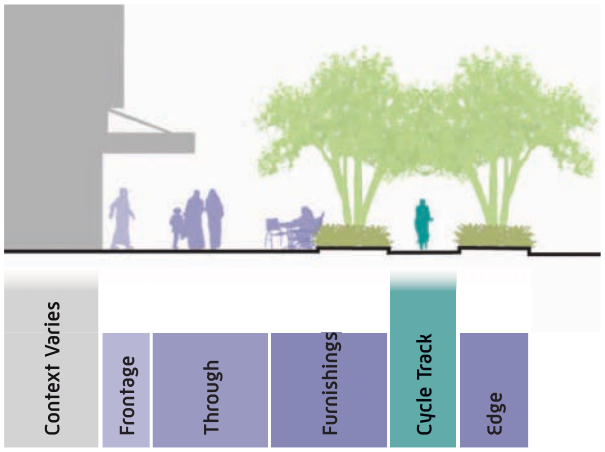


Figure 5.2 Pedestrian Realm Zones

"If we can develop and design streets so that they are wonderful, fulfilling places to be – community-building places, attractive for all people – then we will have successfully designed about one-third of the city directly and will have had an immense impact on the rest."
— Allan Jacobs

Figure 5.3 The Function of the Pedestrian Realm Zones

Frontage	Through	Furnishings	Cycle Track	Edge
Space between the building façade, wall or fence and the through zone of the pedestrian realm.	Obstacle-free space for clear pedestrian through travel. This is the primary walking area of the pedestrian realm.	Primary buffer space between the active pedestrian walking area of the through zone and adjacent thoroughfares.	Designated track for bicyclists; may not be required on some streets.	Interface between the on-street parking or travel lane.

Pedestrian Realm Zones

The frontage, through, furnishings, and edge zones shall be designed to fit the neighborhood context and adjacent land uses along the street. Refer to Chapter 6 for streetscape guidelines related to these zones of the pedestrian realm.

5.3 Standard Cross Sections

The following dimension tables and cross sections have been organized according to the Emirate's land use context categories: City, Town, Commercial, Residential, Industrial, and No Active Frontage. The tables and cross sections presented use a color code to identify the street design elements that compose the pedestrian realm and the traveled way. Where space within the cross section fulfills multiple functions or accommodates multiple modes, this is reflected by the use of colored bars in the tables and cross sections.

Most of the dimensions in the preferred dimension tables are fixed values. These prescribed dimensions reflect best practices applied under typical conditions with regard to the specific element and in the given land use context. However, dimension ranges are provided for the furnishings zone and edge zone as design flexibility of these areas provides designers with the opportunity to accommodate localized design elements.

5.3.1 City Context

Definition

Mixed use Central Business Districts (CBD) and high density neighborhoods with high levels of pedestrian activity, where buildings are typically seven stories and higher.

Design Considerations

Designing for the comfort and safety of pedestrians is the highest priority. Transit efficiency and reliability, as well as the comfort of transit passengers should be prioritized. A network of high quality bicycle facilities should be provided according to DOT guidance. Focus shade, landscape, café seating, public art, and other amenities in the pedestrian realm, particularly at major destinations such as prominent retail areas, mosques, schools, and tram stops. Provide frequent, signalized pedestrian crossings, particularly at Boulevards and Avenues in areas of high pedestrian activity. Use care in the design of transit stops and taxi lay-bys, ensuring comfortable waiting areas for passengers without interrupting cycle tracks or pedestrian Through zones.

Examples

The entire Abu Dhabi CBD and most of Al Reem Island.

Development Code Designations

Office High Density, High Density Mixed Use, High Density Residential (O-HD / MU-R / R80 / R60 / R50)

Standard City Dimensions

Street Family	Pedestrian Realm					Frontage Lane			Traveled Way				
	Frontage	Through	Furnishings	Cycle Track [2]	Edge [2]	Parking [1] Curb Extension	Travel Bicycle	Side Median	Parking Curb Extension	Bicycle Lane [2]	Curb Lane Bus [3]	Travel Lane(s)	Center Median [4]
Boulevard	0.8	3.5	1.5 - 3.0	2.0	0.5 - 1.5	n/a	n/a	n/a	n/a	n/a	3.5	3.3	6.0
with Frontage Lane	0.8	3.5	1.8 - 3.0	n/a	0.5	2.3	2.8	2.0	n/a	n/a	3.5	3.3	6.0
Avenue	0.8	3.0	1.5 - 2.0	2.0	0.5 - 1.5	n/a	n/a	n/a	2.5	2.0	3.5	3.3	6.0
with Frontage Lane	0.8	3.0	1.5 - 2.0	n/a	0.5	2.3	2.8	2.0	2.5	2.0	3.5	3.3	6.0
Street	0.5	2.8	1.2 - 1.8	n/a	0.5	n/a	n/a	n/a	2.3	2.0	3.0	n/a	n/a
Access Lane	n/a	1.8	n/a	n/a	0.5	n/a	n/a	n/a	n/a	n/a	3.0	n/a	n/a

1 Parking along pedestrian realm.

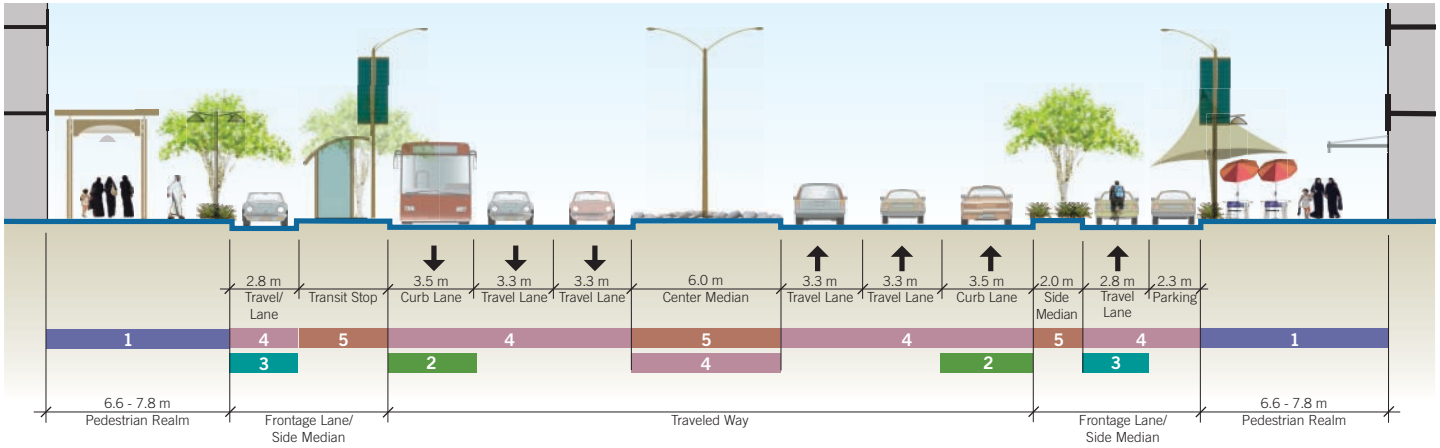
2 Designers to determine type of bicycle facility per Section 5.8 and consult with the DOT. If cycle track is used, the edge zone will be 1.5 m. If a bicycle lane is used, the edge zone will be 0.5 m. Streets and Access Lanes may have bicycle lanes or bicycles may share the curb lane. Where there is on-street parking, the edge zone will be 1.5 m.

3 Use 3.5 m if buses use curb lane as part of a regular transit route.

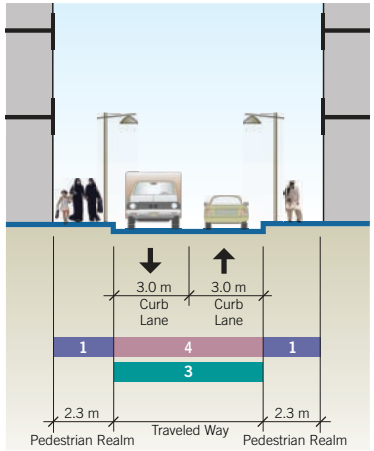
4 Median dimensions include 3.0 m left turn lane.

Optional

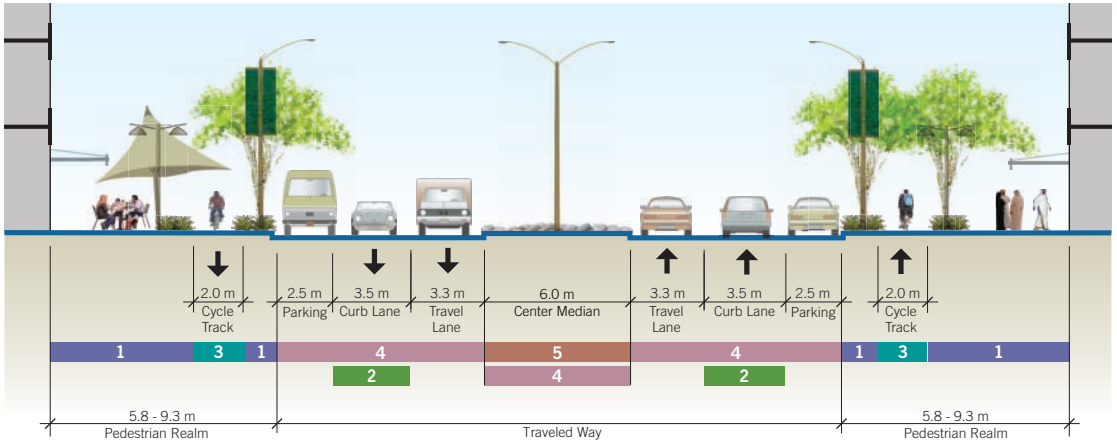
Standard City Boulevard (with Frontage Lane)



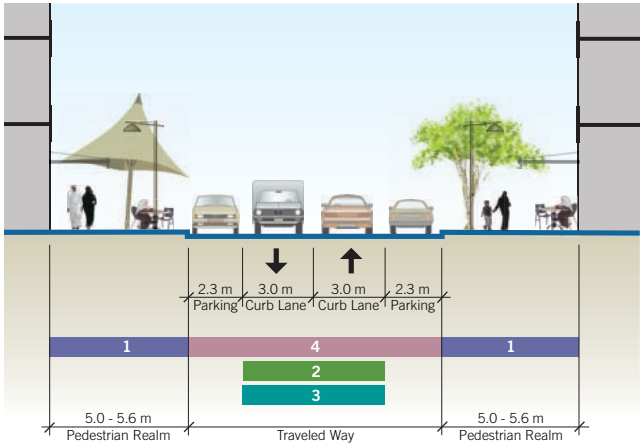
Standard City Access Lane



Standard City Avenue



Standard City Street



Street Design Elements

- **1 Pedestrians** Section 5.6
- **2 Transit Users** Section 5.7
- **3 Bicyclists** Section 5.8
- **4 Motor Vehicles** Section 5.9
- **5 Medians** Section 5.8.9

5.3.2 Town Context

Definition

Mixed use areas with medium levels of pedestrian activity, where buildings are typically three to six stories.

Design Considerations

Considerations are the same as the City context, but somewhat lower pedestrian volumes are expected and pedestrian realm dimensions are slightly narrower.

Examples

The Al Ain CBD. The retail centers of many Abu Dhabi City neighborhoods, such as in Khalifa City A.

Development Code Designations

Medium Density Mixed Use, Medium Density Residential (MU-DC / R25 / R15C / R15B)

Standard Town Dimensions

Street Family	Pedestrian Realm					Frontage Lane			Traveled Way				
	Frontage	Through	Furnishings	Cycle Track [2]	Edge [2]	Parking [1] Curb Extension	Travel Bicycle	Side Median	Parking Curb Extension	Bicycle Lane [2]	Curb Lane Bus [3]	Travel Lane(s)	Center Median [4]
Boulevard	0.8	3.5	1.5 - 3.0	2.0	0.5 - 1.5	n/a	n/a	n/a	n/a	n/a	3.5	3.3	6.0
with Frontage Lane	0.8	3.5	1.8 - 3.0	n/a	0.5	2.3	2.8	2.0	n/a	n/a	3.5	3.3	6.0
Avenue	0.8	3.0	1.5 - 2.0	2.0	0.5 - 1.5	n/a	n/a	n/a	2.5	2.0	3.5	3.3	6.0
with Frontage Lane	0.8	3.0	1.5 - 2.0	n/a	0.5	2.3	2.8	2.0	2.5	2.0	3.5	3.3	6.0
Street	0.5	2.4	1.2 - 1.8	n/a	0.5	n/a	n/a	n/a	2.3	2.0	3.0	n/a	n/a
Access Lane	n/a	1.8	n/a	n/a	0.5	n/a	n/a	n/a	n/a	n/a	3.0	n/a	n/a

1 Parking along pedestrian realm.

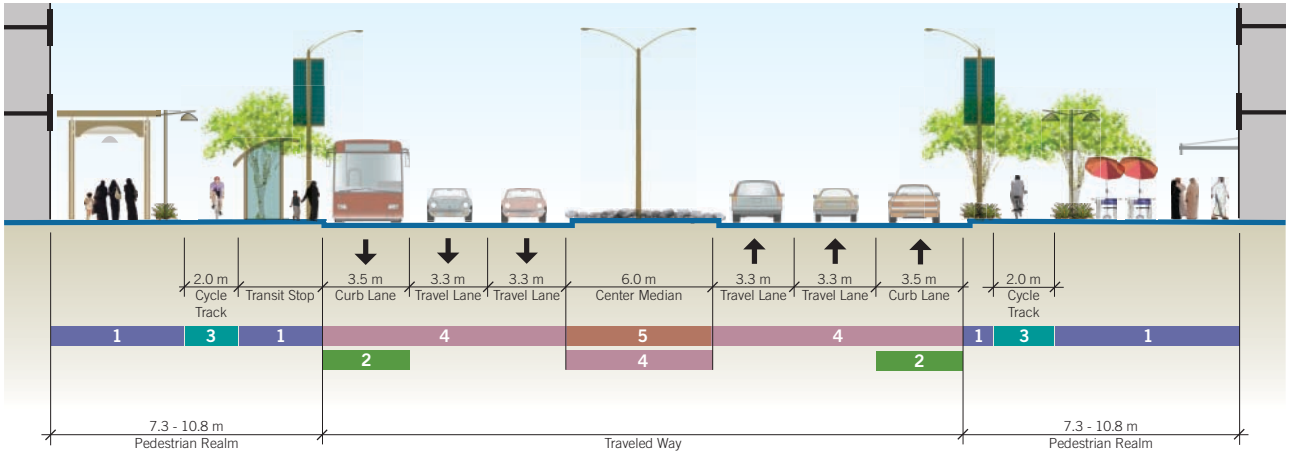
2 Designers to determine type of bicycle facility per Section 5.8 and consult with the DOT. If cycle track is used, the edge zone will be 1.5 m. If a bicycle lane is used, the edge zone will be 0.5 m. Streets and Access Lanes may have bicycle lanes or bicycles may share the curb lane. Where there is on-street parking, the edge zone will be 1.5 m.

3 Use 3.5 m if buses use curb lane as part of a regular transit route.

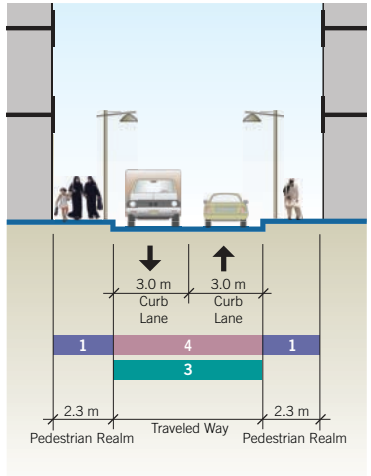
4 Median dimensions include 3.0 m left turn lane.

Optional

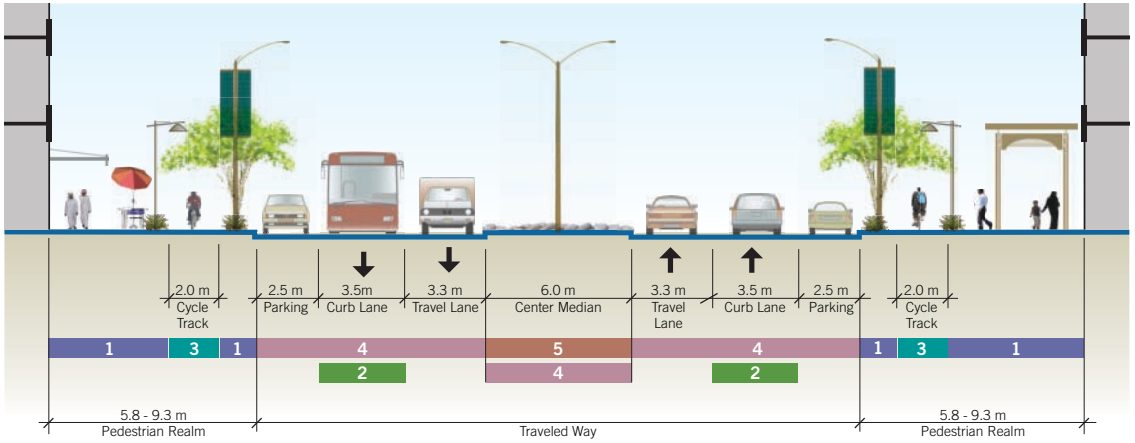
Standard Town Boulevard



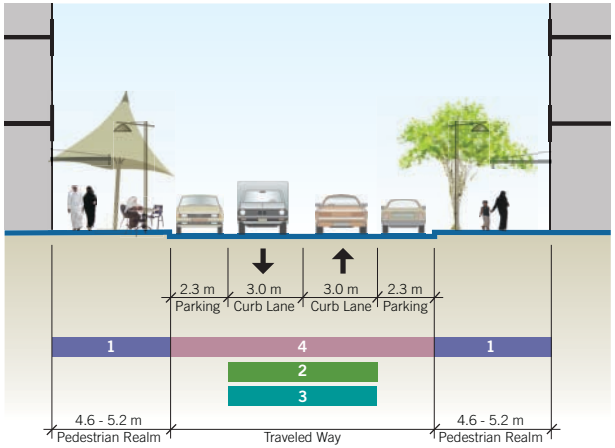
Standard Town Access Lane



Standard Town Avenue



Standard Town Street



Street Design Elements

1	Pedestrians Section 5.6	2	Transit Users Section 5.7	3	Bicyclists Section 5.8	4	Motor Vehicles Section 5.9	5	Medians Section 5.8.9

5.3.3 Commercial Context

Definition

Areas throughout the city intended to provide a variety of working, shopping, and service options and convenience.

Design Considerations

While land uses in this zone may be auto-oriented, pedestrians must still be accommodated, and walking should be safe and comfortable along all streets. Care should be taken to minimize the number of driveways and reduce the speed of motorists at pedestrian crossings. Landscape investment should focus on providing shade and comfort to pedestrians.

Examples

Auto-oriented retail zones along Airport Road in Abu Dhabi City and the commercial strip along Liwa Road in Madinat Zayed in Al Gharbia.

Development Code Designations

Low Density Mixed Use Commercial Employment (MU-NC / SC / O-MD)

Standard Commercial Dimensions

Street Family	Pedestrian Realm					Frontage Lane			Traveled Way				
	Frontage	Through	Furnishings	Cycle Track [2]	Edge [2]	Parking [1] Curb Extension	Travel Bicycle	Side Median	Parking Curb Extension	Bicycle Lane [2]	Curb Lane Bus [3]	Travel Lane(s)	Center Median [4]
Boulevard	0.5	2.5	1.5 - 1.8	2.0	0.5 - 1.5	n/a	n/a	n/a	n/a	n/a	3.5	3.3	6.0
with Frontage Lane	0.5	2.5	1.5 - 1.8	n/a	0.5	2.3	2.8	2.0	n/a	n/a	3.5	3.3	6.0
Avenue	0.5	2.2	1.5 - 1.8	2.0	0.5 - 1.5	n/a	n/a	n/a	2.5	2.0	3.5	3.3	6.0
with Frontage Lane	0.5	2.2	1.5 - 1.8	n/a	0.5	2.3	2.8	2.0	2.5	2.0	3.5	3.3	6.0
Street	0.5	2.0	1.2 - 1.5	n/a	0.5	n/a	n/a	n/a	2.3	2.0	3.0	n/a	n/a
Access Lane	n/a	1.8	n/a	n/a	0.5	n/a	n/a	n/a	n/a	n/a	3.0	n/a	n/a

1 Parking along pedestrian realm.

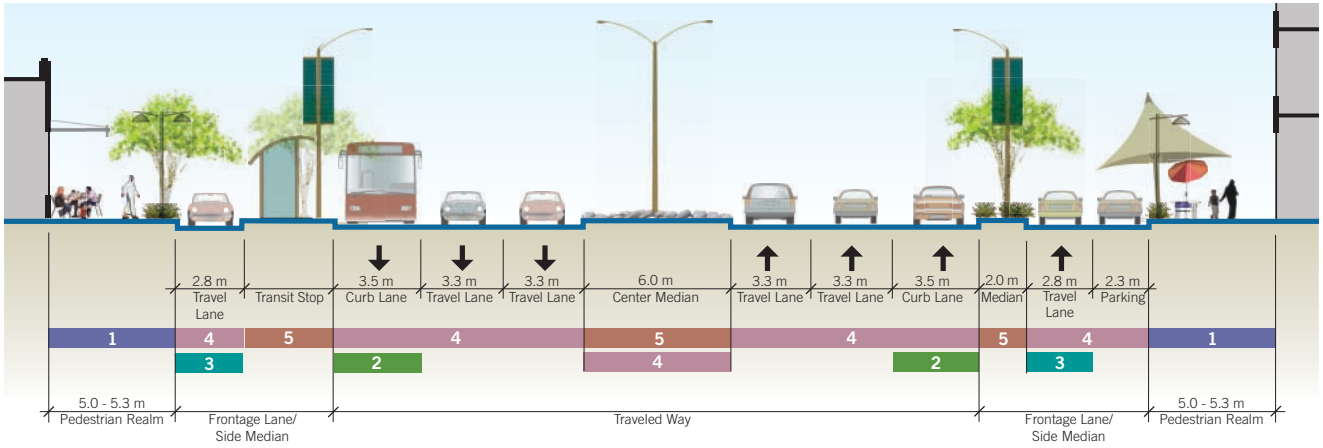
2 Designers to determine type of bicycle facility per Section 5.8 and consult with the DOT. If cycle track is used, the edge zone will be 1.5 m. If a bicycle lane is used, the edge zone will be 0.5 m. Streets and Access Lanes may have bicycle lanes or bicycles may share the curb lane. Where there is on-street parking, the edge zone will be 1.5 m.

3 Use 3.5 m if buses use curb lane as part of a regular transit route.

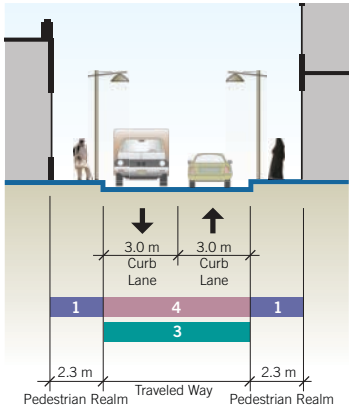
4 Median dimensions include 3.0 m left turn lane.

Optional

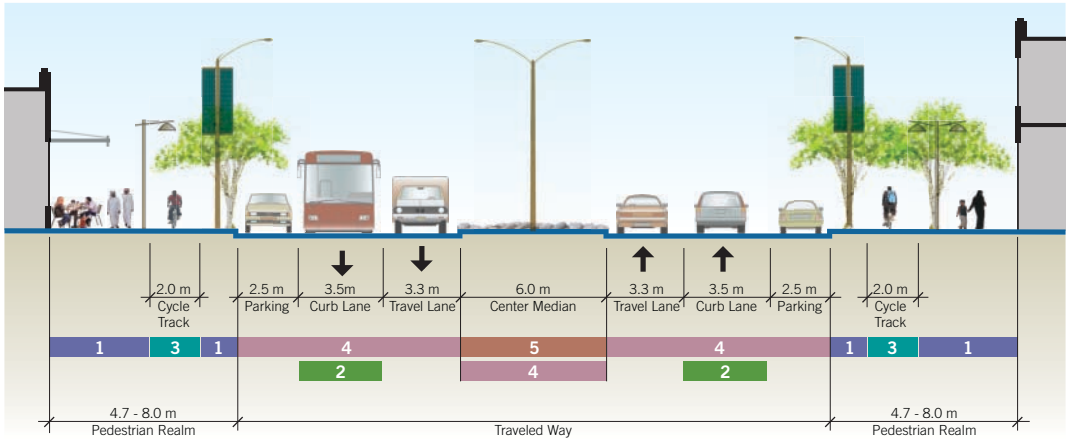
Standard Commercial Boulevard (with Frontage Lane)



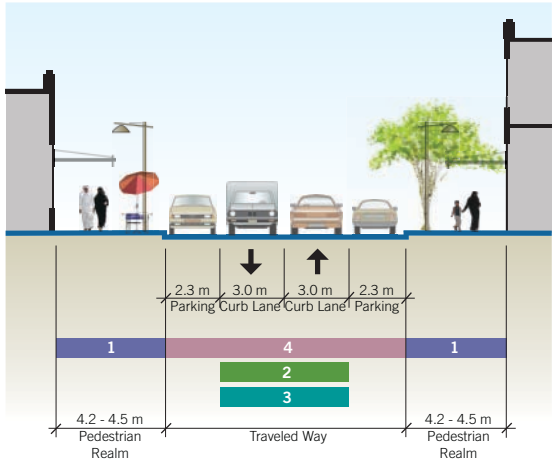
Standard Commercial Access Lane



Standard Commercial Avenue



Standard Commercial Street



Street Design Elements

- 1 **Pedestrians** Section 5.6
- 2 **Transit Users** Section 5.7
- 3 **Bicyclists** Section 5.8
- 4 **Motor Vehicles** Section 5.9
- 5 **Medians** Section 5.8.9

5.3.4 Residential Context

Definition

Areas that provide a variety of housing opportunities, allowing for densities varying from villa to multi-dwelling residential buildings.

Design Considerations

Pedestrian safety is of paramount importance. On some Residential Streets and all Residential Access Lanes, children's play should be accommodated in the street by ensuring very low speeds for automobiles. Landscape should provide shade for pedestrians and enhance residential quality of life. High levels of street connectivity, including use of Sikkas and other pedestrian-only ways, should be provided to allow direct access for all residents to transit stops, retail centers, mosques, and schools.

Examples

Low density residential neighborhoods, including most of Madinat Zayed, Al Mirfa, Al Ain, and Emirati neighborhoods in Abu Dhabi City.

Development Code Designations

Low Density Residential (R15A / VR)

Standard Residential Dimensions

Street Family	Pedestrian Realm					Frontage Lane			Traveled Way				
	Frontage	Through	Furnishings	Cycle Track [2]	Edge [2]	Parking [1] Curb Extension	Travel Bicycle	Side Median	Parking Curb Extension	Bicycle Lane [2]	Curb Lane Bus [3]	Travel Lane(s)	Center Median [4]
Boulevard	0.5	2.2	1.5	2.0	0.5 - 1.5	n/a	n/a	n/a	n/a	n/a	3.5	3.3	5.0
with Frontage Lane	0.5	2.2	1.5	n/a	0.5	2.3	2.8	2.0	n/a	n/a	3.5	3.3	5.0
Avenue	0.5	2.0	1.5	2.0	0.5 - 1.5	n/a	n/a	n/a	2.3	2.0	3.5	3.3	5.0
with Frontage Lane	0.5	2.0	1.5	n/a	0.5	2.3	2.8	2.0	2.3	2.0	3.5	3.3	5.0
Street	0.3	1.8	1.2 - 1.5	n/a	0.5	n/a	n/a	n/a	2.3	2.0	3.0	n/a	n/a
Access Lane	n/a	1.8	n/a	n/a	0.5	n/a	n/a	n/a	n/a	n/a	3.0	n/a	n/a

1 Parking along pedestrian realm.

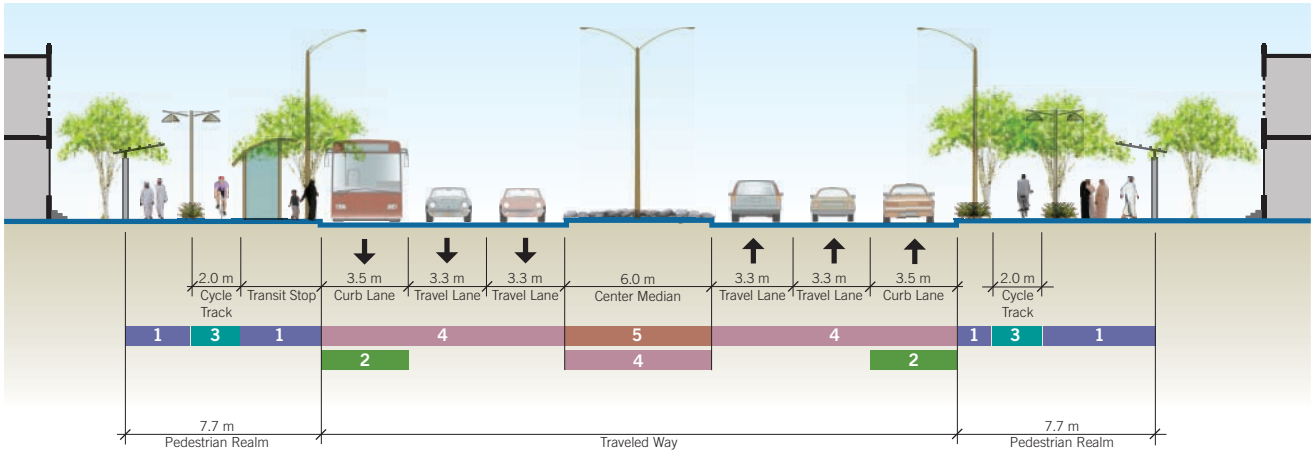
2 Designers to determine type of bicycle facility per Section 5.8 and consult with the DOT. If cycle track is used, the edge zone will be 1.5 m. If a bicycle lane is used, the edge zone will be 0.5 m. Streets and Access Lanes may have bicycle lanes or bicycles may share the curb lane. Where there is on-street parking, the edge zone will be 1.5 m.

3 Use 3.5 m if buses use curb lane as part of a regular transit route.

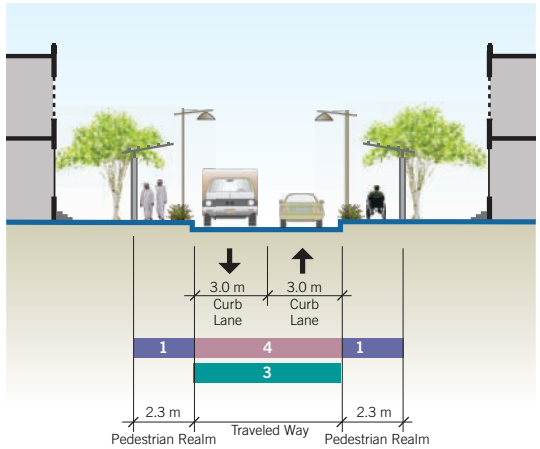
4 Median dimensions include 3.0 m left turn lane.

Optional

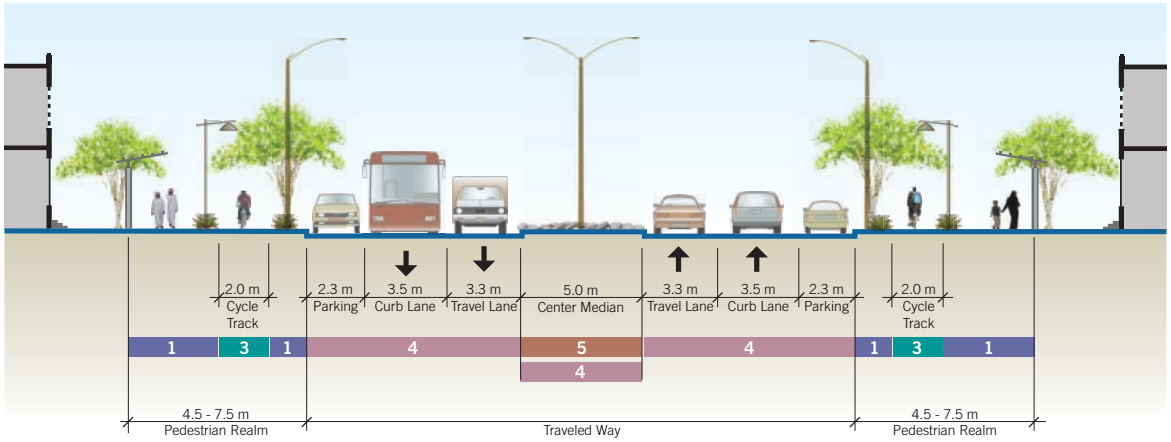
Standard Residential Boulevard



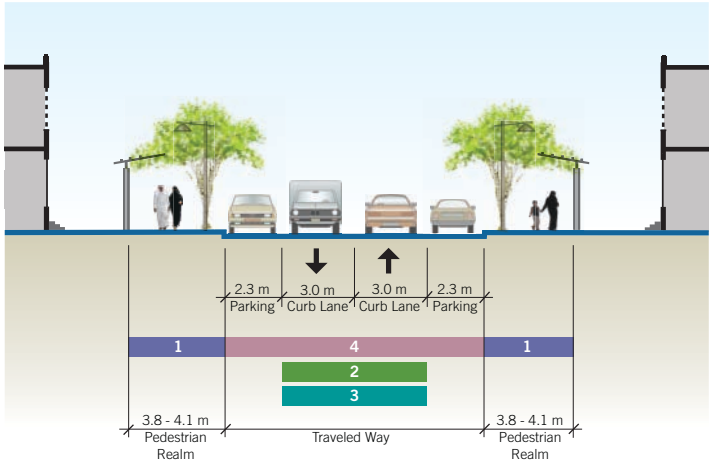
Standard Residential Access Lane



Standard Residential Avenue



Standard Residential Street



Street Design Elements

- **1 Pedestrians** Section 5.6
- **2 Transit Users** Section 5.7
- **3 Bicyclists** Section 5.8
- **4 Motor Vehicles** Section 5.9
- **5 Medians** Section 5.8.9

5.3.5 Industrial Context

Definition

Areas for businesses that have potential to create adverse visual, noise, or other impacts to adjoining public and residential properties. Uses include warehousing and distribution with support commercial services, ancillary office space, and labor camps.

Design Considerations

While land uses in this zone are auto-oriented, pedestrians must still be accommodated, and walking should be safe and comfortable along all streets. Care should be taken to minimize driveways and reduce speed of motorists crossing the pedestrian realm. Landscape investment should be limited and focused on providing shade and comfort to pedestrians.

Examples

Industrial zones and labor camps in Mussaffah in Abu Dhabi City and an industrial street in Sila'a in Al Gharbia.

Development Code Designations

General and Heavy Industrial (GI / HI)

Standard Industrial Dimensions

Street Family	Pedestrian Realm					Frontage Lane			Traveled Way				
	Frontage	Through	Furnishings	Cycle Track [2]	Edge [2]	Parking [1] Curb Extension	Travel Bicycle	Side Median	Parking Curb Extension	Bicycle Lane [2]	Curb Lane Bus [3]	Travel Lane(s)	Center Median [4]
Boulevard	0.5	2.0	1.2 - 1.5	2.0	0.5 - 1.5	n/a	n/a	n/a	n/a	n/a	3.5	3.5	5.0
with Frontage Lane	0.5	2.0	1.5	n/a	0.5	3.5	4.0	2.0	n/a	n/a	3.5	3.5	5.0
Avenue	0.5	2.0	1.2 - 1.5	2.0	0.5 - 1.5	n/a	n/a	n/a	3.5	2.0	3.5	3.5	5.0
with Frontage Lane	0.5	2.0	1.5	n/a	0.5	3.5	4.0	2.0	3.5	2.0	3.5	3.5	5.0
Street	0.3	1.8	1.2	n/a	0.5	n/a	n/a	n/a	3.5	2.0	3.5	n/a	n/a
Access Lane	n/a	1.8	n/a	n/a	0.5	n/a	n/a	n/a	n/a	n/a	3.5	n/a	n/a

1 Parking along pedestrian realm.

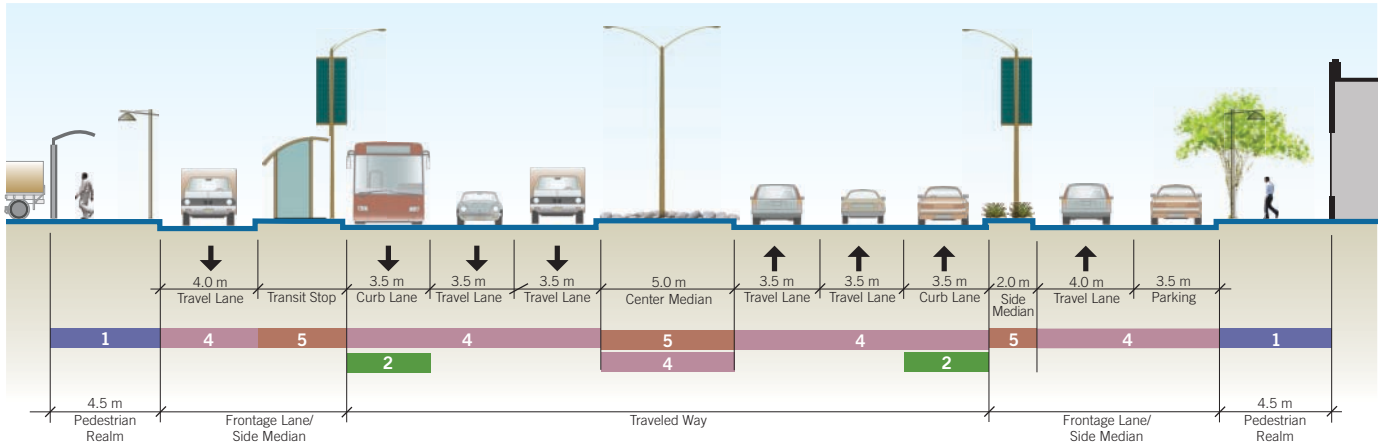
2 Designers to determine type of bicycle facility per Section 5.8 and consult with the DOT. If cycle track is used, the edge zone will be 1.5 m. If a bicycle lane is used, the edge zone will be 0.5 m. Streets and Access Lanes may have bicycle lanes or bicycles may share the curb lane. Where there is on-street parking, the edge zone will be 1.5 m.

3 Use 3.5 m if buses use curb lane as part of a regular transit route.

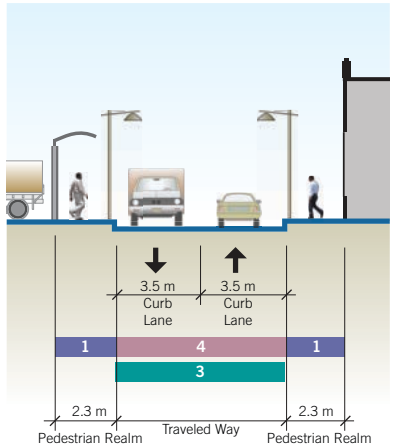
4 Median dimensions include 3.0 m left turn lane.

Optional

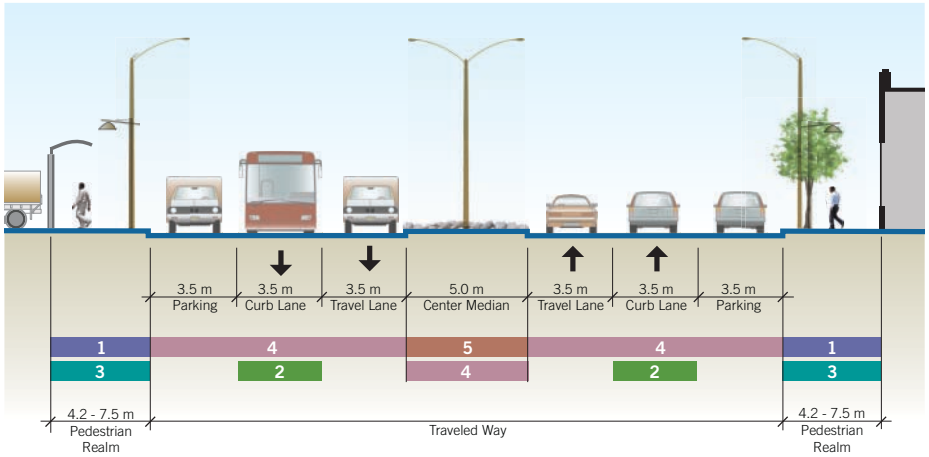
Standard Industrial Boulevard (with Frontage Lane)



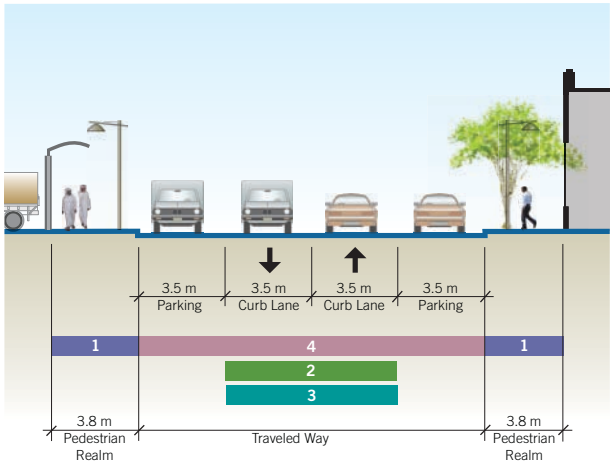
Standard Industrial Access Lane



Standard Industrial Avenue



Standard Industrial Street



Street Design Elements

- 1 **Pedestrians** Section 5.6
- 2 **Transit Users** Section 5.7
- 3 **Bicyclists** Section 5.8
- 4 **Motor Vehicles** Section 5.9
- 5 **Medians** Section 5.8.9

5.3.6 No Active Frontage

Definition

Places where no buildings or land uses front onto the street, such as a perimeter wall around a palace or residential neighborhood. These areas experience low levels of pedestrian activity.

