This chapter outlines the process for identifying, emphasizing, and applying freight-supportive transportation strategies, facility design guidelines, and policies within freight corridors and subareas. The strategies and guidance suggest the best way to integrate freight planning issues into the transportation planning and project development process. The guidance provides methods for identifying and responding to freight needs as FDOT and their partner agencies advance transportation projects from planning concepts to design and as communities engage in and partner with FDOT during long-range and comprehensive planning.

Integrating freight planning issues into the initial phases of regional and local transportation planning processes will help save time and money in the long-term.

The guidance complements existing processes and takes advantage of freight-specific resources, including a multifunctional Comprehensive Freight Improvement Database (CFID) and a set of Freight Corridor Study Guidelines. It builds on the standards in the FDOT Plans Preparation Manual and other adopted documents that regulate the design of roadways, emphasizing design solutions that support freight vehicle mobility, access and operations in a number of urban environments. The guidance provides planners and engineers with considerations in defining strategies that respond to freight needs while respecting the various functions of the roadway network and sensitivities of the context and character of the freight corridors.

PLAN OBJECTIVES AND POLICY TOPICS

The freight mobility and compatibility objectives described in Chapter 7 provide the framework for developing context sensitive freight transportation strategies and concepts. The freight mobility objectives imply the need to understand facility functions to streamline freight movements, provide high levels of accessibility between freight activity areas and major highways, and enhance truck mobility through and beyond the Tampa Bay region. Strategies and guidance that emerge from these objectives emphasize freight network connectivity, ease of truck operation, effectively processing traffic, circulation within activity centers and access to sites that generate and attract freight traffic. While the freight mobility objectives give rise to functional considerations, the compatibility objectives imply the need to understand the geography of local livability initiatives and significant freight activity areas and corridors. The fourth compatibility objective, in particular, calls for coordination with local planning entities to ensure that improvements to the regional freight transportation network support local community livability goals.

FREIGHT COMPATIBILITY AND LIVABILITY

When used in the context of transportation and community planning, the term "livability" is used to describe community goals and objectives or multimodal facility needs that may conflict with high speed and high volume vehicular movement, roadway geometry, and traffic operations. Design standards for roadways have traditionally focused on optmizing the functionality and safety of the roadway network while accommodating vehicular traffic at the highest speed possible. Over the past twenty years, the considerations for pedestrians, bicyclists and transit patrons have been elevated in the roadway planning and design process. In FDOT's Plans Preparation Manual Volume I Chapter 21, transportation planning for livable communities considers the following principles:

1. Safety of pedestrians, bicyclists, motorists and public transit users
2. Balancing community values and mobility needs
3. Efficient use of energy resources
4. Protection of the natural and manmade environment
5. Coordinated land use and transportation planning
6. Local and state economic development goals
7. Complementing and enhancing existing Department standards, systems and processes

While the purpose of this guidance is not to address freight issues within the context of the PPM Volume I Chapter 21, these principles do reflect the intent of the freight compatibility objectives and provide specific topics that should be considered within the context of any roadway improvement project, including those aimed at improving conditions for freight. With these considerations in mind, the guidelines that follow direct transportation planners and engineers how to best support freight where livability principles are emphasized in the region and where freight movements and industrial activities are emphasized. In some cases, especially in the established urban areas in the region, these areas overlap, presenting potential conflicts among freight activities and the adjacent land uses. The guidelines describe suitable approaches to freight facility design for various land use contexts including areas with high freight activity, areas where pedestrians and commuter traffic is of high importance, and areas where livability-freight activity conflict. Taken within a variety of urban contexts, this varied approach to design ultimately enhances freight, while mitigating or avoiding freight impacts on the community.

The strategies and guidelines provided in this chapter emphasize ways that the impact of freight on communities will be mitigated or avoided while also enhancing necessary freight movements.

Low Activity

Community Oriented

Freight Oriented

Diverse Activity

These images display examples of the four context areas from low livability/low freight activity to high livability/high freight activity (top to bottom).

HOW TO USE THIS GUIDANCE

A policy framework has been developed that considers roadway function and geographical contexts and identifies tiers of strategies and policies for enhancing the freight transportation network in ways that are consistent with the goals and objectives of the Strategic Freight Plan. The policy framework is dictated by both the freight facility types and land use context. The freight facility types include:

- Limited Access Facilities
- Freight Mobility Corridors
- Freight Distribution Routes
- Freight Activity Center Connectors
- Freight Activity Center Streets

The four areas that account for land use compatibility and define the geographical context include:

- Low Activity - Low Livability/Low Freight Activity
- Community Oriented - High Livability/Low Freight Activity
- Freight Oriented - Low Livability/High Freight Activity
- Diverse Activity - High Livability/High Freight Activity

The following considerations should be used to identify freight strategies within the policy framework of the Strategic Freight Plan. The considerations support the identification of strategies for a corridor study or design project, but generally apply to other planning efforts as well. Information needed to support the identification of strategies is available through interactive mapping and database tools on the Tampa Bay Regional Goods Movement Web Site, which is www.tampabayfreight.com. The freight facility classifications and context areas are available with interactive mapping supported by the existing mapping tool on the site.

Freight facility functionality

The Strategic Freight Plan defines a freight roadway network and facility types listed above and described in Chapter 8. The classification of the primary roadway and cross streets needs to be considered in a typcial corridor study. Knowledge of the freight roadway network facilities and function is also important for areawide or systemwide planning and analysis. Each freight facility type has a primary function that should be a focus of strategies and design solutions that are considered. The guidance that follows is organized in large part by freight facility type.

Freight and land use compatibility

The Strategic Freight Plan has defined context areas as listed above and described in Chapter 8. These areas consider the relationship between freight activities and various urban contexts. These contexts can vary considerably within localized areas, making it likely that there will be more than one context area within the limits of a given roadway corridor. The freight-related strategies and guidelines appropriate for each project should vary accordingly. For issues that affect the entire length of a project, strategies and roadway design solutions will have to be applied within the context of all of the user needs within the corridor, being mindful of the freight function and how the facility fits within the overall function of the freight roadway network.

The Comphrehensive Freight Improvement Database (CFID) includes an inventory of freight hot spots in the Tampa Bay region such as those on Ulmerton Road in Pinellas County.

Information available in freight database

The CFID and map series on the Tampa Bay Regional Goods Movement Web Site include freight hot spots that represent discrete locations where geometrics or traffic operations present barriers to truck mobility and accessibility. When conducting a corridor study, including a Project Development and Environment (PD&E) study or design engineering project, the CFID should be queried to identify freight hot spots and issues that have been identified in the corridor. The freight needs in the database include corridor-based strategies, operational improvements, maintenance needs and safety strategies.

Freight corridor screening results

In conjunction with the Strategic Freight Plan, a preliminary Freight Corridor Screening Process was developed to evaluate operations and travel conditions on freight corridors within the Tampa Bay region. Almost all of the roads on the freight roadway network have been screened, and the results are posted on the Tampa Bay Regional Goods Movement Web Site in the CFID. A map series shows the corridors that have been screened. When conducting a detailed study of an individual corridor, the results of the preliminary Freight Corridor Screening Process should be reviewed to become aware of the freight related issues that have been identified in the corridor.

