Bus Priority Treatment Guidelines

Webinar

Regional Bus Subcommittee of the TPB

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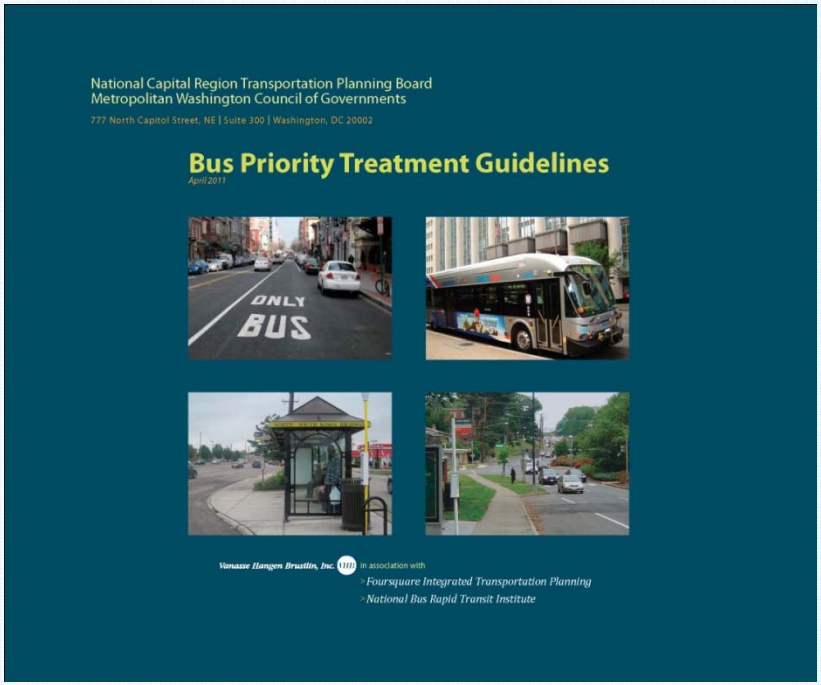
Today's Briefing

- Study Background
- Study Objectives / Scope of Work
- Guidelines Objective
- Guidelines Summary
- Lessons Learned
- Next Steps
- Discussion



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Acknowledgements

- COG/TPB Staff: Eric Randall, Jerry Miller
- WMATA: Sean Kennedy, Michael Eichler
- Technical Advisory Committee
  - Transportation staff from TPB regional agencies
- Contributing state and local traffic engineers
- Study team: VHB, Foursquare ITP, National Bus Rapid Transit Institute

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Study Background

- 2009 TPB and WMATA regional, corridor-level PCN evaluation conclusions:
  - Corridors would attract more riders
  - Increase access to jobs
  - Improve corridor travel times
  - Potential operational cost savings

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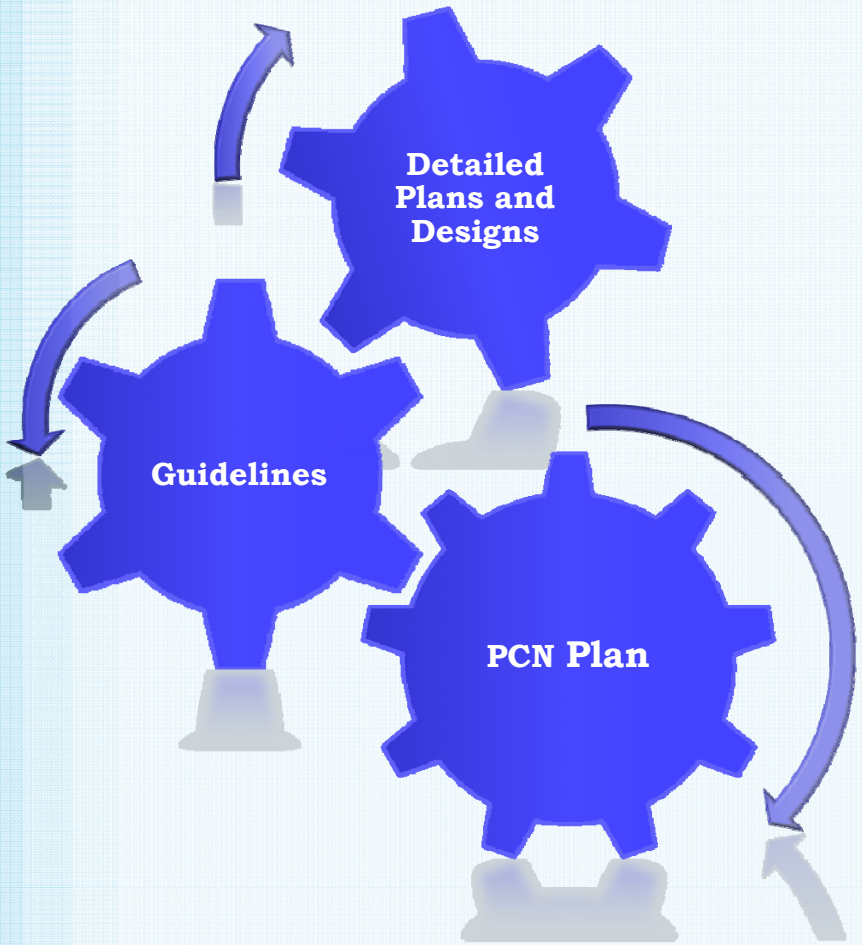
Why Develop Guidelines?