Design Considerations

Compared to other context areas, the lowest level of pedestrian amenity should be provided here. However, pedestrians must still be accommodated safely along all these streets. Many No Active Frontage streets may also serve significant volumes of bicyclists traveling from one neighborhood to another. Transit may also serve these streets, and particular care should be taken to ensure personal security and comfort of passengers waiting at transit stops.

Examples

The streets along the perimeter villa walls around Khalifa City A in Abu Dhabi City and the palaces of Al Ain.

Development Code Designations

Palace wall, Open Space (EC / HR / RR / DI / NI)

Standard No Active Frontage Dimensions

Street Family	Pedestrian Realm					Frontage Lane			Traveled Way				
	Frontage	Through	Furnishings	Cycle Track [2]	Edge [2]	Parking [1] Curb Extension	Travel Bicycle	Side Median	Parking Curb Extension	Bicycle Lane [2]	Curb Lane Bus [3]	Travel Lane(s)	Center Median [4]
Boulevard	n/a	2.0	1.2 - 1.5	2.0	0.15 - 1.5	n/a	n/a	n/a	n/a	n/a	3.5	3.3	5.0
with Frontage Lane	Street Type Not Applicable												
Avenue	n/a	2.0	1.2 - 1.5	2.0	0.15 - 1.5	n/a	n/a	n/a	2.3	2.0	3.5	3.3	5.0
with Frontage Lane	Street Type Not Applicable												
Street	n/a	1.8	1.2 - 1.5	n/a	0.15 - 0.5	n/a	n/a	n/a	2.3	2.0	3.0	n/a	n/a
Access Lane	n/a	1.8	n/a	n/a	0.5	n/a	n/a	n/a	n/a	n/a	3.0	n/a	n/a

1 Parking along pedestrian realm.

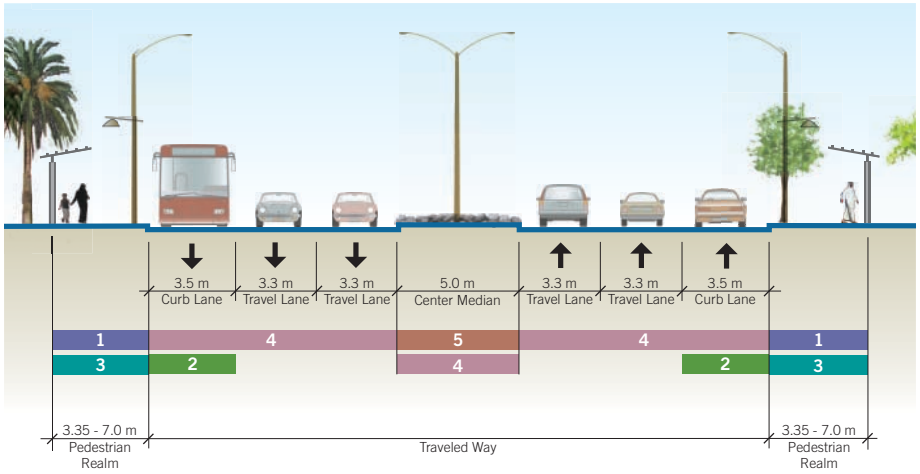
2 Designers to determine type of bicycle facility per Section 5.8 and consult with the DOT. If cycle track is used, the edge zone will be 1.5 m. If a bicycle lane is used, the edge zone will be 0.5 m. Streets and Access Lanes may have bicycle lanes or bicycles may share the curb lane. Where there is on-street parking, the edge zone will be 1.5 m.

3 Use 3.5 m if buses use curb lane as part of a regular transit route.

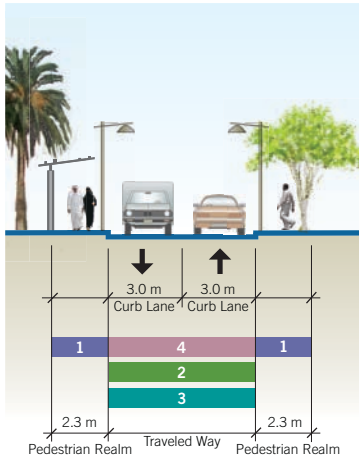
4 Median dimensions include 3.0 m left turn lane.

Optional

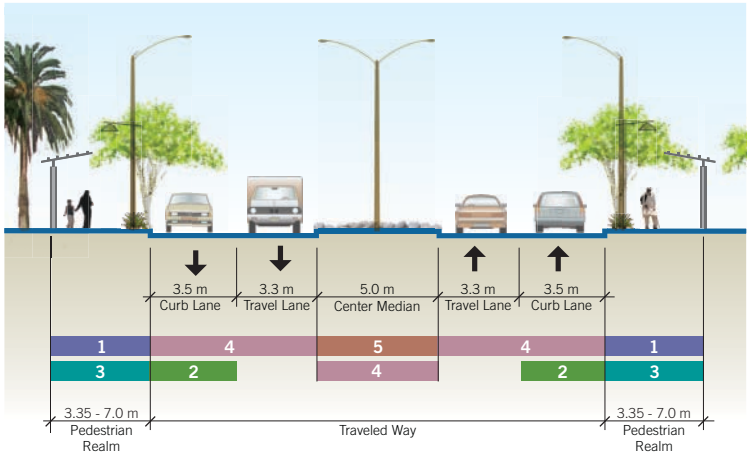
Standard No Active Frontage Boulevard



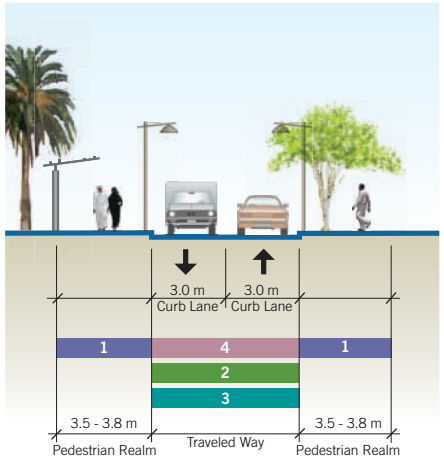
Standard No Active Frontage Access Lane



Standard No Active Frontage Avenue



Standard No Active Frontage Street



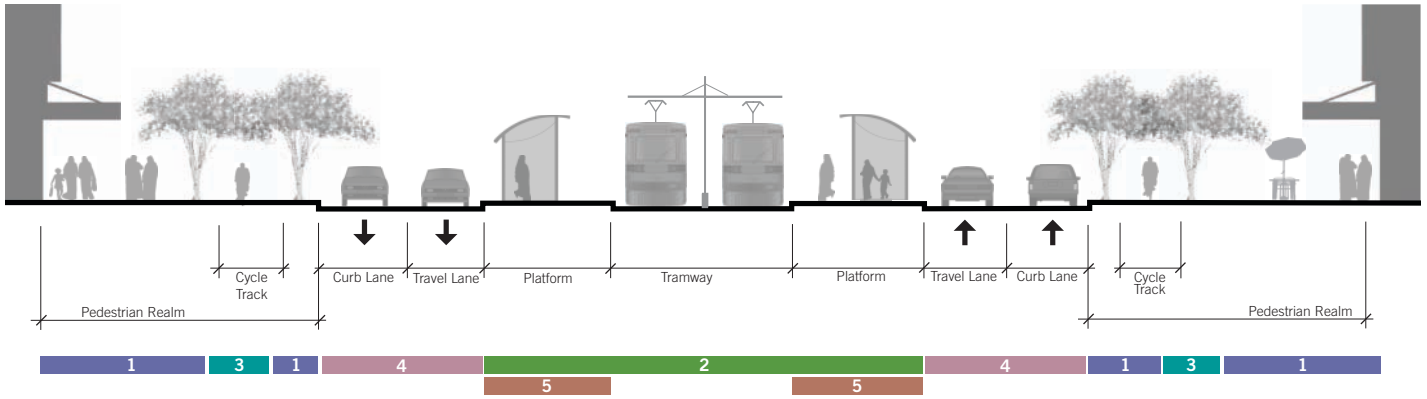
Street Design Elements

- 1 **Pedestrians** Section 5.6
- 2 **Transit Users** Section 5.7
- 3 **Bicyclists** Section 5.8
- 4 **Motor Vehicles** Section 5.9
- 5 **Medians** Section 5.8.9

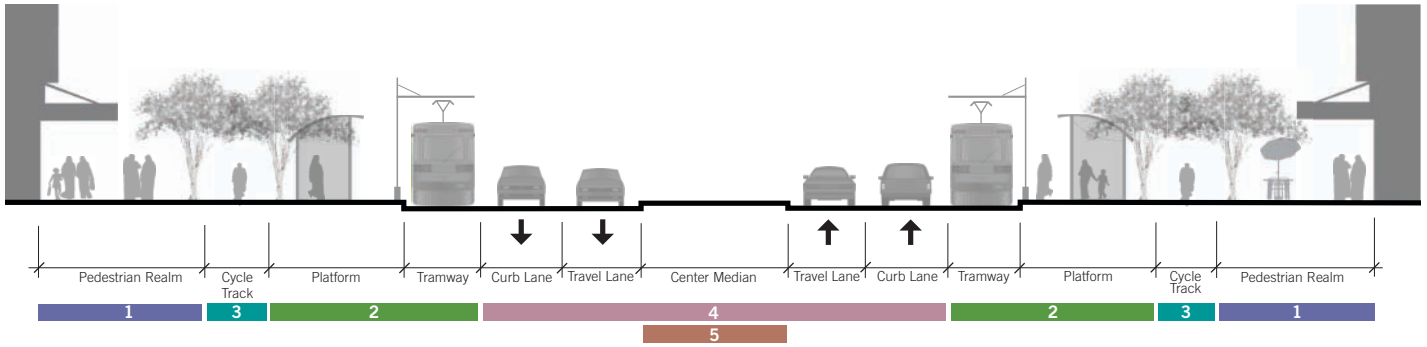
5.3.7 Transit Dedicated Lanes

Transit accommodation may be provided on a street through the addition of dedicated travel lanes for trams or buses, as required by the DOT. Transit lanes may be accommodated in the center median or side travel lanes. Transit streets may benefit from a wider pedestrian realm than the standard dimensions in order to accommodate stops, shelters, and high pedestrian activity. Design guidance for transit facilities within the right-of-way is provided, however design standards from the DOT will take precedence and shall be used over these dimensions.

Example of a City Transit Avenue with Center-Running Tram



Example of a City Transit Avenue with Side-Running Tram



5.4 Flexible Dimensions for Restricted Right-of-Way

In cases where existing conditions prevent the use of standard dimensions, design flexibility has been provided through the use of the minimum and maximum dimensions provided in Table 5.1. The use of these tables requires a Category 1 Exception, as described in Section 4.7.1. The Category 2 Exception detailed in 4.7.2 addresses street designs that go outside these ranges.

Table 5.1 Minimum and Maximum Dimensions

Street Family	Pedestrian Realm										Frontage Lane						Traveled Way									
	Frontage		Through		Furnishing		Cycle Track		Edge [1]		Parking Curb Extension		Travel Lane Bicycle		Side	Median	Parking Curb Extension		Bicycle Lane		Curb Lane Bus		Travel Lane(s)		Center Median [2]	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
City Context																										
Boulevard	0.5	1.5	2.8	4.0	1.2	3.5	1.5	2.5	0.15	2.0	2.0	2.3	2.5	3.0	0.5	4.0	n/a	n/a	n/a	n/a	3.3	3.5	3.3	3.3	2.0	6.0
Avenue	0.5	1.5	2.4	4.0	1.2	3.0	1.5	2.5	0.15	2.0	2.0	2.3	2.5	3.0	0.5	4.0	2.1	2.5	1.5	2.5	3.3	3.5	3.3	3.3	2.0	6.0
Street	0.5	1.5	2.4	3.0	1.0	2.4	1.5	2.5	0.15	2.0	n/a	n/a	n/a	n/a	n/a	n/a	2.1	2.4	1.5	2.5	3.3	3.5	3.0	3.3	n/a	n/a
Access Lane	n/a	n/a	1.8	2.5	n/a	n/a	n/a	n/a	0.15	0.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2.7	3.0	n/a	n/a	n/a	n/a
Town Context																										
Boulevard	0.5	1.5	2.4	3.5	1.2	3.0	1.5	2.5	0.15	2.0	2.0	2.3	2.5	3.0	0.5	4.0	n/a	n/a	n/a	n/a	3.3	3.5	3.3	3.3	2.0	6.0
Avenue	0.5	1.5	2.0	3.0	1.2	2.4	1.5	2.5	0.15	2.0	2.0	2.3	2.5	3.0	0.5	4.0	2.1	2.5	1.5	2.5	3.3	3.5	3.3	3.3	2.0	6.0
Street	0.5	1.5	2.0	2.4	1.0	2.0	1.5	2.5	0.15	2.0	n/a	n/a	n/a	n/a	n/a	n/a	2.1	2.4	1.5	2.5	3.0	3.5	n/a	n/a	n/a	n/a
Access Lane	n/a	n/a	1.8	2.5	n/a	n/a	n/a	n/a	0.15	0.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2.7	3.0	n/a	n/a	n/a	n/a
Commercial Context																										
Boulevard	0.5	1.5	2.4	3.0	1.2	3.0	1.5	2.5	0.15	2.0	2.0	2.3	2.5	3.0	0.5	4.0	n/a	n/a	n/a	n/a	3.3	3.5	3.3	3.3	2.0	6.0
Avenue	0.5	1.5	2.0	3.0	1.2	2.4	1.5	2.5	0.15	2.0	2.0	2.3	2.5	3.0	0.5	4.0	2.1	2.5	1.5	2.5	3.3	3.5	3.3	3.3	2.0	6.0
Street	0.5	1.5	2.0	2.4	1.0	2.0	1.5	2.5	0.15	2.0	n/a	n/a	n/a	n/a	n/a	n/a	2.1	2.4	1.5	2.5	3.0	3.5	n/a	n/a	n/a	n/a
Access Lane	n/a	n/a	1.8	2.5	n/a	n/a	n/a	n/a	0.15	0.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2.7	3.0	n/a	n/a	n/a	n/a
Residential Context																										
Boulevard	0.5	1.0	1.8	2.8	1.2	2.0	1.5	2.5	0.15	1.8	2.0	2.3	2.5	3.0	0.5	4.0	n/a	n/a	n/a	n/a	3.3	3.5	3.3	3.3	2.0	5.0
Avenue	0.5	1.0	1.8	2.0	1.2	2.0	1.5	2.5	0.15	2.0	2.0	2.3	2.5	3.0	0.5	4.0	2.1	2.4	1.5	2.5	3.3	3.5	3.3	3.3	2.0	5.0
Street	0.3	1.5	1.8	2.0	1.0	1.8	1.5	2.5	0.15	2.0	n/a	n/a	n/a	n/a	n/a	n/a	2.1	2.4	1.5	2.5	3.0	3.5	n/a	n/a	n/a	n/a
Access Lane	n/a	n/a	1.8	2.5	n/a	n/a	n/a	n/a	0.15	0.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2.7	3.0	n/a	n/a	n/a	n/a
Industrial Context																										
Boulevard	0.3	0.5	2.0	3.6	1.2	2.4	1.5	2.5	0.15	2.0	3.3	3.7	3.7	4.0	0.5	4.0	n/a	n/a	n/a	n/a	3.3	3.7	3.3	3.7	2.0	5.0
Avenue	0.3	0.5	2.0	3.4	1.2	2.4	1.5	2.5	0.15	2.0	3.3	3.7	3.7	4.0	0.5	4.0	3.3	3.7	1.5	2.5	3.3	3.7	3.3	3.7	2.0	5.0
Street	0.3	0.5	2.0	3.0	1.0	1.5	1.5	2.5	0.15	2.0	n/a	n/a	n/a	n/a	n/a	n/a	3.3	3.7	1.5	2.5	3.3	3.7	n/a	n/a	n/a	n/a
Access Lane	n/a	n/a	1.8	2.5	n/a	n/a	n/a	n/a	0.15	0.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2.7	3.0	n/a	n/a	n/a	n/a
No Active Frontage																										
Boulevard	0.3	0.5	1.8	3.5	n/a	n/a	1.5	2.5	0.15	0.5	2.0	2.3	2.5	3.0	0.5	4.0	n/a	n/a	n/a	n/a	3.3	3.5	3.3	3.3	2.0	5.0
Avenue	0.3	0.5	1.8	3.0	n/a	n/a	1.5	2.5	0.15	0.5	2.0	2.3	2.5	3.0	0.5	4.0	n/a	n/a	1.5	2.5	3.3	3.5	3.3	3.3	2.0	5.0
Street	0.3	0.5	1.8	2.4	n/a	n/a	1.5	2.5	0.15	0.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.5	2.5	3.0	3.5	n/a	n/a	n/a	n/a
Access Lane	n/a	n/a	1.8	2.5	n/a	n/a	n/a	n/a	0.15	0.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	2.7	3.0	n/a	n/a	n/a	n/a

Optional

5.5 Additional Street Types

Variations from the preferred cross sections may be permitted, along with unique, custom-designed streets. All of the detailed design guidance in this Manual applies to these custom-designed streets, and the dimensional guidance of individual elements of the example cross sections may also apply. Sikkas, Mushtaraks, and Shared Access Lanes do not require an exceptions process. Provided other variants and custom-designed streets stay within the minimum and maximum dimensions in Table 5.1, they fall into the Category 1 Exception process detailed in section 4.7.1.

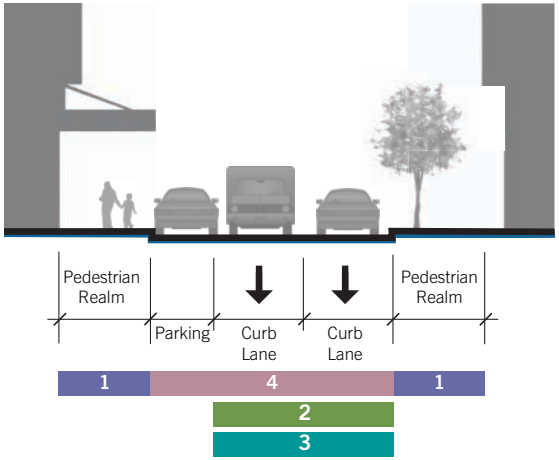
5.5.1 One-way Streets

One-way streets accommodate traffic moving in only one direction. One-way streets may be designed using the sample cross-sections above, by removing the median and one direction of travel lanes and increasing lane widths. One-way streets in the Emirate require a Category 2 Exception process.

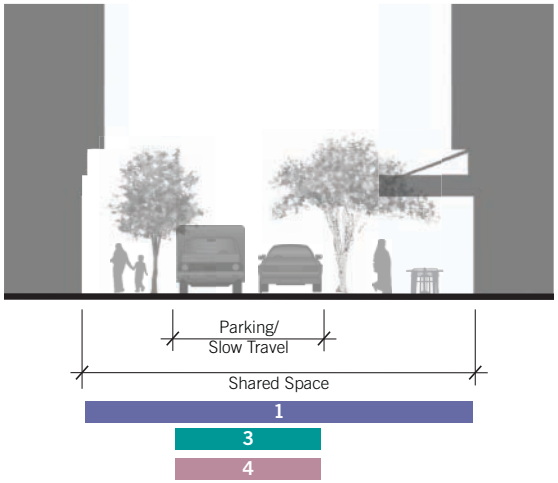
5.5.2 Shared Streets/Mushtaraks

Mushtarak is the Arabic word for a space that is shared by multiple modes. These streets are typically narrower and intended primarily for pedestrian use, but they can accommodate motor vehicles at very low speeds. They are generally an exception to the vertical separation design method mentioned in Chapter 3, as all modes share the same paved surface so that there are no defined travel lanes. For design guidance on Shared Streets, see the UK publications on "Home Zones" and the Dutch publications on "Woonerfs."

Example of a One-Way Street



Example of a Mushtarak



Example of a Mushtarak in Abu Dhabi

5.5.3 Sikka

A Sikka is a pedestrian passageway between properties common throughout the Emirate in historic and new neighborhoods. No motor vehicles are accommodated in a Sikka, however bicyclists may share this space. They can be a useful tool for increasing the walkability of a neighborhood. The narrow width of the Sikka (typically 2.5 – 5.0 m) increases the amount of shading for pedestrians.

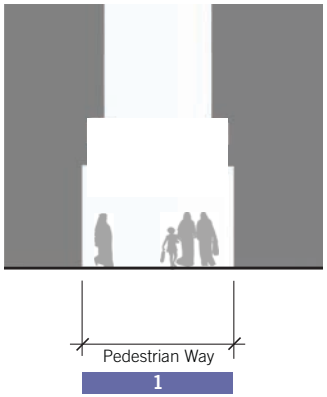
5.5.4 Shared Access Lane

The Shared Access Lane is a variation of the Access Lane in that it provides a single wide lane that accommodates both directions of travel. The pedestrian realm dimensions on a Shared Access Lane are the same as the standard Access Lane, but the standard travel lane dimension is a maximum of 4.2 m in order to allow a motor vehicle and bicycle to pass each other when traveling in opposite directions. The minimum travel lane width is 2.7 m. Shared Access Lanes are only used on very low volume streets.

5.5.5 Special Condition Streets

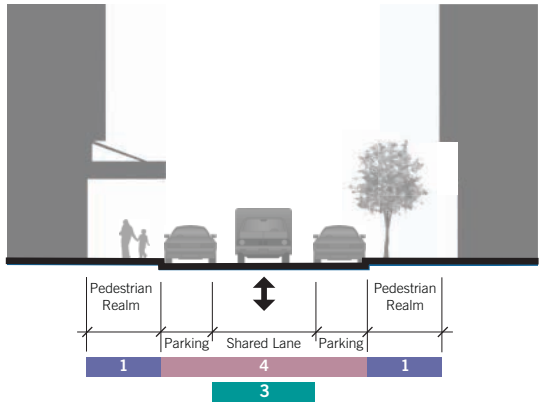
Special streets may include ceremonial streets, parkways (4+4), and other unique streets. Ceremonial streets may have wider travel lanes than the standard cross sections and significantly wider medians. The pedestrian realm may also be wider with greater attention to landscape. Water budget requirements, as referred to in section 4.2.4, are especially important on these streets and will need to be confirmed at the beginning of the design process.

Example of a Sikka



Sikka in Abu Dhabi.

Example of a Shared Access Lane



5.6 Designing for Pedestrians

Pedestrians require movement not only along the street in the pedestrian realm but also at interaction areas where multi-mode user movements cross. As pedestrians are the most vulnerable of all street users, special care and consideration is needed to identify potential issues and to design facilities accordingly.

5.6.1 Pedestrian Crossing Locations

Pedestrian crossings are located at junctions and sometimes mid-block where significant pedestrian movement is anticipated. To provide a high-quality pedestrian environment and ensure pedestrian safety, pedestrian crossings shall be provided on all streets to accommodate primary pedestrian desire lines and must meet the spacing standards below.

- Provide at all traffic-controlled junction legs.
- Locate along desire lines:
  - Align with entrances to buildings, parks, walkways, etc.
  - Use to delineate preferred pedestrian route.
- Spacing maximums by land use:
  - 120 m City, Town, and Commercial
  - 150 m Residential
  - 200 m Industrial
- If u-turns are included, consider locating pedestrian crossings to minimize conflicts with turning traffic.

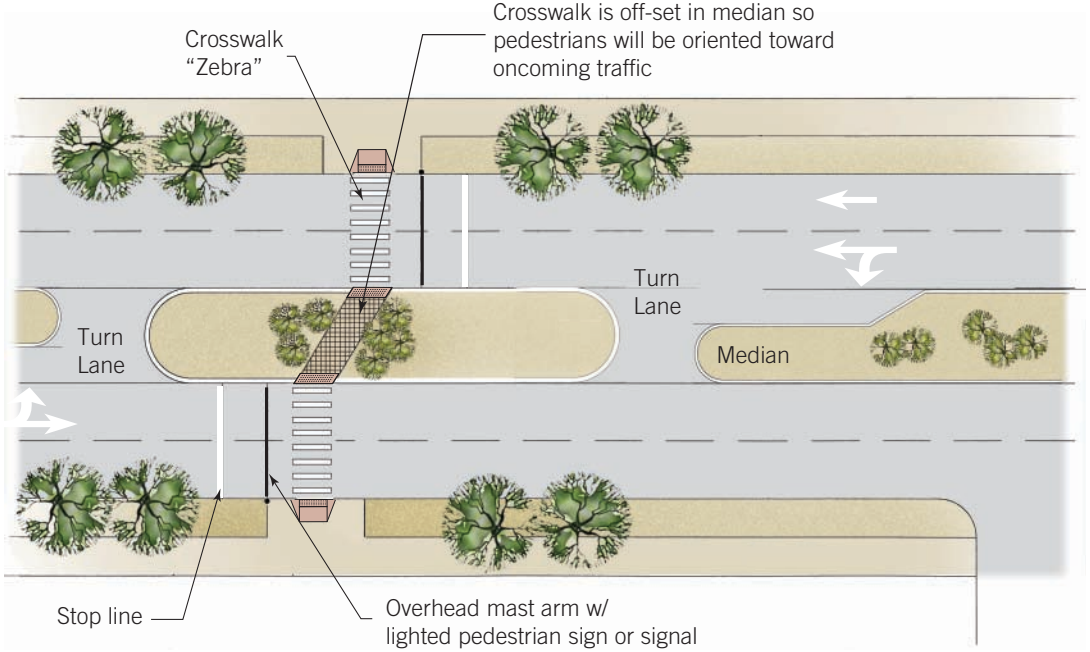


Figure 5.4 Offset mid-block crossing, oriented so that pedestrians face oncoming traffic

Mid-Block Crossings

- Locate mid-block crossings based on pedestrian movement, building entrances, attractions, etc.
- Include overhead signage and lights (see Figure 5.4).
- Provide curb extensions where there is on-street parking to maintain pedestrian visibility.
- Provide raised crossings where traffic calming is necessary.

5.6.2 Crossing Design

Pedestrian crossings range from raised speed table style crosswalks to informal crossings. Table 5.2 provides recommendations for facility type, based on street family.

- Maximum uninterrupted crossing distance shall not exceed 13.1 m. To reduce crossing distance:
  - Provide curb extensions;
  - Narrow width of travel lanes (see section 5.9.1);
  - Reduce the number of travel lanes; and/or
  - Install refuge islands located within clearly visible areas.

Table 5.2 Recommendations for Installing Pedestrian Crossings at Mid-Block Locations

Street Family	Vehicle ADT < 9,000			Vehicle ADT > 9,000 to 12,000			Vehicle ADT >12,000 to 15,000			Vehicle ADT > 15,000		
	Speed Limit											
	≤ 30 km/h	40 km/h	60 km/h	≤ 30 km/h	40 km/h	60 km/h	≤ 30 km/h	40 km/h	60 km/h	≤ 30 km/h	40 km/h	60 km/h
Street	●	●	N/A	●	●	N/A	●	●	N/A	●	○	N/A
Avenue	●	●	○	●	○		○	○				
Boulevard												

● Acceptable to use marked uncontrolled crossing

○ Consider traffic calming, signal, or other Do not use marked crosswalk without a signal, and consider additional traffic calming measures

- Provide curb ramps to accommodate the change in grade at the ends of crossings.
- Place in line with and at the same width as the adjoining walkway or curb ramp.
  - The pedestrian route may diverge by no more than 1:5.
- Typical width: 3 m; 5 m on Boulevards.
- Vehicle stop lines 3 m ahead of the crosswalk, 10 m ahead at mid-block crosswalks.

Signalized Crossings

- Use fixed-time (no push buttons; exception may be made at mid-block crossings).
- Prioritize pedestrians over vehicles or provide exclusive phase.
- Provide dynamic timing (countdown) signals.
- Provide audible pedestrian signals.

Pedestrian Refuges

- Minimum width: 2 m (typically 10 m^2; 12 m^2 on Boulevards).
- Extend median tips/noses past crossings at junctions (see Figure 5.5).
- Crossing area to be flush (cut-through).
- Crossing may be off-set or angled to orient pedestrians to oncoming traffic.

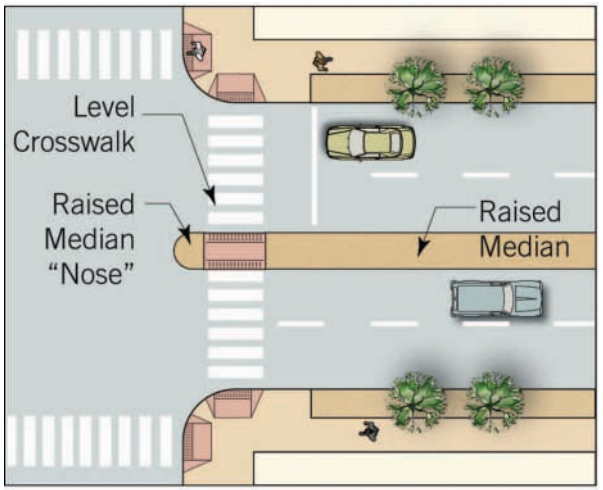
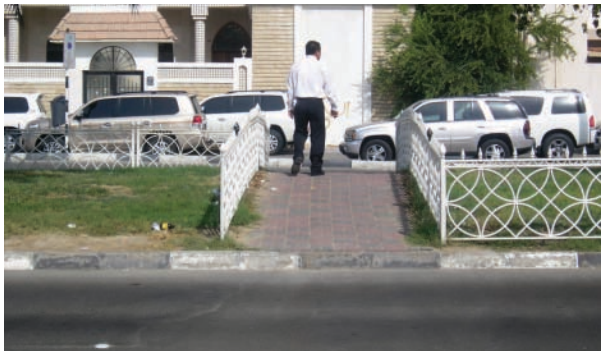


Figure 5.5 Typical Crosswalk Elements

Raised crosswalk aligned with pathway, Abu Dhabi; this is a preferred approach.

Driveway designed as a curb cut, not a minor junction, Washington, USA.

Stop sign for drivers at pedestrian crossing, Washington, USA.



Mid-block crossing, Abu Dhabi; proper design would include curb ramps and a marked crosswalk.

5.6.3 Driveway Design

Driveways shall be designed to ensure pedestrians have the right-of-way over motor vehicles. Vehicles shall be required to change grade, not pedestrians.

Other guidance for driveway design includes:

- Orient driveways at 90 degree (right angles) to roadway.
  - Bend the drive lane if necessary.
- Design driveways as ramps, not as minor junctions.
- Ramp driveways up to pedestrian realm level.
  - Continue pedestrian realm treatment across driveway.
- Maximum entry speed: 15 km/h.
- Maximum width: 7 m (this may be increased in Industrial contexts).
- Control vehicles via stop and yield signs.
- Minimize the number of driveways on Boulevards and Avenues; see Access Management 5.9.4.

5.6.4 Curb Height

Curbs shall be designed to discourage motor vehicles from encroaching onto the pedestrian realm while still making it easy for pedestrians to step up and down from the pedestrian realm to the traveled way.

- Typical preferred height: 150 mm.
- Where parking on curbs in the pedestrian realm is an issue, employ pedestrian protective techniques such as bollards and planters instead of higher curbs.
- Provide for positive drainage via swales, cross-slopes, longitudinal grades, and other grading techniques – not higher curbs.

5.6.5 Slopes & Grade

Provide a maximum 1:50 cross slope on all paved surfaces in the pedestrian realm and street crossings (including sidewalks and ramps). Maintaining this maximum cross slope will facilitate travel by wheelchair users, minimize tripping hazards for pedestrians, and provide positive drainage for hard surfaces.

- Longitudinal grades in the pedestrian realm shall not exceed a maximum of 1:20. If the grade is larger anywhere in the pedestrian realm (such as along a building frontage), a longitudinal ramp shall be constructed.
- Longitudinal ramps may not exceed a maximum ramp grade of 1:12.
- Provide edge protection for ramps steeper than 1:20 or landings more than 1.3 m above the adjacent grade.

5.6.6 Curb Ramps

Curb ramps provide accessibility at street junctions, mid-block crossings, and other areas where elevated walkways are edged with curbing. Curb ramps facilitate crossing for wheelchair users, people pushing strollers, bicyclists, and others. They also help sight-impaired pedestrians identify the street crossing location.

- Two curb ramps per corner should be provided at all junctions, one in the direction of each crosswalk (see Figure 5.6).
- Locate curb ramps in the center of the crosswalk and construct them with the ramp the full width of a crosswalk.
- Design the low end of the curb ramp so it meets the street grade with a smooth transition and no lip (see Figure 5.7).
- Curb ramps should not be provided at channelization islands or median refuge islands. Full cut-through openings shall be provided at grade with the street in these cases.
- Provide good drainage at intersection corners so standing water does not accumulate at the crossing area. Place drainage inlets on the uphill side of the crosswalk and outside the crosswalk area.

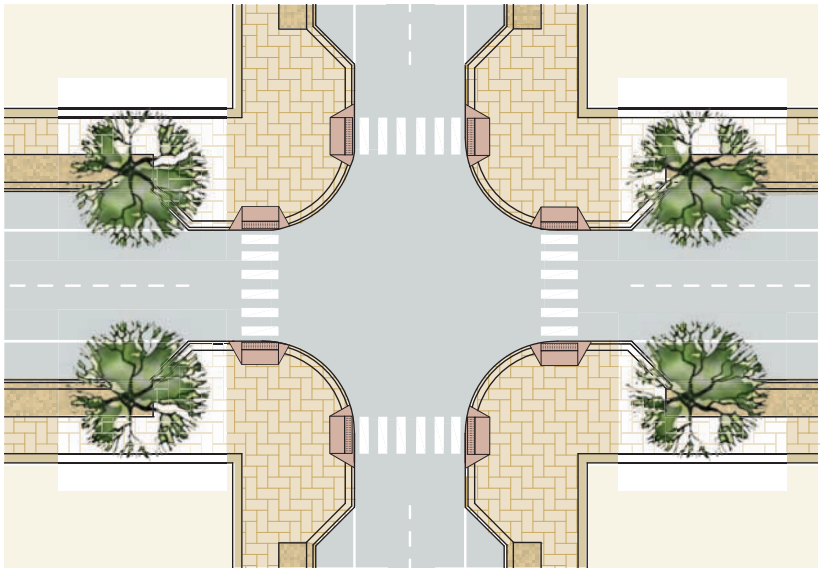


Figure 5.6 Aligning Ramps and Crossings

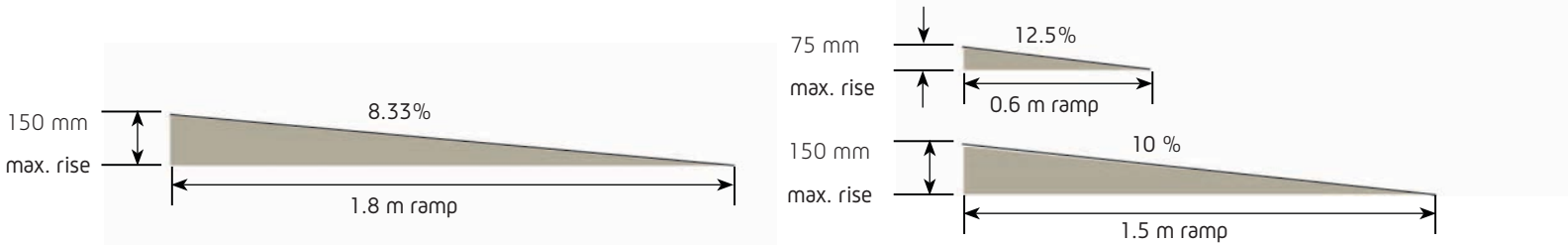


Figure 5.7 Curb Ramp Details

New Construction

Permissible Exceptions if 8.33% Slope is Technically Infeasible

5.7 Designing for Transit Users

The introduction of transit, including Metro, tram, bus rapid transit (BRT), buses, and taxis, is integral to meeting the goals of the 2030 plans. DOT guidance takes precedence for all streets and all types of transit (Metro, tram, bus rapid transit, and bus).

Where lay-bys for taxis and private buses, transit bus pullouts, bus stop amenities, or entrances to crossings or Metro stations need to be accommodated within the pedestrian realm, they should primarily occur in the space formed by the combined width of edge and furnishing zones as well as curb extensions. In cases where the combined width of these elements is insufficient to accommodate these facilities, a reduction of the through zone width up to the minimums indicated Table 5.1 is permitted (see section 5.4).

High quality Metro station entrance, Paris, France.

5.7.1 Metro

Entrances to Metro stations are typically placed in the furnishings zone of the pedestrian realm or internal to buildings along the street. If necessary, designers may use the minimum and maximum pedestrian realm dimensions from section 5.4 to accommodate a Metro station entrance.

- Provide full access for people with mobility impairments.
- Do not obstruct the through zone.

5.7.2 Tram

Typically, trams run in the center of the street where limited interference from other traffic allows them to operate most efficiently and safely. Except when there is highly constrained right-of-way, trams should operate in their own dedicated travel lanes. On streets with insufficient right-of-way for median platforms, or where transit efficiency is not a priority, trams may be operated in the curb lane. Trams may be operated for short distances in the pedestrian realm or in parks and plazas for specific reasons (such as to connect across a plaza where the street grid does not continue). Table 5.3 lists comparative advantages and disadvantages of each alignment. Design guidance for tram shall be obtained from DOT.

5.7.3 Bus Rapid Transit

Bus Rapid Transit (BRT) is similar to a tram service in that buses operate mainly in their own right-of-way, protected from congestion, with high quality "stations." Design guidance for BRT shall be obtained from DOT.

High quality tram station, Minneapolis, USA.

Table 5.3 Comparative Advantages and Disadvantages of Center, Side, and Sidewalk-running Trams in Order of Importance

	Center	Side	Sidewalk Plaza
Conflicts with Other Traffic	●		○
Tram Speed	●	○	
Pedestrian Waiting Comfort		●	●
Pedestrian/Cyclist Interference	●	○	
Right Turn Interference	●		○
Driveway Interference	●		
Left Turn Interference		●	●
Pedestrian Realm Vitality		○	●
More Right-of-Way Required for Platforms		●	●

● Advantage ○ Neutral ■ Disadvantage

5.7.4 Bus

Bus service should be prioritized over other traffic to increase the attractiveness of transit via:

- Bus-only lanes, including part-time
- Priority at signals
- Parking restrictions
- Bus stops in travel lane

Bus Stop Locations

Bus stops may be placed at junctions or mid-block depending on the route, transfers, passenger generators, and destinations. Table 5.4 compares characteristics of near-side, far-side, and mid-block bus stops, in order of importance.

- If route turns left, place stop on the far side after the turn, or mid-block.
- At complex junctions with dual right or left turns, place stop on the far side.
- Eliminate driveways where they interfere with transit operations.

Bus Stop Design

All bus stops are to offer clear, paved pedestrian access, shade, seating, and route information. Other amenities include trash receptacle, bicycle parking, lighting, real-time information display for bus arrivals, and air-conditioning.

- Curbside bus stop length:
  - Near-side: 28 m
  - Far-side: 25 m
- Curb extensions at bus stops (bus bulbs) need only be long enough to service bus doors.
- Bus lay-bys shall only be used where travel speeds are greater than 60 km/h, where bus volumes exceed 10 vehicles per hour in the peak period, and where the peak hour curb lane vehicle volume is less than 1000. To minimize bus delay and improve safety of buses re-entering traffic, buses shall otherwise stop in the curb lane.
  - Bus lay-by length to be 20 m plus 1:2 tapers
- Consider utility connections and requirements, such as electrical for lighting.
- Integrate solar powered lighting and LED signing where feasible.

Design guidance for bus facilities shall be obtained from DOT.

5.7.5 Taxis and Private Transit

Lay-bys may be provided for taxis and private buses, particularly on Boulevards and Avenues near major destinations. At major taxi stands, shade and other amenities should be provided for waiting passengers. Where the lay-by will compromise the pedestrian realm or bicycle facilities, eliminate parking on the frontage lane and/or narrow the combined width of the edge and furnishings zones.

Where taxi lay-bys or bus shelters are provided mid-block on Boulevards with Frontage Lanes, designers may create additional space for waiting passengers by eliminating parking in the frontage lane to expand the side median, shrinking the furnishings zone, and re-aligning the frontage lane toward the pedestrian realm. Where there are transit medians, a shift of travel lanes into the medians along tramways may also provide additional space.