The above considerations support the identification of appropriate strategies and roadway design solutions for the corridor or area of interest. The strategies that follow are types of roadway and system improvements and operational management practices that can be applied to the freight roadway network to support mobility, connectivity, circulation and access. The guidelines demonstrate how specific roadway design elements should be implemented for freight transport within the context of existing standards, such as the FDOT Plans Preparation Manual.

FREIGHT STRATEGY APPLICABILITY

A menu of potential strategies for addressing freight mobility needs on the regional freight transportation roadway network is provided below, along with a description of what each strategy entails.

- **Roadway widening** involves adding through travel lanes to increase capacity on the freight facility. It often requires the acquisition of right-of-way and substantial study of the feasibility and potential impacts posed by the project. As a freight mobility strategy, roadway widening would generally be deployed to provide additional capacity on congested freight facilities to improve travel speeds and accessibility for trucks.

- **New road construction** is similar to roadway widening in that it adds capacity to the freight transportation network, but it involves the development of an entirely new facility. This strategy may be appropriate when widening an existing congested facility is not feasible, when network redundancy is needed to alleviate congestion or circumvent choke points, or when emerging freight activity centers or freight travel patterns are inadequately served by the existing freight network.

- **Interchange upgrades** pertain primarily to limited access facilities, where they interact with regional freight mobility corridors and other freight distribution routes. Improvements to interchange design can improve capacity and/or operations to enhance the flow of goods entering or exiting limited access highways that provide high speed connections to the rest of the state and nation.

A potential strategy to reduce the conflicts between motorists and freight trucks on limited access facilities includes exclusive truck lanes.

- **Exclusive truck lanes** involve the designation of travel lanes for use by trucks alone. This may include the creation or adaptation of auxiliary lanes, usually on limited access facilities, to separate truck traffic from commuter traffic and cater to the specific operational needs of trucks.

- Use of **High Occurpancy Vehicle (HOV)/High Occupancy Toll (HOT) lanes** for trucks is similar to providing exclusive truck lanes, but does not necessarily involve a complete separation of truck and commuter traffic. In this case, HOV lanes (or high-occupancy toll lanes) would be used by carpoolers (or solitary motorists who purchase the right to access HOT lanes) during peak commuting hours, but would be available for carpoolers, paying motorists, and trucks during non-peak travel periods. Such a plan would require clear communication of what restrictions exist at various times, but would provide additional capacity on the freight transportation network throughout the day while catering to the needs of commuters during the peak period. There are currently no HOV or HOT lanes in the Tampa Bay region.

- **Intelligent Transportation System** projects such as variable message signs throughout the project corridor provide motorists and truckers with real time traffic information, apprising them of anticipated travel times, alerting them about delays cause by accidents or construction, and in some cases, providing detour information. ITS projects are most effective on regional corridors where parallel facilities exist to enable trucks to circumvent delays.

Intelligent transportation system projects will help truckers and motorists by providing real time traffic information and alerting drivers to roadway incidents, which may cause them delay, such as accidents or construction.

- **Geometric improvements** refer to design enhancements at intersections to expedite truck movements and may include wide turn radii, compound turn radii (to accommodate trucks and pedestrians), or lane configurations that create additional space for turning trucks.

- **Signal timing optimization** means coordinating traffic signals in a freight corridor to account for the slow acceleration of trucks and allow for the continuous movement of through trucks to achieve higher travel speeds in the corridor.

- **Grade-separated crossings** eliminate conflicts between railroad and roadway operations or between two roadways. Grade separation of railroads prevents temporary road closures resulting from train operations, enhancing the reliability and efficiency of goods movement, as well as improving circulation for vehicular traffic. Grade separating two roads can alleviate traffic signal delays, expedite turning movements, and improve safety at congested intersections.

- **Truck bypass routes** may be appropriate where a freight need is identified in a community oriented or diverse activity area. Opportunities for capacity enhancements on the facility may be constrained by surrounding land uses, public opposition, costs, or a variety of other factors, while truck traffic competes with commuter traffic for use of the facility. In these cases, the identification and/or creation of alternative routes bypassing the conflict area may represent the most efficient means of enhancing regional goods movement and may create new industrial and commercial development opportunities.

- **Access and circulation plans** help to manage freight flows in a particular area, especially in community oriented and diverse activity areas where freight access is important for specific uses, but where designing for trucks may conflict with the community character or present problems for other users of the transportation system. A freight access and circulation plan would address issues like defining a localized street hierarchy for goods movement, governing driveway placement and design to allow adequate truck access while protecting other users, and managing parking and loading zones for trucks.

- **Way-finding signage** programs may be needed to channel truck traffic on to target freight facilities and assist truckers in taking the safest and most efficient routes through particular areas. A signage program may, for example, be part of the implementation of an access and circulation plan.

Freight improvements in community and diverse activity areas need to also emphasize the safety of pedestrians within the area.

- **Pedestrian street crossing protection** is warranted as part of freight mobility enhancements undertaken in community oriented and diverse activity areas to ensure the safety of pedestrians while accommodating truck movements.

- **Increased roadway lane widths** may be appropriate in some instances on freight facilities. Increasing lane widths improves safety, operations, and average speeds by providing more space for all vehicles, eliminating delays and hazards posed by wide vehicles like trucks.

STRATEGIES BY FACILITY AND CONTEXT

Not all of the strategies described above are appropriate for a given facility type or within certain community contexts. **Table 9-1** through **Table 9-5** provide guidance on the applicability of certain strategies for each freight facility type by community context area type. While the set of strategies that would be deployed to address a freight mobility need would be decided on a case by case basis and tailored to the specific circumstances of the identified need, these tables provide a general sense of what strategies would be most efficient and effective for a particular facility function and land use context. Strategies that are not generally applicable to the facility type in question are omitted from the table.

When a strategy is said to be “applicable”, the implication is that there would be few, if any, major obstacles to the implementation of that strategy in the specified context area. These would generally be thought of as “first choice” strategies for a given facility and area type combination.

A strategy that is "somewhat applicable" would likely face some community and/or physical obstacles to its implementation. These strategies would be thought of as "second choice" options, which may be deployed alone or in conjunction with a set of other strategies to address the freight need.

A strategy that has "limited applicability" would likely face substantial community and/or physical obstacles to its implementation. These would be considered "third choice" strategies that would generally require substantial coordination and additional costs to mitigate their environmental and sociocultural impacts. However, these strategies may still warrant consideration in addressing a freight need depending on the specific circumstances in the area.