- Bridge between planning and application
- Provide traffic engineers with a toolkit of possible applications
- Provide an overview of
  - Suitability
  - Criteria
  - Impacts and Benefits
- Further analysis is recommended at the corridor, segment and intersection levels

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Study Objectives

- Provide a common regional reference
  - Support WMATA PCN, TIGER, and other bus priority and/or BRT projects
- Collect and disseminate information on feasible bus priority strategies
- Learn from local experience
- *Meet with regional roadway owners and traffic agencies*
- Foster coordination between transit and traffic stakeholders

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Guidelines Content

ORGANIZATION

- Priority Bus Treatments Overview
- Street Segments
  - Running Way
  - Bus Stops
- Intersections
  - Transit Signal Priority (TSP)
  - Queue Jumps and Crosswalks
- Sidewalks
  - Sidewalk Design and Bus Shelters

PRESENTATION

- Question and Answer Format
- Descriptions
- Drawings
- Local Examples
- Citations

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Local Examples Reviewed

- Richmond Highway Express (REX)
- Metrobus #79 Georgia Avenue
- Metrobus #37 Wisconsin Avenue Express
- Metrobus 28X Bailey's Crossroads-Tysons Corner
- Metrobus S9 Silver Spring – McPherson Square Line

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Transit Concepts from a Traffic Engineering View

TRANSIT PLANNING CONSIDERATIONS	TRAFFIC ENGINEERING CONSIDERATIONS
Riders	Vehicles
Headway	Frequency
Stop Frequency	Stop Location
Exclusive Lane	Restricted Lane
Transit Signal Priority	Signal System Timing
Shelter	Sidewalk Capacity
Fare Collection	Pedestrian Circulation
Schedule Reliability	Congestion
Crosswalk Location	Crosswalk Design

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Strategies Described

- Transit Signal Priority
- Queue Jumps
- Bus Bulbs
- Stop Location Alternatives
- Shelter Design
- Crosswalk Design
- Reserved Lane Options
- Sidewalk Design

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Transit Signal Priority

- TSP modifies signal timing to give an advantage to transit vehicles
  - Green extension or advance green
  - Conditional or unconditional
  - Active or passive
- TSP can improve the person throughput of an intersection
  - Bus passengers vs. car passengers
  - Person throughput included in HCM 2010
- Minimum green phase retained for adequate pedestrian crossing time

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TSP Limitations

- TSP should be considered where bus delays are due to heavy congestion
  - LOS D/E with V/C between 0.8 and 1.0
- TSP can be applied for both exclusive and mixed-traffic bus lanes
  - Integrate with queue jumps for mixed-traffic
- Signal priority not signal preemption
  - Signal preemption is for emergency vehicles (first responders)
  - Signal priority for priority buses

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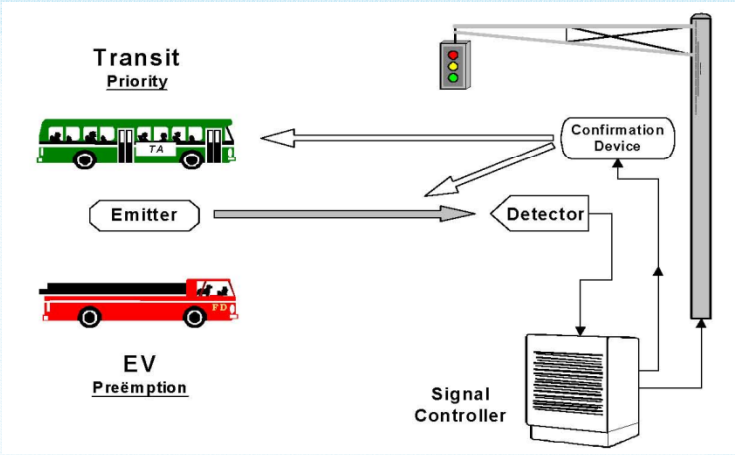
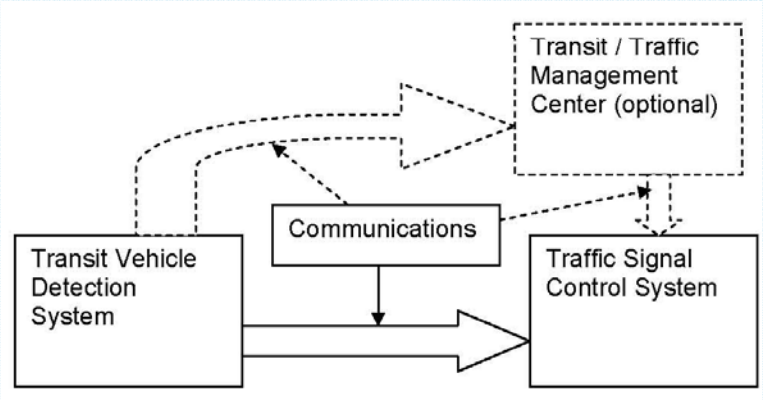
TSP Principles