Bus Rapid Transit on boulevard, Mexico City, Mexico.

Table 5.4 Comparison of Near-side, Far-side and Mid-Block Bus Stops

	Near-side	Far-side	Mid-block
Walk Time to Junction	●	●	
Pedestrian Sight Distance			●
Junction Capacity			●
Right Turn Conflicts		●	●
Approach Sight Distance		●	●
Cross Traffic Sight Distance			●
Increased Chance of Rear-End Collisions	○		●
Congested Waiting Area			●
Right Turn Capacity		●	●
Traffic Can Block Junction	●		●

● Preferred ○ Acceptable ■ Not Preferred

5.8 Designing for Bicyclists

This section addresses bicycle facilities and provides guidance as to their location and bicycle parking. Refer to the DOT for standards and details on any bicycle requirements within the street design area.

Important design points include the following:

- Highlight bicycle facilities with colored pavement, especially at junctions and other conflict zones.
- Create bicycle facilities that are wide enough for bicycles with two passengers, especially parents with children.
- Design to reinforce that bicyclists are to yield to pedestrians at all intersection points.

5.8.1 Bicycle Facility Type & Selection

Bicycle facility selection is largely a function of motor vehicle speed and volume, plus available width; facilities will vary along a route just as street type varies. Bicycle facilities come in three general types.

- A Cycle Track – any number of facilities reserved for bicyclists and separated from motor vehicle traffic.
  - Where a cycle track passes by a bus stop, route the track behind the stop (see Figures 5.8 and 5.9)
- A Bicycle Lane – a lane (1.5 – 2.5 m) reserved for cyclists. Design to discourage drivers from blocking bicyclists in the bicycle lane. Include buffer zones between bicycle lane and on-street parking and travel lanes.
  - Where a bicycle lane passes by a bus stop, route the lane to the back of the stop and clearly mark it.
  - When locating bicycle lanes adjacent to on-street parking, reduce parking lane to minimum width and increase bicycle lane to maximum width. This will encourage motorists to park close to the curb and provide space for motor vehicle doors to open without impeding bicycle travel. Pavement markings may also be used to delineate door zones.
- A Yield Lane is a narrow (3.0 m max), low speed lane that bicyclists and drivers share and generally do not pass each other, e.g. Access Lane or Frontage Lane. The width may be increased in Industrial contexts.

Facility selection is an iterative process. A higher quality facility will encourage additional ridership, including that of children and older adults. Projected ridership volumes will affect the type and width of bicycle facilities. See Figure 5.10 for examples of the three types of bicycle facilities.

Bicyclists can also share space with pedestrians in some low density areas if projected volumes do not warrant a separate facility. Coordination with the DOT is necessary to confirm the application of this facility.

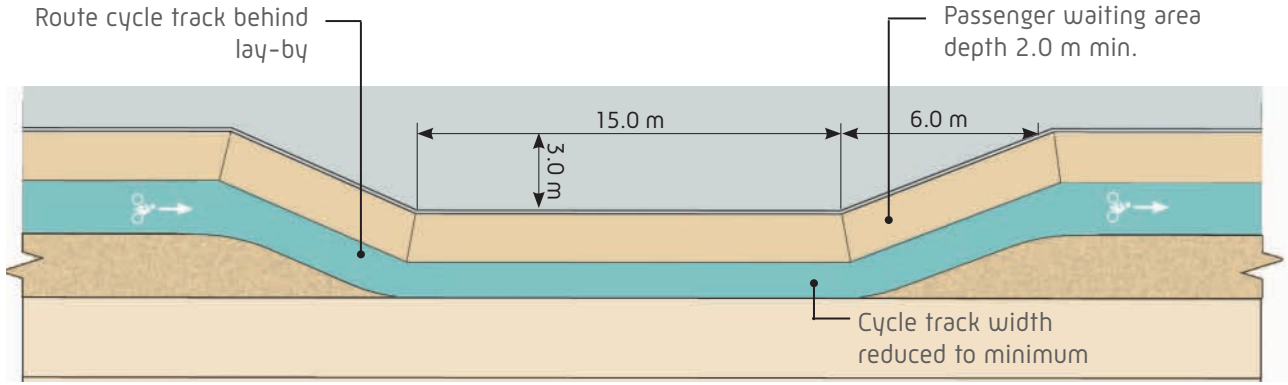


Figure 5.8 Taxi and Private Bus Lay-By

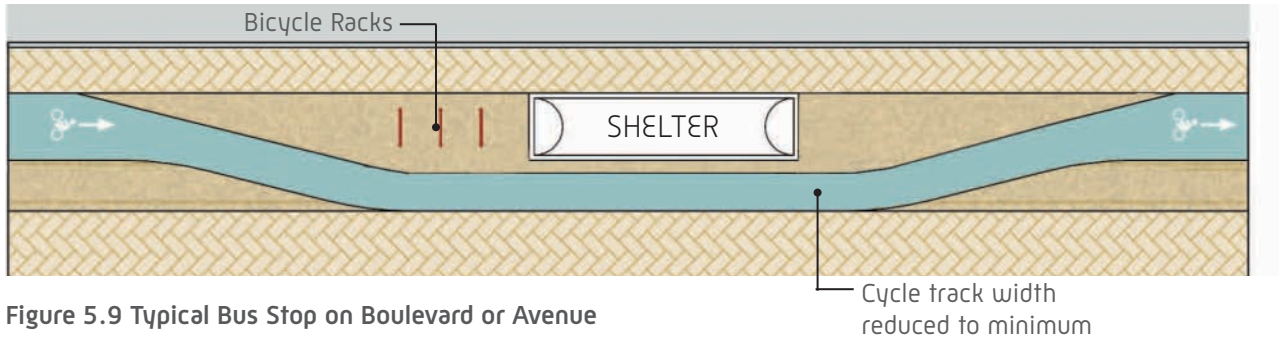
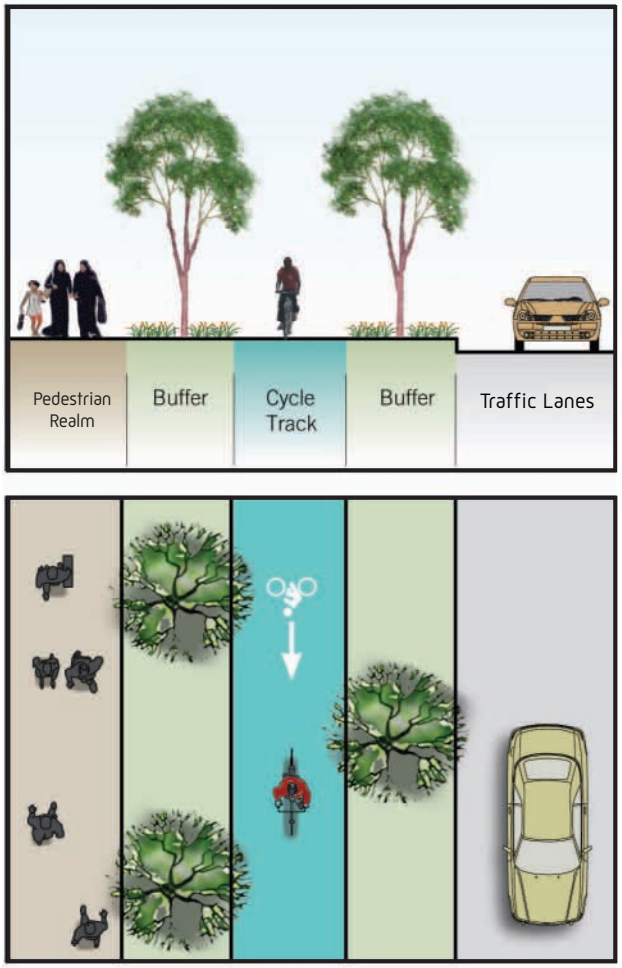
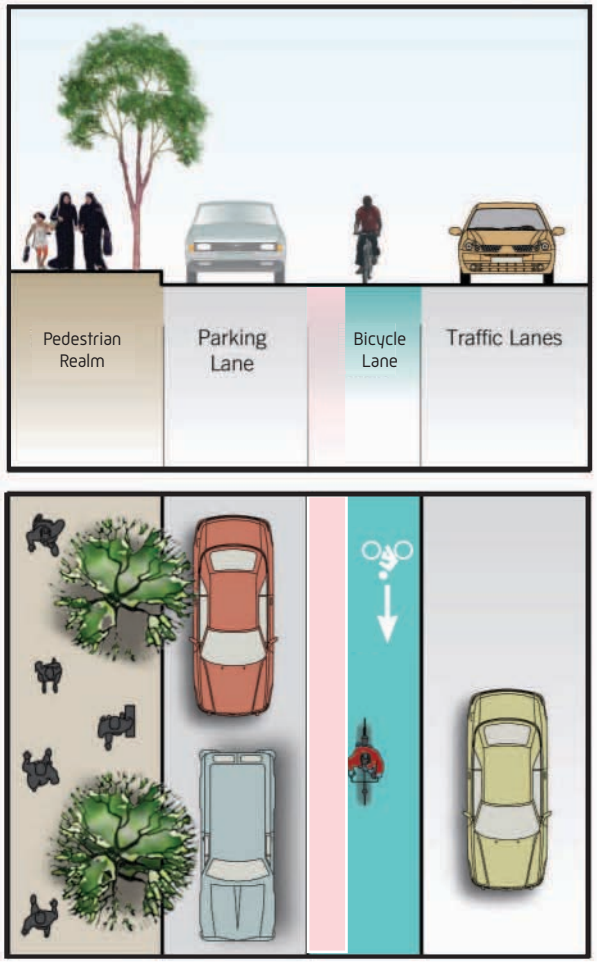


Figure 5.9 Typical Bus Stop on Boulevard or Avenue

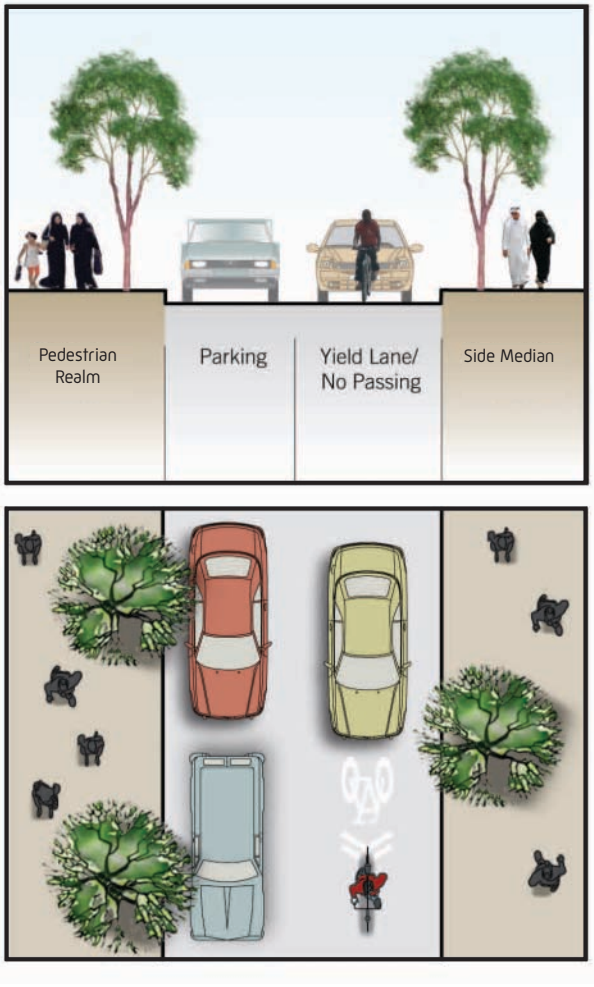
Figure 5.10 Examples of Bicycle Facilities



Typical Cycle Track



Typical Bicycle Lane with Parking and Door Zone



Typical Yield Lane with "Sharrow" Making for Shared Lane

5.8.2 Bicycle Facilities at Junctions

Specific provisions for bicyclists are necessary at junctions, both major and minor, including driveways (see Figures 5.11 and 5.12).

- Continue cycle tracks at the pedestrian level through driveways and minor junctions, as illustrated in Figure 5.11.
- Mark and color bicycle lanes through junctions.
- An Advanced Stop Line (ASL) or "bicycle box" should only be used under direction from the DOT.
    - If used, the bicycle box shall be a minimum of 4.0 m deep and surfaced in the same color as a bicycle lane (refer to DOT for specifications).
- While bicycle facilities must remain continuous, they may transition from a bicycle lane to cycle track to frontage lane to accommodate changing conditions along a street.
- Cycle crossings through main junctions shall be separated from through vehicle traffic.
- Design crossing locations with sufficient space to accommodate bicyclists mixing with pedestrians.

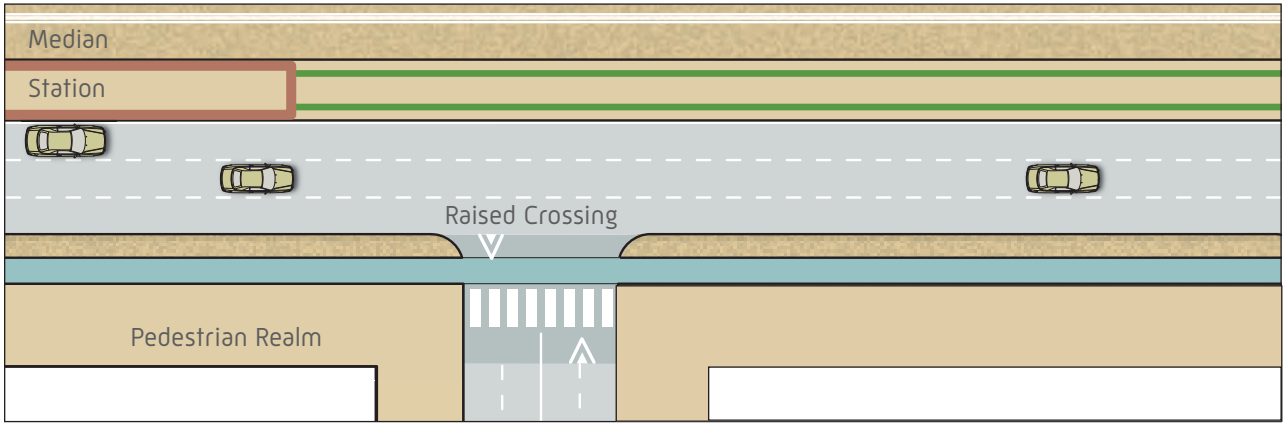


Figure 5.11 Cycle Track through Minor Junctions

An example of a bicycle box, surfaced in the same color as the bicycle lane.

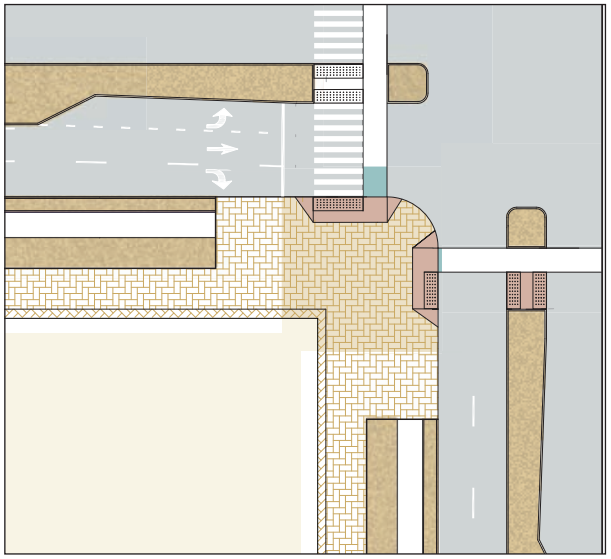


Figure 5.12 Shared Waiting Space for Bicyclists and Pedestrians at Junction

5.8.3 Bicycle Parking

The following are general design criteria for bicycle parking facilities:

- Locate parking in furnishings zone, out of the through zone or driveways, on curb extensions within 15 m of the main entrance or between buildings.
- Provide longer term bicycle parking in convenient, shaded, well-lit, and secure locations.
- Provide directional signage if parking is not readily visible to visitors.
- Bicycle lockers should be provided to encourage bicycle commuting.

Bicycle racks are to be durable and securely anchored. They are to be designed so that:

- The bicycle frame and at least one wheel can be locked.
- The bicycle frame can be supported in at least two places.
- Rack spacing is such that bicycles can park without disturbing one another.

Pictures of acceptable bicycle racks.

5.9 Designing for Motor Vehicles

The design of motor vehicle facilities, including u-turn design, lane transitions, access management, and on-street parking (frontage lanes), is discussed in this section of the Manual. It is important to recognize the increasing number of two- and three-wheeled motor vehicles, including motorcycles and motor scooters, on Abu Dhabi streets. These users do not have designated rights-of-way as they share the traveled way with other vehicles. Design of all streets shall be safe and shall consider all types of motor vehicles. Consult the DOT for specific guidance during this process.

5.9.1 Travel Lanes

The width of travel lanes varies depending on the street family and the specific land use. On Boulevards and Avenues, curb lanes shall be 3.5 m, while other lanes widths are 3.3 m. These widths are illustrated on the standard cross sections shown in section 5.3.

5.9.2 Lane Transitions

Lane transitions shall be minimized on urban streets to ensure a maximum pedestrian crossing distance of 13 m is maintained.

- Do not use lane transitions within junctions.
  - Match entry and exit lanes, drop turn lanes
- Maximum lane transition 1:10
- Tapers to turn lanes 1:2
- Lane shifts may be used for traffic calming purposes.

5.9.3 U-Turns

U-turns enhance motor vehicle traffic flow, facilitate access management, and reduce left turn pressure at junctions. They may be used on Boulevards and Avenues.

- Locate before crosswalks (see Figure 5.13).
- Signalize where there are two or more receiving lanes.

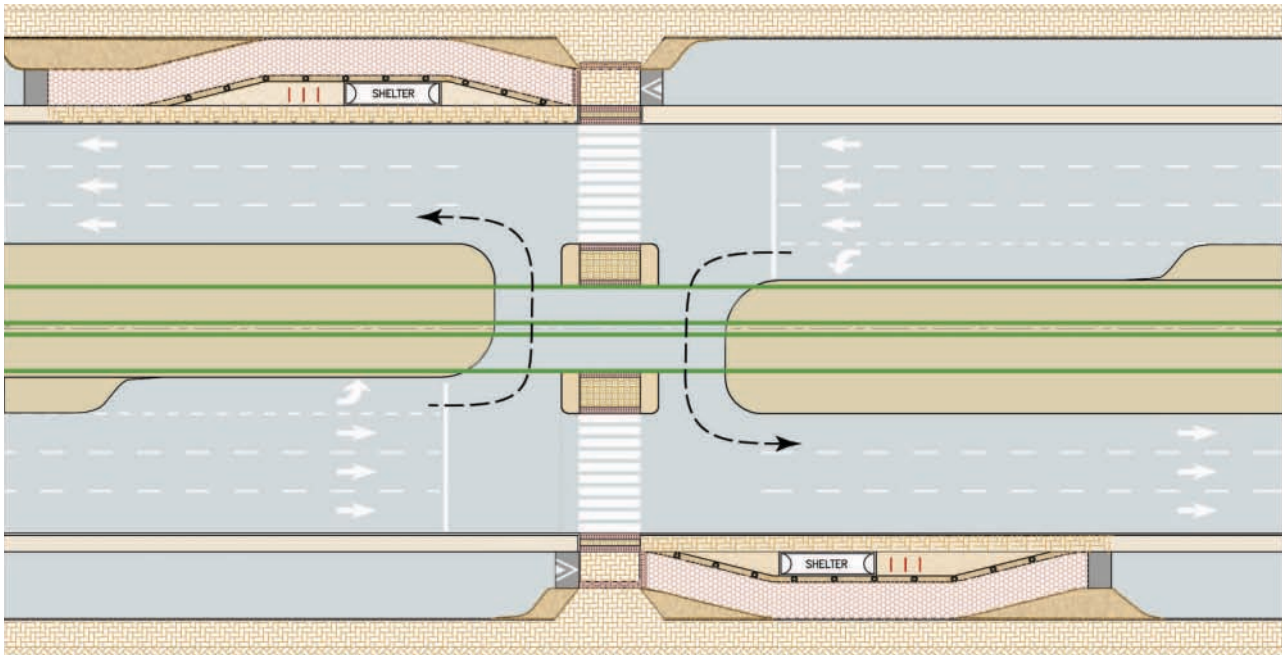


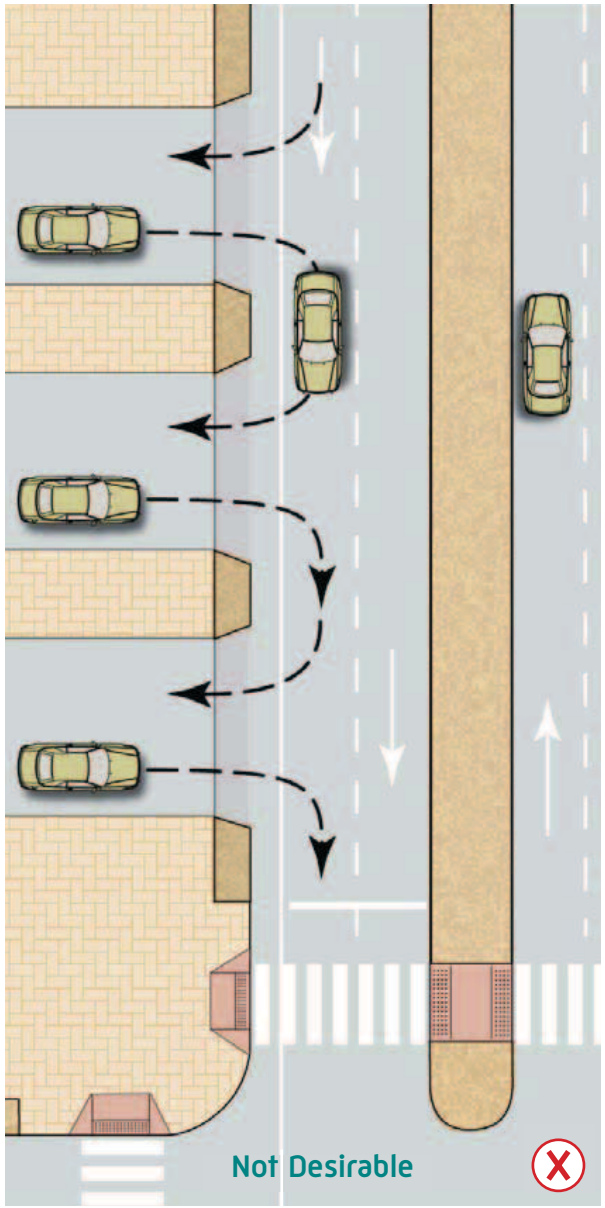
Figure 5.13 Signalized U-turns with Crosswalk on Transit Boulevard

5.9.4 Access Management

Access management techniques shall limit vehicle movement, manage driver behavior, and otherwise support pedestrian, transit, and bicycle-friendly design.

- Limit the size, quantity, and frequency of driveways to reduce conflict points in the pedestrian realm, as illustrated in Figure 5.14.
  - Combine access points
  - Restrict within 30 m or greater of major junctions
  - Restrict within 15 m of other junctions, crosswalks, etc.
- Construct alternate routes to disperse traffic.
- Limit turns onto and off of main streets.
- Manage access to construction sites and other temporary conditions.
- Design driveways and minor street crossings to favor pedestrians and bicyclists, as they are the most vulnerable users.

Consolidate driveway access.



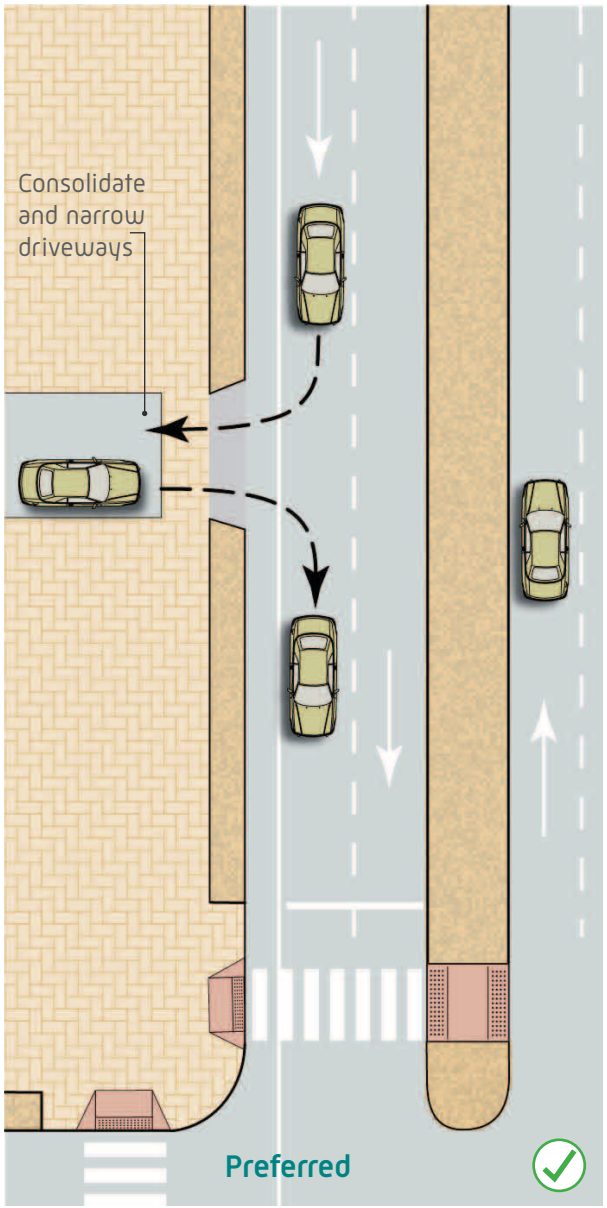


Figure 5.14 Limited Driveway Access

5.9.5 On-Street Parking

The standard dimensions and cross sections provided in section 5.3 provide guidance for the width and location of on-street parking. Boulevards may only provide on-street parking through the addition of a frontage lane. General objectives include the following:

- Provide 0.5 m horizontal clearance in the edge zone where there is parallel on-street parking and 0.7 m clearance where there is angled parking.
- Include curb extensions wherever possible at crossings, transit stops, and junctions (see section 5.9.7).
- Angled and perpendicular parking should be avoided except in retrofit cases and on streets where there is ground-floor retail and additional front-door parking is needed. Details of acceptable parking configurations for too much right-of-way scenarios are shown in Figure 5.15.
- Angled parking:
  - Back-in operation is acceptable because it enhances visibility between motorists and bicyclists. Back-in parking requires good signage and education and may not be appropriate in all locations.
  - Head-in operation may be used adjacent to playgrounds, sidewalk cafes, vendors, etc.
  - 45, 60, or 90 degrees only
  - Stall width: 2.5 m
  - Stall projection: 5.0 m

5.9.6 Frontage Lanes

Although they are used by motor vehicles, Frontage Lanes are intended to act as a portion of the pedestrian realm and speeds shall be managed accordingly. Refer to Figures 5.16 and 5.17 for examples of frontage zone design.

- Frontage Lanes are required when there is a parking demand on Boulevards; they may also be included on Avenues.
- It is essential to keep Frontage Lanes as narrow as possible in order to ensure slow travel speeds. They need not accommodate fire trucks – fire trucks can access buildings from the Boulevard's main travel lanes.
- Diagonal and perpendicular parking should be avoided along Frontage Lanes because they require extra width for the drive aisle and therefore encourage excessive speeds. Use diagonal and perpendicular parking only on the retrofit situations with significantly excessive right-of-way and a significant shortage of parking.
- Frontage Lanes offer a high quality bicycle facility; where provided, additional cycle tracks or bicycle lanes are not necessary.
- Avoid connections to Frontage Lanes except at intersecting streets. Cars entering a street from a Frontage Lane should be required to stop and yield to traffic on the street.
- At taxi lay-bys and bus stops, it is appropriate to eliminate on-street parking along a Frontage Lane and/or deviate the Frontage Lane into the Furnishings Zone in order to provide sufficient waiting area for transit and taxi passengers along the side median.
- Use raised intersections and speed tables where Access Lanes or major pedestrian paths intersect Frontage Lanes in order to reduce speeds.
- Specific geometry shall be developed for each frontage lane entry and exit, depending on individual requirements and conditions.

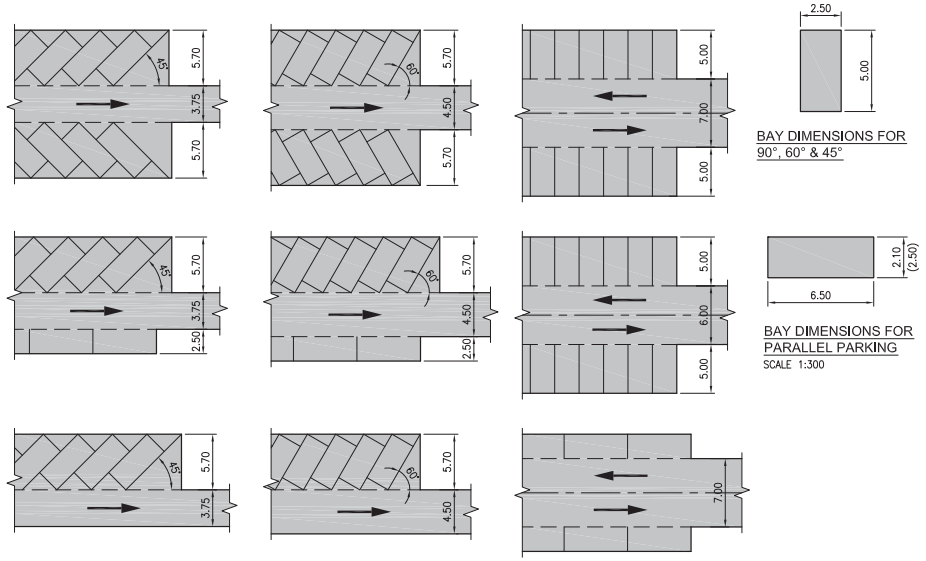


Figure 5.15 Acceptable Parking Configurations for "Too Much Right-of-Way" Scenarios

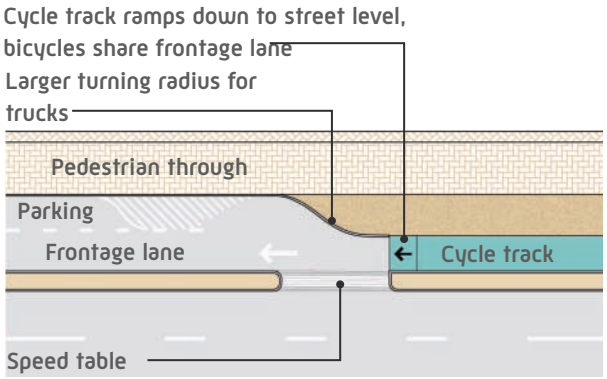


Figure 5.16 Typical Entry to Frontage Lane

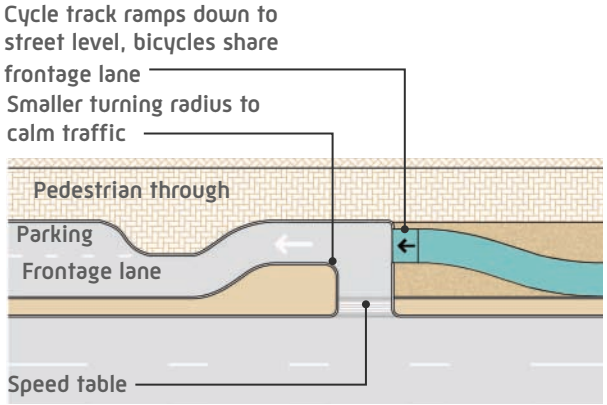


Figure 5.17 Alternative Entry to Frontage Lane

5.9.7 Curb Extensions

Curb extensions are to be employed wherever there is on-street parking. They are typically 0.5 m narrower than the parking lane as shown in Figure 5.18. This space is used by bicyclists when queuing at a signal or while waiting to turn. Alternatively, the curb extension may extend into the travel lane, at which point it becomes a traffic calming device. Curb extensions must be provided for at least every 10 spaces (65 m).

5.9.8 Medians

Medians, the dividing part of the traveled way, are typically used to separate traffic flows and control turning movements. They are typically located in the middle of the street, but may be located on the sides (side medians) where there are frontage lanes. Medians benefit pedestrians by providing a protected pedestrian "refuge" in the middle of the street. It is preferable to minimize median widths in order to reduce the overall width of the street and the length of the street crossing. Wide medians increase the street crossing distance, which adds time to the signal sequence and causes traffic delay.

Figure 5.18 Curb Extensions Create Parking Pockets

Medians should be:

- Minimum width of 2 m, increasing to 3 m where there is heavy pedestrian activity. Left turn lanes shall be accommodated with an additional 3 m (see Figure 5.19).
- Include vertical elements (trees, banners, light poles) in medians for street rhythm.
- Cluster trees where shade is most valuable, such as at pedestrian crossings of the median, while also ensuring that pedestrians are clearly visible to oncoming traffic.

Where medians serve as refuges in a pedestrian crossing, they should be:

- Designed with a cut-through at street level
- Designed with a pedestrian actuated control device, if such devices are located at the junction corners of signalized crossings

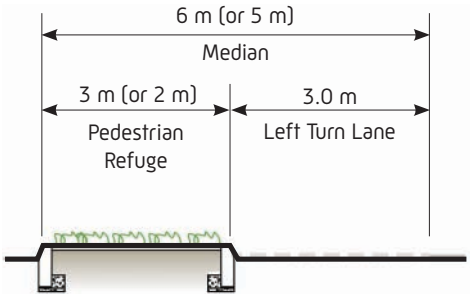


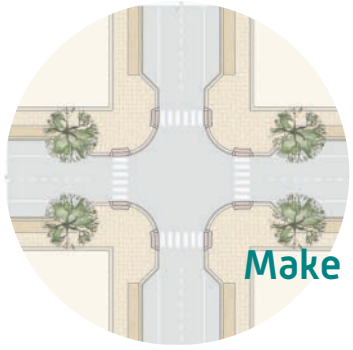
Figure 5.19 Left Turn at Median

5.10 Junction Design

Junctions are intersections of streets where through-moving and turning pedestrians, bicyclists, transit vehicles, and motor vehicles all share the space. Junction types shall be selected to address specific, and sometimes combined, user interactions identified during the design process.

Urban junctions shall be as compact as possible and designed for low speeds. There are many ways to achieve this. For example, a junction of two Access Lanes may be best served by a raised junction with an all-yield condition. In this manner, vehicle speeds are kept low; drivers, bicyclists, and pedestrians are forced to make eye contact; and conflicts are minimized.

At the other extreme, a large junction is best served by separating lanes for the various vehicle flows, providing pedestrian refuge islands and distinct bicycle travel ways, as well as installing traffic control devices. Travel speeds through large junctions can be moderated by design features and operations.



Make urban junctions as compact as possible.

Urban junctions must be designed so that all users understand that they must share space with and be aware of others.

- Accommodate the needs and accessibility of all modes of transport.
- Design for a hierarchy of users.
  - Vulnerable users (pedestrians) first
  - Least vulnerable (larger motor vehicles) last
- Design all junctions to be as compact as possible.
- Minimize "conflicts" between modes sharing the same location at the same time.
- Provide good visibility, particularly between pedestrians and motorists.
- Avoid extreme angles and complex junctions.
- Minimize pedestrian exposure to moving vehicles by reducing crossing distance and the duration of the crossing.

5.10.1 Junction Types

Table 5.6 lists various junction types along with basic characteristics of each.

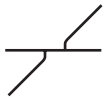
Type	Notes
	**Rectilinear Junction** 75-90° angle
	**T-junction** 75-90° angle
	**Offset Junction** bend minor streets to create junction max 15° angle, otherwise separate into two junctions (possibly with one signal control)
	**Y-junction** bend minor street max 15° angle
	**Angle Junction** treat as two Y-junctions
	**Rectilinear Junction with Extra Legs** separate extra legs into right-in, right-out junctions
	**Roundabout** multi-arm, yield to circulating traffic

Table 5.6 Junction Type Matrix

5.10.2 Junction Layout

The following are important objectives to be achieved in junction layout and design. Figure 5.20 provides an example of two Boulevards intersection with tram and a cycle track.

- Pedestrians and cycles must be routed through the intersection with minimum deviation from their direct path.
- Provide shade at and near junctions, particularly in areas where pedestrians are waiting to cross the street.
- Design junctions with the understanding that turning vehicles may turn into any lane of the receiving street and larger vehicles may cross the centerline.
- Cycle tracks shall be brought into the junction at the pedestrian level.
- Any surface that extends across the pedestrian realm should be paved. Conversely, pedestrians should be required to transition down to the traveled way level across junctions, with the exception of raised crossings/speed tables that may occur where traffic calming is required.

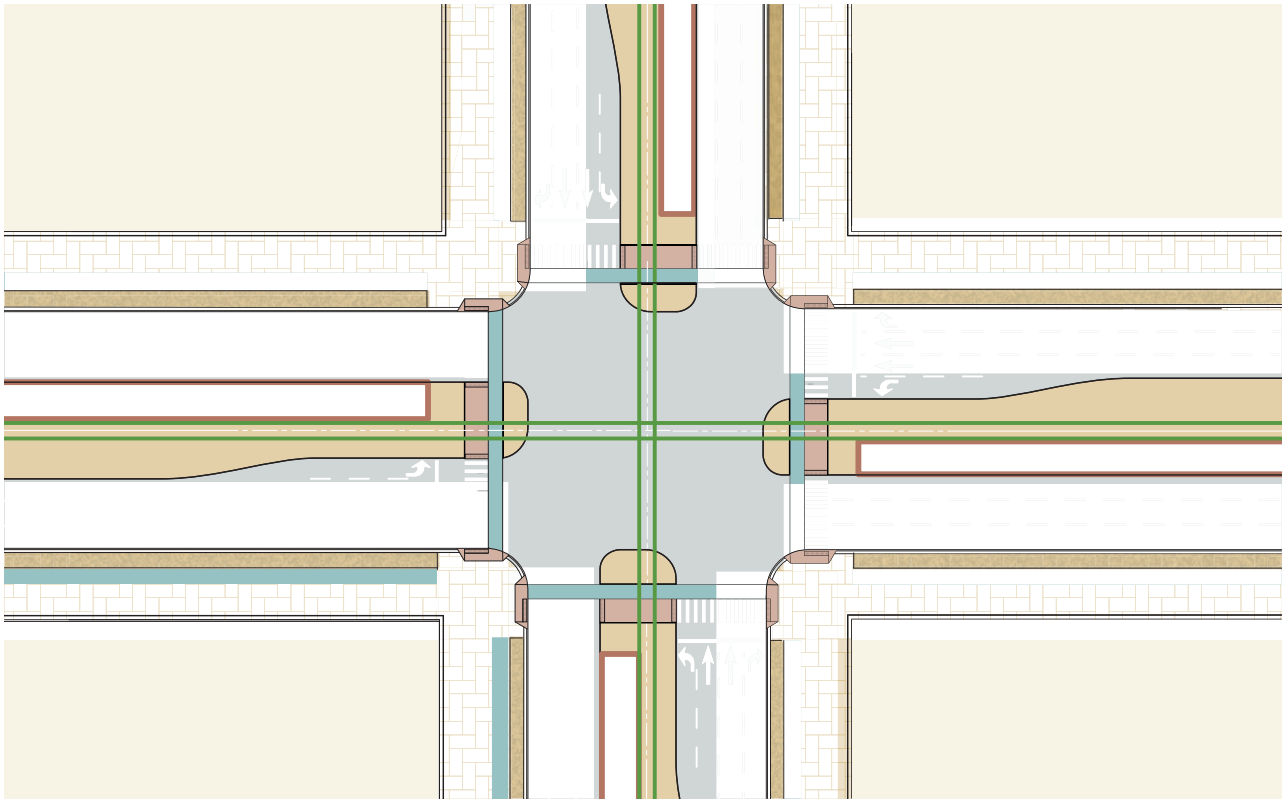


Figure 5.20 Typical Boulevard and Boulevard Junction with Tram and Cycle Track

5.10.3 Through Street Junction Spacing

It is important to the functionality and capacity of street networks and individual streets that suitable spacing is maintained between junctions.

- If junctions are too close to each other, then the operational capacity may suffer as traffic queues can "back-up" if sufficient queuing space is not available.
- If junctions are spaced too far apart from each other, then there may be insufficient connectivity within the overall street network and the overall capacity of the network will suffer.

Either of these situations will reduce efficiency and create vehicle delay. In order to reduce their potential impact, it is preferred that recommended street and junction spacing is maintained where possible.

Figure 5.21 and Table 5.7 provide recommended dimensions for street spacing. For new development networks and new street design, the recommended street spacing dimensions correspond to junction spacing. For existing street retrofit designs, the dimensions shall be used as a guide for considering additional street links and improving connectivity.

Consideration shall be given to Access Lane locations as these will have a significant impact on the operation of junctions. Refer to the Access Management section (5.9.4) for guidance.

5.10.4 Control Measures

While this Manual does not address the details of junction operations, Table 5.8 provides general highlights of the types of operation control for junctions.