Table 9-1: Applicability of Selected Freight Mobility Strategies for Limited Access Facilities

Limited Access Facilities				
Strategies	Context Areas			
	Low Activity	Community Oriented	Freight Oriented	Diverse Activity
Roadway widening	2	2	1	2
Interchange upgrades	2	2	1	2
Exclusive truck lanes	2	2	1	2
Use of HOV/HOT lanes for trucks	2	2	1	2
ITS projects	2	1	1	1

Legend: 1 - Applicable
2 - Somewhat Applicable
3 - Limited Applicability

Table 9-2: Applicability of Selected Freight Mobility Strategies for Regional Freight Mobility Corridors

Regional Freight Mobility Corridors				
Strategies	Context Areas			
	Low Activity	Community Oriented	Freight Oriented	Diverse Activity
Roadway widening	2	3	1	2
Geometric improvements	2	3	1	2
Signal timing optimization	2	2	1	2
ITS projects	2	1	1	1
Grade-separated crossings	3	3	1	2
Truck routes bypassing conflict areas	3	2	3	2
Access and circulation plan	3	3	1	1
Way-finding signage program	3	2	2	1
Exclusive truck lanes	3	3	1	2
Pedestrian street crossing protection	3	1	3	1

Legend: 1 - Applicable
2 - Somewhat Applicable
3 - Limited Applicability

Table 9-3: Applicability of Selected Freight Mobility Strategies for other Freight Distribution Routes

Other Freight Distribution Routes				
Strategies	Context Areas			
	Low Activity	Community Oriented	Freight Oriented	Diverse Activity
Roadway widening	2	3	1	2
Geometric improvements	2	3	1	2
Signal timing optimization	2	3	1	2
Grade-separated crossings	3	2	1	2
Truck routes bypassing conflict areas	3	2	3	2
Access and circulation plan	3	1	1	1
Way-finding signage program	3	3	2	1
Pedestrian street crossing protection	3	1	3	1

Legend: 1 - Applicable
2 - Somewhat Applicable
3 - Limited Applicability

Table 9-4: Applicability of Selected Freight Mobility Strategies for Freight Activity Center Streets

Freight Activity Center Streets				
Strategies	Context Areas			
	Low Activity	Community Oriented	Freight Oriented	Diverse Activity
Increase roadway lane widths	2	3	1	2
Signal timing optimization	2	3	1	2
Geometric improvements	2	3	1	2
Access and circulation plan	3	1	1	1
Way-finding signage program	3	3	2	1
Pedestrian street crossing protection	3	1	3	1

Legend: 1 - Applicable
2 - Somewhat Applicable
3 - Limited Applicability

Table 9-5 provides a general assessment of the applicability of the design considerations described above for non-limited access freight facilities (regional freight mobility corridors, other freight distribution routes, and FAC streets) based on area type. Even though all non-limited access freight facilities are addressed in a single table here, the facility type and function will still influence roadway design. Limited access facilities are not addressed because they have unique typical design elements that are not usually contingent on area type considerations.

Table 9-5: Applicability of Freight Facility Design Considerations on Non-Limited Access Roadways

Non-Limited Access Regional Freight Network Facilities				
Strategies	Context Areas			
	Low Activity	Community Oriented	Freight Oriented	Diverse Activity
Roadway widening	2	3	1	2
Geometric improvements	2	3	1	2
Signal timing optimization	2	2	1	2
ITS projects	2	1	1	1
Grade-separated crossings	3	3	1	2
Truck routes bypassing conflict areas	3	2	3	2
Access and circulation plan	3	3	1	1
Way-finding signage program	3	2	2	1
Exclusive truck lanes	3	3	1	2
Pedestrian street crossing protection	3	1	3	1

Legend: 1 - Applicable
2 - Somewhat Applicable
3 - Limited Applicability

DESIGN GUIDANCE

The strategies described above are best identified during the system planning phase by outlining a tailored conceptual approach to addressing an identified freight mobility need (system deficiency) or opportunity (emerging travel pattern). Freight mobility projects and conceptual strategies should be incorporated into long term planning documents such as a LRTP. When a project proceeds to a PD&E Study, more specific freight design considerations are needed to address the configuration and number of lanes and how freight vehicle operations affect the facilities that serve other users. In the subsequent design phase, the implementation of freight strategies involves addressing a number of more specific design considerations, especially at intersections.

The particular approach to freight-friendly roadway design will vary depending on the specific set of circumstances surrounding the project. However, the facility design should generally reflect both the freight facility function and the context area type. This guidance is designed to assist with the identification of viable approaches to design that serve a number of different situations and purposes, such as the following.

1. Throughput/Movement
2. Right Turn – Departing
3. Right Turn – Receiving
4. Right Turn – Side Street
5. Left Turn – Departing
6. Left Turn – Receiving
7. Left Turn – Side Street
8. Queuing
9. Miscellaneous/Special Circumstances
10. Multimodal Accommodations (Pedestrian, Bicycle, Transit)

Table 9-6 through **Table 9-8** show the typical elements of a roadway and how those elements should be scaled and located depending on the freight facility type and community context. The tables also show which of the purposes listed above are served or affected by the roadway element. These tables are followed by example intersections that demonstrate the types of elements that would be included on freight facilities with varying characteristics and in different community contexts.

Table 9-6: Freight Mobility Corridor Design Elements

Design Elements		Context Areas			
		Purpose	Community Oriented	Freight Oriented	Diverse Activity
Lane Widths	Outside Lane	1, 2	11-12 ft	12-13 ft	11-13 ft
	Other/Inside Travel Lanes	1, 5	11-12 ft	11-12 ft	11-12 ft
	Turn Lanes	1, 2, 5, 8	Min 11 ft	Min 12 ft	Min 11 ft
Turning Radii (Right Turn)	One Receiving Lane	1, 2, 3	Taper or limit truck turns	Taper or multiple radius	Taper or multiple radius
	Two Receiving Lanes	1, 2, 3	Up to 45 ft	Up to 65 ft	Taper or multiple radius
	Three Receiving Lanes	1, 2, 3	Up to 30 ft	Up to 45 ft	Taper or multple radius
Right Turn Corner Islands		9, 10	Not Recommended	Optional	Optional
Turn Lane Length		1, 8	Min 160 ft	Min 480 ft	Min 400 ft
Tapered Curbs		1, 2, 3, 4	Recommended	Recommended	Recommended
Raised Medians	Width	1, 5, 6	13-14 ft	14-16 ft	13-16 ft
	Nosing	1, 5, 6	Set back	Set back	Set back as needed
Refuge Islands		9, 10	Optional	Optional	Optional
Bicycle Lanes		1, 2, 3, 10	Include	Consider alternative route	Consider other route where there are 6 or more lanes
Bulb-Outs		9, 10	Optional	Not Recommended	Not Recommended

Table 9-7: Freight Distribution Route Design Elements

Design Elements		Context Areas			
		Purpose	Community Oriented	Freight Oriented	Diverse Activity
Lane Widths	Outside Lane	1, 2	11-12 ft	11-13 ft	11-12 ft
	Other/Inside Travel Lanes	1, 5	10-12 ft	11-12 ft	10-12 ft
	Turn Lanes	1, 2, 5, 8	Min 10 ft	Min 11 ft	Min 10 ft
Turning Radii (Right Turn)	One Receiving Lane	1, 2, 3	Taper or limit truck turns	Taper or multiple radius	Taper or multiple radius
	Two Receiving Lanes	1, 2, 3	30 ft max or taper	Up to 65 ft	Taper or multiple radius
	Three Receiving Lanes	1, 2, 3	Up to 30 ft	Up to 45 ft	Taper or multple radius
Right Turn Corner Islands		9, 10	Not Recommended	Optional	Optional
Turn Lane Length		1, 8	Min 120 ft	Min 400 ft	Min 320 ft
Tapered Curbs		1, 2, 3, 4	Optional	Recommended	Recommended
Raised Medians	Width	1, 5, 6	8-14 ft	13-16 ft	12-14 ft
	Nosing	1, 5, 6	Set back	Set back as needed	Set back as needed
Refuge Islands		9, 10	Optional	Optional	Recommended
Bicycle Lanes		1, 2, 3, 10	Include	Consider other route where there are 6 or more lanes	Consider other route where there are 6 or more lanes
Bulb-Outs		9, 10	Optional	Not Recommended	Optional

Table 9-8: FAC Streets Design Elements

Design Elements		Context Areas			
		Purpose	Community Oriented	Freight Oriented	Diverse Activity
Lane Widths	Outside Lane	1, 2	11-12 ft	11-13 ft	11-12 ft
	Other/Inside Travel Lanes	1, 5	10-12 ft	11-12 ft	10-12 ft
	Turn Lanes	1, 2, 5, 8	Min 10 ft	Min 11 ft	Min 10 ft
Turning Radii (Right Turn)	One Receiving Lane	1, 2, 3	Taper or limit truck turns	Taper or multiple radius	Taper or multiple radius
	Two Receiving Lanes	1, 2, 3	30 ft max or taper	Up to 65 ft	Taper or multiple radius
	Three Receiving Lanes	1, 2, 3	Up to 30 ft	Up to 45 ft	Taper or multple radius
Right Turn Corner Islands		9, 10	Not Recommended	Optional	Optional
Turn Lane Length		1, 8	Min 120 ft	Min 400 ft	Min 320 ft
Tapered Curbs		1, 2, 3, 4	Optional	Recommended	Recommended
Raised Medians	Width	1, 5, 6	8-14 ft	13-16 ft	12-14 ft
	Nosing	1, 5, 6	Set back	Set back as needed	Set back as needed
Refuge Islands		9, 10	Optional	Optional	Recommended
Bicycle Lanes		1, 2, 3, 10	Include	Include	Include
Bulb-Outs		9, 10	Optional	Not Recommended	Optional

Freight Oriented Area

Intersections in Freight Oriented context areas should be designed to optimize the operational efficiency of trucks. This is particularly important where two facilities on the Freight Network meet, but applies generally to all intersections. The above graphic demonstrates the following recommended stratgies:

1. **Truck channels** facilitate right turn movements for trucks while providing space for pedestrian refuge and signal poles and equipment. They give the truck storage space that is outside the departing through lane for the yield condition, creating better operating and safety conditions for through traffic.

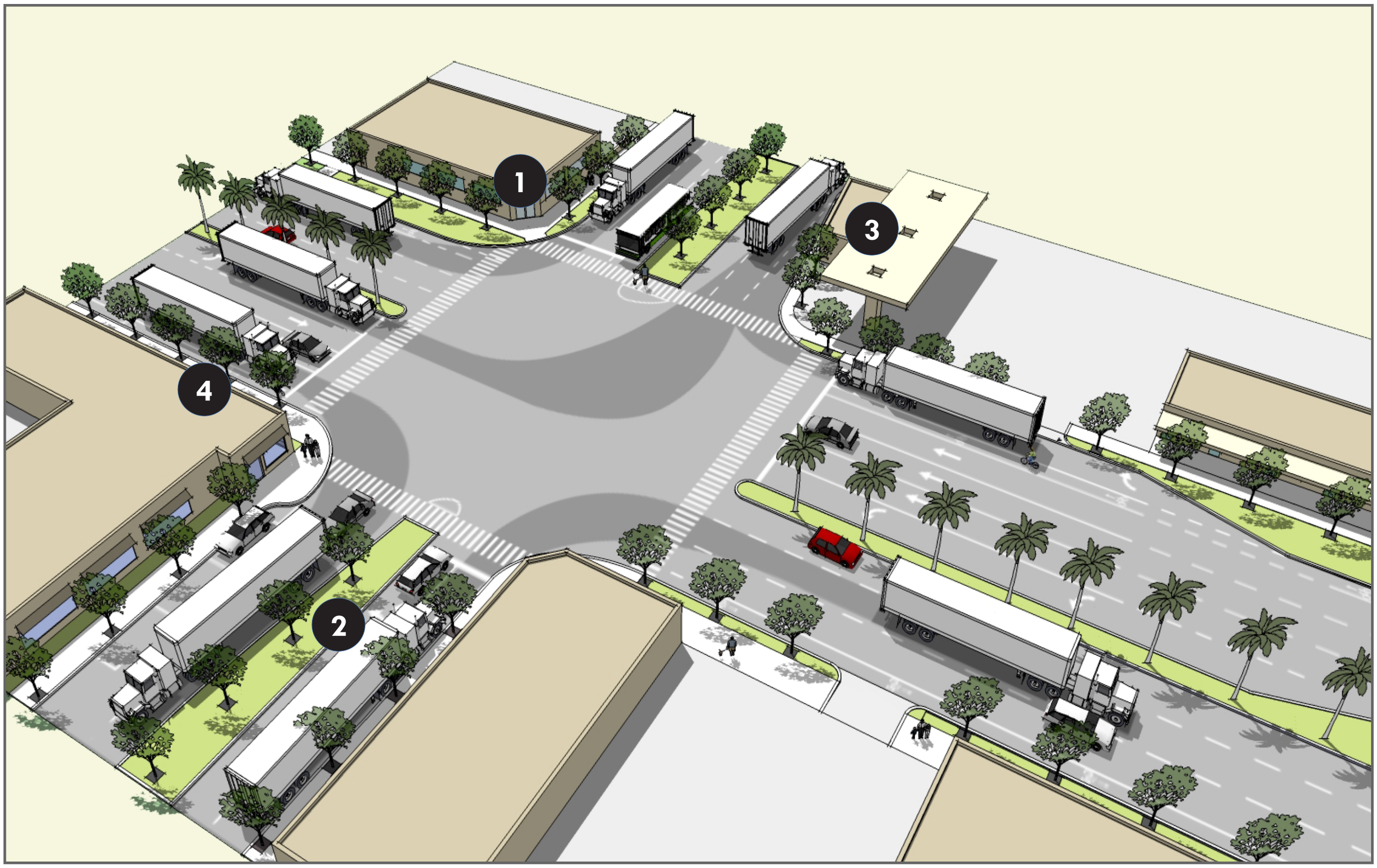
2. **Median nosings** can be designed to allow additional space for trucks making left turns on or off the mainline facility. They assist trucks in departing left turn lanes and entering recieving lanes. They can be set back from the crosswalk further than normal or striped, depending on the width of the median and the need to guide vehicles into a particular turning pattern.

3. **Left turn lanes** should be designed as single lanes where volumes and the intersection signal phasing and timing strategy support it. Dual lefts can be problematic for traffic in adjacent lanes and opposing traffic in the middle of the intersection where the truck wheel tracking distance is the greatest. Dual lefts can also make it difficult for trucks to enter the recieving lane.

4. **Extended left turn lanes** provide additional storage for trucks and other vehicles. Signal timing and phasing should be designed to allow for processing slower-moving trucks.