Figure 5.21 Town Maximum Spacing

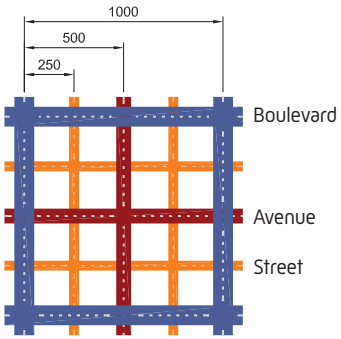


Table 5.7 Through Street Spacing Criteria (meters)

Context		Boulevard	Avenue	Street
City	Min	400	200	100
	Max	750	375	175
Town	Min	600	300	140
	Max	1000	500	250
Commercial	Min	1000	400	125
	Max	1500	750	375
Residential	Min	1000	400	125
	Max	1500	750	375
Industrial	Min	800	400	-
	Max	1500	750	300

Table 5.8 Junction Control Matrix

	Boulevard-Boulevard	Boulevard- Avenue	Boulevard-Street	Boulevard-Access	Avenue-Avenue	Avenue-Street	Avenue-Access	Street-Street	Street-Access	Access-Access
Signal	●	●	●	○	●	●	○	○		
Signalized Roundabout	●	●			●	○				
1-Lane Roundabout					○	○		●		
2-Lane Roundabout					○	○				
Mini-Roundabout								●	●	○
All-Way Stop					○	○		●	○	○
2-Way Stop or Yield			●	●		●	●	○	●	○
All-Way Yield								●	○	●

● Preferred ○ Acceptable ■ Not Preferred

5.10.5 Sight Distances

Sight distance requirements include the following:

- Provide curb extensions and restrict parking near crossings to improve visibility between motorists and pedestrians (see Figure 5.22).
- Lower vehicle speeds.
- Restrict turning movements.
- Clear visual obstacles from the pedestrian realm.

It is important to note that that urban, signalized junctions will have lower sight distance requirements than other junctions.

For unsignalized junctions, a minimum clear sight distance of 25.0 m shall be maintained from the centerline of the side street, a distance of 2.4 m from the stopline; see Figure 5.23.

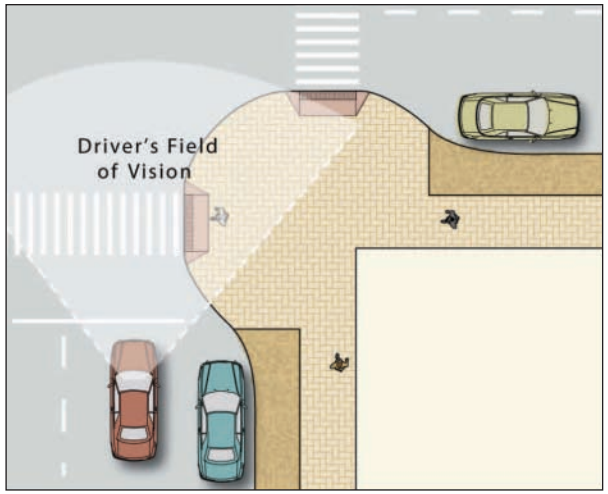


Figure 5.22 Curb Extension Increases Visibility

5.10.6 Design Vehicle

Junction design requires consideration of at least four design vehicles:

- Speed control vehicle - for all street types, this is a passenger car, and it is used to determine maximum vehicle speeds at turns.
- Design vehicle – a vehicle that must be regularly accommodated without encroachment into the opposing traffic lanes. This vehicle may vary depending on street type and context.
- Control vehicle – a vehicle that infrequently uses a facility and must be accommodated. For these vehicles encroachment into the opposing traffic lanes, multiple-point turns, or minor encroachment into the roadside is acceptable.
- Non-motorized vehicles – on priority bicycle routes, special design consideration is necessary for bicycles (see section 5.8).

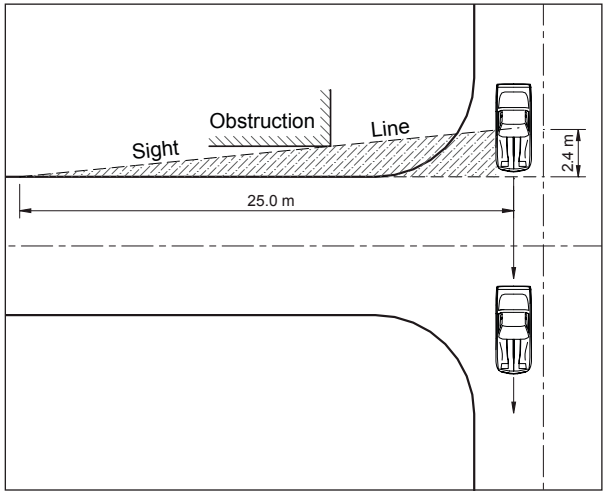


Figure 5.23 Sight Distance Requirements

A junction designed to accommodate a large vehicle will allow faster turns by smaller vehicles. Figure 5.24 illustrates this point: a junction large enough to accommodate a WB-15 at 15 km/h allows passenger car speeds of 43 km/h, creating an unsafe condition for pedestrians crossing the street.

Table 5.9 lists recommended design and control vehicle types for streets and junctions. These should confirmed with the DOT at the beginning of the street design process.

Table 5.9 Junction Control Matrix

Street Family	Design Vehicle	Control Vehicle
Boulevard Avenue	WB-15M (Semitrailer CB)	WB-33DM (Double Trailer)
Street	City-Bus M	Smeal Aerial RM 100 Fire Truck
Access Lane	SUM (Medium Truck)	SUM (Medium Truck)

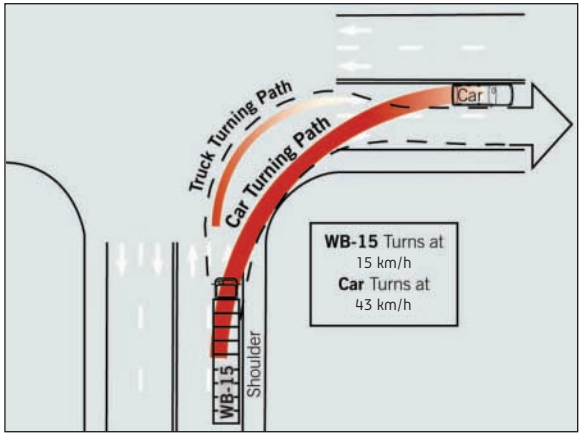


Figure 5.24 Corners Designed for Trucks Allow High Car Speeds

5.10.7 Corner Radii

Corner design deserves special consideration as it directly impacts pedestrian crossing distances and vehicle turning speeds. Corner radius is the actual dimension of the curb, while turning radius is the effective dimension of the motor vehicle turn (see Figure 5.25).

- A recommended maximum corner radius of 5 m shall be used for urban junctions. Design actual corner with a 2–5 m radius, or 0.5 m where there are no turns.
- Design turns so that vehicles may not turn faster than 15 km/h.
- Calculate effective turning radius and available space for turning, including the space for on-street parking, bicycle lanes, and all travel lanes on the receiving street (not just the nearest lane).
- Use computer software for designing and testing turning radii, provided the built-in tolerances do not cause overly large radii; see Figure 5.26 for an example.
- Corner radii can be increased to meet the operational requirements of the Civil Defense department at specific locations. In all cases, the minimum radius to meet these requirements shall be used.
- Larger vehicles may cross into opposing lanes and drive over corners and medians to complete the turn.

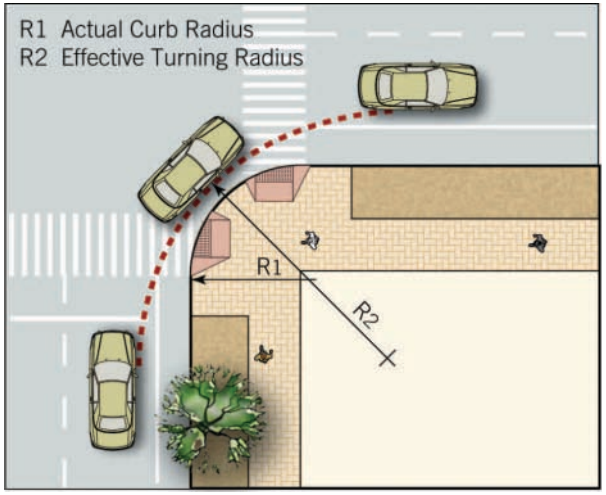


Figure 5.25 Actual Versus Effective Turning Radius

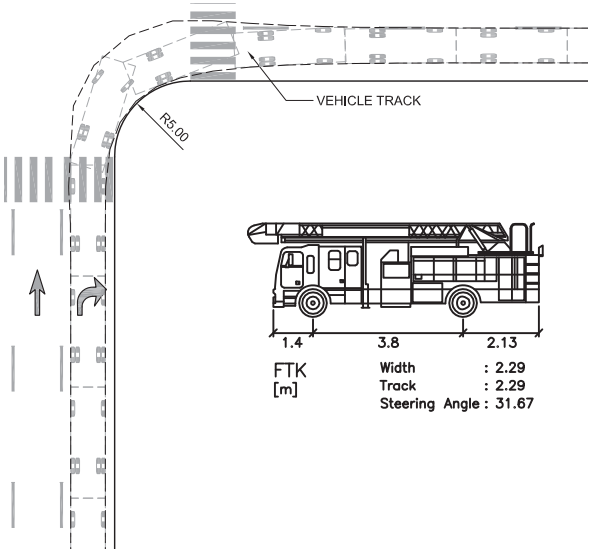


Figure 5.26 Example of Swept Path Simulation

5.10.8 Left Turn Lanes

Left turn lanes shall be at least 3.0 m wide and a minimum of 24 m long. Tapers shall be 1:2. Left turns shall occur after the through phase of a signal (not before). On Boulevards and Avenues, a minimum 2.0 m pedestrian refuge must be provided in the median when introducing left turn lanes.

For operational purposes, it is recommended that double left turns are only used to reduce delay at a signal, not to increase capacity, and will need to be agreed with the UPC and DOT.

5.10.9 Right Turn Lanes

Minimize the use of dedicated right turn lanes and right turn slip lanes. Listed below are four alternatives for right turns, in priority order. A traffic analysis (software simulation) of both the intersection turning movements and the localized network is required for all but Option 1.

Option 1 No dedicated right turn lane (preferred option); see Figure 5.27

Option 2 Dedicated right turn lane; see Figure 5.28

Option 3 Signalized right turn slip lane with raised pedestrian crossing (see Figures 5.29 through 5.31 for configuration and dimensions)

Option 4 Yield-controlled right turn slip lane raised pedestrian crossing (15 km/h design speed)

At each option, the design team shall consider the alternatives of increasing turning capacity through network improvement and increased connectivity.

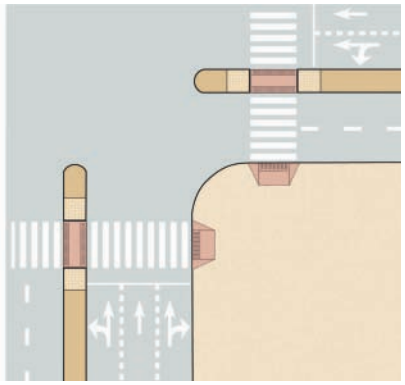


Figure 5.27 Option 1: No Dedicated Right Turn Lane

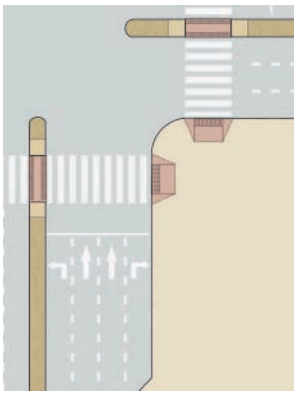


Figure 5.28 Option 2: Dedicated Right Turn Lane

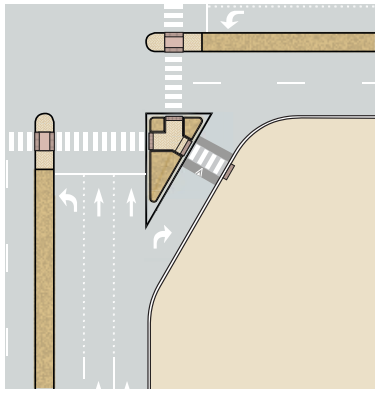


Figure 5.29 Option 3: Signalized Right Turn Slip Lane

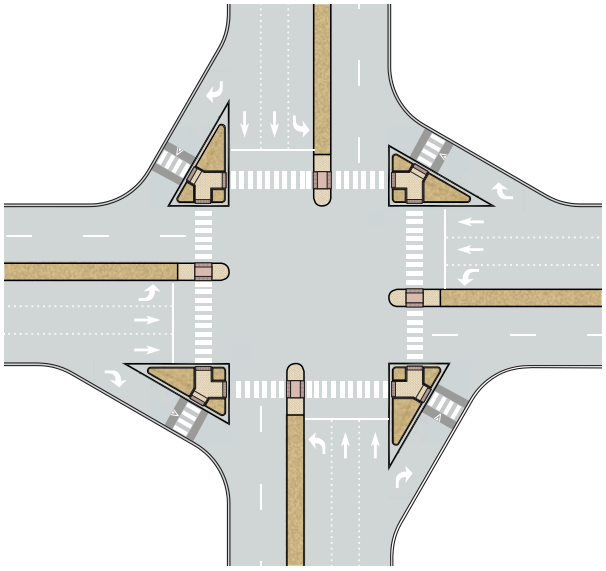


Figure 5.30 Application of a Right-turn Slip Lane at a Full Movement Junction

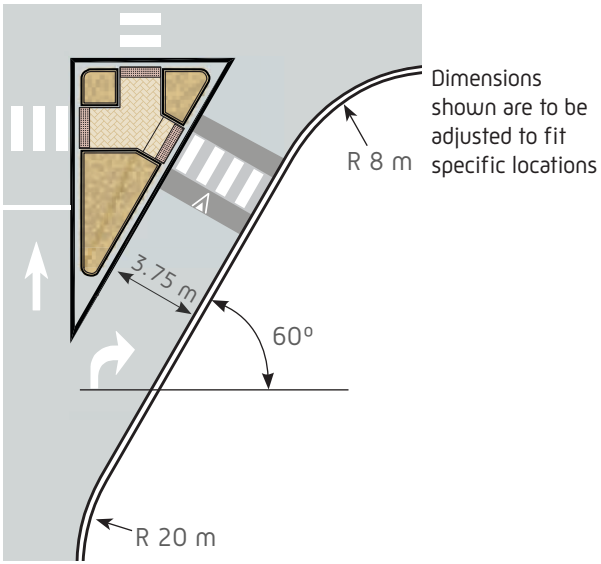


Figure 5.31 Right-turn Slip Lane Dimensions

5.10.10 Roundabouts

Modern roundabouts may be used according to the Junction Control Matrix in Table 5.8, provided in section 5.10.3. Table 5.10, Modern Roundabout Criteria Matrix, lists basic design parameters.

Roundabouts shall be designed so that drivers yield to pedestrians and bicyclists. Roundabout design guidelines include:

- One-lane roundabouts shall have raised, marked crossings. Refer to Figure 5.33 for design guidance related to one-lane roundabouts.
- Two-lane roundabouts may have raised crossings across entry and exit areas; see Figure 5.34.The dimensions of a two-lane roundabout will be determined by the design vehicle and capacity.
- Roundabouts with more than two lanes are not recommended without initial approval from the UPC.
- Pedestrian crossing distances shall be as short as possible, with a maximum of two lanes to cross.
- Bicycle lanes are not striped within a roundabout. Lanes should end a minimum of 20 meters ahead of the roundabout pedestrian crossing. A bicycle ramp should be provided to allow bicyclists to ride up onto the pedestrian realm and either travel through or dismount to cross. The pedestrian realm shall have ample width in these areas to accommodate bicyclists and pedestrians.
- Splitter islands serve as pedestrian refuges, and a minimum width of 3.0 m is required at pedestrian crossing locations.
- Marked crosswalks and bicycle lanes are not required within mini-roundabouts, but may be needed on adjoining streets depending upon the street type; see Figure 5.32.

Roundabout geometries will be dependant on capacity, which shall be identified and presented as part of the Transport Study for DOT.

There are many several helpful resources that guide the design of modern roundabouts including: www.roundaboutsusa.com and www.trl.co.uk.

Figure 5.32 Mini-Roundabout Design

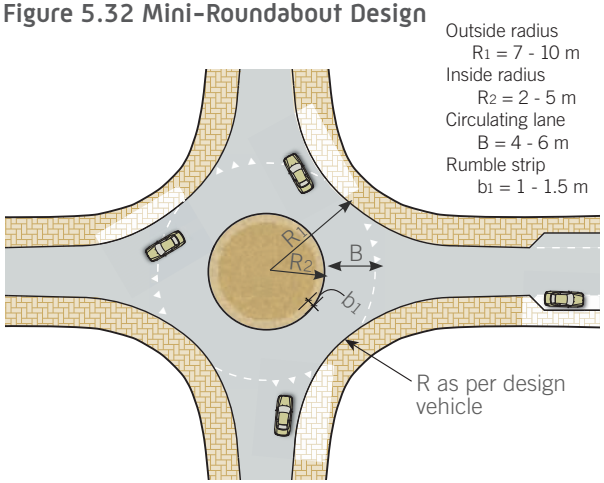


Table 5.10 Modern Roundabout Criteria Matrix

	Mini-roundabout	1-lane roundabout	2-lane roundabout (signalized)
Maximum Entry Speed, km/h	15	20	30
Maximum Exit Speed, km/h	15	25	35
Maximum Daily Motor Vehicle Volume	6000	30,000	35,000
Maximum Hourly Motor Vehicle Volume of Single Leg	--	1200	1500
Maximum Outside Diameter, m	20	20	--
Maximum Island Diameter, m	15	15	--
Circulating Lanes	1	1	2
Entry Lanes	1	1	2
Exit Lanes	1	1	1
Splitter Island	No	Yes	Yes
Truck Apron	No	Maybe	Yes
Mountable Island	Yes	No	No
Separate Cycle Track	No	Maybe	Yes
Raised Crosswalk	Maybe	Yes	Maybe
Signalized Crosswalk	No	No	Yes

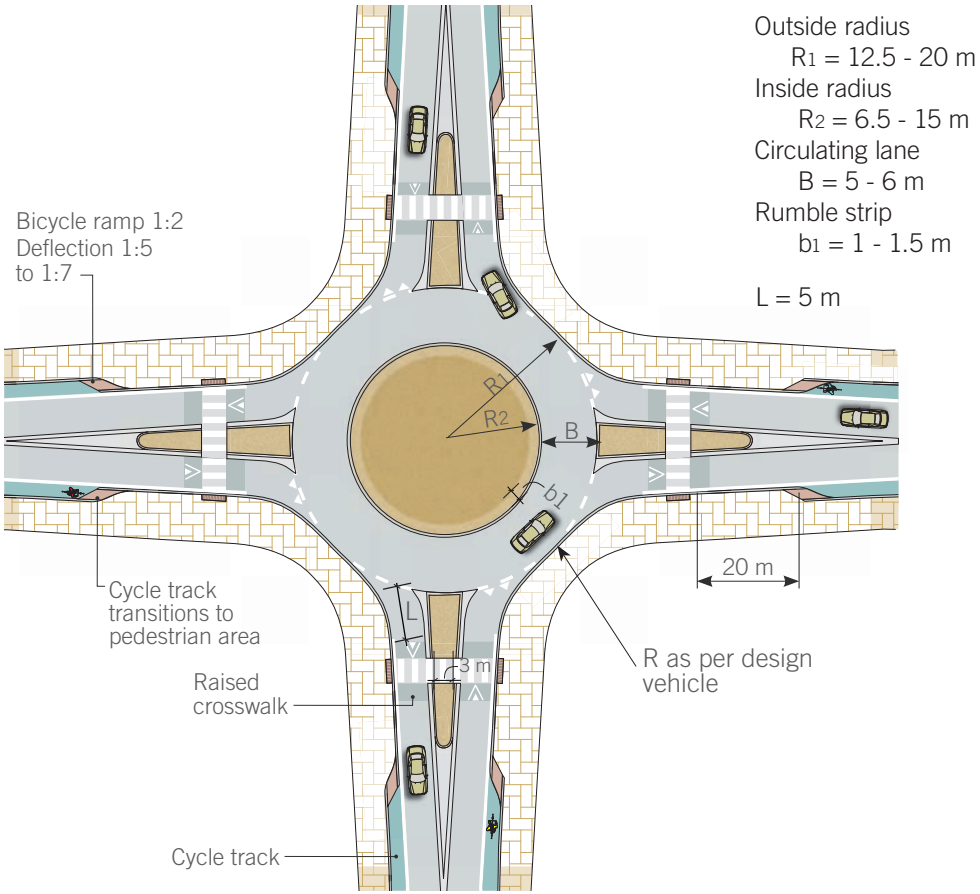


Figure 5.33 Design for One-Lane Roundabout

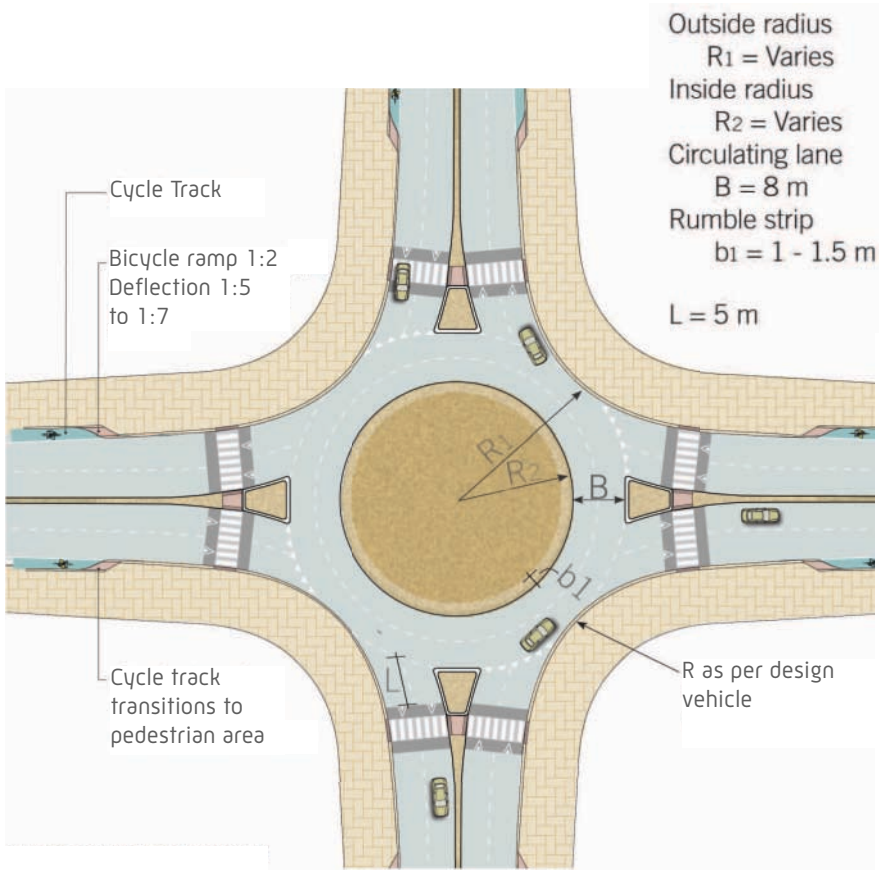


Figure 5.34 Design for Two-Lane Roundabout

5.10.11 Grade Separations

Pedestrian bridges and tunnels (underpasses) shall not be used on streets covered by this Manual, except as permitted by the UPC and DOT. They may be considered only in the following situations:

- To traverse a major obstacle, such as a highway, railway, or waterway
- To provide a direct pedestrian route, such as between an elevated Metro station and a shopping mall or a park
- Where there are extensive pedestrian flows, such as at a stadium

For approval the following must be demonstrated:

- The bridge or tunnel will add no more than 50 percent to the time it would take a person to cross the street at grade.
- The bridge or tunnel will positively affect the identity of the area.

Motor vehicle grade separation shall not be permitted on urban streets without an exception from the UPC and DOT. When permitted, they may be built provided that they do not adversely impact the surrounding urban structure of the location.

Pedestrian bridge as architectural icon, Chicago, USA.

Pedestrian bridge connecting two halves of a park over a highway, Guangzhou, China.

Existing pedestrian tunnel, Abu Dhabi.

5.11 Traffic Calming Measures

Streets in the Emirate of Abu Dhabi shall be designed to decrease vehicle speeds; however, in some instances additional measures may be required. This section covers traffic calming techniques that may be applied throughout the Emirate. Vehicle speeds shall be managed in order to provide a balanced, safe environment for all street users.

In 2008 the Emirate of Abu Dhabi lost an average of three people (pedestrians and vehicle occupants) each day to vehicle crashes. Many of these fatalities could have been avoided if vehicle speeds were maintained at a safer level. This Manual intends to manage vehicle speed to provide a safe environment for all street users. Designing streets to mitigate the negative impacts of motor vehicle traffic is known as "traffic calming."

5.11.1 Traffic Calming Principles

Traffic calming devices affect one or more of the following:

- **Vehicle speed:** vehicle speed is a significant determinant of severity of crashes; it is a critical factor in safety where there are conflicting modes. Vehicle speed in a heavily populated urban environment shall be kept below 60 km/h to reduce the severity of crashes.
- **Exposure risk:** shorter crossing distances and priority at signals reduce pedestrian and bicycle exposure to the risk of a crash.
- **Legibility and predictability:** users are more able to accurately respond to their surroundings.
- **Traffic volume:** fewer vehicles equates to fewer negative impacts.

Traffic calming must function at all times of the day, especially at night when volumes are lower and speeds tend to be higher.

Traffic calming measures may be applied on a street-by-street basis or in an area-wide plan. Providing traffic calming measures for entire neighborhoods and/or districts is more comprehensive as it allows for better management of speed and volumes throughout the entire area, rather than redirecting traffic to adjacent streets.

Traffic calming measures are usually physical because of their proven effectiveness in reducing speeds, cut-through volumes, or collisions. Education and enforcement measures are an important supplement to physical traffic calming measures, but they are ineffective on their own over the long term.

Traffic calming can be either proactive or reactive. The street cross sections and junction details earlier in this chapter are meant to produce streets that keep speeds low and crossings short naturally. At locations where pedestrian safety is of special concern, such as near schools, designers should use traffic calming devices as part of the new street design process. After streets are built, if designers find that traffic speeds or volumes are excessive, or high crash rates are recorded, traffic calming devices should be retrofitted into the problem streets. In both scenarios, design and implementation are an iterative process that requires monitoring and adjustment.

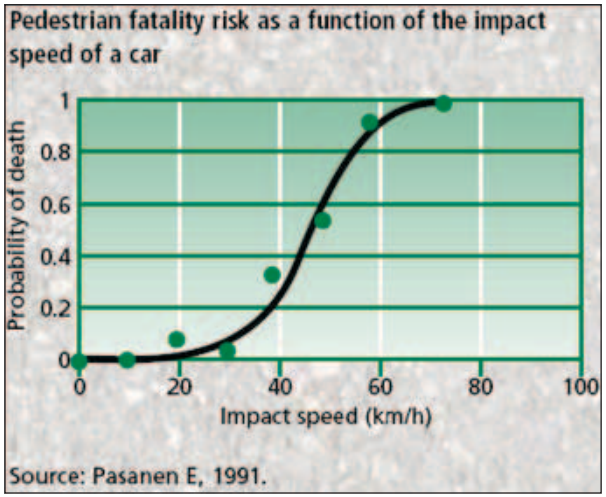


Figure 5.35 Relationship between Speed and Pedestrian Fatality

5.11.2 Traffic Calming Approaches

The following describes selected traffic calming devices for use throughout the Emirate. Designers may also use other devices from other detailed traffic calming guidelines adopted for use in the Emirate, or by using other guidelines and following the Category 1 Exception process detailed in section 4.7.1.

Speed tables are ramped, flat-topped raised areas, 75–100 mm high. They are applicable in all street contexts and easily retrofitted into existing streets; see Figure 5.36 for an example.

Speed cushions are sloped raised areas, 75–100 mm high, with wheel cutouts designed to allow large vehicles, such as fire trucks and buses, to pass with minimal disruption. They are used in lieu of speed tables on primary emergency response or transit routes; see Figure 5.37 for an example.

Raised crossings are speed tables marked for pedestrian crossing, built to curb height (150 mm), or slightly lower; see Figure 5.38.

Raised junctions are speed tables placed within an intersection, built to curb height (150 mm), or slightly lower. They cover the entire junction and have the benefit of calming two streets at once; see Figure 5.39.

A lateral shift is a technique where the travel lane is offset, with the transition angle enforcing a particular speed. It typically includes an island and curb extensions; see Figure 5.40.

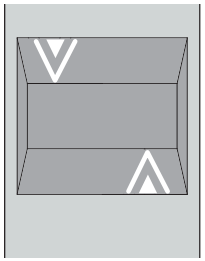


Figure 5.36 Typical Speed Table

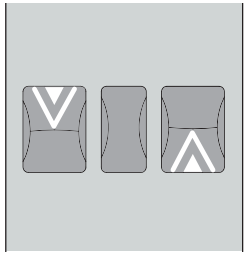


Figure 5.37 Typical Speed Cushions

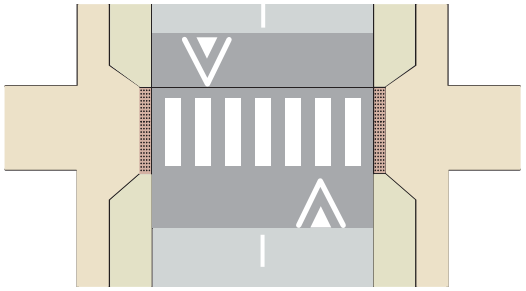


Figure 5.38 Typical Raised Crossing

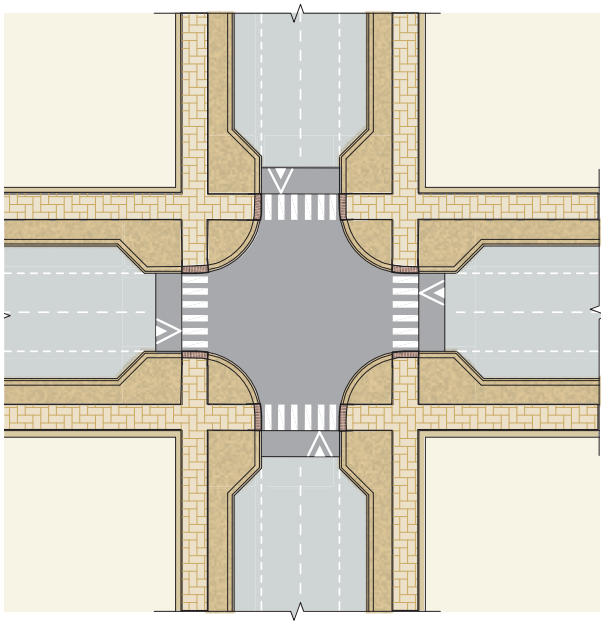


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Figure 5.39 Typical Raised Junction

Chicanes are similar to lateral shifts, but the travel lane is shifted back to the original alignment, which produces lower speeds; see Figure 5.41.

A choker is any specific narrowing of the street which causes drivers to slow and negotiate with oncoming traffic. A one-lane choker reduces a two-lane street to one-lane. It is largely used for retrofit purposes, although it can be included in a new street layout; see Figure 5.42.

A center island narrowing is an island placed in the center of the street, causing drivers to steer around it. It can be coupled with on-street parking to create a lateral shift or chicane. The island also creates a pedestrian refuge. It is largely used for retrofit purposes, although it can be included in a new street layout; see Figure 5.43.

Audio Tactile Paving ATP (also known as Rumble Strips) is a type of long life road marking that has raised ribs orientated perpendicular to the direction of travel and closely spaced at regular intervals before the stop line. As a vehicle's tire runs on or over an ATP road marking it provides an audible and tactile warning to the driver, improving safety by making the drivers aware of an approaching conflict. As such, ATP road markings can be a very powerful and cost effective road safety intervention.

It is considered that ATP lines are generally not suitable for urban use, as the noise that is generated when a vehicle travels over them can be annoying for residents. Use of this form of traffic calming will need to be discussed with the UPC and local municipality before incorporating into designs.

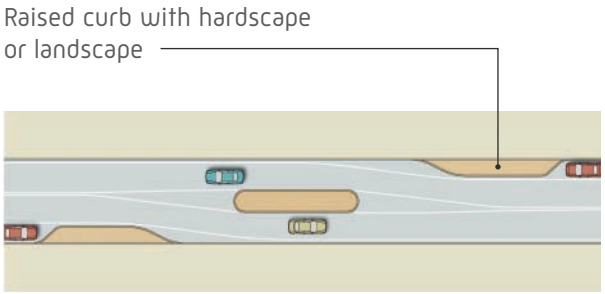


Figure 5.40 Typical Lateral Shift

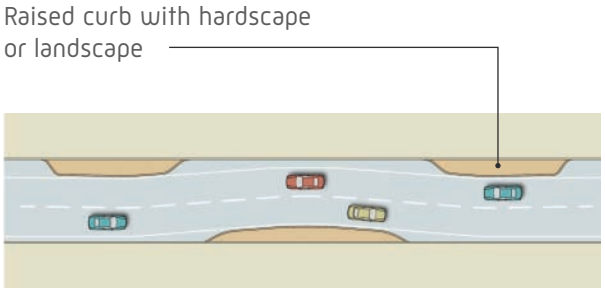


Figure 5.41 Typical Chicane

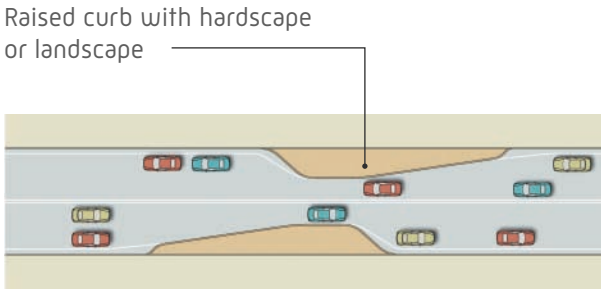


Figure 5.42 Typical Choker

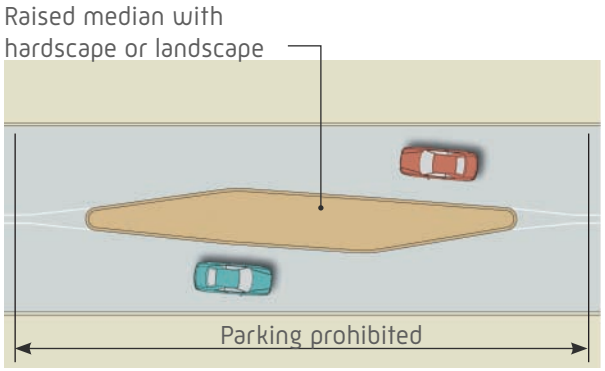


Figure 5.43 Typical Center Island Narrowing

5.11.3 Application

Table 5.18 describes the applicability and vertical placement of traffic calming devices on different street types. Combining devices and street geometry increases effectiveness and is encouraged. Examples include a raised crosswalk with curb extensions, a center island with a speed table.

Speed bumps – narrower than a speed hump and with a sharper rise – are not accepted for use in Abu Dhabi because the other devices listed here are more effective in calming traffic and safer for all users. Volume control devices such as diagonal diverters, restricted entry, and forced turn islands are not specifically described although they may be used as part of a general network strategy. See the publications in Chapter 11, References, for additional information about traffic calming.

Bicycles are to be accommodated by either allowing them to pass by the measure, or slowing vehicles such that cyclists can merge into the travel lane. The use of temporary devices (rubber speed cushions) is encouraged in order to test effectiveness and reflect desire lines.

Speed table used as raised crosswalk, Abu Dhabi.

Traffic calming for pedestrian safety.

Table 5.18 Traffic Calming Matrix

Traffic Calming Device	Height Above Traveled Way	Max Daily Vehicle Volume	Boulevard	Avenue	Street	Access Lane
Speed Table	100 mm	7,500	X	X	X	X
Speed Cushion	100 mm	4,000		X	X	X
Raised Crossing, Raised Junction	150 mm	7,500	X	X	X	X
Lateral Shift	150 mm	10,000	X	X	X	X
Chicane	150 mm	5,000			X	X
Two-lane Choker	150 mm	20,000		X	X	
Center Island Narrowing	150 mm	20,000			X	X
One-lane Choker	150 mm	3,000			X	X

مجلس أبوظبي للتخطيط العمراني
ABU DHABI URBAN PLANNING COUNCIL

Chapter 6 – Streetscape Design

6.1 Introduction

Streetscapes are important public resources, and collectively they are an essential part of the open space of urban areas. They are a representation of a city's vitality and livability.

Improving urban streetscapes throughout the Emirate of Abu Dhabi will achieve an important objective: to develop a high-quality, connected pedestrian realm. The design guidelines presented in this chapter apply primarily to the pedestrian realm, but may also be applicable to other areas within the right-of-way, such as medians.

6.1.1 Streetscape Design Principles

Streetscapes should be designed to be complete systems that blend all components into a safe, functional, attractive, and cohesive place. Follow the design guidelines of this chapter to develop the details of the streetscape. Customize the design and aesthetics to strengthen and reinforce the desired character of the municipality, district, and neighborhood. Apply the guidelines with flexibility to adapt to the specific conditions of the design project. Use innovation balanced with functionality and practicality to produce a high quality design. The following important principles will guide all streetscape design in the Emirate of Abu Dhabi.

Figure 6.1 Streetscape as a Complete System

Context Sensitive Design
Streetscape design shall strengthen and enhance each municipality and the districts, neighborhoods, and community centers within. Lighting, furnishings, shade shelters, paving, and other elements shall be designed to reinforce the signature character and create a sense of place, which also will facilitate wayfinding.

Strong Relationship between Streets & Adjacent Land Uses
Visual and physical interaction between the streetscape and the adjacent land uses and architectural styles is important. Pedestrian spaces along the street shall support and enhance the uses of the buildings that front onto them.

Estidama
Design of the streetscape shall reinforce and comply with the sustainability principles of Estidama.

Water Management
Landscapes that minimize water use and maintenance are required.

Wise Use of Public Resources
As an extension of the public realm, streetscapes shall be designed for intensive public use and the wise use of public resources. All streetscapes shall be designed for longevity – emphasizing durability, high quality materials, and maintainability.

Multi-modal Transport
Design streetscapes to directly influence the comfort, convenience, and attractiveness of walking, bicycling, and riding transit in order to encourage travel by multiple transportation modes.

Vitality & Livability
Incorporate public art, pedestrian signs, wayfinding elements, sidewalk cafes, shade ways, desert appropriate trees and landscaping, and various other types of outdoor spatial experiences to enhance the streetscapes of the Emirate of Abu Dhabi.

Creative, Integrated, & Collaborative Design
Design creativity and interdisciplinary collaboration are strongly encouraged in development of the streetscape environments in the Emirate. Close coordination and collaboration between urban designers, landscape architects, civil engineers, architects, planners, and other professionals involved in streetscape projects must occur from the outset and throughout design and construction.

Streetscape design shall reinforce the character and identity of each municipality, district, and neighborhood.

6.2 Universal Design Guidelines

Universal design should result in comprehensive and seamless mobility options from origin to destination and the removal of any barriers and obstacles.

Urban Braille in the form of visual or textural cues could also be installed to warn pedestrians when exiting the pedestrian realm. Additional guidance can be found in the UPC's Urban Braille guidelines.

6.2.1 Provide Direct & Continuous Pedestrian Routes

The through zone of the pedestrian realm shall be clearly visible, open, and continuous.

- Pedestrians shall not be required to travel out of their way unnecessarily.
- Walking routes shall not stop abruptly. If a route must detour, it shall seamlessly connect to another viable route.

6.2.2 Maintain Horizontal & Vertical Clearances

Maintaining horizontal and vertical clear widths is particularly critical for accommodating people with visual impairments. No obstacles such as awnings, overhangs, signs, newspaper stands, trash receptacles, or other elements shall protrude into the clear width and height area.

- Keep the pedestrian Through zone clear; provide accommodations for pedestrians with sight impairments (see Figure 6.2).

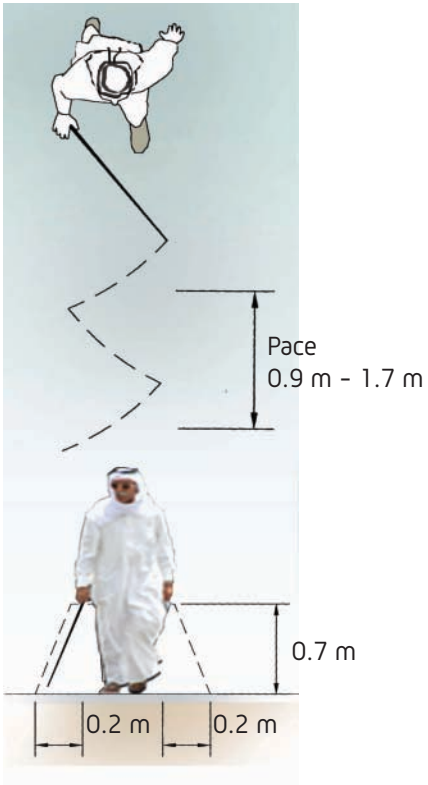


Figure 6.2 Clear Pedestrian Through Zone

- At a minimum, two pedestrians should be able to walk side by side (Chapter 3 defines this dimension at 1.8 m), and different walking speeds should be possible along any pedestrian route. (Refer to the dimensional standards in Chapter 5 for minimum, maximum, and preferred widths for all pedestrian realm zones.)
- In areas of intense pedestrian use, more space should be provided.
- A minimum clear height (vertical) of 2.1 m is required in all areas used by pedestrians (relating to the 2.0 m pedestrian design dimensions as established in Chapter 3, plus an additional 10 cm clearance), measured from grade level to the lowest above grade element in the pedestrian area. The minimum clearance above a cycle track or path, however, shall be 2.4 m (relating to the 2.3 m bicycle design dimensions as established in Chapter 3, plus an additional 10 cm clearance).

6.2.3 Minimize Obstacles

Consolidate obstacles in the furnishings zone (e.g. place multiple signs on one post, place signs on light standard posts, etc.). Make sure fixed objects are clearly detectable at grade level.

6.2.4 Provide Passing & Resting Areas

Provide resting areas along the pedestrian route in the furnishings zone. These will aid people with lower stamina or health impairments. Locate benches and seating walls strategically and frequently. Provide resting posts, leaning rails, drinking fountains, and other amenities to aid pedestrians.

6.2.5 Provide Level Pedestrian Routes

Abrupt changes in elevations create barriers and tripping hazards for pedestrians. Curbs, steps, and stairways obstruct wheelchair users and people pushing strollers or carts.

- The pedestrian through zone shall be level, with no vertical changes in grade.
- Paved surfaces shall be well maintained to avoid buckled unit pavers or cracks.
- Tree grates, drainage inlets, and other elements shall be flush with grade and shall contain no open spaces wider than 1.2 centimeters in one direction.
- Where it is not possible or practical to avoid the installation of steps and stairways, longitudinal ramps should be provided to facilitate full access.
- Longitudinal ramps may not exceed a maximum ramp grade of 1:12. Provide minimum width of 1.1 meters with clear space of 0.9 meters between handrails. Provide maximum cross slope of 2 percent and sufficient to provide positive drainage.
- Provide a maximum 2 percent cross slope on all paved surfaces in the pedestrian realm and street crossings (including sidewalks and ramps). Maintaining this maximum cross slope will facilitate travel by wheelchair users, minimize tripping hazards for pedestrians, and enable positive drainage for hard surfaces.

6.3 Surface Materials

Surfaces where pedestrians travel shall be firm, smooth, stable, and slip resistant. Surfaces must be firm enough to support higher point loads of wheelchair wheels, crutch tips, and other mobility aids.

- Concrete unit pavers (concrete or brick), cut stone, and tile provide acceptable surfaces (presuming they have slip resistant finishes). Asphalt is not desirable in the pedestrian realm due to its high heat absorption characteristics.
- Crushed fines, such as decomposed granite, can be compacted to a sufficient level of firmness, and the use of a binding agent can further improve surface stability and longevity.
- Smooth surfaces are important. Unit pavers, used extensively throughout the Emirate, can provide a smooth surface if laid end-to-end with no joint space and maintained in a smooth and level condition with a sufficiently deep and compacted subsurface (to reduce possibilities of settling).

6.3.1 Reduced Vibration Zone

Include a "reduced vibration zone" (1.5 m minimum width) within or for the full width of the pedestrian through zone and other areas in which pedestrians travel. This surface should be free of unit paver joints, utility covers, and other rough and bumpy surface conditions to accommodate people using personal mobility devices.

6.3.2 Slip Resistance

Slip resistance is based on the frictional force necessary to stop a shoe, wheelchair tire, or cane tip from slipping when ambulating on the surface.

- Broom finishes, gritty surfaces, or rough textures increase slip resistance.
- Highly polished, slick surfaces (such as polished granite tiles), and other decorative surfaces (such as exposed aggregate) that are not slip resistant and that add to glare should be avoided.

6.3.3 Detectable Warning Strips

People with sight impairments need cues as they travel through a pedestrian system to detect changes in slopes and curb drops, and to identify traffic areas. Detectable warning strips (tactile paving) and surfaces can provide this cue.

The detectable warning strip is a discernable, standardized surface intended to function much like a stop sign to alert pedestrians who are visually impaired to the presence of hazards in the line of travel (such as at the edge of streets or tram line platforms) and should only be used for this purpose.

- Use an accepted truncated dome standard surface for the detectable warning strip.
- The strip shall be placed for a width of 0.6 m (60 cm) in the direction of travel and extend the full width of the curb ramp, cut through, or other flush surface.
- There shall be a minimum of 70 percent visual contrast in light reflectance between the detectable warning and an adjoining surface, or the detectable warning should be a contrasting color.

An example of a "reduced vibration zone" in Barcelona, Spain: a smooth surface highlights the path of travel amid cobblestone pavers.

Curb ramps with detectable warning strips.

6.4 Cohesive Design with Adjacent Building Frontage

Successful streetscapes are contingent upon what happens outside and along the right-of-way, just as much as what happens within the right-of-way. Adjacent buildings and land uses strongly influence the ability to create pleasant urban environments for pedestrian activity. Developments must be designed to strongly relate to the pedestrian realm (with pedestrian oriented features and accommodations). Refer to the Abu Dhabi Development Code for design guidance on these elements.

- Frequency, orientation, and detailing of building entrances are important to create a functional and engaging pedestrian environment. Entrances should be clearly articulated, and the streetscape design should complement and highlight the entrance.
- Narrow passageways (sikkas) are encouraged to connect the interiors of adjacent neighborhoods and developments with the surrounding street network.

6.4.1 Changes in Vertical Elevations along Existing Buildings

In the existing Abu Dhabi CBD and other locations throughout the Emirate, the finish floor elevation of the ground floor level (and building plinth) varies from the elevation of adjacent pedestrian areas. This variation creates vertical disparities, such as uneven step downs and platforms.

As these properties redevelop, building frontages should be reconstructed with low planters, seating walls, stairways with ramps aligned at entries, and arcades to clearly define pedestrian areas. This reconstruction will remove the vertical disparities from pedestrian areas, as shown in Figure 6.3. The furnishings zone should be used to reconcile grade changes.

Wrap-around one- and two-level arcades, outdoor porches, or shaded atriums could enhance the building's relationship to the sidewalk and street, reduce overly wide sidewalks, and allow opportunities for architectural enhancements and signing upgrades.

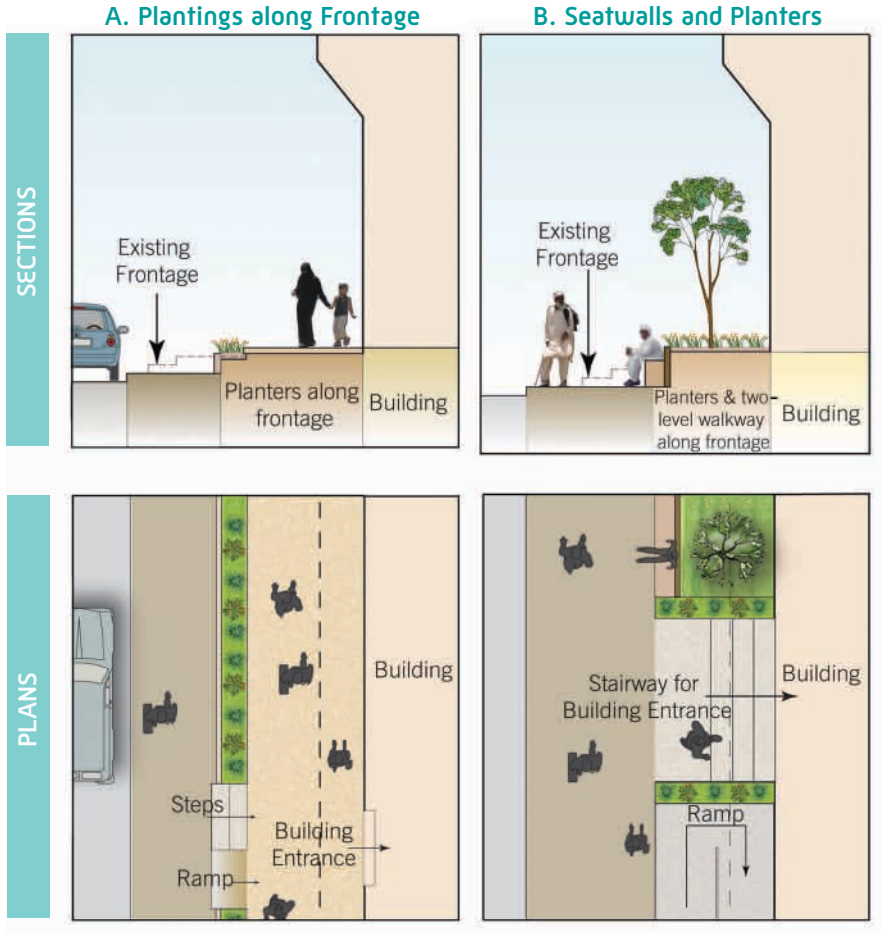


Figure 6.3 Examples of Addressing Vertical Changes in Existing Conditions

6.5 Shade & Climate Attenuation

Streetscape elements that attenuate the Emirate of Abu Dhabi's hot and humid climate will be critical for encouraging multi-modal travel. Thermal comfort for bicyclists and pedestrians is a key factor in mode choice.

In traditional Arabian architecture and urban form, streets and pedestrian passageways (sikkas) were narrow and shaded by buildings. Where additional or temporary shade was needed, fabric or wooden coverings were constructed to span over areas of the street adjacent to buildings, particularly where pedestrian activity was focused.

Shade and shelter from the sun, as well as climate attenuation through wind capture, landscaping, and selection of suitable materials as part of the streetscape design will be critical in creating a comfortable street environment in the Emirate's desert climate.

Streetscape should complement architectural treatment.

6.5.1 Mitigating the Urban Heat Gain Effect

Thermal comfort in intensely urbanized areas of the Abu Dhabi Emirate is influenced not only by the local climate, but also by additional heating effects from urban heat gain caused by direct and reflected sun light and heat radiating back from warmed surfaces (see Figure 6.4). Effective reduction of the urban heat gain can be achieved through:

- Architectural elements and ground surfaces constructed with materials that retain and radiate less heat.
- Passive shading measures that lessen the exposure of pavement and wall surfaces and increase air circulation.
- Desert adaptive, drought tolerant trees and landscaping to lower ambient temperatures. Such landscaping can also induce a psychological "cooling" effect.
- Unused ground surface areas should be left unpaved, as exposed crushed rock, decomposed granite, or stabilized sand or soil.

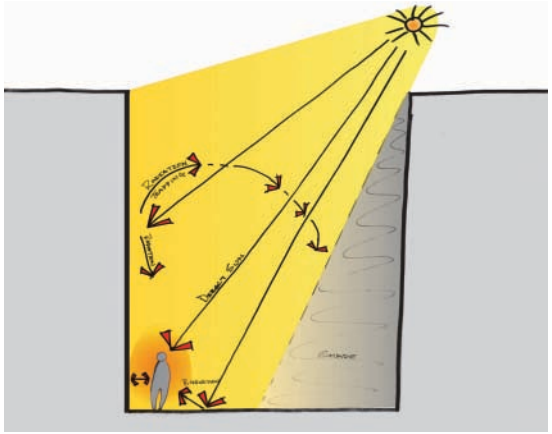


Figure 6.4 Urban Heat Gain Effect

Sculptures create shade in the pedestrian realm; pavement delineates through zone, Dubai, UAE.

Arcade over the through zone; Mesa, Arizona, USA.

6.5.2 Shadeways & Shade Spots

Streetscape design in the Abu Dhabi Emirate shall enhance thermal comfort by creating a network of safe, comfortable, and continuous shaded routes called "shadeways" and "shade spots." Refer to Figures 6.5 and 6.6. In accordance with the Abu Dhabi Development Code, pedestrian walkways should be shaded by buildings, trees, or other acceptable means.

Primary shadeways and shade spots may also include landscaping, pedestrian furnishings, and other elements that enhance character and strengthen identity and wayfinding. This approach will result in a comprehensive, comfortably shaded, and attractive pedestrian system that maximizes public investment and value.

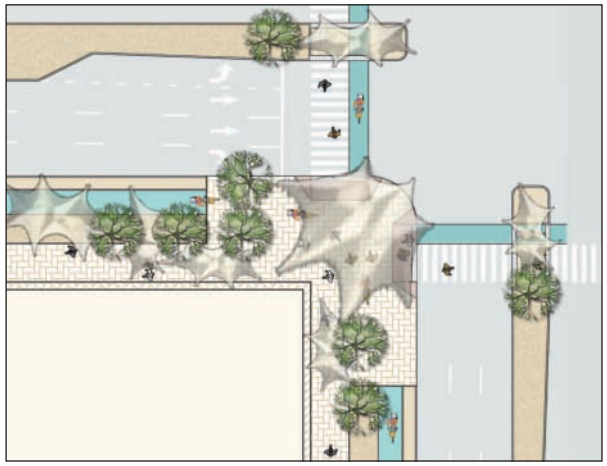


Figure 6.5 Shade Shelters and Trees at Junction Corners

Shadeways will be the primary routes that allow pedestrian travel under relatively shaded conditions throughout the day. In many circumstances, this may be simply a matter of designating routes that are already shaded by building shadows for many hours out of the day. In other cases, supplemental shading through shading devices, trees, and landscape may be needed.

- Complete detailed sun angle/shade projection studies to effectively inform the need for streetscape shadeways and shade spots.
- Be sure your design is appropriate to the context based on street type, location within the street, adjacent land use and building height, sun exposure, and availability of water if necessary.
- Refer to district or area design guidelines as appropriate.

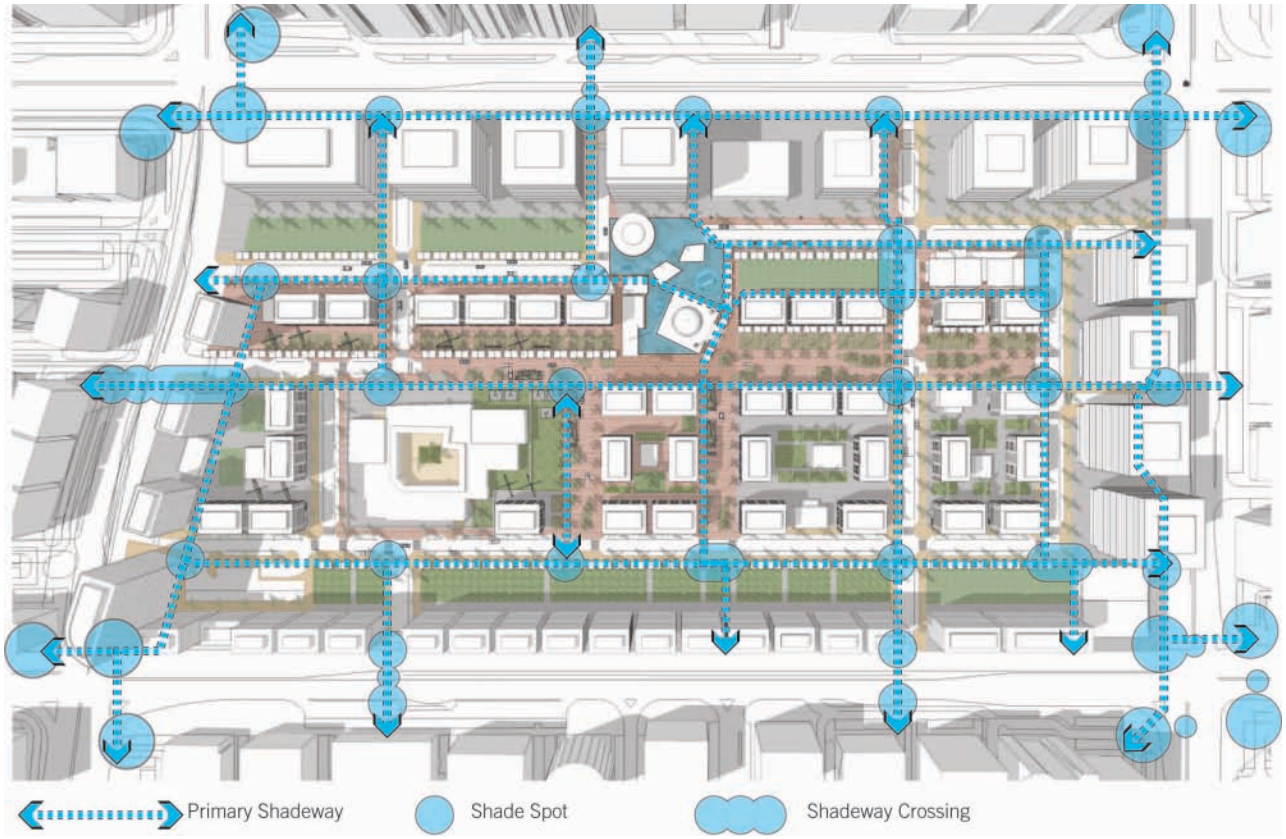


Figure 6.6 Example Plan of Potential Network of Primary Shadeways and Shade Spots

- Coordinate architectural and site design with the UPC and the Abu Dhabi Development Code.
- Provide free-standing shade or trees when architecturally integrated or attached shade structures are not feasible - particularly in areas where there is regular pedestrian activity and where the sun angles/shadow analysis dictates the need for shade.
- Use materials that will minimize and mitigate urban heat gain.
- Allow air to flow through via passive ventilation design.
- Provide adequate lighting to ensure shade structures provide a sense of security for pedestrians at night.
- Consider the possibility of integrating efficient radiant cooling and solar photovoltaic systems into the architecture of the shade structure.
- Comply with the minimum horizontal and vertical clearance dimensions.
- Locate trees strategically, consistent with the guidelines in section 6.6.
- Locate shade devices such that they do not mask or hide the location of main building entrances.

6.5.3 Types of Shading

Table 6.1 illustrates and describes the various types of shading elements that can be designed and installed along shadeways and in shade spots.

Table 6.1 Types of Shading

TYPE	Architectural - Attached	Architectural - Free Standing
Photo References	 	 
Examples/Notes	• Attached colonnades • Attached galleries and passages • Attached trellises	• Free standing arcades • Free standing trellises • Transit shelters • Shade structures for pedestrians
Appropriate Locations	• Along ground level building facades • May be overhanging the frontage zone and through zones • Less likely, but could be set back from the right-of-way line, adjacent to the pedestrian realm	• Streets with wide sidewalks and frequent pedestrian traffic • May be overhanging the frontage zone and through zone (columns in furnishings zone) • Intersection locations, curb extensions, transit and taxi stops, etc.

Table 6.1 continued

TYPE	Sculptural Free Standing and Independent Elements	Trees and Landscaping	Vertical Screens
Photo References	 	 	 
Examples/Notes	• Large scale shade sculptures and structures • Artist-designed shade elements that combine function, form, and creative design • Can be particularly responsive to context	• Shade-providing trees (better in bosques and groupings) • Provide adequate root zone space • Use desert adaptive, drought tolerant species	• Patterned screens of metal, wood, or other materials • Vertical lattice work • Cast immediate shade for pedestrians in areas where sun is at low angles • "Green walls" with vines are psychologically cooling
Appropriate Locations	• Streets with wider sidewalks and frequent pedestrian traffic • May overhang portions of pedestrian realm or entire streets • Intersection locations, curb extensions, transit and taxi stops, etc.	• Streets with narrower sidewalks and frequent pedestrian traffic • Typically located in the furnishings and edge zones; may be located at edges of through zones with accessible tree grates	• Along pedestrian through zones • At transit stops and waiting areas • Opportunities for privacy and creating outdoor rooms and corridors • Provide transparency for security

6.5.4 Wind Capture

Wind capture has been a long-standing tradition of Arabian architecture. Wind can be captured and funneled to the pedestrian realm in certain areas of Abu Dhabi. Northwesterly corridors closest to the coast hold the most promise for capturing wind, but wind flows can also be captured in other areas.

- Each street design project should include a site analysis of existing wind and micro-climate conditions at the outset in order to determine potential opportunities for using wind capturing treatments.
- Shelters should be designed with architectural elements that funnel winds to cool pedestrian areas, as practicable.
- A potential reinterpretation of the traditional "wind tower" may be a useful device to funnel moving air to the pedestrian level at transit stops or in other pedestrian gathering areas.

Open air street market; architectural louvers provide shade and direct winds to the ground level, Dubai.

Historical photograph showing wind capture through the use of a wind tower, integrated in a sikka.

6.6 Landscaping & Water Use

Water is a precious resource in the desert. Streets shall be designed to use irrigation water efficiently. Street designs must reach a balance between the benefits of a green streetscape and the costs of irrigating that green.

High quality, attractive streetscapes are desired, particularly to improve the pedestrian environment and increase transit use, but they must be carefully designed in order to conserve water to the maximum extent. Streetscape designers shall carefully consider where to prioritize the use of water.

Design of the landscape should also consider environmental variations of the different regions of the Emirate. Refer to the UPC, DMA, and local municipalities for additional guidance, as well as the June 2009 Parks and Recreational Facilities Division, ADM, document entitled "Landscape Design Guideline."

Street trees, landscaping, and water use should align with the following key principles:

Sustainability: Application of Estidama principles in landscaping, such as the use of water conserving native trees and plants, xeriscaping, and the introduction of shade in pedestrian areas, will be critical.

Climate Attenuation: Street trees and landscaping in the streetscape should be designed and placed to provide shade and to lower ambient temperatures. These functions create more comfortable micro-climates by reducing the amount of heat reflected off paved surfaces.

Aesthetics and Character: Plantings should add color, texture, contrast, motion, and scents that create a beneficial association between nature and street travelers (pedestrians, bicyclists, transit riders, and motorists). Trees and plants should be provided to enhance urban character and introduce human scale to the streetscape.

Function and Form: Plantings should delineate edges or identify special places and add a processional quality to a street (particularly on ceremonial streets). Planting of native, drought tolerant shrubs and ground cover on road verges can also help stabilize the sandy verges and reduce maintenance requirements and costs.

Public Safety and Security: Public safety and security should be maximized by keeping sight lines and views clear and open. Trees and plants selected should be appropriate for public use. Refer to the guidelines of the municipality in this regard.

Cultural Value: Some plant species may have a cultural association that can be honored in how they are used in the streetscape design. The date palm, for instance, is associated with the image of the Emirate, particularly in the City of Al Ain.

6.6.1 Tree & Plant Selection & Qualities

- Select plant materials that thrive in urban conditions and climates.
- Choose the best plant material for aesthetic and functional purposes, and avoid use of plant materials that can become invasive, drop messy fruits, or may be gaseous, thorny, or toxic.
- Trees and plants that are either native or desert-appropriate are required. Consider microclimate influences of the different regions and areas of the Emirate when selecting the plant palette. Conduct a site analysis of specific conditions (climate, wind, soils, etc.) for each project.
- Trees, shrubs, and groundcovers should be chosen for the following qualities:
  - Growth habit – typically upright and branched above 2 m for street trees
  - Low or moderate water usage
  - Aesthetic compatibility and enhancement – appropriate contrast or harmony of color, texture and form
  - Shading capability, including mature height, spread, and density of foliage
  - Maintenance requirements – low maintenance plants should be used in difficult-to-maintain areas, such as medians
- Refer to the UPC and other agencies for preferred trees, shrubs, and groundcovers for streetscapes in the Emirate.

Trees and other plantings are important for improving the aesthetic quality, character, functionality, and the micro-climate along street corridors.

6.6.2 Plant Placement & Location

Select appropriate species for the local environment. Species that thrive in Abu Dhabi City may not be right for the different conditions of Al Ain or Liwa, for instance.

- Plants with similar water requirements should be grouped for more efficient irrigation. Generally, a variety of species should be used for compositional and seasonal interest and to avoid the risks associated with monotypic planting. Certain trees and shrubs, however, may be planted along the entire length of a street for maintenance efficiency and visual cohesiveness.
- Trees, shrubs, and groundcover plantings should be installed where they are most effective visually and functionally.
- Shrubs that grow to a maximum height of 1 m should be used where open sight lines between motorists, pedestrians, and bicyclists are needed. Trees may be placed in these areas as long as the mature trunk width will not exceed 0.3 m diameter.
- The location and depths of utility lines should be confirmed before developing the planting plan. If utility lines are shallow (above 1 m but below 0.3 m) only shrubs and groundcovers shall be installed in these areas, although trees planted in movable planters are allowed. Depending upon the species, trees may be planted over utilities when the depths of the lines exceed 1 meter, with the approval of relevant utility providers.
- Plants and trees shall be planted in locations set back sufficiently from the pedestrian and bicycle through zone so as not to impede travel (no protruding branches or spiny leaves).
- Native, drought tolerant shrubs and high ground cover plants can help stabilize the sandy soils and reduce maintenance needs.
- A regular presence of trees in the edge zone is desirable to frame the street, calm traffic, and enhance pedestrian crossings. Informal groupings or double rows can be provided at a regular intervals discernable to motorists. This spacing should coincide with pedestrian crossing points along the street.
- Locating trees in groups will maximize shade and root zone access to air and water. Trees also provide an additional cooling effect through transpiration, particularly when planted in clusters or closely spaced double rows. In other areas along streetscapes, tree spacing may vary.
- Shrubs and groundcover plantings should be included in the tree planting areas.

6.6.3 Tree Pits

Tree pits expand the area for root growth for trees, and research shows that tree pits extend the life of street trees and result in less root interference with paved surfaces and utilities. Tree pits can be individual, elongated, or connected. They may be surfaced with pavers, rocks, or grates that allow water to readily flow to the root zone, or they may be landscaped with soil and mulch. Along with the use of tree pits, landscape architects should consider the use of structural soils to further enhance tree health and longevity. Tree pits should be adequately sized to fit the species of tree being planted.

Streetscapes will maximize the use of xeriscaping and drought tolerant plant materials.

6.6.4 Softscape & Hardscape Materials in Landscaped Areas

Landscaped areas do not have to be completely filled with plant material. Decorative rock, stones, shells, stabilized soil and decomposed granite, mulches, and other materials may be used as an alternative to hardscape (paving) and landscaping that requires water.

In addition to the softscape materials, hardscape materials such as natural stone embankment, tiles, or pervious pavers may be used in landscaped areas, using care in the selection of the material to avoid reflective colors and finishes.

Mulch
Mulch decreases the rate of evaporation so that less irrigation water is needed. It also reduces the likelihood of soil erosion so that sidewalks and roadways are cleaner. Mulch can also:

- Reduce soil compaction, especially near heavily traveled walkways.
- Provide necessary plant nutrients as micro-organisms decompose the mulch.
- Add texture and color to the landscape.

6.6.5 Water Use

As part of a large scale development, a water balance will need to be undertaken to show levels of water consumption. Potable water should not be used in irrigation. Treated Sewage Effluent and alternative water sources are preferred for irrigation of streetscapes. The potential for alternative irrigation water sources and collection shall be thoroughly explored and demonstrated on each streetscape design.

- Explore opportunities to use alternative water sources for certain segments of the streetscape or public gardens.
- Cisterns holding harvested water from adjacent public sites could be incorporated into streetscape design, as could earth-formed stormwater basins and catchment techniques.
- The collection of air conditioning condensate water is proving to be a viable irrigation water source in hot and humid communities internationally.
- Condensate water coupled with other alternative water sources, such as the collection of ablution water from mosques or rain water, would be a significant contribution to the irrigation needs of a streetscape design.

It may be possible to collect grey water for use in irrigation of public areas within a few special project locations without compromising the overall Abu Dhabi system.

Only water efficient drip irrigation (under and above ground) systems shall be allowed in streetscapes.

Decorative rock between plantings.

Use locally produced mulch products that tend to appear more appropriate in the context for use under paving where loose soils cannot otherwise be provided.

Water Management Plans
Along with a site analysis, soils report, landscape plan, and irrigation plan, streetscape projects must include a water management plan submitted as part of the design approval process. The water management plan will demonstrate that the proposed water use meets the applicable requirements. The proposed water management plan shall indicate:

- Total planted area of the streetscape design in square meters
- Graphic depiction of the planted area that will include low water use plantings (a recommended 80 percent) and the planted area that will include moderate water-use plantings (a recommended 20 percent) – correlated to the planting plan and irrigation zones
- Total area of irrigated landscape broken out according to water use hydrozones and hydrozone information table
- Description of the source of irrigation water, including sources and documentation of alternative water source investigation and findings
- Other special landscape care instructions or maintenance requirements
- Water budget calculations

Water Features
Any use of water that might be or appear wasteful shall be avoided. Water features are allowed in streetscape projects, but only with design review to ensure that the features are carefully designed and water conservation is maximized. Water features integrated into the streetscape can bring multiple benefits, such as:

- Psychological cooling effects
- Microclimate temperature reduction, particularly with wind interaction
- Funneling of water to vegetated areas
- Masking urban noise

If provided, water features must be designed in accordance with Abu Dhabi Estidama principles and the following provisions:

- Water features must serve multiple purposes, such as runnels that cool adjacent walkway zones and direct water to planted areas.
- Water must re-circulate.
- The amount of water used must be the minimum necessary to be effective.
- Water features should be placed where many people can enjoy them.
- The water feature must be placed in a shaded area to minimize exposure to evaporation.
- Salt water features should be considered for coastal areas.
- The feature must be integral to other elements of the streetscape and attractive when water is not present (such as when the water is turned off or repairs are underway).
- Standing water features are not allowed in streetscapes.

Streetscapes should be planted with drought tolerant species to conserve water.

6.7 Lighting

Lighting, whether to illuminate the street, pedestrian areas, or crosswalks, is an integral part of street design. This is especially true in the Emirate of Abu Dhabi where much activity occurs in the evening after the sun goes down and temperatures drop.

Typically, two levels of illumination are appropriate for a streetscape:

- Lighting along the motor vehicle travel way, placed in the edge zone (sometimes combined with the furnishings zone) or the median.
- Pedestrian-oriented lighting along sidewalks and bike ways, placed in the furnishings zone (depending on the width of the pedestrian realm, it may be combined with the edge zone) or on buildings.

Street light for motor vehicles.

Lighting also may be provided for adjacent public spaces, buildings, transit stops, parking areas, and other outdoor areas. Lighting is a key element in creating walkable pedestrian networks. Illumination also improves safety and wayfinding. Coordinate with the UPC, local municipalities, and district master plans on specific lighting styles to be used. Consider the use of energy efficient, non-light pollution fixtures, as well as the use of solar energy through photovoltaics to power light sources.

6.7.1 Street Lighting for the Traveled Way

The principal purpose of street lighting is to facilitate immediate visibility (clear, accurate, and comfortable) at night for motorists. In general, street lighting in Abu Dhabi shall provide levels of illuminance at intersections and along street corridors in accordance with the tables provided in Appendix D.

Following design standards for illuminance has been shown to result in reduced pedestrian accidents, reduced fear of crime, and promotion of business through use of public streets and spaces at night. The illuminance design methodology follows prescribed standards for the amount of light to be provided at the surface of the street. The following design requirements apply to general street lighting.

- Street lighting in urban areas typically provides fixtures that should be mounted at 7.6 m to 12.2 m above grade, depending on the style of light pole and luminaire selected.
- Cutoff luminaires should be provided to minimize glare and light pollution.
- Street lights for motor vehicle lanes should generally be located in the edge zone or the median.
- Lighting patterns at junctions need to differ from the approaching streets to provide an advance warning to drivers.
- Light pole locations need to be coordinated in design to avoid conflicts with other above- and below-grade utilities and street signing.
- Regular spacing of street lights may not always be possible due to driveway cuts or other features, so placement requires some flexibility.
- When street trees are located along the same line as street lights, the lights should be located in between the trees so that the tree canopies do not interfere with the illumination coverage.
- Choose fixtures that are durable and resistant to environmental conditions. Choose energy efficient light sources that have a longer lamp life to minimize repeated replacement of lamps.
- Transition lighting should be provided along streets that lead from more intensely illuminated urban areas to outer, less developed areas. This involves a gradual change in lighting level as motorists transition to a different type of street and/or significant change in urban density.
- When locating lighting near important buildings or along view corridors, care should be taken to preserve important view corridors and eliminate sight obstructions.
- For lighting along highways, refer to the DOT lighting standards.

6.7.2 Pedestrian Lighting

Environments with high levels of pedestrian activity require more intense and even lighting because pedestrians move at a slower pace, look at more detail, and stop frequently for longer periods of time when compared with people in a moving vehicle. Pedestrians do not have their own source of light; motor vehicles do. Standard street lighting fixtures on tall poles are not sufficient to meet the needs of pedestrians. However, a pedestrian-scaled light fixture may be integrated into the pole design.

A system of lighting for pedestrians should be provided along all urban streets in Abu Dhabi.

- Provide a greater level and uniformity of lighting intensity in high pedestrian activity areas. Lighting levels for all areas of the streetscape shall never fall below the minimums required for personal safety and security.
- Lighting should be designed to increase recognition of other people and not create inordinate shadows.
- Streetscape lighting can also be a defining visual element that enhances the aesthetic character and identity of the corridor and district.
- Pedestrian lighting fixtures shall be spaced closely and evenly to allow the use of lighting fixtures with low wattage luminaires, as opposed to a less frequent spacing of fixtures that require high wattage. This approach will reduce the overall lighting power density, reduce glare, and provide consistent lighting levels.
- Sufficient lighting must be provided throughout the streetscape. Certain locations may require additional lighting (beyond uniformly spaced fixtures) to meet the prescribed lighting levels, including:
    - Intersection crosswalks and mid-block crossings
    - Stairs and ramps
    - Transit stops
    - Pedestrian underpasses
    - Building entrances
    - Plazas and public spaces
    - Parking garages
    - Under awnings and colonnades
- On retrofit designs of existing streets, pedestrian light fixtures may be mounted onto existing street light poles (at a suitable level) if providing a separate pedestrian lighting system is not practical and sufficient pedestrian lighting can be provided.
- The same requirements regarding placement of light poles to avoid conflicts with trees and utilities mentioned for street lights apply for pedestrian lights
- Specialty light pole styles can be selected to convey a particular theme or design character in coordination with the local municipality.
- Light poles can include brackets for hanging banners for special events or to reinforce district/ neighborhood identity.
- Creative forms of lighting can add interest and appeal to the streetscape. Hanging votive style lights, sparkling accent lights, lanterns, in-ground lights, colored lights, and other illumination can add beauty and art to the street and also attract pedestrians.

Pedestrian scale lighting in Dubai.

Light pole wraps can be retrofitted to existing street lights.

6.8 Streetscape Furnishings

Street furniture includes smaller-scale amenities located in the furnishings zone (sometimes combined with the edge zone) provided for convenience and comfort. Coordinate with UPC and the local municipality on selection of streetscape furnishings. Table 6.2 provides examples and placement guidelines for a variety of streetscape furnishings.

Design and select street furnishings in accordance with the following considerations.

- A palette should be developed for each streetscape project that includes furnishings, parking meters, electric car recharge stations, shade structures, lighting, trees, landscaping and paving. Choose materials and styles for maximum durability, comfort, safety, security, and usability. The palette should illustrate how the streetscape will enhance the identity and character of the corridor and surrounding district in accordance with municipal requirements.
- Concentrate streetscape furnishings where pedestrian traffic is regular and furnishings will receive use and appreciation (such as within shaded areas of the street, transit stops, and near intersection crossings and building entrances).
- Locate furnishings primarily in the furnishings zone, and secondarily in other areas, such as intersections, transit stops, and edge zone, where they are needed and where space permits.

Table 6.2 Types of Furnishings

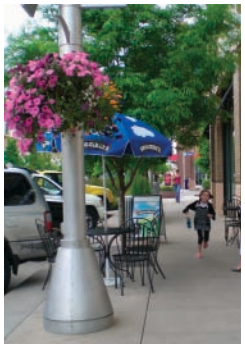
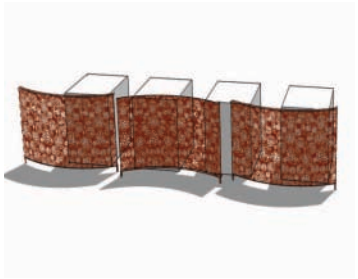
Streetscape Furnishings		
 	 	 
Hanging Baskets, Banners	**Planting Boxes/ Pots**	**Other Amenities**
• Add color, life, identity to the streetscape • Maintain horizontal and vertical clearances	• Add color, life • Maintain horizontal and vertical clearances • Maintenance needs should be considered	• Custom designed shade shelters, street clocks, and other elements add unique identity to the streetscape • Public art and water features

Table 6.2 continued

Streetscape Furnishings				
	 	  	 	 
Benches/Seating	**Bicycle Racks**	**Bollards**	**Trash/Recycling Receptacles**	**Leaning Rails/ Protection Railing**
• Essential for pedestrian areas • Provide center/ intermediate armrests on benches • Wide variety of materials and styles • Low heat reflecting	• Essential for transit stops and at key bicycling destinations • See Bicycle Parking in section 5.8.3	• Delineate pedestrian space • Provide protection from vehicle movements • Can be lit or unlit • Keep height in scale with pedestrians	• Street/pedestrian realm stays cleaner • Coordinate recycling containers with municipality programs • Wide array of styles, colors, materials	• Provide protection from vertical drops of 0.7 m or more • Leaning rails are popular at transit stops

Table 6.2 continued

Streetscape Furnishings				
 	 	 	 	 
Tree Grates and Guards	**Custom Manholes/Utility Screens**	**Kiosks/ Pedestrian Signs**	**Transit Stops/ Shelters**	**Drinking Sinks/ Ablution Sinks**
• When combined with tree pits/boxes and good sub-structure, grates can provide enhanced growth environment • Guards only needed in areas where trees are susceptible to damage	• Can screen unsightly elements • Add character and interest to the pedestrian realm	• Locate in key areas where pedestrians may change their route; pedestrian gathering areas, etc. • Should be professionally designed by graphic artists	• Maximize shade • Provide lighting for security • Can be customized with special designs, artist and community involvement	• Provide only in essential areas, such as pedestrian gathering areas and mosques • Provide good drainage to avoid wet surfaces • Provide accessible height drinking fountains

6.9 Signing & Wayfinding

Signing and wayfinding elements shall be cohesively integrated into the Emirate of Abu Dhabi urban street system. Signing and wayfinding should function well and establish a sustainable identity and memorable sense of place in the street network. Refer to UPC and the local municipality signage guidelines for more information.

- Establish consistent design standards and guidelines for all signs (materials, color, scale, type, location, etc).
- Enhance the visitor experience with key placement of signs.
- Ensure that signing and wayfinding elements are consistently placed and are not inadvertently located; avoid their placement becoming an impediment or barrier to pedestrians and bicyclists or an obstruction between sight lines.
- Establish the brand and a unified visual language for the street network, as well as a recognizable hierarchy.
- Reinforce primary gateways and landmarks.

6.9.1 Placement of Signing & Wayfinding

In general, design and placement of signing and wayfinding should be consistent.

- Avoid interfering with pedestrian travel; do not locate signs in the through zone.
- No signs or advertising structures shall be placed within 10 meters of junctions.
- Minimize sign clutter.
- Avoid conflicts with underground utilities.
- Provide flexibility for expansion and change in the signing and wayfinding system as needed.

6.9.2 Types of Signs

The following is a list of types and locations for a variety of signs.

Identification Signs

Identification signs indicate special places and are used to welcome people and orient them to locations and services. In this context, identification elements include vehicle, pedestrian, and transit identification and should be placed within the edge zone.

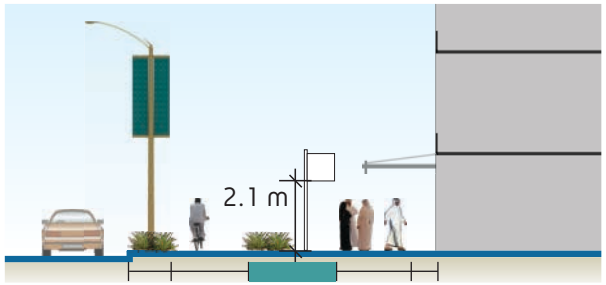


Figure 6.7 Pedestrian Direction Sign in the Furnishings Zone

Example of pedestrian direction sign.

Direction Signs

Vehicle and pedestrian direction signs direct people to destinations within a city. Vehicle signs are meant to be read from a car and shall be placed in the edge zone or the median, and can span over the travel lanes. Messages typically include directions to destinations and parking. Pedestrian signs are intended to be read while walking and may be placed in either the edge or furnishings zones. Maximum three (3) messages per vehicle signs. More messages may be listed on pedestrian signs.

Information Signs

Information signs are intended to give people more detailed information about the city's environment. These signs may include information pertaining to parking information, location maps, hours of operation, listings of tenants and services, site and project directories, and other public information. They are placed within the furnishings or edge zones.