5. **Corner radii** should be designed to accommodate trucks turning on and off the mainline facility. In most cases, trucks will use two recieving lanes to complete the turn and each intersection radius can be sized accordingly.

Diverse Activity Area



Intersections in Diverse Activity context areas should be designed to facilitate truck movements while balancing the needs of other users of the roadway. This often has to occur in constrained rights-of-way where established curb lines, existing infrastructure and equipment and limited right-of-way widths shape truck-friendly solutions. The above graphic demonstrates the following recommended stratgies:

1. **Corner radii** should be designed to accommodate trucks turning on and off the mainline facility while maximizing the use of recieving lanes to complete the turn. Tapered curbs and multiple-radius curbs can be used in lieu of increasing a single radius curb to accommodate the truck turn.

2. **Tapered medians** or **expanded recieving lanes** on the side street provide additional turning space where the recieving lanes are inaddequate and/or where the corner radius cannot or should not be increased. Tapered medians and expanded recieving lanes do not increase the crossing distance for pedestrians like increased corner radii do. They also do not require additional right-of-way in retrofit conditions.

3. **Tapered curbs** can expand the area for trucks to make left and right turns from the mainline facility to the side street. They do increase the crossing distance for pedestrians. Tapered curbs need to be considered as retrofits in light of a number of conditions, including right-of-way, sidewalk width, drainage and location of equipment.

4. **Bicycle lanes** provide a secondary benefit for trucks beyond their primary function. When trucks are turning right out of a shared through lane, the offset from the curb provides the truck more room to trun by shifting the inside wheel tracking away from the corner radius. When present on the side street, bicycle lanes increase the effective recieving area width.

Community Oriented Area

Intersections in Community Oriented context areas should be designed to accommodate trucks while optimizing the roadway operations for other vehicles and facilitating safe, comfortable and convienent pedestrian access. These areas often have constrained rights-of-way, a limited number of through lanes and shared turn lanes. Roadways should be designed so that smaller trucks can operate. Larger trucks need to be anticipated on the mainline facility, but may not be the appropriate design vehicle for side street conditions and turns due to physical limitations or lack of need due to very low large truck volumes. The above graphic demonstrates the following recommended stratgies:

1. **Median nosings** can be set back from the crosswalk further than normal on the mainline facility where large truck turns are anticipated. Extended median nosings with crosswalks in advance of the nosing do not typically interfere with small truck turning movements.

2. **Curb extensions/bulb outs** and **on street parking** should be avoided in the portions of receiving lanes that would allow for expanded outside wheel tracking. Providing this space makes it easier for trucks to turn right and left off the mainline facility onto the side street. On street parking should be avoided on mainline facilities on the Freight Network.

3. **Corner radii** should be designed to accommodate larger trucks on and off the mainline facility at intersections with other facilities on the Freight Network and at major arterials. Radii should be designed to accommodate smaller trucks turning on and off the mainline facility at secondary side streets.

4. **Stop bar set backs** allow for larger trucks to make left turns from the mainline facility onto the side street by providing more space for inside wheel tracking. Depending on the departure lane and corner condition, they can also help facilitate right turns from the mainline facility onto the side street. The stop bar can be staggered for multiple lane approaches with no median such that only the stop bar on the outside lane is set back from the crosswalk.

FREIGHT FACILITY DESIGN CONSIDERATIONS

The major design topics relating to freight are described below, along with general information about how variations in these elements relate to the context areas and the affect on the mobility of trucks and other system users. **Table 9-10** at the end of this section outlines the general applicability of each design element on non-limited access facilities based on the context area type.

Design Vehicle

It is important to understand and accommodate the types of trucks that will be using a particular freight facility. The types of trucks using a freight facility will depend on a number of factors, including the surrounding land use context, throughway facility type, and cross-street facility type. For the purposes of these design guidelines, the Wheel Base-67 and Wheel Base-40 trucks were used in the graphics accompanying the recommendations for freight facility design. **Table 9-9** provides recommendations for the type of design truck to be used at the various combinations of throughway facility types and cross-street facility types.

Table 9-9: Design Truck Types for Throughway Facilities

Cross-Street Facility Type	Throughway Facility Type			
	Limited Access	Freight Mobility Corridor	Other Freight Distribution Routes	FAC Streets
Limited Access Facilities	WB 67	WB 67	WB 62	WB 62
Freight Mobility Corridors	WB 67	WB 67	WB 62	WB 62
Other Freight Distribution Routes	WB 67	WB 67	WB 62	WB 62
Freight Activity Center Streets	WB 67	WB 67	WB 62	WB 62
Other Major Arterials	WB 62	WB 62	WB 40	WB 40
Other Minor Arterials and Collectors	N/A	WB 62	WB 40	WB 40
Local Roads	N/A	WB 40	WB 40	WB 40

Lane Widths

In general, design engineers should consider maximizing lane widths to enhance truck mobility and maneuverability in freight oriented areas where there would generally be few obstacles to implementing wide lanes. However, in community oriented and diverse activity areas, wider lane widths may be undesirable because of their impact on the availability of right-of-way and curb to curb space available to accommodate pedestrian and bicycle facilities. Wide lanes increase crossing distances for pedestrians and promote higher travel speeds for automobiles, which creates an uncomfortable and potentially unsafe environment for non-motorized users. In these context areas, lane widths should be assessed in terms of the facility's primary freight function (mobility, connectivity, circulation, or access) and in light of local land use and urban design considerations.

Lane width can vary depending on whether a lane is the outside or inside lane of a street. Outside travel lanes are the preferred location for trucks and buses due to slower acceleration and travel speeds. Therefore, they are typically wider than inside travel lanes to accommodate these larger vehicles. In addition to providing a travel lane, outside lanes can also serve as parking lanes, bus lanes, bicycle lanes, or a combination of each.

In **Figure 9-1** shown below, the outside travel lanes are 12 feet wide, while the inside travel lanes are 11 feet wide.

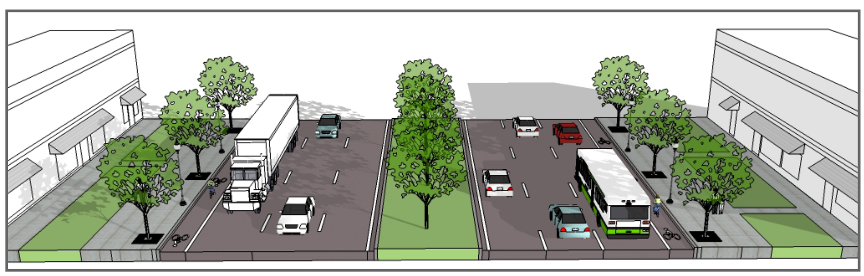


Figure 9-1: Expanded Outside Lane Widths

Intersections

Lane Configuration

Intersection design is one of the most critical factors affecting freight circulation and accessibility. Because large trucks require more space to make right turns than passenger vehicles, truck turning movements often utilize multiple travel lanes. Depending on the traffic and land use conditions at an intersection, these maneuvers can present significant operational difficulties and/or safety hazards. In freight oriented areas, intersection design should accommodate the largest design vehicle, the WB-67 truck. Where intersection improvements are needed to facilitate truck turning movements, a number of design options are available to enhance the intersection's freight functionality while providing for the safety of other system users.