Regulation Signs

These signs communicate laws and regulations to the public primarily for vehicle traffic regulation. Design and placement of these signs shall comply with DOT standards and requirements. They are placed within the edge or furnishings zone, depending on if they are directed at vehicles or pedestrians.

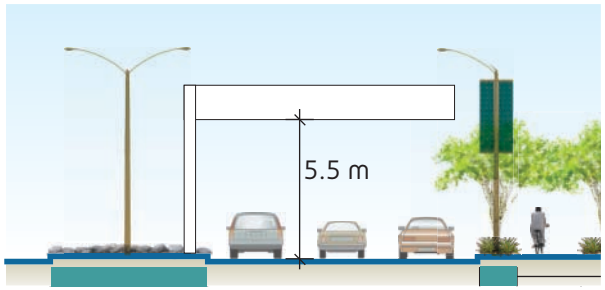


Figure 6.8 Primary Vehicle Direction Sign in the Median or Edge Zone

Example of a primary vehicle direction sign.

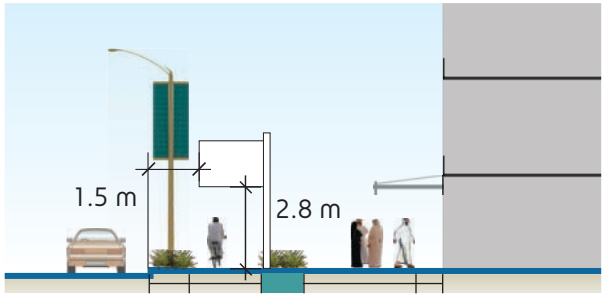


Figure 6.9 Secondary Vehicle Direction Sign in the Furnishings Zone

Example of a secondary vehicle direction sign.

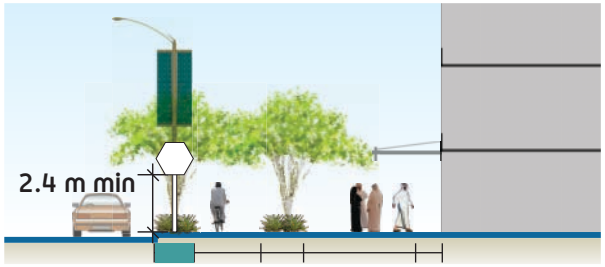


Figure 6.10 Regulation Sign in the Edge Zone

Example of a regulation sign.

مجلس أبوظبي للتخطيط العمراني
ABU DHABI URBAN PLANNING COUNCIL

Chapter 7 - Sample Projects

7.1 Introduction

Previous chapters described the various principles and processes involved in the design of urban streets in Abu Dhabi Emirate. This chapter discusses North Wathba, a new master planned city, designed following the basic principles of the Manual. This example also demonstrates how street design must consider the context within which the street lies.

At the time of the development of the Manual, North Wathba was in the master planning stage. There are three main design scenarios covered in the street design process of this Manual: street network design, new street design, and flexible design for streets with fixed right-of-way dimensions. North Wathba is used to illustrate all three design scenarios.

The design process, as described in Chapter 4, entails four phases:

- Phase I: Gather and present information
- Phase II: Develop conceptual design
- Phase III: Evaluate and review design
- Phase IV: Finalize design

7.2 North Wathba Development

North Wathba is located to the southeast of the Capital City District (see Figure 7.1). It is comprised of approximately 17,000 residential units, with a total projected residential population of approximately 125,000. The development area also contains some mixed use elements in the form of office, retail, community facilities, and light industrial uses.

The street network for North Wathba was developed with the overall goal of establishing a network of safe, legible, and efficient streets. Interconnected streets and small block lengths are intended to encourage walking, bicycling, transit use, and efficient vehicular movements, thus reducing vehicle trip generation. The changing land use context along the street and anticipated traffic flows defined the street types to be incorporated.

The following steps and figures illustrate the design process.

7.3 Phase I: Gather & Present Information

At the beginning of the design process, relevant information was gathered from UPC, DOT, ADM and the utility agencies. All of the information gathered was presented in the context plans (see Figure 7.2). Following are the fundamental factors that influenced the street and network design for North Wathba.

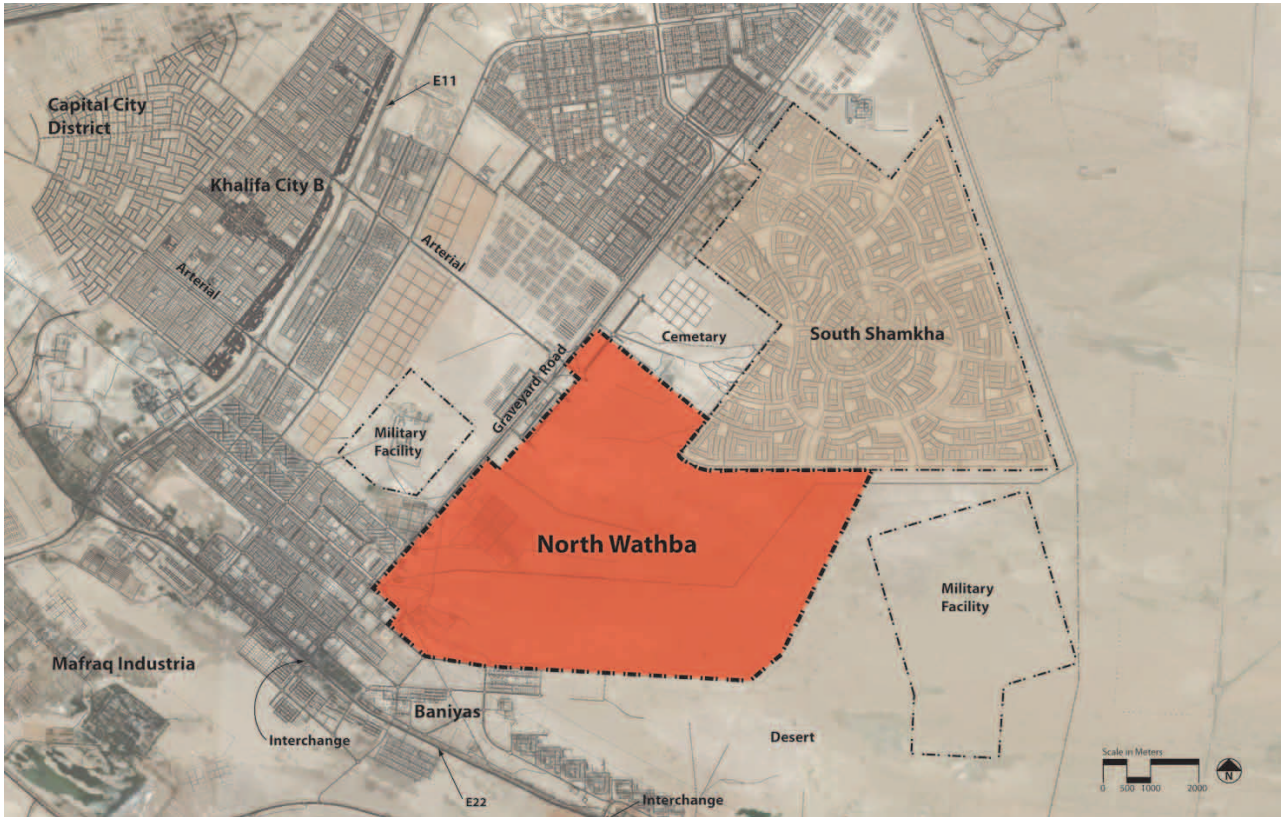


Figure 7.1 North Wathba Location

7.3.1 Land Use Influence

The site is bounded by the master planned community of South Shamkha to the northeast, a small residential neighborhood to the north, and the community of Baniyas to the south of the site boundary. Connections must be made to these existing and planned uses. Existing uses on the site include an oil well and industrial facilities (see Figure 7.3).

7.3.2 Transport Requirements

Data regarding existing and planned streets, transit, and connections to the surrounding developments were collected (Figure 7.4). There are plans for metro and tram lines to go through the site.

7.3.3 Existing Environment

Desert ridges that run east-west through the site and lowlands that exist in the southwest portion of the site influenced the street network layout (Figure 7.5). The prevailing winds come from the northwest and, if channelled properly, could be used to provide natural cooling on streets.

7.3.4 Estidama

Estidama principles were applied to the street design, especially with regard to the provision of shade, allocating irrigation and landscaped areas, and minimizing urban heat gain effect. In order to optimize the water budget, shade elements and landscape features need to be located where they most benefit pedestrians.

7.3.5 Urban Design

Plan Abu Dhabi 2030, the Draft Abu Dhabi Development Code, and an examination of the opportunities and constraints of the site informed the urban design objectives for North Wathba. Potential view corridors, especially along major streets, guided the location of neighborhood facilities and landmark buildings. Connections to the external corridors also mark gateways to the site, requiring special treatment.

7.3.6 Utility Requirements

Utility service reserves required by the utility providers informed right-of-way widths. Storm water, electricity, telecommunications, and gas are preferably located below parking areas constructed with interlocking pavers within the pedestrian realm. Where right-of-way widths need to be minimized, sewer and storm water drains may be located below asphalt travel lanes. Provision was also required for district cooling in certain areas.

Using the information gathered, a context plan was developed which shows the planned and proposed conditions of the network within its surrounding context (see Figure 7.2).

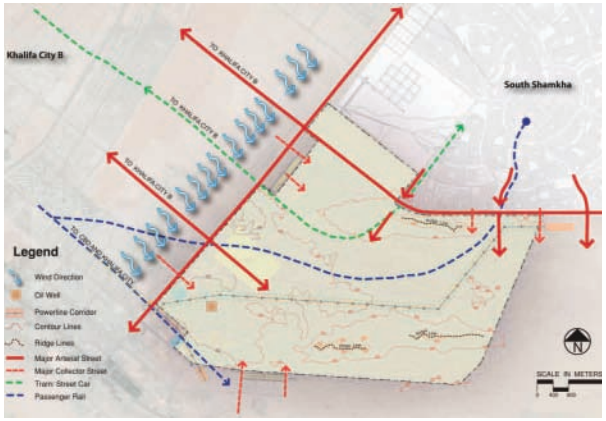


Figure 7.2 Context Plan

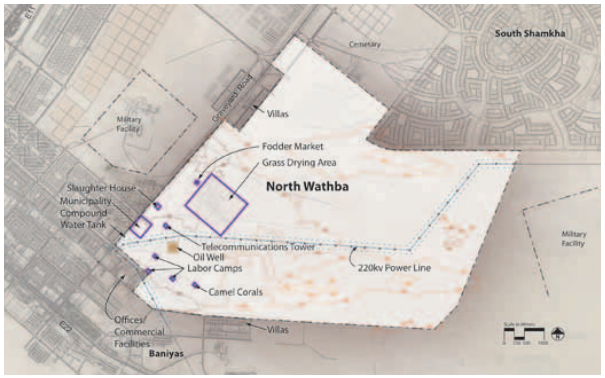


Figure 7.3 Land Use Requirements

Figure 7.4 Transport Requirements

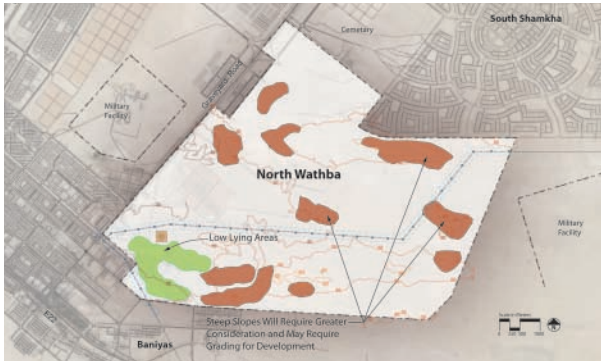


Figure 7.5 Low Land and Desert Ridges

7.4 Phase II: Develop Conceptual Design

The following steps illustrate the development of conceptual design.

7.4.1 Determine & Assign Land Uses

Two intersecting street grids were introduced to respond to the natural topography, surrounding land use, transportation networks, and the prevailing wind direction.

The Town Center was located at the center of the site, and the convergence of the grid and the Town Center determined the location of the metro station and transit hub (Figure 7.6). Three district nodes provide community facilities for areas to the north, west, and south of the Town Center.

Neighborhoods were designed on a 600 m by 600 m grid, which is adaptable to transit stop spacing (Figure 7.7). Higher density neighborhoods were located adjacent to transit corridors and district nodes. Community facilities such as mosques, schools, parks, and recreational centers were placed in highly accessible locations that are walkable, create focal points, and enhance the design of individual neighborhoods.

Figure 7.8 shows the allocation of land uses in the master plan.

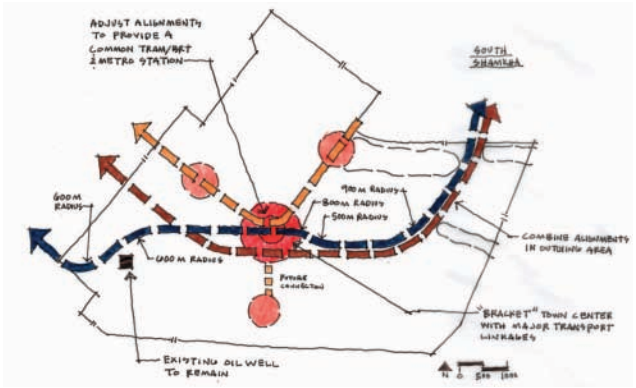


Figure 7.6 Transport Elements and Nodes

Figure 7.7 600 m Grid Pattern

Figure 7.8 Land Use Plan

7.4.2 Identify Pedestrian, Transit, Bicycle, and Vehicle Networks

The master plan illustrates a multi-modal transportation network that provides access throughout the community and the region. Mass transit components include an elevated metro line that traverses the site with one stop at the town center and a tram line that is incorporated into an Avenue corridor. Within North Wathba, a hierarchy of streets provides distinct boundaries to neighborhoods and links to destinations within the community (Figures 7.9 and 7.10).

The street hierarchy consists of six street types:

- Boulevard: 3+3 travel lanes with a center median
- Transit Avenue: 2+2 travel lanes with parallel parking and a center aligned tram line
- Avenue: 2+2 travel lanes with parallel parking and a center median
- Street: 1+1 travel lanes with parallel parking
- Street: 1+1 travel lanes with parallel parking on one side
- Local Access Lane: Intended for garage access and serve as alleys

The master plan also provides an interconnected pedestrian and bicycle system (Figure 7.11), and the street rights-of-way are a component of the open space network. They are utilized to link destinations such as civic uses, retail venues, transit stops, parks, and open spaces. Additional pedestrian connections are made through Sikkas.

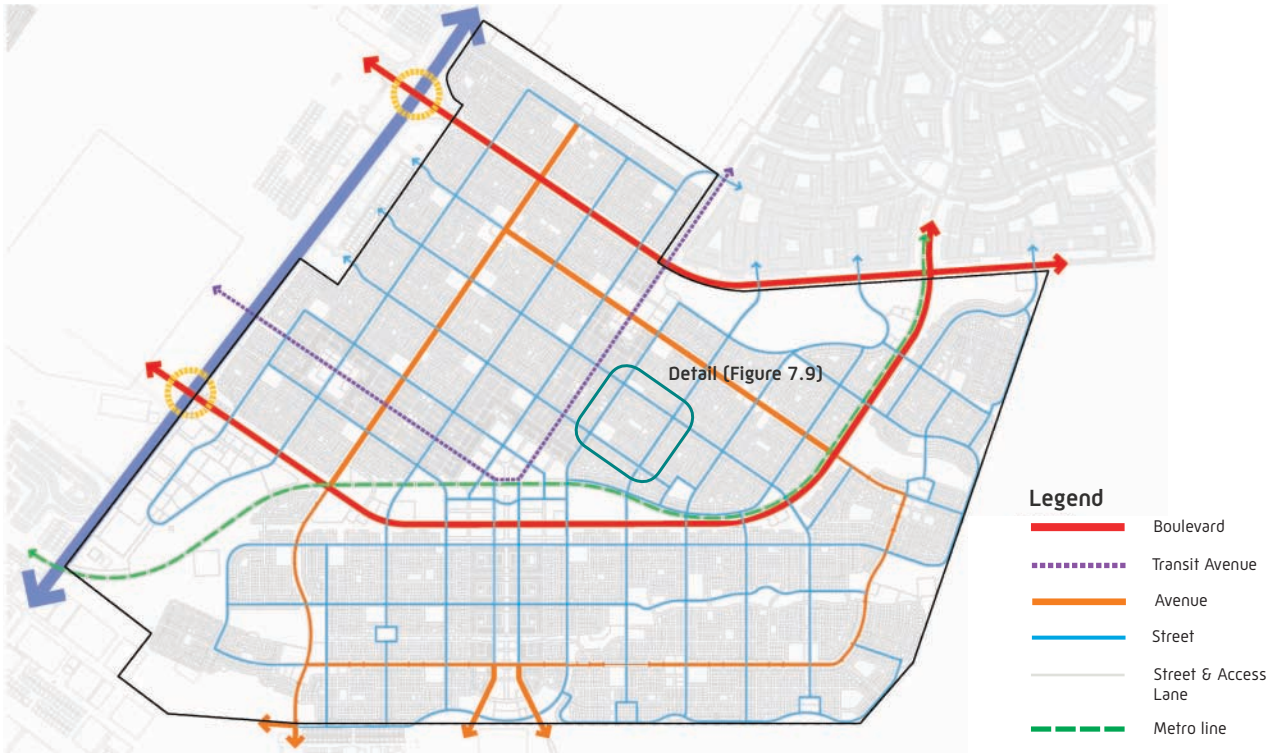


Figure 7.9 Multimodal Networks & Street Hierarchy

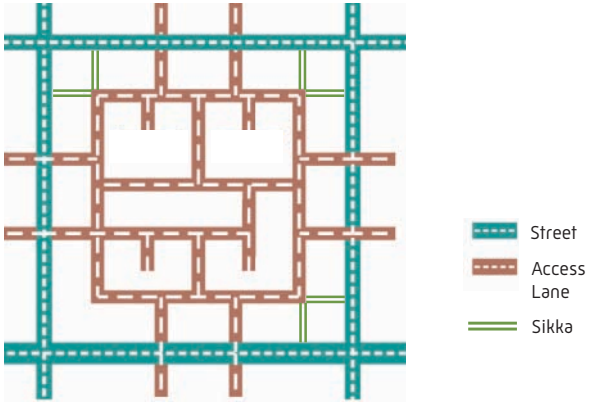


Figure 7.10 Neighborhood Detail

Figure 7.11 Pedestrian/Bicycle Circulation

7.4.3 Determine Street Cross Sections

Street types and the corresponding cross sections were determined by adjacent land uses, projected traffic volumes, and transit and bicycle networks. Street cross section dimensions were determined using the standards in Chapter 5.

The Avenue with tram running through the northern part of North Wathba can be used to illustrate the street design process. Figure 7.12 shows how land use varies as the Avenue passes through the development.

Pedestrian realm dimensions vary according to adjacent land uses. For instance, more vegetation and shade structures, wider sidewalks, and higher pedestrian amenities are provided along mixed use town areas with higher pedestrian activity. Using the recommended cross section tables, the preferred dimensions for each zone (frontage, through, furnishings, and edge) were identified (Fig 7.14).

The Avenue has a proposed tram line running through the median with a central platform serving both transit-way directions (Figures 7.15 and 7.16). Mid-block pedestrian crossings are provided on either side of the platform. At junctions, tram lines shift to the center of the median to incorporate left turn lanes for vehicles.

A cycle track is provided in the pedestrian realm along the Avenue as it connects high density residential areas, neighborhood centers, civic centers, transit stops, and community facilities. Two typical cross sections of the Avenue are shown in Figure 7.15 and 7.16, and these correspond to residential and mixed use town land uses.

The traveled way remains the same along the entire length of the Avenue, since the volumes of traffic that are expected along its length all fit the 2+2 lane configuration. Lane widths were determined from the tables in Chapter 5. On-street parallel parking is provided along the Avenue.

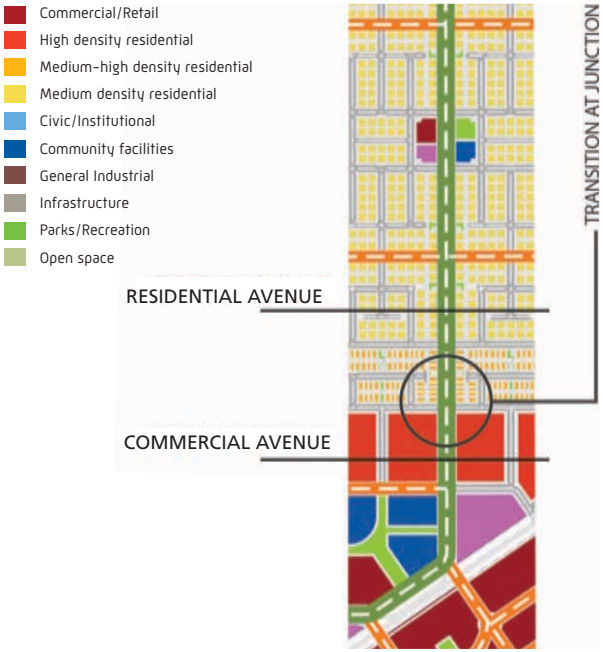
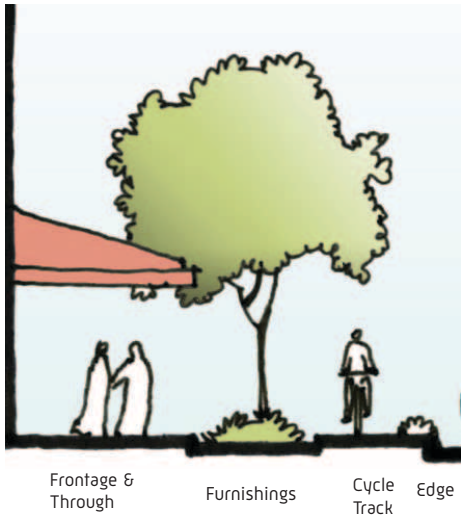
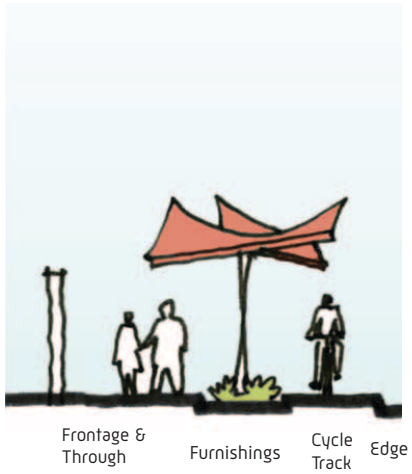


Figure 7.12 Changes in Land Use

Figure 7.13 Location of Transit Avenue



Town Transit Avenue



RESIDENTIAL TRANSIT AVENUE

Figure 7.14 Pedestrian Realm

7.4.4 Transfer into a Plan

Cross section dimensions were applied to the entire length of the corridor. The initial concept plan shows planned land uses and natural features in the surrounding context. All of the street elements (including the zones in the pedestrian realm, transit median, cycle track, parking, and travel lanes) were included in the initial concept plan. Figure 7.17 shows a small portion of the Transit Avenue where it intersects a Street. Both street types provide on-street parking.

7.4.5 Locate Street Elements

Other design elements were identified along the Avenue corridor, including tram stops, bus stops, taxi lay-bys, and utilities. Tram stops are located mid-block on central platforms, approximately spaced at 600 m. Platforms are 80 m long and 7 m wide. Mid-block crossings give pedestrians easy access to the tram stops. Bus stops are also located mid-block for easy transfer, better sight distance, and reduced conflicts with traffic at junctions.

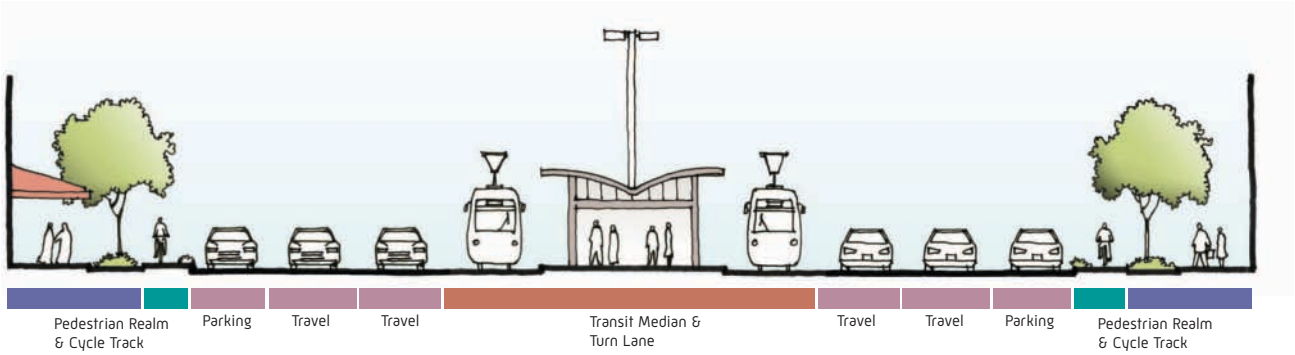


Figure 7.15 Town Transit Avenue

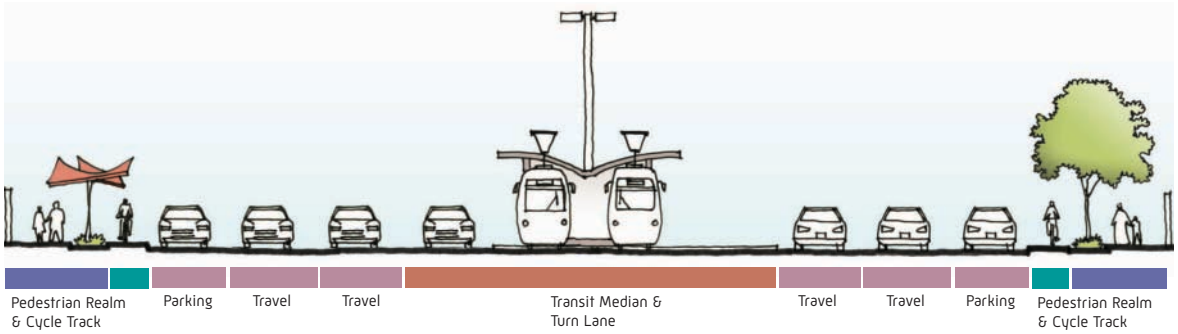


Figure 7.16 Residential Transit Avenue

Note changes in the pedestrian realm, transit alignment and the left turn lanes.

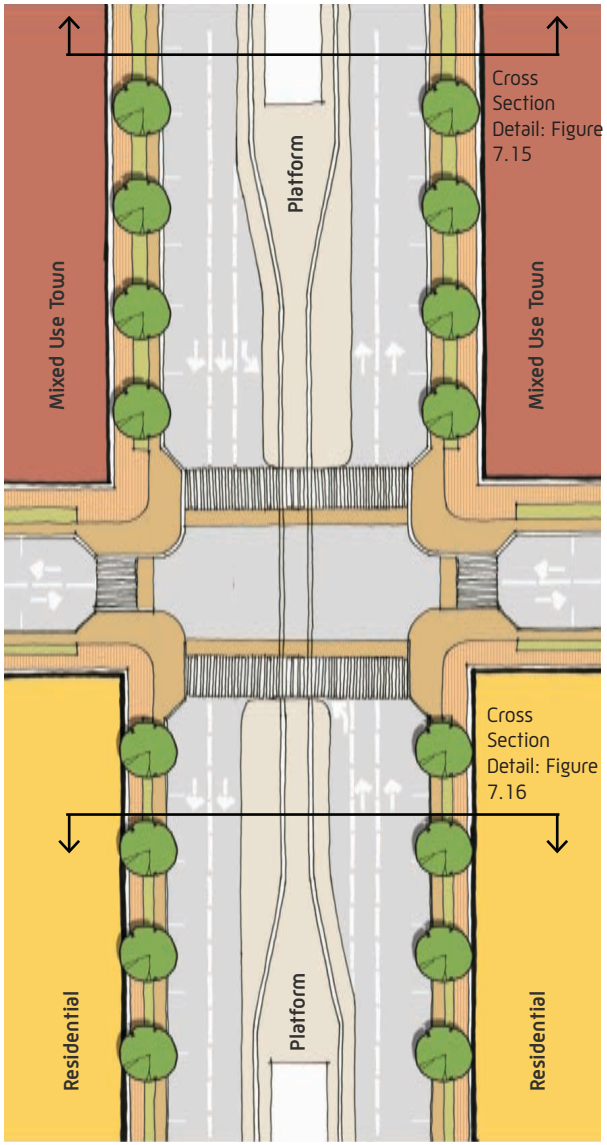


Figure 7.17 Street Layout Plan

7.4.6 Note Interaction Areas on Plan

The Avenue accommodates various modes, including pedestrians, trams, buses, bicycles, and vehicles. These modes have exclusive zones along most of the corridor, but they interact at various locations and this led to potential conflict areas Figure 7.18 shows a mid-block interaction area with tram stop, bus stops, and pedestrian crossing. Areas of potential conflicts include:

- Mid-block crossing (pedestrians, transit, and vehicle)
- Bus stop (pedestrian and bicycle)

7.4.7 Rationalize Solutions

Mid-block crossings were signalized to minimize conflicts with the traffic. Pedestrian pathways were angled in the median to orient pedestrians to oncoming traffic. Curb extensions were provided to separate the waiting area from on-street parking. Cycle tracks were routed behind bus stops (Figure 7.18).

7.4.8 Begin Urban Design and Landscape Planning

Urban design and landscape planning aimed to reinforce North Wathba's unique identity. The selection of materials and facilities also responded to the water budget, adjacent land uses, and cultural preferences.

For example, landscape features and shade elements were placed where highest concentrations of pedestrians occur, such as at junctions, transit stops, and along pedestrian through zones near major destinations (Figure 7.18).

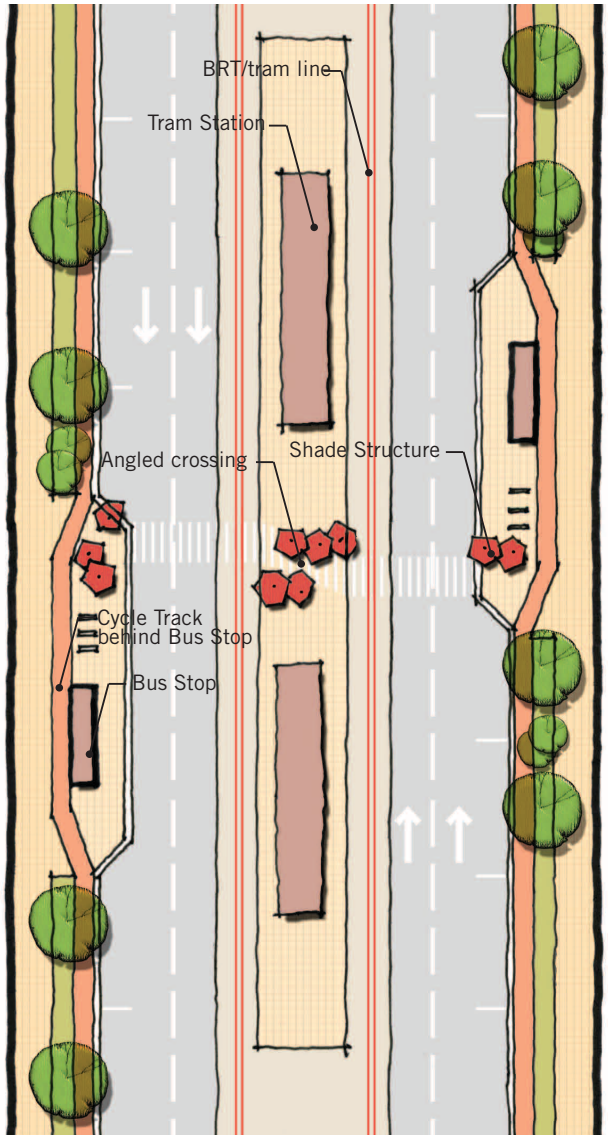


Figure 7.18 Mid-block Interaction Area

7.5 Phase III: Evaluate & Review Design

Results from a Transport Study will determine the traffic capacity in the traveled ways. A Street Design Audit and Traffic Safety Audit will be conducted to determine whether the street design meets the project's larger goals and achieves highest quality spaces.

7.5.1 Apply Performance Measures

The following tests and performance measures were conducted to determine initial traffic capacity, network connectivity, and accessibility.

Pedestrian Catchment

Street capacity was adjusted based on preliminary capacity analysis and pedestrian catchment requirements. The neighborhood and regional centers are located in such a way that more than 67 percent of the community is within a 300 m walking distance and practically all of the community is within 600 m walking distance. This ensures that most residents and employees will be within a comfortable walking distance of local schools, neighborhood retail, and mosques. For example, connectivity to the Metro/tram station in the middle of the Town Center is ensured by overlaying 300 m and 600 m pedestrian walking distances (see Figure 7.19).

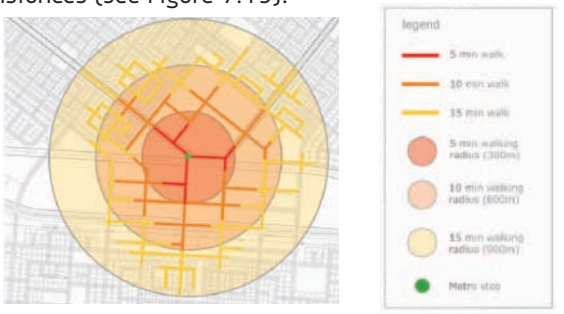


Figure 7.19 Pedestrian Catchment

Direct Route Index

A Direct Route Index was used to measure the ease of access from one point to another within the development. Additional information about Direct Route Index is provided in Appendix B. Figure 7.20 illustrates the Direct Route Index in North Wathba. In this case, a random plot (A) was selected as the origin of three different routes: the first leads to an exit point (B); the second route to the transit and commercial hub (C); and the third link to another random plot (D). Solid lines on the map represent the actual route, whereas dashed lines show direct routes.

Table 7.2 shows the calculated results of the index for these routes. The general consensus is that an actual path that is less than or equal to 1.5 times its direct path is acceptable. The results for North Wathba are all below 1.5 (ranging from 1.28 to 1.47) and imply good accessibility, on average, within the development.

Figure 7.20 Direct Route Index

Origin	Destination	Direct Path Distance (m)	Actual Path Distance (m)	Direct Route Index
Plot A	Exit Point (B)	2615	3765	1.44
Plot A	Transit Hub (C)	2195	3230	1.47
Plot A	Plot D	2655	3400	1.28

Table 7.2 Direct Route Index

Connectivity Index

A Connectivity Index was used to quantify how well the roadway network connects destinations. Indices can be measured separately for motorized and non-motorized travel. For the North Wathba preliminary connectivity index calculations, only motorized paths were used, such as streets and alleys. Sikkas were considered pedestrian only and were not used in the calculations.

The Connectivity Index is the number of roadway links divided by the number of roadway nodes (Ewing, 1996). Links are the segments between intersections, nodes are the intersections themselves. Dead ends count the same as any other link end point. Dead ends reduce the index value (see Figure 7.21). A higher index means that travelers have increased route choices. The more intersections, the greater the degree of connectivity. Connectivity index values averaging above 1.5 are a good indicator that a community will be walkable and community facilities will be easily accessible to its residents.

The typical residential neighborhood block in North Wathba (Figure 7.22):

- Measures 600 m by 600 m
- Has approximately 166 villa plots (30 m by 35 m)
- Average connectivity index values above 1.5

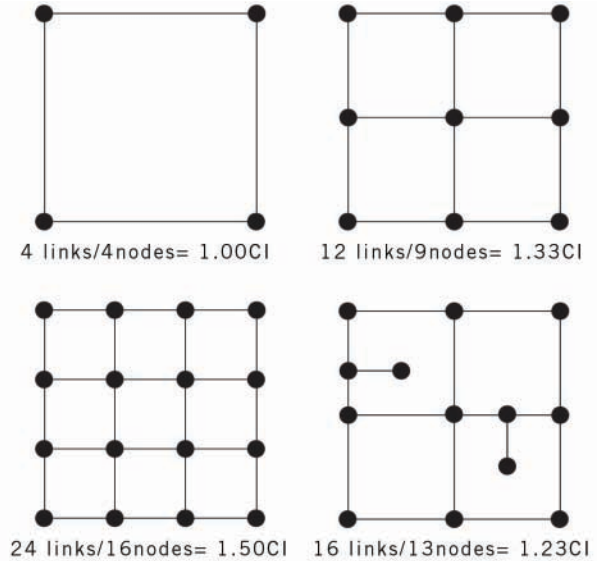


Figure 7.21 Connectivity Index (CI)

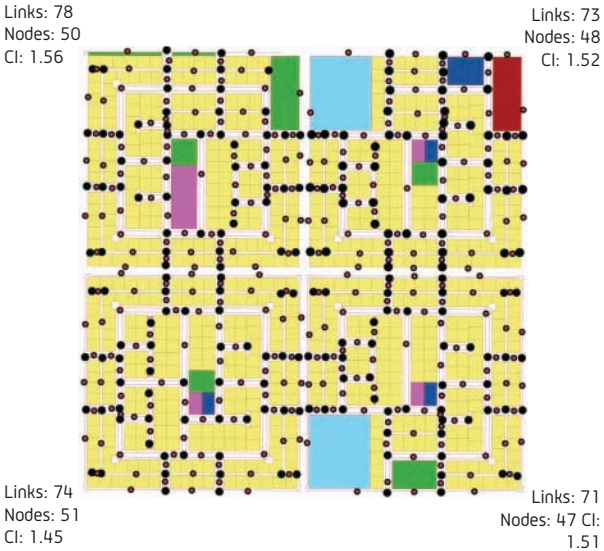


Figure 7.22 Vehicle Connectivity Index

7.6 Finalize Design

After initial reviews with approvals agencies, the concept plans and street cross sections were prepared for a detailed planning review (Figure 7.23 and 7.24). The level of detail ensures that the street design is sensitive to adjacent land uses and complies with Universal Design requirements. Detailed urban design and landscape drawings will be prepared to identify materials, shade structures, plants, water usage, and other details such as signage, lighting structures, and utility works.

The final proposed street layout creates a network of interconnected streets and access lanes (Figure 7.25). Mosques and open spaces are located in the middle of each block, while commercial facilities, schools, and civic centers are placed close to junctions. A high degree of connectivity in the street network also creates multiple opportunities for interruptions in the network in the form of tee intersections, squares, parks, and the like to slow traffic generally and to discourage through traffic particularly.

Attention to Design Detail

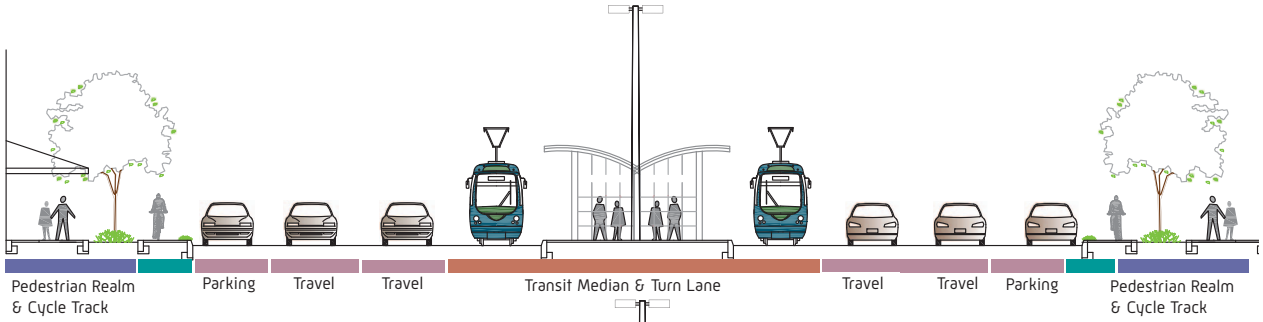


Figure 7.23 Town Transit Avenue

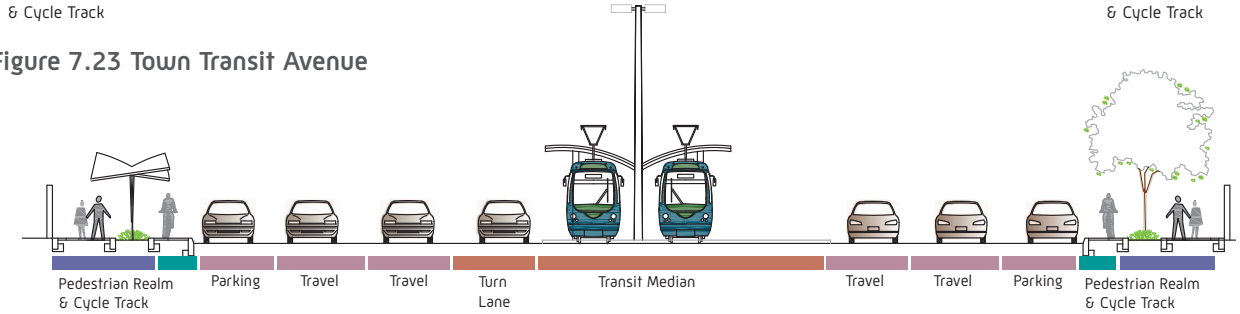


Figure 7.24 Residential Transit Avenue

Figure 7.25 North Wathba Master Plan Showing Land Use and Street Types

7.7 Design Flexibility

The Boulevard running through North Wathba accommodates a major utility corridor. Most of the utilities, except for storm drains, cannot be located below asphalt travel lanes. This makes the pedestrian realm, and hence the total right-of-way, too wide compared to the preferred street design standards. This was addressed through a flexible design process, using the priorities for expanding the street to fit the predetermined right-of-way. Safety and comfort of all street users was the main consideration while applying these priorities.

As the Boulevard passes through residential and mixed use town neighborhoods, the additional right-of-way is treated differently to respond to the land use. The following steps were completed, in order, until the street filled the available right-of-way:

- Along the Town Boulevard, frontage lanes were added to allow better access to active land uses (Figure 7.26).
- Width of the furnishings zone was increased to provide attractive streetscaping.
- Width of the through zone was increased to make sure that shading requirements are met for pedestrian comfort.
- Width of the edge zone was increased to provide a buffer between pedestrian realm and traveled way.
- Width of the frontage zone was increased.
- Width of cycle tracks was increased.

Some of the utilities (including electric, telecom, and gas) are acceptable below frontage lanes constructed with interlocking pavers. This enabled the provision of frontage lanes in the mixed use town area. The Residential Boulevard has no active frontage, hence the pedestrian realm stayed close to the traveled way. Pathways were provided where pedestrian access was needed for individual plots.

Figures 7.27 and 7.28 show typical cross sections for the Residential Boulevard and the Town Boulevard with frontage lane. Note that the width of pedestrian realm remains the same due to fixed right-of-way dimensions, despite changes in land use.

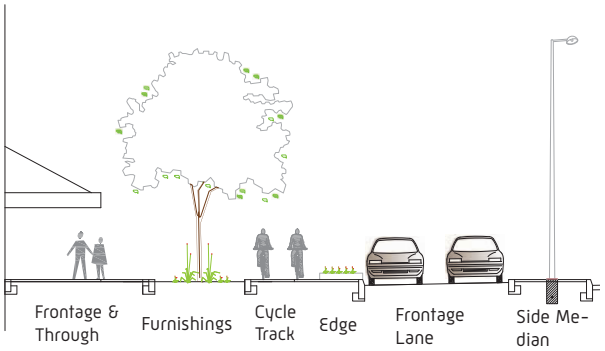


Figure 7.26 Frontage Lane

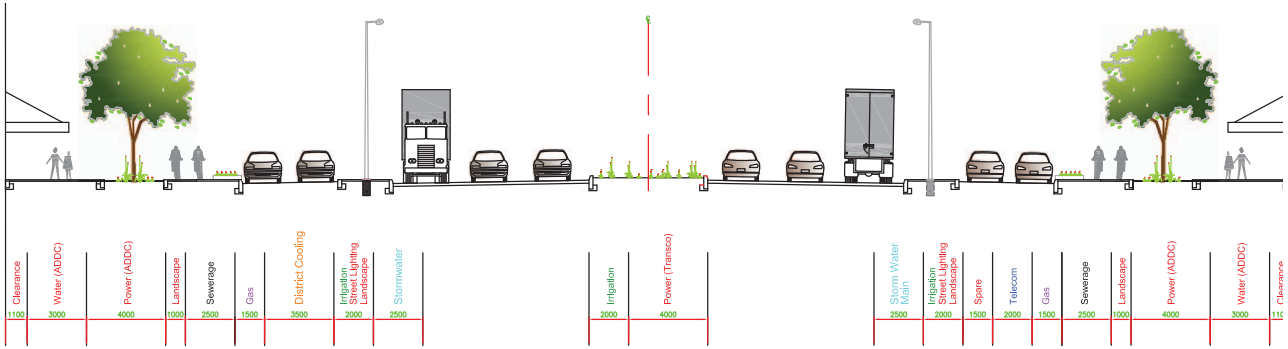


Figure 7.27 Town Boulevard with Frontage Lane

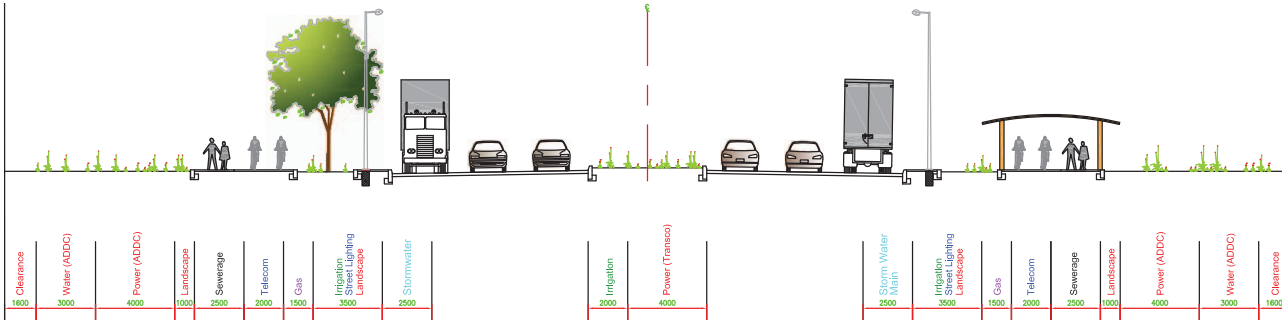


Figure 7.28 Residential Boulevard

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Chapter 8 – Maintenance & Management

8.1 Introduction

Streets can only function if they are maintained properly. In order to ensure that the street network is able to function as intended, it is important that a suitable maintenance schedule and program is developed and adhered to through a robust Geographic Positioning System (GPS) based asset management program.

Regular condition surveys and maintenance can prevent minor issues from escalating into major ones.

8.2 Sand Buildup

Streets built in a desert environment will be subject to sand deposits and accumulation and therefore require a regular clearing regime.

Clean up sand deposits to avoid buildup.

The most common locations for this sand accumulation is at vertical deviations in the street surface (such as up-stand curbs at the edge of the traveled way and at roundabout islands) and at storm drains.

It is possible to maintain a laminar air flow, thus greatly reducing the amount of sand deposited, by designing gentle approach slopes (1:10) and removing vertical obstacles, such as curbs, on a street cross section. This approach is acceptable in rural environments, some low density residential areas, and in Mushtaraks (shared streets) where there is no vertical deviation in street surface. In these areas, remedial schemes have proved to be quite successful. However, it is not appropriate to remove curb up-stands on urban streets where they serve a specific separation function.

In urban areas, a regular street sweeping maintenance schedule is required to ensure the streets stay clear of sand deposits.

8.3 Traffic Signs

Traffic signs need to be maintained to ensure that they are clear and legible, kept at the correct height and angle to the street, and updated or replaced so that the information they provide remains valid.

It is strongly recommended that a local street sign plan be developed and maintained by the local municipality, detailing the content of each sign so that updates and maintenance can be managed.

Traffic signs need to be maintained at the correct height and angle to the street.

Street signs should be visible, legible, and relevant with updated information.

8.4 Surface Water Drainage

A positive surface water drainage system requires a regular maintenance and clearing program. It is important that sand accumulation (see 8.2) is regularly cleared from gutters before the anticipated wet season.

In order to reduce the level of blockage within the surface water drainage system, it is acceptable for local offices of the DMA to block the openings of surface water gutters to restrict sand intrusion, provided there is a suitable mechanism in place to remove the blockage before the wet season.

Maintain the quality of surface water drainage.

8.5 Utility Provider Responsibilities

When work is undertaken for existing or new utilities, it is the responsibility of the utility provider to reinstate any and all disturbed elements within the street to their original quality.

Utility providers must adhere to the vertical element placement advice in this Manual. Government agencies supervising their work shall ensure that the placement of at- or above-grade utility assets does not detract from the public realm, impair pedestrian and vehicular sight lines, and or obstruct pathways.

Maintain at- and above-grade utility facilities.

8.6 Trees & Plantings

Landscaping should be designed to last at least 20 years or longer, avoiding the need for frequent replacement. Trees and planting areas require regular trimming and maintenance to ensure that they are kept clear of debris and rubbish and that foliage does not obstruct sight lines or lighting. Dead and dying trees and plants can be a safety issue if limbs and branches fall into the traveled way or obstruct pedestrian areas. A regular maintenance program needs to be established with suitably qualified staff inspecting and maintaining the health and suitability of planted areas.

8.7 Street Furniture

When street furniture is provided as part of the street design and construction, it is important to ensure that these furnishings are maintained to a suitable standard to meet the purposes for which they were installed.

8.8 Surface Treatment

All travel surfaces must be maintained to ensure that an even and undisrupted horizontal surface is maintained and in safe operating condition for all users at all times. This applies to paved surfaces in the pedestrian realm, cycle tracks, transit areas, and the traveled way.

Maintain and trim foliage to keep signage visible.

Maintain street furniture to provide pleasing and comfortable seating in the public realm.

Maintain surface treatment to avoid hazardous conditions, and ensure the upkeep of markings.

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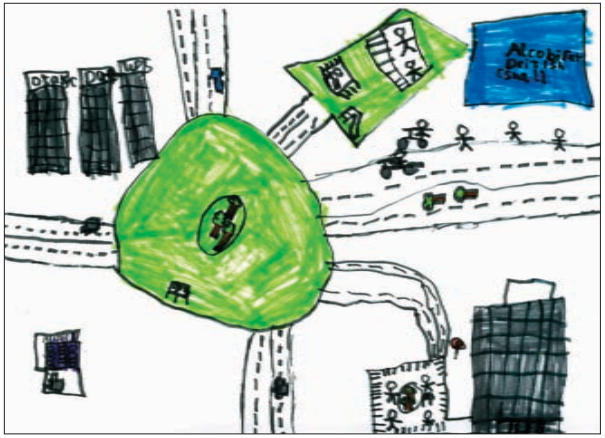
Chapter 9 - Evaluation & Updates

9.1 Introduction

This Manual was developed in 2009 with extensive input and review by a Technical Advisory Committee (TAC) that included the Urban Planning Council (UPC), Abu Dhabi Department of Transportation (DOT), Abu Dhabi Department of Municipal Affairs (DMA), Abu Dhabi General Directorate of Civil Defense, Abu Dhabi Municipality (ADM), Al Ain Municipality (AAM), and Western Region Municipality (WRM).

It was adopted as the reference document for the design of all urban streets throughout the Abu Dhabi Emirate by the Executive Council in November 2009.

It is expected that this Manual will be updated regularly, and that it will be supplemented with more detailed guidance on specific topics. Designers should check frequently with the UPC and DOT for the most current versions of relevant guidance documents.



Contact the UPC for updates

9.2 Review Committee

This manual is intended to be a "living document" and it is expected to evolve and adapt to the changing economic and social environment in the Emirate of Abu Dhabi.

In order to maintain the effectiveness of this manual, it is recommended that a permanent review committee be established, with members of the TAC group to represent each of the concerned parties.

This Review Committee is to meet every 6 months to discuss issues arising from, or related to, the manual and to agree on measures to address any and all issues.

Special Review Committee meetings can also be called should a particular issue arise requiring immediate consideration.

The recommendations from the Review Committee are to be implemented with either:

i) A special update release, replacing sections or adding additional content, which can be issued immediately,

or:

ii) Included in the next scheduled update of the manual.

9.3 Updating the Manual

It is currently expected that updated versions of the entire manual will be issued on a regular basis. These updates are to include all revisions and updates applicable at the time of the new manual release, and the new release will entirely supersede the previous version. The updated manual versions will be available through the UPC:

Urban Planning Council (UPC)
Abu Dhabi, United Arab Emirates
P.O.Box 62221
Telephone: +971 (0) 2 409 6000
Fax: +971 (0) 2 443 2903
E-mail: info@upc.gov.ae
www.upc.gov.ae

9.4 Suggestions & Requests

To submit suggestions and requests on updates, corrections, or inclusions for the Manual, written correspondence should be addressed to:

ADSDM Review Committee
Urban Planning Council (UPC)
Abu Dhabi, United Arab Emirates
P.O.Box 62221

or emailed, with ADSDM as the subject, to:

info@upc.gov.ae

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Chapter 10 - Definitions

Access Management
The management of the interference with through traffic caused by traffic entering, leaving, and crossing streets.

Accessibility
The ability for all people, including people with impaired mobility and all ages, to physically reach desired destinations, services and/or activities. See also Universal Design.

Accessible Pedestrian Signal (APS)
A device that communicates information about pedestrian signal timing in a non-visual format, including audible tones, verbal messages, and/or vibrotactile information.

Angled Parking
Parking that is provided at an angle between 90 degrees (perpendicular) and 0 degrees (parallel) to the path of travel.

Approach
The section of the accessible route that flanks the landing of a curb ramp.

Arcade
A passage with an arched roof.

Arterial
A street that typically emphasizes a high level of traffic mobility and a low level of access to land.

Articulation
An architectural term that refers to dividing building facades.

Audible Warning
A devise used to aid people with visual impairments. See Accessible Pedestrian Signal (APS).

Barrier Curb
See Vertical Curb.

Bicycle
A non-motorized, human powered wheeled vehicle. Can include 2-wheel bicycles, tandem bicycles, 3-wheel tricycles, bikes with trailers, etc.

Bicycle Facility
Any portion of the traveled way or pedestrian realm specifically intended for the use of bicyclists.

Bicycle Lane
An exclusive lane for bicycle travel located at the outer edges of the traveled way. Bicycle lanes are one way, traveling with the flow of motor vehicle traffic.

Bicycle Way
Any facility provided primarily for bicycles and other non-motorized vehicles. Includes bicycle lanes, cycle tracks, and other facilities.

Bicyclist
A person using a non-motorized, human-powered wheeled vehicle for travel (with the exception of wheelchairs).

Block
The smallest area that is surrounded by streets.

Block Face
Any side of a block, as seen from the street.

Bulb-Out
See Curb Extension.

Clear Width
The portion of a surface that is free of obstruction. See also Effective Width.

Collector
A street that typically balances traffic mobility and access to land.

Commercial Uses
Areas throughout the city intended to provide a variety of working, shopping, and service options and convenience.

Community
A group of people living within a defined geographic area or political boundary such as a neighborhood, district, town, city, or region.

Community Livability
Refers to the environmental and social quality of an area as perceived by residents, employees, customers, and visitors.

Connectivity
A measure of how well streets are linked with each other.

Context
The nature of the natural or built environment created by the land, topography, natural features, buildings and associated features, land use types, and activities on property adjacent to streets and on sidewalks, and a broader area created by the surrounding neighborhood, district, or community. Context also refers to the diversity of users of the environment.

Context Directed Design
A street design process that begins with the intended land uses and the built and natural environments the streets will serve rather than the prioritization of through movement for automobiles.

Context Sensitive Solutions (CSS)
Collaborative, interdisciplinary process that involves all stakeholders to design a transportation facility that fits its applicable setting and preserves scenic, aesthetic, historic and environmental resources while maintaining safety and mobility.

Context Zone
One of a set of categories used to describe the overall character of the built and natural environment.

Control Vehicle
A vehicle that infrequently uses a facility and must be accommodated, but for which encroachment into the opposing traffic lanes, multiple-point turns, or minor encroachment into the roadside is acceptable.

Corner Radius
The actual radius of a curb at the corner. See also Turning Radius and Effective Turning Radius.

Corridor
A transportation pathway that provides for the movement of people and goods between and within activity centers.

Corridor Plan
Document that defines a comprehensive package of recommendations for managing and improving the transportation system within and along a specific corridor.

Cross Section
A view of the interior of an object as it is sliced along a plane.

Cross Slope
The slope measured perpendicular to the direction of travel.

Crossing / Crosswalk
The lateral extension of a walkway across the traveled way (from curb to curb). May or may not be designated by signs and markings.

Curb
A vertical separation between the motor vehicle traveled way and the pedestrian realm.

Curb Extension
An extension of the pedestrian realm into the traveled way, typically at crosswalks and junctions adjacent to on-street parking.

Curb / Pedestrian Ramp
A ramp between two levels, typically located between the traveled way and the pedestrian realm at the curb.

Cycle Track
A cycle way physically separated from motor vehicle lanes.

Design Control
Physical factors and operational characteristics and properties that control or significantly influence the selection of certain geometric design criteria and dimensions.

Design Principle
A fundamental rule that becomes a basis for a design action.

Design Vehicle
Vehicle that must be regularly accommodated without encroachment into the opposing traffic lanes.

Detectable Warning Strip
Standardized surface feature built in, or applied to, the base of curb ramps or in other locations to identify and warn sight impaired pedestrians of specific conditions.

Deviation
Any digression from standards and guidelines.

Diagonal Curb Ramp
Curb ramp positioned at the apex of the curb radius at an intersection, bisecting the corner angle.

Diagonal Parking
See Angled Parking.

Drainage Inlet
Site where water runoff from the street or sidewalk enters the storm drain system.

Driveway
The connection provided for vehicles between a street and a site.

Driveway Crossing
Extension of the through zone and any cycle track in the pedestrian realm across a driveway.

Dual Carriageway
A traveled way where opposing directions of automobile traffic are separated by a raised median.

Edge Zone
The area between the face of curb and furnishings zone in the pedestrian realm.

Effective Width
The portion of the clear width that excludes any shy distances.

Effective Turning Radius
The actual, inside, turning radius of a vehicle around a corner.

Environment
The natural and built places within or surrounding a community.

Estidama
The established designation for sustainability of projects within Abu Dhabi and the region.

Façade
The exterior wall of a building exposed to public view, or that wall viewed by persons not within the building.

Feasible / Feasibility
Capable of being accomplished with a reasonable amount of effort, cost, or other hardship.

Flare
Sloped surface that flanks a curb ramp and provides a graded transition between the ramp and the pedestrian through zone.

Flush Curb
A type of curb separating the traveled way and pedestrian realm where both are at the same level.

Frontage Zone
The distance between the through zone and the building front or private property line in the pedestrian realm that is used to buffer pedestrians from window shoppers, appurtenances, and doorways.

Functional Classification
A conventional system in which streets, roadways, and highways are grouped into classes according to the balance they strike between automobile mobility and land use access.

Furnishings Zone
The area of the pedestrian realm that provides a buffer between pedestrians and the edge zone, cycle track, parking lane, and/or vehicle travel lanes.

Gap
(1) An opening embedded in the travel surface.
(2) A break in the flow of vehicular traffic.

Goal
An ideal future outcome, condition, or state related to the public health, safety, or general welfare toward which planning, design, and implementation measures are directed.

Grade
The slope parallel to the direction of travel that is calculated by dividing the vertical change in elevation by the horizontal distance or length of the traveled way, measured as a percentage.

Grade Separation / Grade-Separated Crossing
A facility that allows movement over or under a barrier, such as a freeway, or waterway.

Grate
A framework of lattice, grid, or bars that prevents large objects from falling through a drainage inlet but permits water and some elements to fall through the slots.

Ground Floor
The street level floor of the building adjacent to the pedestrian realm (ground floor level).

Guideline
Guidelines are not mandatory but are considered the preferred practice in typical situations.

Guidestrip
Some type of raised material with grooves that pedestrians with vision impairments use for cane directional cues.

Gutter
Space along the curb line designed to carry drainage water that runs off the roadway. The gutter line is also the lip along the edge of a curb ramp.

Hearing Impairment
Condition of partial or total deafness.

Highway
A limited access roadway designed largely for use by automobiles. The design requirements for highways are different from those of urban streets and are not covered by this Manual.

Human Scale
How humans perceive the size of their surroundings and their comfort with the elements of the natural and built environment relative to their own size.

Implementation
An action, procedure, program, or technique that ensures that policies are followed and goals and objectives are achieved.

Industrial Uses
Areas for businesses that have potential to create adverse visual, noise, or other impacts to adjoining public and residential properties. This use allows for general industrial uses, heavy and light industry uses, warehousing, and distribution with support commercial services and ancillary office space.

Intermodal
Refers to the connections between transportation modes. Intermodal transportation involves the combination modes for travel mobility, efficiency, sustainability, economy, and environmental health.

Intersection
See Junction.

Junction
Where two or more public streets meet. They are characterized by a high level of activity and shared use, multi-modal conflicts, complex movements, and special design treatments.

Kinesthetic
A sensory experience derived from the movement of the body or limbs.

Landing
Level area of sidewalk at the top or bottom of a ramp.

Landscape
The planting, configuration, and maintenance of trees, ground cover, shrubbery and other plant material, decorative natural and structural features, earth patterning and bedding materials, and other similar site improvements that serve an aesthetic or functional purpose.

Lane Drop
A transition where one travel lane is eliminated from the traveled way.

Lay-By
A portion of the traveled way recessed into the pedestrian realm for taxis and loading so that travel lanes are not blocked.

Light Fixture
The assembly that holds a lamp.

Local Street
Streets with lower levels of traffic mobility and higher levels of land access, serving residential, commercial, and industrial areas.

Lux
The SI (international system of units) unit of illuminance and luminous emittance on a surface equal to 1 lumen per square meter.

Median / Median Island
The center area of the street, or a non-vehicular space, such as a planted median, transit median, or a paved surface (raised or at grade). A median island is the center of a street that physically separates the directional flow of traffic and can provide pedestrians with a place of refuge and reduce the crossing distance between safety points. It may also accommodate transit facilities. See also Refuge Island.

Mid-Block / Mid-Block Crossing
A crossing point positioned between junctions rather than at a junction.

Minimum Clearance Width
The narrowest width that is maintained free of obstacles.

Mixed Use
Areas that include more than one major class of uses.

Mobility
The ability of people or goods to move within the transportation system.

Mountable Curb
A curb that is easily driven over by large vehicles, especially fire trucks; also known as a Sloping Curb.

Mulch
A natural or synthetic groundcovering used to control weeds and protect soils from moisture loss, erosion and temperature fluctuations.

Multimodal
Refers to the availability of transportation options within a system or corridor.

Mushtarak
Arabic word for shared street; abbreviation of "Sharah Mushtarak." See Shared Street.

Network
A system of interconnecting streets.

New Construction
Project where an entirely new facility or street will be constructed.

Objective
A specific outcome, condition, or state that is an intermediate step toward attaining a general goal.

Obstacle
An object that limits the horizontal or vertical passage space by protruding into the circulation route and reducing the clearance width of a travel way.

On-Street Parking
Parking areas and parking spaces that are located on the street and/or in areas adjacent to the street within a right of way.

Option
A non-mandatory choice available to the designer.

Parallel Curb Ramp
Curb ramp design where the pedestrian realm slopes down on either side of a landing.

Parallel Parking
Parking that is parallel to the curb and path of travel.

Parking Bay
Parking that is provided in combination with curb extensions; also known as Parking Lay-By.

Parkway
A broad, landscaped street with a high transport capacity, configured with 4 (or more) travel lanes in each direction – variation of a Boulevard.

Passing Space
Section of a path or sidewalk wide enough to allow two wheelchair users to pass one another or travel abreast.

Path / Pathway
A track or route along which pedestrians and/or cyclists are intended to travel.

Pedestrian
A person afoot or in a wheelchair.

Pedestrian Realm
The public area between the curb and the boundary of the right-of-way that is generally accessible to pedestrians.

Perpendicular Curb Ramp
Curb ramp design where the ramp path is perpendicular to the edge of the curb.

Placemaking
A holistic and community-based approach to the development and revitalization of cities and neighborhoods.

Policy
An adopted course of action, procedure, or strategy that guides decision making and commitment of government.

Private Realm
Privately owned lands that abut the public right-of-way.

Public and Stakeholder Participation and Involvement
A collaborative process that encourages stakeholders to participate in the formation, evaluation, and conclusion of a plan or transportation improvement project.

Public Realm
Publicly used land or right-of-way.

Ramp
Transition between two elevation levels.

Refuge Island
An area within the traveled way where pedestrians may wait protected from motor vehicles.

Residential Uses
Areas that provide a variety of housing opportunities, allowing for densities varying from villa to multi-dwelling residential buildings.

Right-of-Way
Publicly operated corridor for transportation of all modes and utilities.

RURAL
A place characterized by undeveloped lands, agriculture, and very low population density.

Rural Road
A street serving undeveloped, agricultural, and very low density areas where few if any pedestrians would be expected.

Shared Street
A common space shared by multiple modes, including pedestrians, bicyclists, and low-speed motor vehicles.

Shoulder
A paved area of a highway to the side of the motor vehicle travel lanes, used for emergency breakdowns, accommodation of driver error, and other functions. Not used on urban streets.

Shy Distance
Area along the pedestrian realm closest to buildings, retaining walls, curbs, fences, and other obstacles generally avoided by pedestrians.

Sidewalk
See Pedestrian Realm.

Sight Distance
Distance that a driver can see ahead in order to observe and successfully react to pedestrians, bicyclists, other vehicles, decision point, maneuver, obstruction, or hazard. This may also be the length of distance visible to a pedestrian – the distance a person can see along an unobstructed line of sight.

Stakeholders
Groups or individuals that have an interest (stake) in the outcome of the planning or project development process.

Standard
A standard is a requirement or mandate.

Storey
A space in a building between the surface of any floor and the surface of the floor next above, or if there be no floor above, then the space between such floor and the ceiling or roof above.

Street
A public or private right-of-way, other than a major or secondary highway or alley, whose function is to carry vehicular traffic or provide vehicular access to abutting property.

Street Realm
The area between curbs that encompasses the motor vehicle travel lanes and may also include parking lanes and transit lanes.

Street Type
A system of categorizing similar streets by contextual land use for the purpose of description, design, and management.

Super Block
A type of city block that is much larger than a traditional city block.

Tactile Warning
Change in surface condition providing a tactile cue to alert pedestrians with vision impairments of a potentially hazardous situation.

Taxi
A motor vehicle and driver privately hired to carry one or more passengers for a single trip.

Thoroughfare
Any roadway intended for regional or inter-district travel.

Through Zone
The main area within the pedestrian realm where pedestrians travel.

Tram
A type of lightweight, street-running passenger train.

Transit
Any type of transport shared by the public in large numbers, including bus, light rail, tram, or Metro.

Transit Median
A portion of median reserved for the exclusive use of public transit vehicles. See Median.

Transitions
(1) A change in street type, context, right-of-way width, number of lanes, or neighborhood or district. (2) The provision of a smooth taper where lanes change width, lanes diverge or merge, or lanes have been added or dropped.

Traveled Way
The public right-of-way between curbs, including parking lanes and travel lanes for private vehicles, goods movement, transit vehicles, and bicycle lanes. Medians, turn lanes, exclusive transit lanes, curb and gutter, and loading/unloading zones are included in the traveled way.

Truncated Dome
Small domes with flattened tops used as tactile warning at transit platforms, along the base of curb ramps, and at other locations where a tactile warning is needed for sight impaired pedestrians.

Turning Pocket
A short travel lane used exclusively by motorists queuing to turn.

Turning Radius
The path that a vehicle takes during a turn. See also Corner Radius and Effective Turning Radius.

Universal Design
Design techniques that accommodate all people, including pedestrians requiring special mobility consideration, pedestrians pushing strollers and delivery carts, and pedestrians that use personal mobility devices.

Upstand Curb
See Vertical Curb.

Urban
A comparative term, distinct from "suburban" or "rural," characterized by density, development intensity, and activity, and typically with a population of 200 or more persons per square kilometer.

Urban Braille
A comprehensive system of tactile information used by the visually impaired to navigate urban areas.

Values
Attributes and characteristics regarded by a community as having ultimate importance.

Vertical Clearance
Minimum unobstructed vertical passage along the pedestrian realm and traveled way. Often limited by bridges, tree branches, signs, awnings, and other overhead elements.

Vertical Curb
A steep-faced curb designed with the intention of discouraging vehicles from leaving the traveled way.

Vision
(1) The faculty or state of being able to see.
(2) Part of the process of planning a community that involves planning for the future, thinking creatively, and establishing what they want their community to be for a specific planning horizon.

Vision Impairment
Loss or partial loss of vision.

Walk / Walking
The act of pedestrian travel.

Walkable
Streets and places designed or constructed to provide safe and comfortable facilities for pedestrians, and are safe and easy to cross for people of all ages and abilities.

Woonerf
See Shared Street.

Yield Lane
A single travel lane used for two directions of travel.

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Street design is directed by land use context.

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Appendix A
Performance Measures

A.1 Performance Measures by Mode

In Abu Dhabi, all modes of transportation contribute toward the success of the transportation system. Level of Service (LOS) measures are used for each mode to describe their contribution toward the efficiency of the transportation network.

Quality of Service (QOS) measures are used to describe the effectiveness of each mode from the users' perspective. Depending upon the design issue, various measures are selected from Table A.1 on the next page in order to judge the effectiveness of the design.

For the purposes of street design, the following LOS measurements are recommended to be used in conjunction with additional guidance from the DOT.

Quality of streets should be provided for all users

Table A.1: Common Performance Measures

Mode	Performance Measures
Pedestrian	Sidewalk crowding (at rail stations or other major destinations) Average crossing delay including average distance to crossing Frequency of protected crossings Percentage active building edge along sidewalk. Percent sidewalk shaded Average block perimeter
Transit Users	Intersection delay Corridor travel time as percentage of speed limit. Passenger crowding Reliability Frequency Service hours Cool waiting areas at stops
Bicyclists	Presence of bicycle lane or cycletrack Bicycle Level of Service, as defined in Chapter 5
Motor Vehicles	Roadway segment and intersection performance using urban corridor analysis techniques from the Highway Capacity Manual 2000 for Urban conditions Corridor travel time. Standard deviation of average speed

Pedestrians

True Pedestrian LOS is subject to a long list of variables, each of which has complex interactions with the others. One measure included in the US Highway Capacity is pedestrian crowding, which is useful at specific locations like rail terminals and stadiums, but is not generally used in the Emirate, since a modest amount of pedestrian crowding is helpful for personal security and urban vitality.

Instead, the Emirate uses an aggregation of five factors of importance to pedestrians in this location, detailed below.

Distance to crossings measures the average distance between designated pedestrian crossings, including signalized junctions and mid-block crossings.

Crossing delay focuses on how long a pedestrian must wait at a signalized junction to get a green phase. (At unsignalized crossings, omit this measure). It is calculated as follows:

$$d_p = \frac{0.5(C-g)^2}{C}$$

where

d_p = average pedestrian delay (s),
g = effective green time (for pedestrians) (s), and
C = cycle length (s).

The comfort LOS measure in the Emirate of Abu Dhabi focuses on shade, as required in the development regulations. Shade at pedestrian waiting areas is weighted more heavily than pedestrian through zones.

It is calculated as follows:

[2 x (percent shade covering the 10 square meters where pedestrians wait at crossings)] + (average percentage shade along the Through Zone).

Crossing exposure considers number of travel lanes to cross and the presence of a pedestrian refuge median.

Finally, conflict-free crossing time considers the total percentage of crossing time when motor vehicles are not allowed across the crosswalk, including leading pedestrian interval, all-pedestrian phase, and no turning traffic.

To calculate the aggregate Pedestrian LOS, measure each of the five components, assign the numerical score that matches the LOS rating, and take the average. For example, a street that scored B on distance, C on delay, A on shade, C on lanes and B on crossing time would get an aggregate LOS of (4+3+5+3+4 divided by 5 = 3.8) B.

Table A.2 Aggregate Pedestrian Level of Service for Street Design

LOS	Score	Average Distance to Adjacent Designated Crossings (meters)	Crossing Delay (seconds)	Comfort Index	Number of Lanes to Cross & Presence of Pedestrian Refuge Median	Conflict-Free Crossing Time
A	5	30 or less	≤ 5	> 5	1 lane (one way)	100%
B	4	31 – 60	6 – 15	4 – 5	1+1 lanes	60 – 90%
C	3	61 – 90	16 – 25	3 – 4	2+2 lanes with refuge	30 – 59%
D	2	91 – 120	26 – 35	2 – 3	3 lanes (one way)	10 – 29%
E	1	121 – 150	36 – 45	1 – 2	3+3 lanes with refuge	1 – 9%
F	0	> 150	> 45	< 1	Any crossing more than 10 m without a refuge or any street greater than 3+3	0%

Transit

In street design and intersection operations, the most critical issue for transit is delay, which relates to transit's overall efficiency as well as corridor travel time and reliability, factors of high importance to passengers. Delay figures below are for average, individual bus stops and intersections in the peak hour, including delay related to congestion (backed up cars prevent bus from reaching intersection or traffic signal) or traffic signals.

Table A.3 Transit Level of Service for Street Design

LOS	Measure
A	Insignificant intersection or congestion-related delay (less than 10 seconds). Dedicated lane for transit and coordinated traffic signal management system so transit does not stop at traffic signals except for other transit at intersecting transit priority street.
B	10-19 seconds delay. Transit prioritization at all signalized intersections. Transit only lane if intersection congestion (Auto-LOS D or worse) projected in peak hour at intersections. If no transit only lane, transit stops in travel lane, not lay-by.
C	20-34 seconds delay.
D	35-54 seconds delay.
E	55-79 seconds delay.
F	80 or more seconds delay.

Bicyclists

Bicycle LOS is largely a function of motor vehicle speed and volume, plus available width. Figure A.4 illustrates this relationship. For example, on a 50 km/h street with 9000 vehicles per day, a bicycle lane yields LOS-C for cyclists.

If a higher LOS is desired then the following ammendments can be made

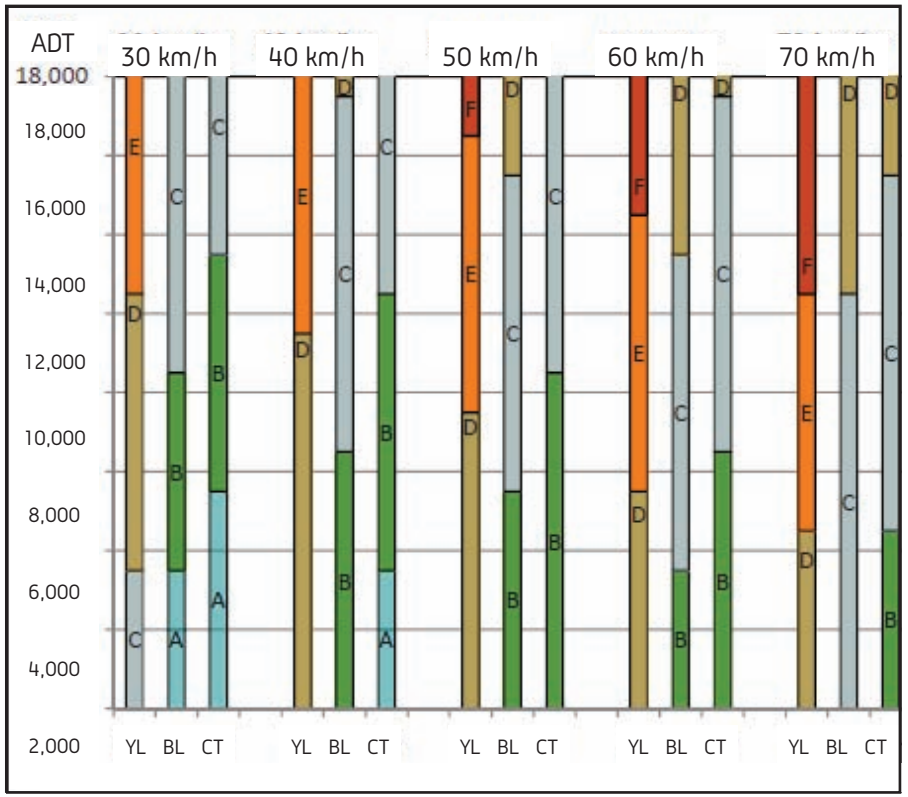
- Reduce vehicle speeds
- Lower vehicle volumes
- Construct a cycle track

A higher-quality facility will produce a higher level of service for cyclists, which will encourage additional ridership, including that of children and older adults. In addition a higher number of cyclists on a certain route would predicate wider facilities.

Automobiles

For automobiles, apply the Urban Street LOS calculations from the Highway Capacity Manual 2000, which focus on entire corridors rather than individual intersections, and compare the difference between free-flow speed and average speed on the corridor as a whole. By focusing on the corridor, rather than individual intersection LOS, designers have more tools for maintaining a smooth flow of traffic.

Figure A.4 Bicycle Level of Service



A, B, C, D, & E = Level of Service

YL = Yeild Lane BL = Bicycle Lane CT = Cycle Track

A.2 Performance Measure Targets by Street Typology

When retrofitting an existing street where sufficient right of way is not available, or when managing any street, designers must balance the needs of all street users against each other. The optimal balance varies according to street type, as shown in Table A.4 below. For each mode, an absolute minimum Quality of Service level is provided, as well as a target level, for typical streets.

The Abu Dhabi Department of Transportation is identifying specific streets that will be high priority for transit service (bus and tram) and for bicycle travel. On those streets, the targets for the priority modes are higher, as shown.

Street audits shall provide opportunities for improvement

Table A.4: Preliminary Level of Service Targets by Mode for each Street typology

Context	Street Family	Target LOS (typical)	Minimum LOS (typicial)	Transit Priority Corridor	Bicycle Priority Corridor
City Town Residential Commercial	Boulevard Avenue Street	Pedestrian: A Transit: B Bicycles: B Autos: C	Pedestrian: C Transit: D Bicycles: D Autos: E	Transit target: A Transit minimum: C	Bicycle target: A Bicycle minimum: C
	Access Lane	Pedestrian: A Transit: None Bicycles: B Autos: None	Pedestrian: B Transit: None Bicycles: C Autos: None	N/A	Bicycle target: A Bicycle minimum: B
Industrial No Active Frontage	Boulevard Avenue Street	Pedestrian: B Transit: B Bicycles: B Autos: C	Pedestrian: C Transit: D Bicycles: D Autos: E	Transit target: A Transit minimum: C	Bicycle target: A Bicycle minimum: C
	Access Lane	Pedestrian: B Transit: None Bicycles: B Autos: None	Pedestrian: C Transit: None Bicycles: D Autos: None	N/A	Bicycle target: A Bicycle minimum: B

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Appendix B
Toolbox of Connectivity Measures

B.1 Direct Route Index

A Direct Route Index (DRI) was used to measure the ease of access from one point to another within the development.

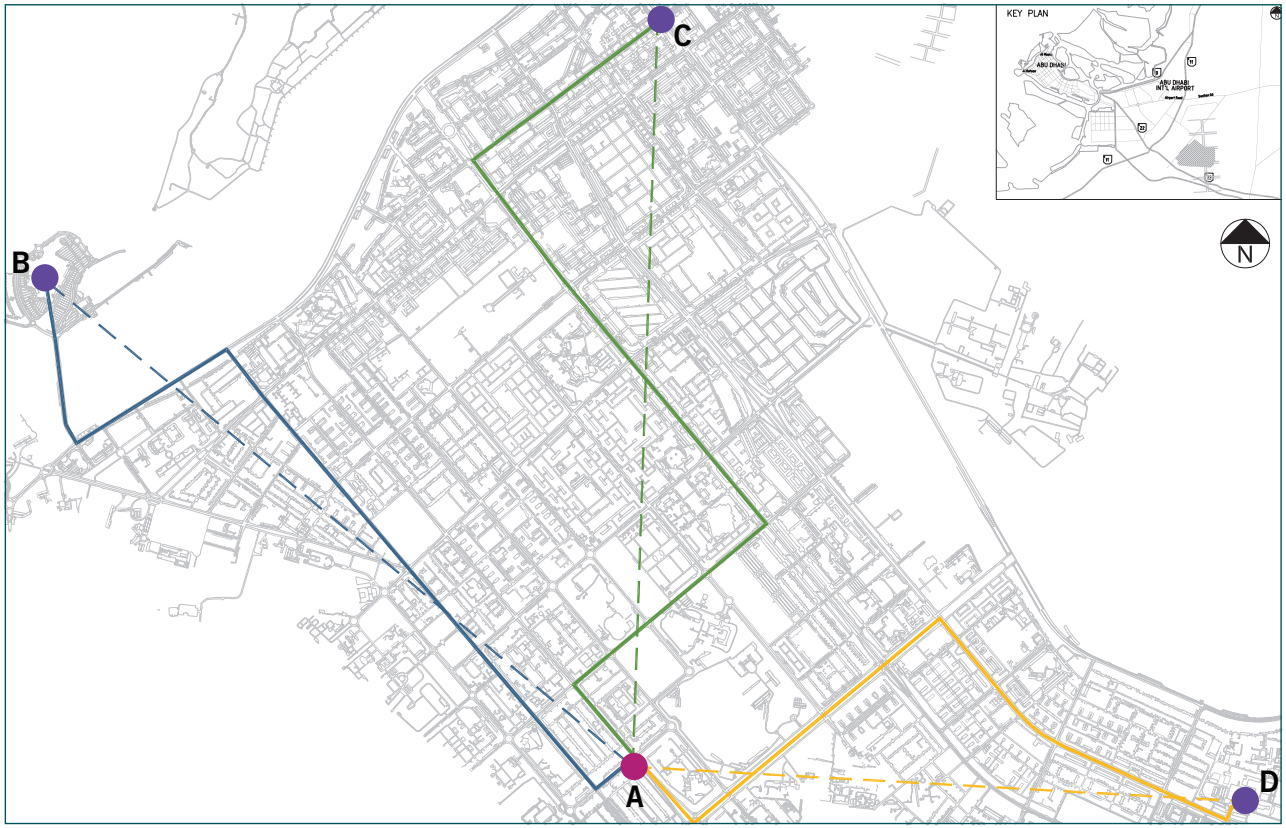
$$DRI = \frac{\text{Length of Actual Path}}{\text{Length of Direct Path}}$$

In order to calculate the level of directness from point A to point B, the length of the actual driving/walking route between the two points, must be divided by the length of the direct , straight, route.