Expanded Departure and Receiving Lanes

One factor that affects truck maneuverability at intersections is the number and width of departure and receiving lanes. Trucks making right turns may hug the lane line or encroach upon the adjacent lane to the left to position the vehicle to complete the turn without entering opposing travel lanes or tracking over the curb when turning. Providing additional width to the departure and/or receiving lanes may alleviate this condition at some intersections (depending on their existing configuration), but often additional lanes – especially receiving lanes – are needed to provide adequate space for trucks to safely and efficiently complete turning movements. Special receiving lanes may be incorporated into the intersection design to provide extra maneuvering space for trucks to complete turns while accommodating turning passenger vehicles simultaneously.

There would generally be few, if any, prospective issues posed by adding lanes at intersections in freight oriented areas. However, in community oriented and diverse activity areas consideration of right-of-way constraints and pedestrian comfort and safety is warranted. Design options for addressing the needs of non-motorized users at intersections are described later in this chapter. **Figure 9-2** and **Figure 9-3** display the different turning movements and curb radii for the WB-67 and WB-40 trucks.

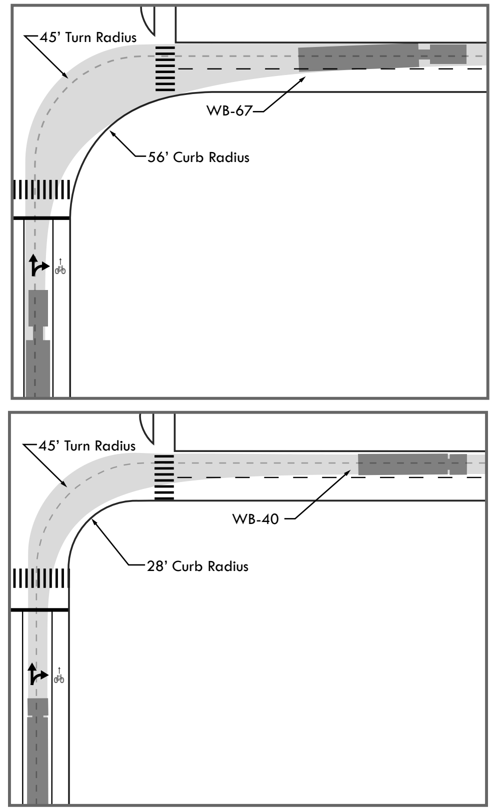


Figure 9-2: Trucks Turning from Departure Lane with a Bicycle Lane

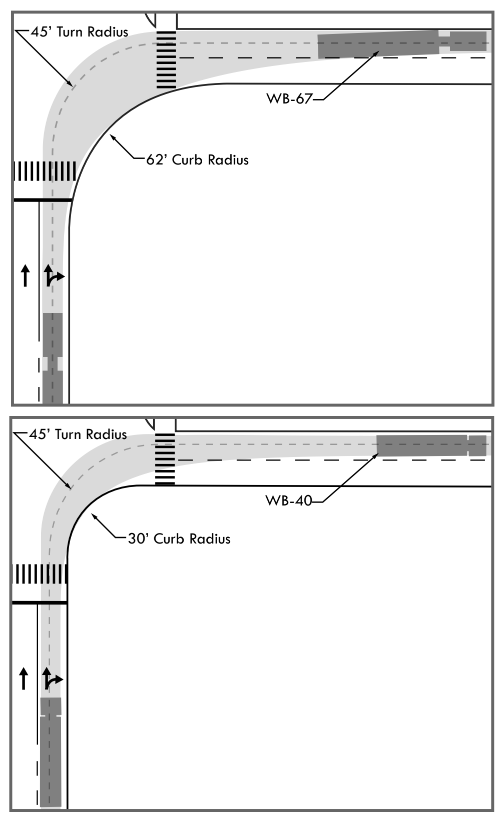


Figure 9-3: Trucks Turning from Departure Lane with no Bicycle Lane

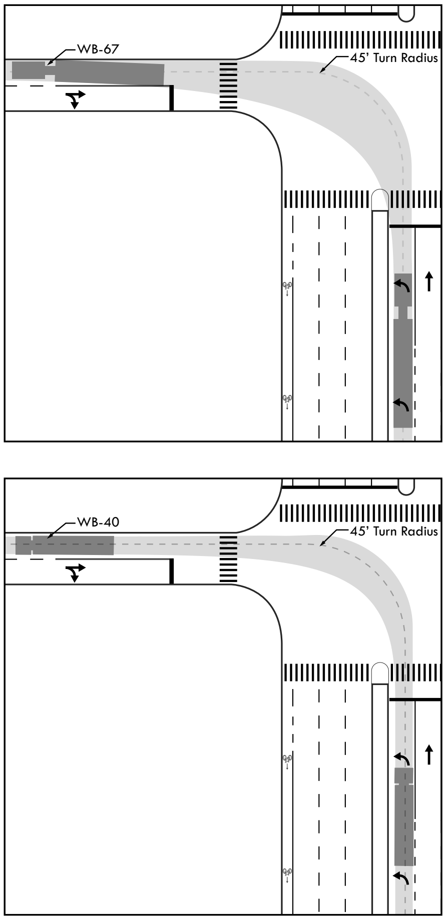


Figure 9-4: Stop Bar Locations

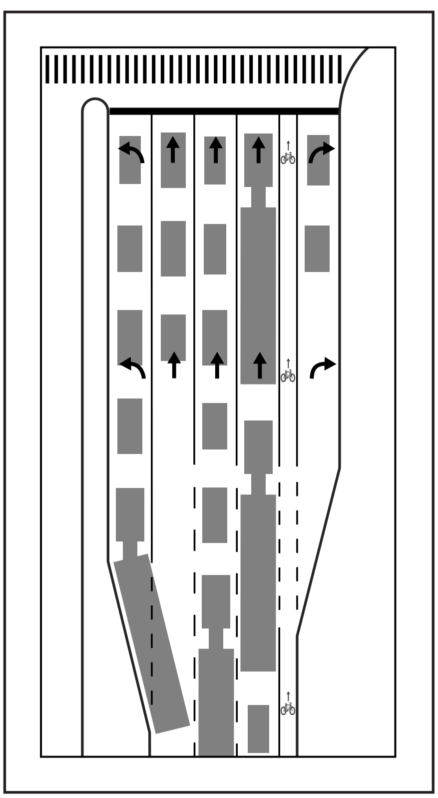


Figure 9-5: Extended Right and Left Turn Lanes

Stop Bars

Another design option for accommodating turning trucks at intersections is to set back stop bars for the travel lanes that oppose the turning vehicle's ultimate trajectory. This provides space for trucks to complete the turn without encroaching on the opposing travel lanes and may be an alternative to adding receiving lanes at constrained intersections. This design treatment also improves pedestrian safety by separating vehicles at the stop bar from the crosswalk. **Figure 9-4** shows how stop bar placement can accommodate left turning movements for both the WB-67 and WB-40 trucks.