A Direct Route Index calculation in Abu Dhabi Island is provided as an example. In this case, a random plot (A) was selected as the origin of three different routes: the first leads to an exit point (B); the second route to another random plot (C); and the last links to a Mosque (D). Solid lines on the map represent the actual route, whereas dashed lines show direct routes.

The table provided shows the calculated results of the index for these routes. The general consensus is that an actual path that is less than or equal to 1.5 times longer than its direct path is acceptable. The results for Abu Dhabi Island are all below 1.5 (ranging between 1.27 and 1.43) and imply the availability of direct routes, on average, within the development.

This model can be applied to any site, no matter the street configuration. It may also be used for both vehicle and pedestrian routes. The best possible result is an index of 1.



Route		Actual Path (m)	Direct Path (m)	Direct Route Index (DRI)
Plot (A) – Exit Point (B)		8350	6585	1.27
Plot (A) – Plot (C)		9150	6410	1.43
Plot (A) – Mosque (D)		7050	5280	1.34

B.2 Cordon Capacity Test

In order to make an initial assessment of the traffic capacity of an existing or proposed street network it is recommended to undertake a cordon capacity test. This test estimates the generated traffic flows from a defined area using approved traffic generation rates, and distributes this traffic over the number of traffic lanes exiting (or entering) the area. A theoretical cordon is placed around a section of, in this example case, a section of proposed development. The theoretical traffic generation is then estimated. In this example an estimated generation rate of 1 vehicle per hour is used, actual generation rates are to be obtained from the Abu Dhabi DOT. A theoretical lane capacity of 1,000 vehicles per hour has been assumed, for actual value refer to Chapter 3 of the Manual. If the generated traffic flow is lower than the exit capacity of the network then the network is assumed to contain sufficient capacity. If the exit flow is greater than the exit capacity then additional street links may be required within the network.

This test is intended to be a network design tool and does not replace or negate any testing to be undertaken as required by the latest DOT traffic assessment requirements.

Test Cordon A	
Large Villas	406
Traffic lanes	10
Vehicle capacity/hour	10,000

Test Cordon B	
Large Villas	67
Small Villas	409
Townhouses	126
Total Res Units	602
Traffic lanes	10
Vehicle capacity/hour	10,000

Test Cordon C	
Large Villas	56
Small Villas	210
Townhouses	248
Condominiums	1,049
Total Res Units	1,563
Traffic lanes	8
Vehicle capacity/hour	8,000

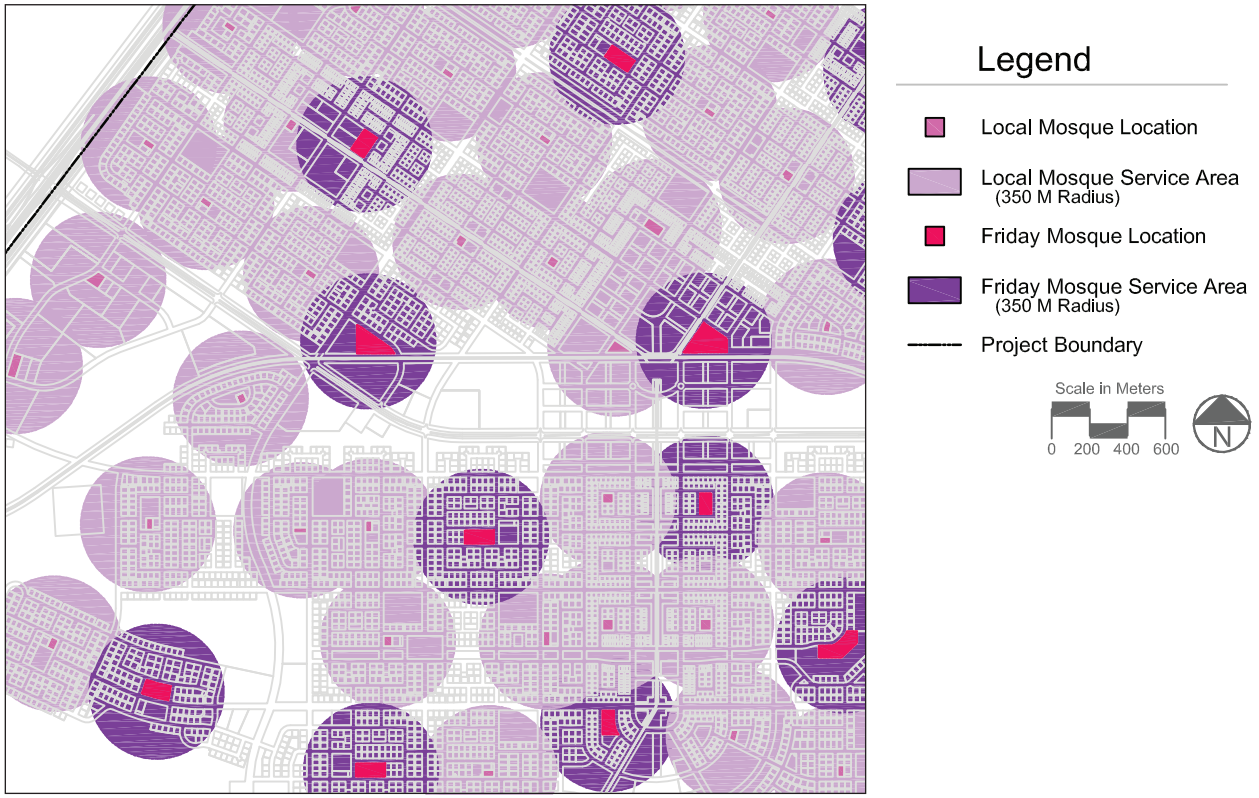
B.3 Pedshed Analysis

A high level of street connectivity is recommended near community centers in order to minimize pedestrian walking distances. By increasing street connectivity, designers can expand the area within a walkable distance of transit stations, retail centres, schools and mosques.

A Pedshed Analysis illustrates the extent of communities within a set walking distance from these community facilities. The distances used in this example are 350 m, approximately representing a 5 minute walk distance with a pedestrian speed of 1.15 m/s. Different distances, speeds and times can be used for different types of development.

It is necessary to identify the physical center of each of the communities being planned, and also the adjoining existing communities. Usually these central points are at the middle of what is likelly to be the busiest mixed use street, and are typically also adjacent to the best public transport services to the community (such as a Metro rail station, tram stop, or intersection of two bus routes). In very low-density residential areas the physical center of the community may consist simply of a prayer mosque, its associated shop and a bus stop, while a regional center may completely fill its five-minute pedshed with multi-storey mixed-use buildings.

Calculate the 350 m pedsheds for each community and shade them dark and light, respectively, with an appropriate colour. Identify any uncoloured areas and determine why they are not within the 5 minute walk of the physical center of a community, and whether or not it is appropriate that they should be (for example only the edges of a large park need to be within 5 minutes walk of the nearest community centers).



Adjust the design until the desired level of coverage is obtained within the 5 minute walk of they physical center of their nearest community (excluding areas of parkland, etc. determined as not requiring this level of walkability). Within a dense urban core served by rail or tram a higher level of walkability should be the objective; typically more than 90% of such areas should be within a 5 minute pedshed of a bus or tram stop.

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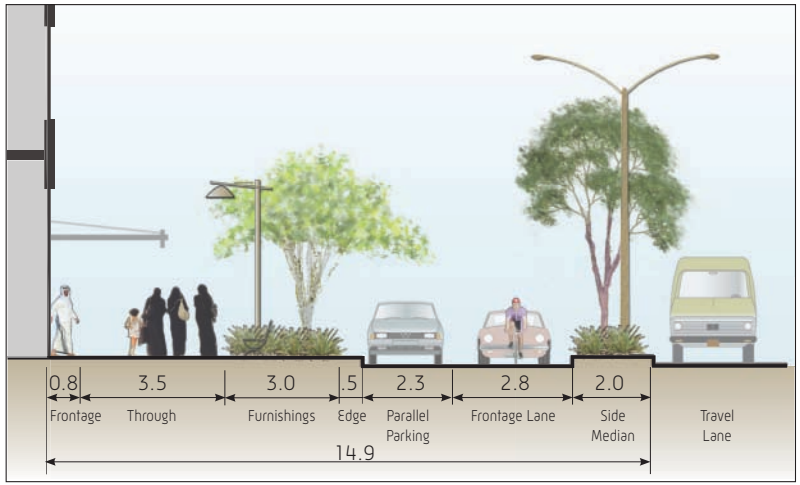
Appendix C
Example Street Configurations

Depending on the available right-of-way and the specific activities taking place along a street, special design considerations must be applied to the streetscape configurations. These considerations vary according to street type, and they include:

- High Pedestrian Activity Areas
- Pedestrian Connections
- Transit Facilities
- Bicycle Facilities
- Parking Facilities
- Utilities
- Signing and Lighting

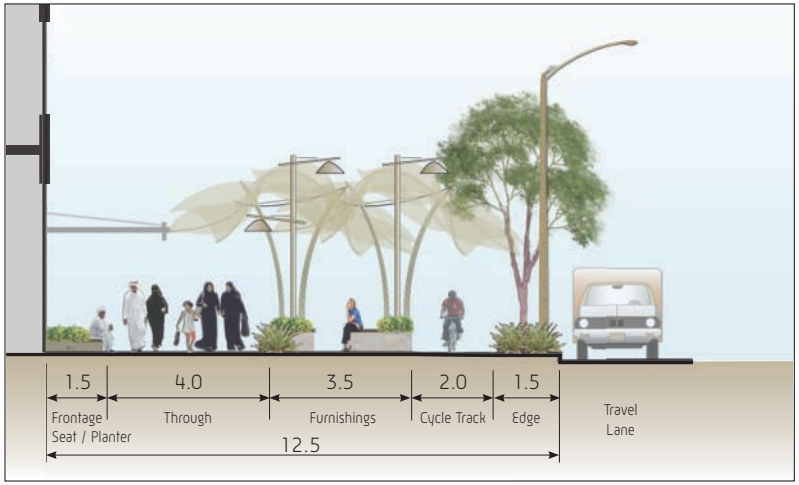
The illustrations on the following pages apply dimensional standards and flexible guidelines for fixed right-of-way scenarios (see Chapter 5).

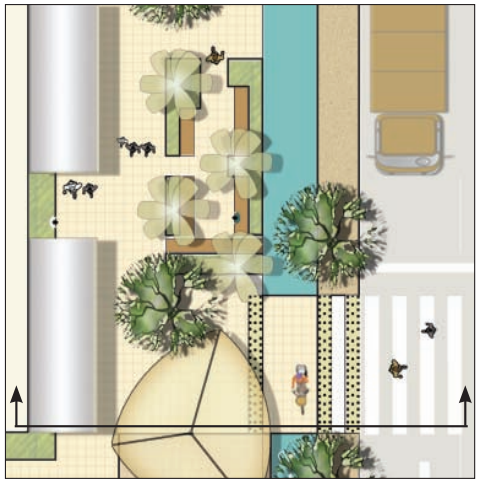
Design concepts provide the opportunity to visualize various options for streetscapes to fit unique conditons throughout the Emirate of Abu Dhabi.



Standard City Boulevard

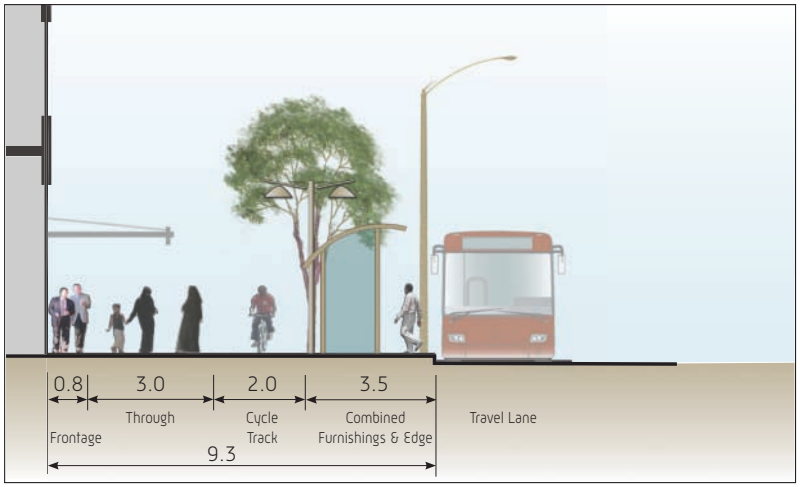
- Cross section taken along a ground floor retail space (high pedestrian activity generator)
- Frontage Lane to accommodate demand for parking
- Parking meters and electric car recharge stations located in the edge zone
- Maximum standard furnishings zone to provide seating areas

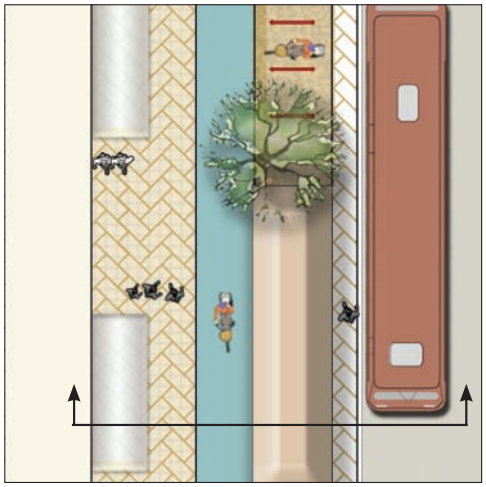




City Boulevard with Too Much Right-of-Way

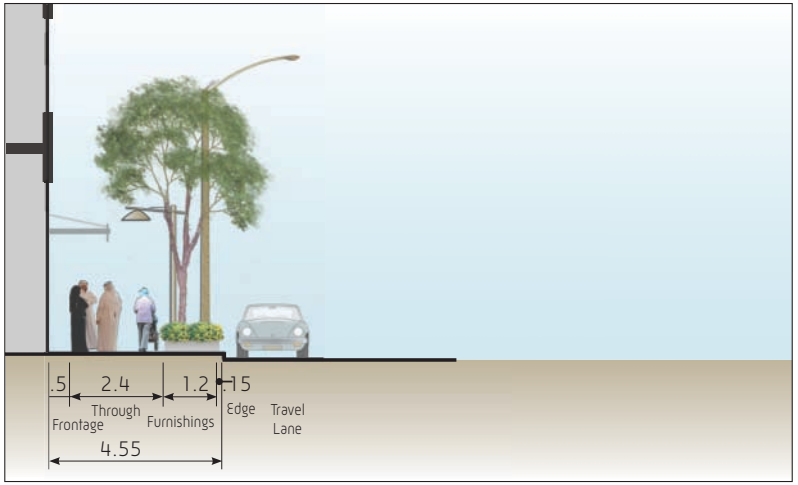
- Space not sufficient to include a frontage lane
- Existing change in grade from the building to the pedestrian realm addressed with the maximum dimensions in the frontage zone
- Maximum through zone and furnishing zone dimensions to accommodate remaining right-of-way space
- A larger edge zone provides room for utilities, lighting, and street signs

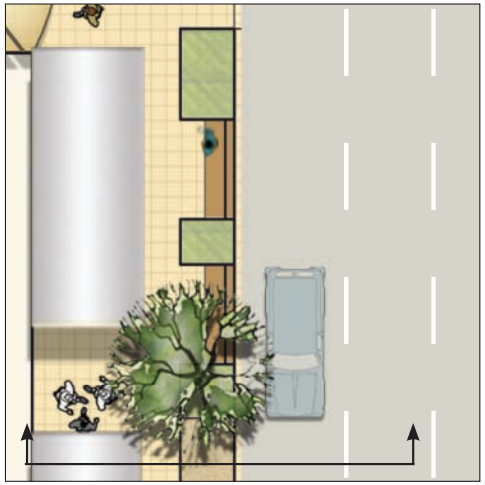




Standard Town Boulevard

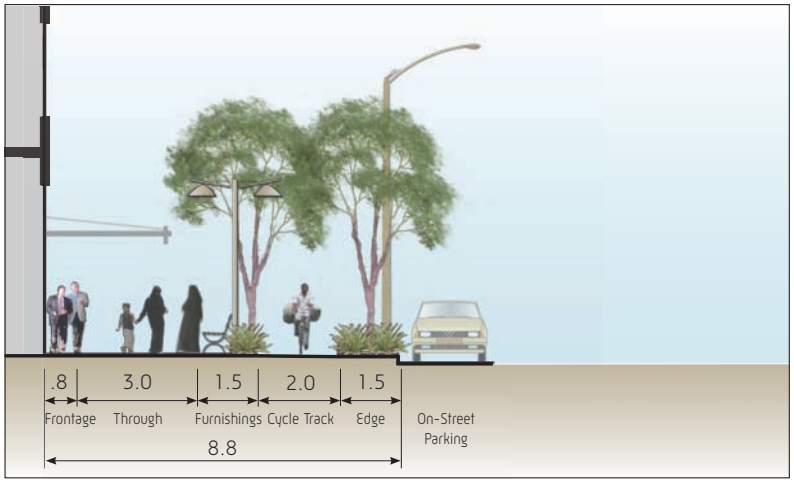
- Edge zone and funishing zone combined to accommodate bus stop
- Cycle track re-routed behind bus stop

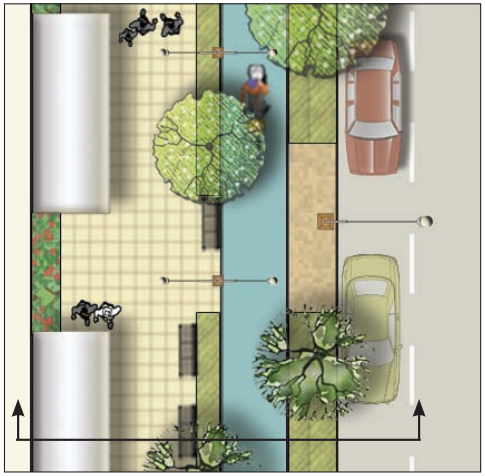




Commercial Boulevard with Too Little Right-of-Way

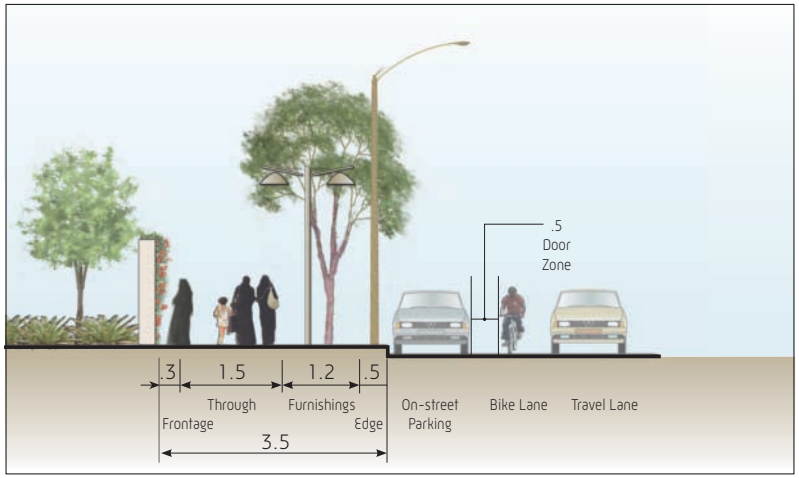
- No cycle track proposed
- Combine furnishing zone and edge zone to provide adequate room for utilities, lighting, and street signs

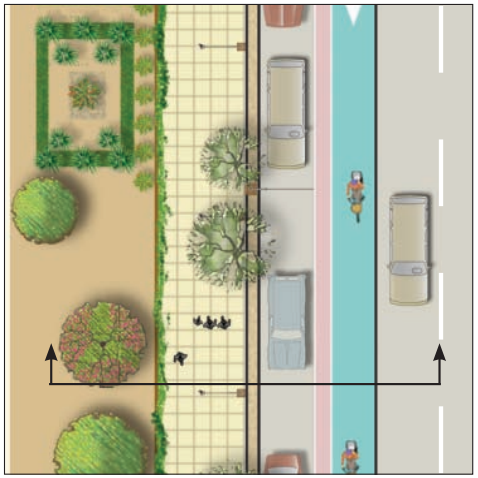




Standard City Avenue

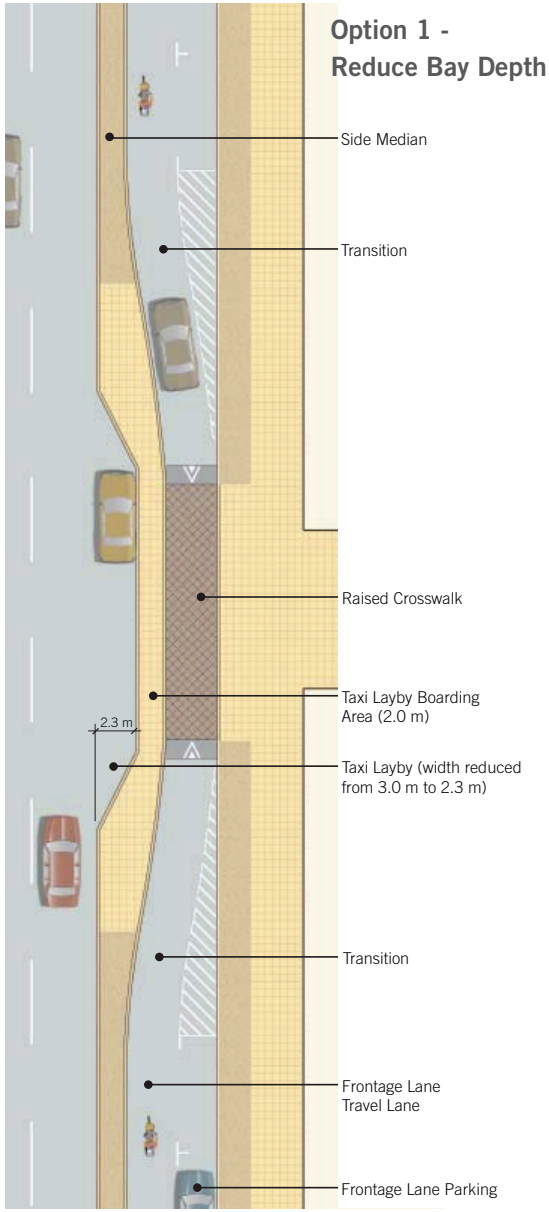
- Cycle track proposed
- Minimum standard dimensions used for furnishing zone suitable for projected volumes of pedestrian activity
- Maximum standard edge zone dimensions used to provide space for parking meters, street lighting, street signs, and utilities.
- Pedestrian lighting in furnishing zone

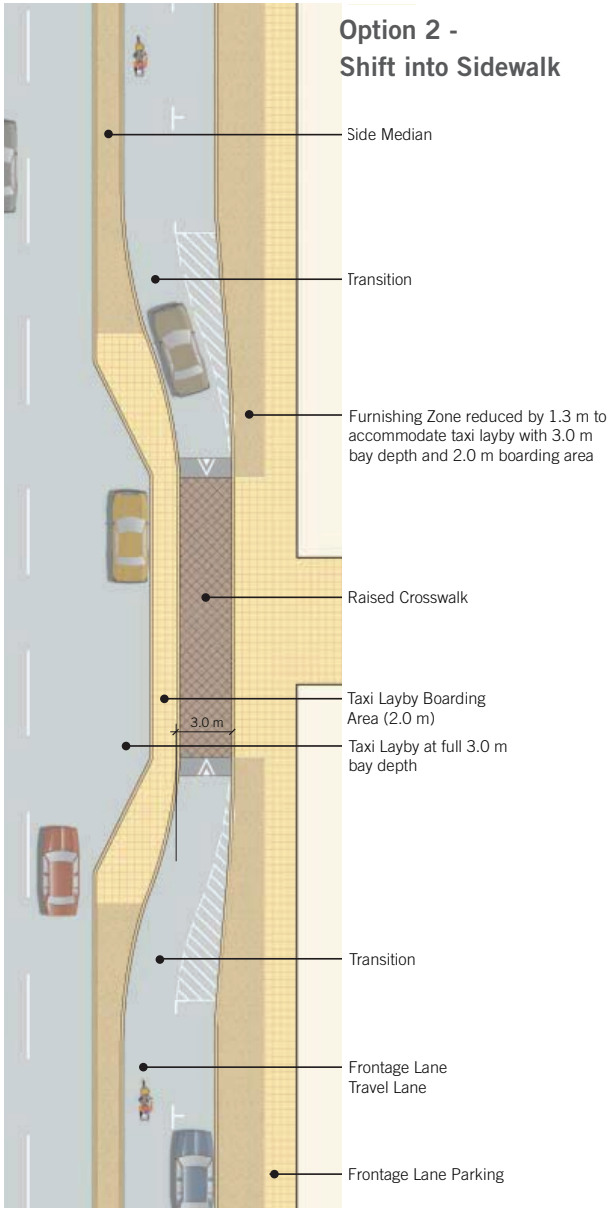


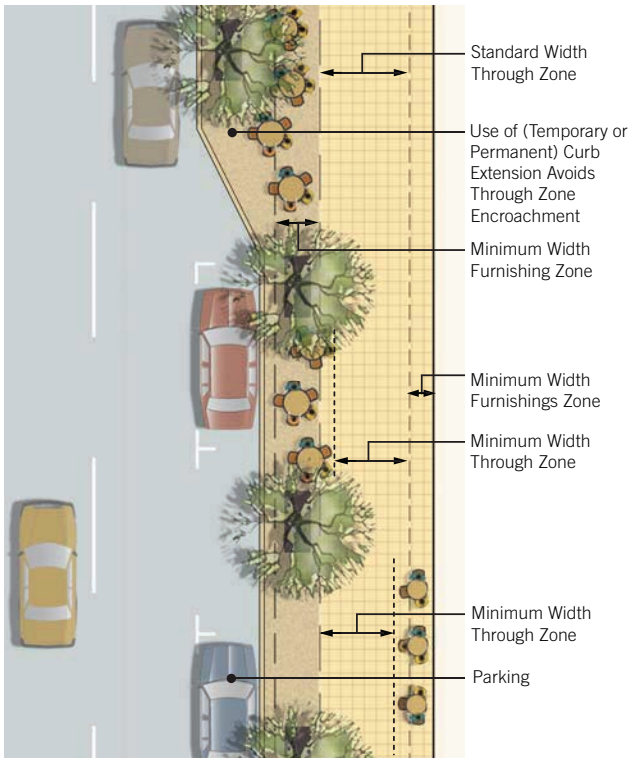


Standard Residential Street

- Furnishings zone and edge zone combined to provide space for parking meters, lighting, street signs, and utilities


Option 1 -
Reduce Bay Depth
Side Median
Transition
Raised Crosswalk
Taxi Layby Boarding
Area (2.0 m)
2.3 m
Taxi Layby (width reduced
from 3.0 m to 2.3 m)
Transition
Frontage Lane
Travel Lane
Frontage Lane Parking


Option 2 -
Shift into Sidewalk
Side Median
Transition
Furnishing Zone reduced by 1.3 m to
accommodate taxi layby with 3.0 m
bay depth and 2.0 m boarding area
Raised Crosswalk
Taxi Layby Boarding
Area (2.0 m)
3.0 m
Taxi Layby at full 3.0 m
bay depth
Transition
Frontage Lane
Travel Lane
Frontage Lane Parking


Standard Width
Through Zone
Use of (Temporary or
Permanent) Curb
Extension Avoids
Through Zone
Encroachment
Minimum Width
Furnishing Zone
Minimum Width
Furnishings Zone
Minimum Width
Through Zone
Minimum Width
Through Zone
Parking

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Appendix D
Recommended Lighting Levels

(Note: lighting levels are shown in Lux – lumens per square meter.)

Recommended Lighting Levels for Junctions

Adapted from the Illuminating Engineering Sociatey of North America (LESNA/IES) Lighting Handbook (Average Maintained Illuminance at the Pavement Level in Lux – Lumens/m^2)

	Average Level of Illuminance by Level of Pedestrian Activity			Uniformity of Illuminance to be Provided
Intersection Type	High Ped Activity	Medium Ped Activity	Low Ped Activity	Ɛ avg / Ɛ min
Boulevard/Boulevard	34	26	18	3
Boulevard/Avenue	29	22	15	3
Boulevard/Street	26	20	13	3
Avenue/Avenue	24	18	12	4
Avenue/Street	21	16	10	4
Street/Street	18	14	8	6
Shared Streets with Mixed Vehicle and Pedestrian Traffic	20	15	10	4

Streets – Recommended Minimum Maintained Average Illuminance in Lux (Lumens / m^2)

See RP-8-00 for Details

Adapted from the Illuminating Engineering Society of North America (IESNA/IES) Lighting Handbook

Application		Uniformity of Illuminance to be provided	Veiling Illuminance Ratio
Street Type	Pedestrian Activity / Conflict Level	Ɛ avg / Ɛ min	L v max / L avg
Boulevard	High	3	0.3
	Medium	3	0.3
	Low	3	0.3
Avenue	High	4	0.4
	Medium	4	0.4
	Low	4	0.4
Street	High	6	0.4
	Medium	6	0.4
	Low	6	0.4

Recommended Lighting Levels for Pedestrian Areas and Bikeways*

(Average Maintained Illuminance at the Pavement Level in Lux – Lumens/m2)

*Lighting should extend outward beyond path of travel by 10 meters, each side. At non-intersection locations; for intersection lighting. Adapted from the Illuminating Engineering Society of North America (IESNA/IES) Lighting Handbook

Application/ Land Use	Minimum Avg. Horizontal Illuminance at Pavement Level	Avg. Vertical Illuminance 1.8 meters above Surface
Commercial and Mixed Use Areas	10	20
Intermediate Areas / Medium to High Density Residential	5	10
Low Density Residential	2	5
Separated Walkways and Bikeways		
Walkways and Bikeways*	5	5
Pedestrian Stairways and Ramps	10 (to 20)	10
Pedestrian Underpasses	20 (to 50)	55
Along Parking Areas	60	10 to 20
Around Building Entrances	50 (to 100)	10 to 20
Trails in Parks/Public Spaces*	6 (to 10)	5 to 8

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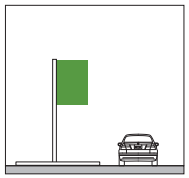
Appendix E
Signing & Wayfinding Guidelines

Note: Requirements for signing and wayfinding are the responsibility of the Department of Municipal Affairs. The following guidelines provide general principles.



A1: Transit / Taxi Identity:

Scale: approximately 3.3 meters X 1.0 meter

Legibility: high contrast, English font – Clearview, Arabic font – Frutiger LT Arabic 55 Roman

Illumination Options: internal illumination, reflective letters to ensure night time visibility

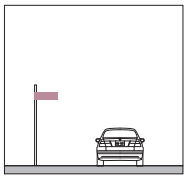
Lines of Sight: perpendicular to walkway, clearly visible to pedestrians, not obstructed by landscape

Material Options: stainless steel, aluminum

Application: freestanding post and panel

Dynamic/Static: dynamic, static

Location: at transit/taxi locations, minimum of 1.5 meters from curb, minimum clearance of 2.5 meters to bottom of panel, allow free flow of pedestrian movement



A2: Street Identity:

Scale: approximately 3.5 meters X 1.2 meters, may be integrated into traffic signal

Legibility: high contrast, English font – Clearview, Arabic font – Frutiger LT Arabic 55 Roman

Illumination Options: internal illumination, reflective letters to ensure night time visibility

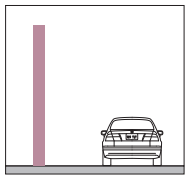
Lines of Sight: clearly visible to approaching vehicles

Material Options: stainless steel, aluminum

Application: freestanding post and panel, panel

Dynamic/Static: static

Location: at two intersecting roads, minimum of 1.5 meters from curb, minimum clearance of 2.5 meters to bottom of panel, allow free flow of pedestrian movement, minimum 2 per intersection



A3: Parking Site Identity:

Scale: approximately 5 meters X 1.0 meters

Legibility: high contrast, English font – Clearview, Arabic font – Frutiger LT Arabic 55 Roman

Illumination Options: internal illumination, reflective letters to ensure night time visibility

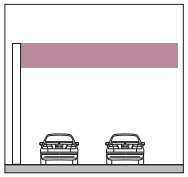
Lines of Sight: clearly visible to approaching vehicles, and to pedestrians

Material Options: translucent glass, stainless steel, aluminum

Application: freestanding pylon

Dynamic/Static: dynamic, static

Location: at or near parking entrances, minimum of 1.5 meters from curb, allow free flow of pedestrian movement



B1: Primary Vehicle Direction:

Scale: approximately 7.05 meters X 9.3 meters

Legibility: high contrast, English font - Clearview, Arabic font - Frutiger LT Arabic 55 Roman

Illumination Options: internal illumination, external uplights, or reflective letters to ensure night time visibility

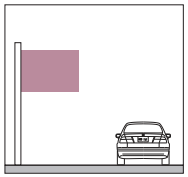
Lines of Sight: clearly visible to vehicles, read at high speeds, not obstructed by landscape

Material Options: stainless steel, aluminum

Application: freestanding cantilever pylon

Dynamic/Static: static, dynamic

Location: preceding street intersection, minimum of 1.5 meters from curb, minimum clearance of 5.5 meters to bottom of panel, allow free flow of pedestrian movement



B2: Secondary Vehicle Direction:

Scale: approximately 5.0 meters X 2.8 meters

Legibility: high contrast, English font - Clearview, Arabic font - Frutiger LT Arabic 55 Roman

Illumination Options: internal illumination, external uplights, or reflective letters to ensure night time visibility

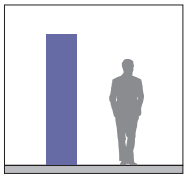
Lines of Sight: clearly visible to vehicles, read at high speeds, not obstructed by landscape

Material Options: stainless steel, aluminum

Application: freestanding cantilever pylon

Dynamic/Static: static

Location: preceding street intersection, minimum of 1.5 meters from curb, minimum clearance of 2.5 meters to bottom of panel, allow free flow of pedestrian movement



B3: Pedestrian Direction:

Scale: approximately 3.3 meters X 1.0 meter

Legibility: high contrast, English font - Clearview, Arabic font - Frutiger LT Arabic 55 Roman

Illumination Options: internal illumination, reflective letters to ensure night time visibility

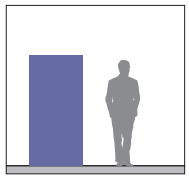
Lines of Sight: perpendicular to walkway, clearly visible to pedestrians, not obstructed by landscape

Material Options: stainless steel, aluminum

Application: freestanding post and panel, monument

Dynamic/Static: static

Location: at decision points, minimum of 1.5 meters from curb, allow free flow of pedestrian movement



C1: Information Directory:

Scale: approximately 3.1 meters X 1.0 meter

Legibility: high contrast, English font – Clearview, Arabic font – Frutiger LT Arabic 55 Roman

Illumination Options: internal illumination, reflective letters to ensure night time visibility

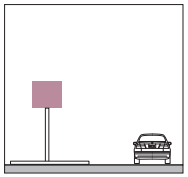
Lines of Sight: clearly visible from all directions, not obstructed by landscape

Material Options: stainless steel, aluminum

Application: freestanding pylon

Dynamic/Static: static or dynamic, touch screen

Location: at primary circulation areas, minimum of 1.5 meters from curb, allow free flow of pedestrian movement



D1: Vehicle Regulation:

Scale:

Standard Traffic Sign Sizes:		
Description	Speed (KPH)	Size(MM) H
Freeway / Express Way	100 or Greater	1200
Arterial	80	900
Collectors	60	750(600)
Local / Service Roads	60	600(450)

Legibility: high contrast, English font – Clearview, Arabic font – Frutiger LT Arabic 55 Roman

Illumination Options: reflective letters to ensure night time visibility

Lines of Sight: clearly visible to vehicles, read at high speeds, not obstructed by landscape

Material Options: stainless steel, aluminum

Application: freestanding post and panel

Dynamic/Static: static

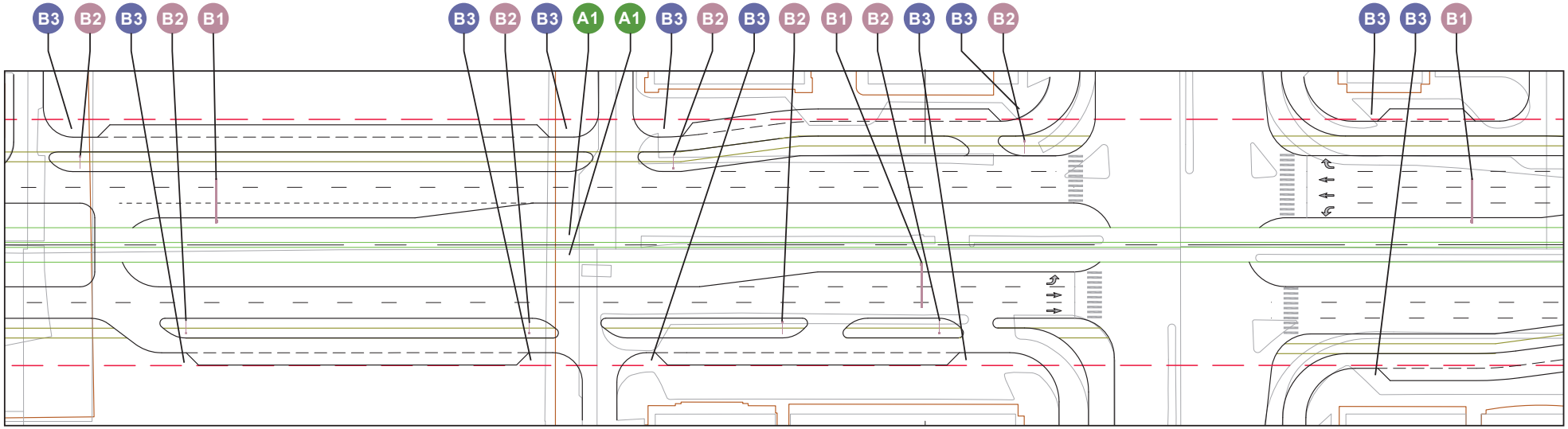
Location: throughout roadway system, minimum of 1.5 meters from curb, allow free flow of pedestrian movement

✓ SIGNING AND WAYFINDING CHECKLIST

- Create a mission statement for the signing and wayfinding system
- Analyze specific urban conditions, including project goals, and vehicular, pedestrian, transit and bicycle routes
- Convene the stakeholders who will be involved in developing and maintaining the system. Understand their needs and design to address them.
- Review all regulatory requirements related to signing and wayfinding
- Use multiple design elements to devise a more complex system, instead of relying on one element
- Incorporate complementary design elements
- Limit the amount of information per sign to ensure visibility and comprehensibility
- Use colors and type that enhance legibility
- Create signs that are attractive to pedestrians, even if they are oriented only to the motorist
- Plan route based on the history and development of the city
- Build signs to withstand physical, stylistic, and technological changes
- Develop a maintenance and management system prior to wayfinding system installation

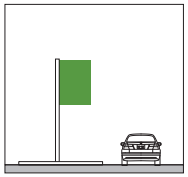
Source: Planning and Urban Design Standards, 2006, Craig M. Berger, Society for Environmental Graphic Design, Washington DC.

Typical Street Section - Scale 1:300

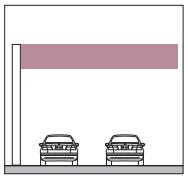


Sign Placement

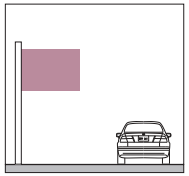
Typical Street Plan - Scale NTS



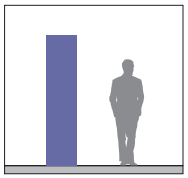
A1 - Transit / Taxi Identity



B1 - Primary Vehicle Direction

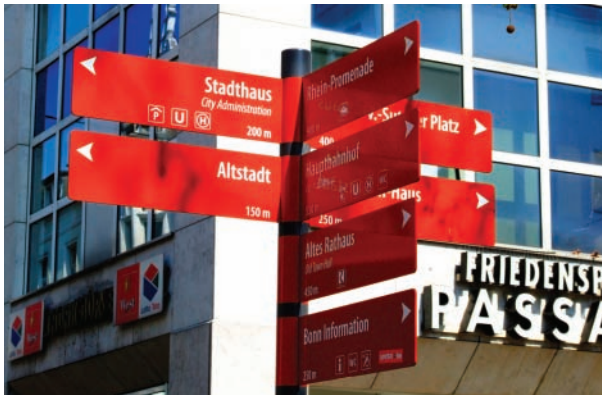


B2 - Secondary Vehicle Direction



B3 - Pedestrian Direction

Identification



Vehicle & Pedestrian Direction

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Vision

دليل تصميم الشوارع الحضرية – أبوظبي
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