Extended Turn Lane Length

Besides requiring additional space to complete turning movements, trucks require more storage space and have slower acceleration than passenger vehicles. Trucks queued to make right or left turns in medians or at signalized intersections may back up into through travel lanes if turn lane storage is inadequate. The backups may also impair the operational efficiency of signalized intersections where turn lane length and/or green times are insufficient to keep the through travel lanes clear. In such cases, it may be appropriate to extend turn lanes to maintain the overall efficiency of an intersection. **Figure 9-5** demonstrates how a short turn lane length can affect the efficiency of an intersection by blocking lanes.

Turn Radii and Curbs

Coupled with lane configuration and addressing the space requirements of turning trucks, turn radii and curb construction at intersections can affect the efficiency of truck movements. A wider turn radius at an intersection diminishes the need for trucks to encroach upon adjacent travel lanes when making right turns. On major regional roads and in freight oriented areas, turn radii are generally wide; on local streets – including some freight distribution routes – and in diverse activity or community oriented areas, turn radii tend to be narrower.

As is the case with lane width, design engineers should generally look to maximize turn radii at intersections with significant volumes of turning trucks and inadequate room for maneuverability in departure and/or receiving lanes. Ultimately, the appropriate turn radius will be determined by the design vehicle (based on the type and size of trucks most often making the turn), the freight facility type and freight function, the context area type, and the presence and needs of other system users.

Tapered curbs and multiple radius (compound) curbs

Where providing an optimally wide turn radius is infeasible (such as in community oriented or diverse activity areas), tapered curbs and multiple radius (or compound) curbs may present acceptable design alternatives. A tapered curb, as shown in **Figure 9-6** provides a short receiving space (like an abbreviated acceleration lane) to maintain a relatively tight turn radius while allowing the rear inside wheels of the truck to track over pavement. This diminishes the need for trucks to encroach on adjacent lanes when turning without increasing crossing distances for pedestrians. Multiple radius curbs, shown in **Figure 9-7**, are similar to tapered curbs but do not include the short receiving lane. The radius of the curb is narrow at the beginning of the turn to accommodate pedestrians but then flattens out to provide additional space for turning trucks.

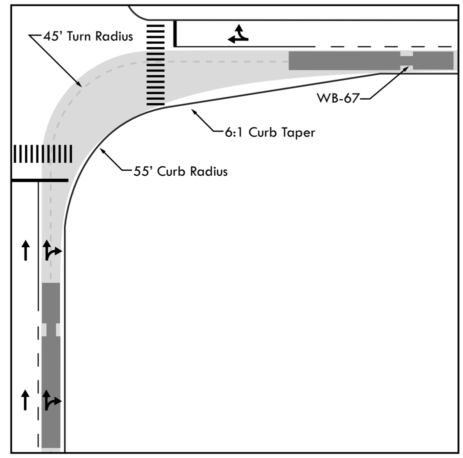


Figure 9-6: Tapered Curbs

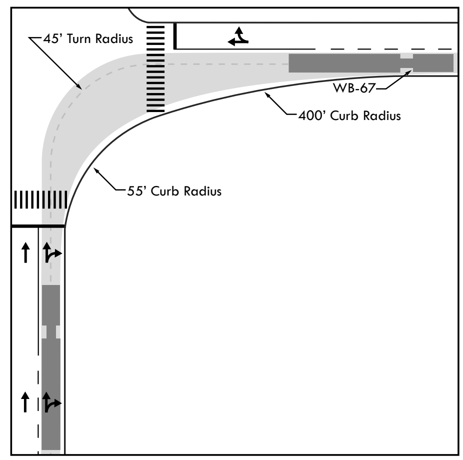


Figure 9-7: Multiple Radius Curbs

Finally, mountable curbs (sometimes referred to as roll curbs) are designed to allow trucks to drive over the curb when making turns without causing damage to the vehicle, trailer, or curb. Mountable curbs may be appropriate in community oriented and diverse activity areas where significant space constraints exist, where the volume of turning trucks is relatively low, and where existing curb lines are prohibitively expensive to move. Mountable curbs can be problematic for pedestrians, who do not anticipate the area back of curb to be potential shared space with turning trucks.

Accounting for Non-Motorized System Users

When implementing a freight mobility improvement, the design engineer should emphasize the primary freight function of the improved facility. However, it is also important to provide for the needs of other system users, including non-motorized users, especially in community oriented and diverse activity areas. Non-motorized users are bicyclists and pedestrians. Some design options for balancing the maneuverability needs of trucks with pedestrian-friendly treatments at intersections through turn radii and curb design are described above. Additional corridor and intersection design elements that address the needs of bicyclists and pedestrians are described below.

With the exception of limited access facilities, it may be appropriate to incorporate bicycle lanes or paved shoulders along a freight corridor. These spaces improve bicyclist safety by limiting conflicts between bicyclists and motor vehicles, including trucks. Bicycle lanes and paved shoulders provide a benefit for larger vehicles, which take advantage of the additional space when making right turns at intersections and driveways. The decision to incorporate bicycle lanes may be based on the context area, a local bicycle master plan, and state or local policies.

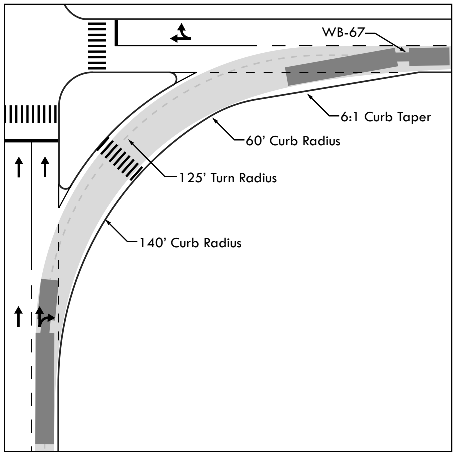


Figure 9-8: Typical Truck Channel

Channelized Turns

At intersections with wide turning radii or where pedestrian crossings span numerous lanes, it may be appropriate to include median and/or right turn corner pedestrian refuge islands. The islands allow pedestrians to make crossings in stages, as shown in **Figure 9-8**, which may be necessary at large and busy intersections, especially those with high volumes of turning traffic. If designed appropriately accounting for inside and outside truck wheel tracking, right turn islands can be used to provide a wide turning radius for trucks while accommodating pedestrian needs.

Curb extensions

A curb extension (or bulb out) can be used as a traffic calming device and to enhance pedestrian visibility at intersections and midblock crossings. Curb extensions also narrow the crossing distance for pedestrians and provide protection for boarding and alighting transit passengers. Additionally, they define areas for on-street parking. On freight facilities, curb extensions should only be considered at intersections where there is adequate space for truck right turns in departure and receiving lanes and where cross streets prohibit trucks. As shown in **Figure 9-9** , WB-67 trucks cannot avoid driving over a typical curb extension with a 25 foot curb radius while making a right turn. This poses a danger to pedestrians on street corners and adds to the wear-and-tear of the curb. Because of this, curb extensions in freight oriented areas should have larger curb radii than usual.

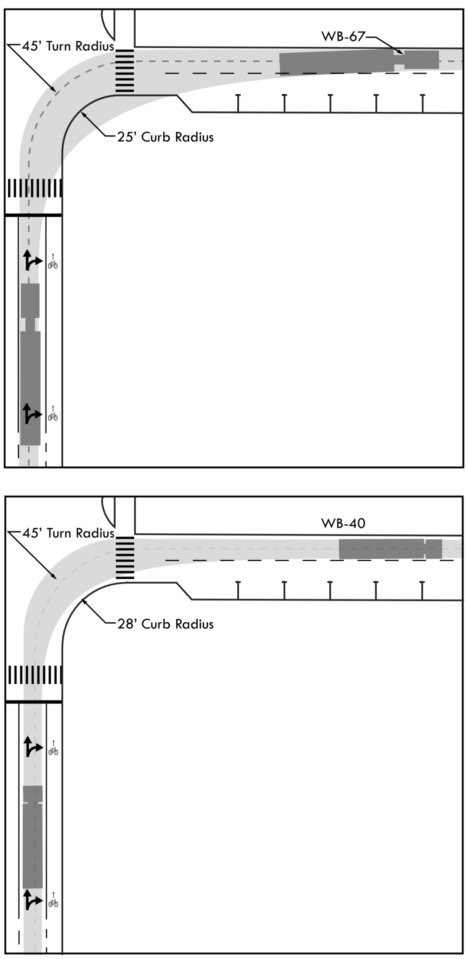


Figure 9-9: Curb Extensions

Buffers

Where there is sufficient right-of-way and depending on the urban design contexts, pedestrian safety and comfort can be enhanced by setting back sidewalks, especially on facilities with high traffic volumes and/or operating speeds. A buffer of trees, vegetation, parking, or other streetscape elements between the road and the sidewalk may further enhance the pedestrian experience. In **Figure 9-10** below, the sidewalk and multi-use trail bordering the street are buffered from the traffic by trees and strips of grass to provide protection and comfort to pedestrians and bicyclists on sidewalks and trails.

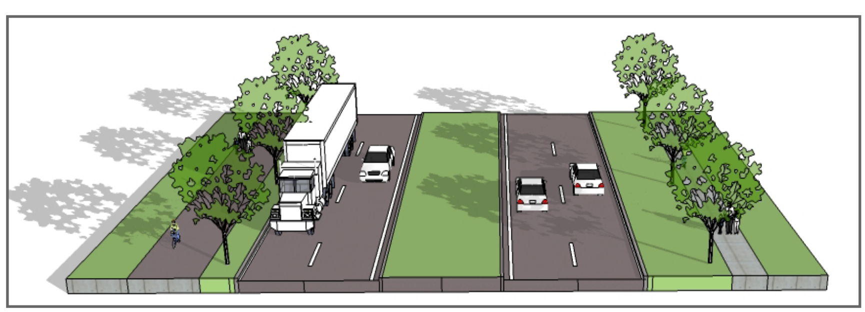


Figure 9-10: Sidewalk Setbacks and Tree Buffers

Fixed Objects

In general, design engineers should offset fixed objects, such as traffic poles, utility poles, street trees, or fire hydrants so that, in the event that a turning truck drives over the curb, these features and the vehicle are not damaged. The location of fixed objects is especially important at intersections with tight turn radii and/or few or narrow lanes. The location of fixed objects, especially trees and the ultimate growth pattern of their branches, needs to be considered relative to the width of the outside lane.

Special Median Considerations

Medians provide important access management and safety functions on major roadways. However, special median considerations for trucks are needed on the freight network. At intersections, medians, pedestrian refuge areas and median nosings adjacent to turn lanes can present difficulties for left turning trucks coming from side street approaches. In these cases, colorized flush medians and medians without nosings may be needed to keep trucks from tracking over the median space. Channelized left turn lanes in medians between signalized intersections need to be designed to accommodate truck movements where significant truck traffic is anticipated, as displayed in **Figure 9-11**.

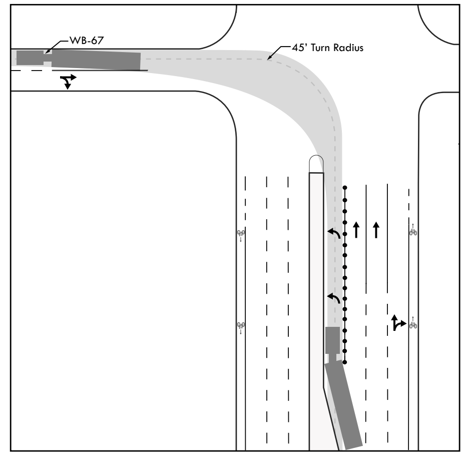


Figure 9-11: Channelized Left Turn

Designated Truck Turn Around Locations

Depending on the number of lanes and lane configuration on a freight facility, trucks can be limited in opportunities to perform U-turns. Medians can result in the need for U-turns to access side streets and properties. In areas where there are significant barriers and limitations to U-turns, designated truck turn around locations with tapered-curb receiving lanes should be considered. A typical U-turn condition is shown in **Figure 9-12**.

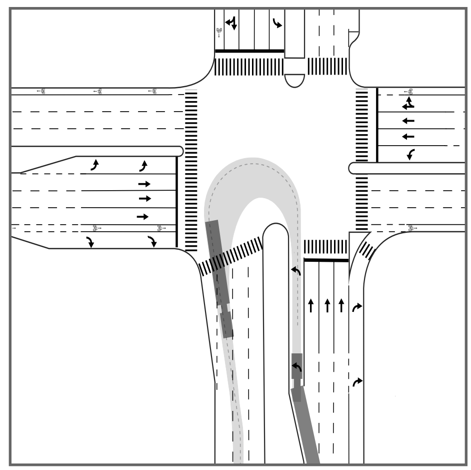


Figure 9-12: Truck Turn Around

Design Element Applicability

The major design topics described abve are listed in **Table 9-10**. The table shows the general applicability of each design element on non-limited access facilities based on the context area type. The particular roadway design strategy will vary depending on the specific set of circumstances surrounding the project. However, the facility design should generally reflect both the freight facility function and the context area type.

Table 9-10: Applicability of Freight Facility Design Considerations on Non-Limited Access Roadways by Context Area Type

Non-Limited Access Regional Freight Network Facilities				
Strategies	Context Areas			
	Low Activity	Community Oriented	Freight Oriented	Diverse Activity
Maximize lane widths	2	3	1	3
Widen/Add Departure, Receiving Lanes	1	3	1	2
Special receiving lanes	2	2	1	2
Set back stop bars	3	3	1	2
Extend turn lanes	2	1	1	2
Maximize turning radii	1	2	1	3
Tapered and multiple radius curbs	2	2	1	2
Bicycle lanes or paved shoulders	2	1	2	1
Modified right turn corner islands	2	2	1	3
Set back sidewalks	2	2	2	1
Curb extensions	3	2	3	1
Offset fixed objects	1	2	1	3
Flush medians/medians without nosings	2	2	1	2
Channelized left turn lanes	1	2	1	2
Designated truck turn around locations	3	3	1	3

Legend: 1 - Applicable
2 - Somewhat Applicable
3 - Limited Applicability