- Many types of TSP give an advantage to transit vehicles
  - Green extension or advance green
  - Conditional or unconditional
  - Active or passive
- TSP can improve the person throughput of an intersection
  - Bus passengers vs. car passengers
  - Person throughput included in HCM 2010
- Minimum green phase retained for adequate pedestrian crossing time





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Comparison of TSP Technologies

Lane Detection

Exclusive Lane	Mixed Traffic
• Induction loop detector • Video detector • GPS/AVL • Optical emitter • Radar detector • RF tag	• RF tag • Optical emitter • GPS/AVL • Infrared

TSP Communication

Technology	Advantages	Disadvantages
Inductive Loops	• Devices placed in guideway rather than vehicle	• Only appropriate for exclusive busways • Devices damaged in road construction
Low Frequency RF (100-150 KHz)	• Transmitters inexpensive and are easily removed or replaced	• Message transmitted may be hindered by accumulated dirt or snow on tag
900-1000 MHz RF	• Transmitters inexpensive and are easily removed or replaced • Can transmit much information	• Message transmitted may be hindered by accumulated dirt or snow on tag
Spread Spectrum Radio	• Can transmit much information	• Not as accurate in locating buses as other radio frequency technologies • Can be affected by weather • May be more expensive
Infrared	• Well proven in Europe	• Limited ability to provide precise vehicle information • Limited amount can be transmitted from vehicle • Requires line of sight
Video		• Requires line of sight
Optical	• Cost savings if already in place for emergency vehicle preemption	• Limited ability to provide precise vehicle information and transmit from vehicle • Requires line of sight
GPS/AVL Vehicle Tracking		• Buildings may block signal • May not provide precise location information for signal priority treatment

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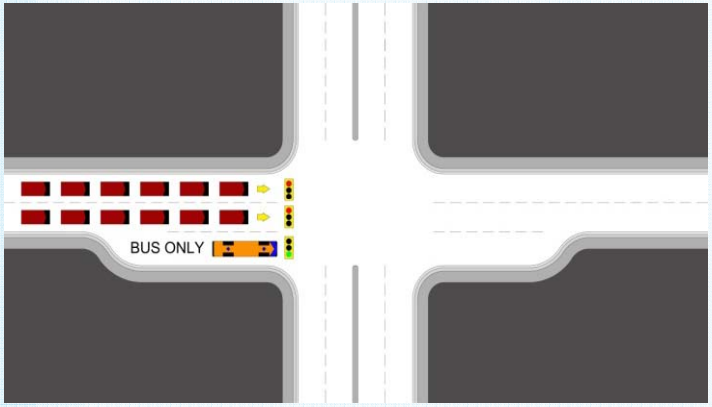
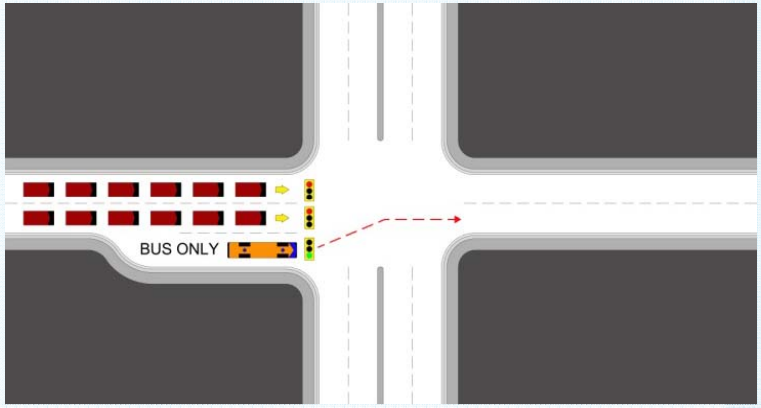
Sources (clockwise from L): ITS America (2004), TCRP #90 (2003), PVTA

Queue Jumps

- Use at intersections with LOS D or worse
- Integrated with stop locations and TSP
- Call for a striped crosswalk for every intersection with a bus stop
- Bus bulbs can reduce crossing distance / time
  - Include cut-throughs for cyclists



Far Side Stop Queue Jump



Near Side Stop Queue Jump

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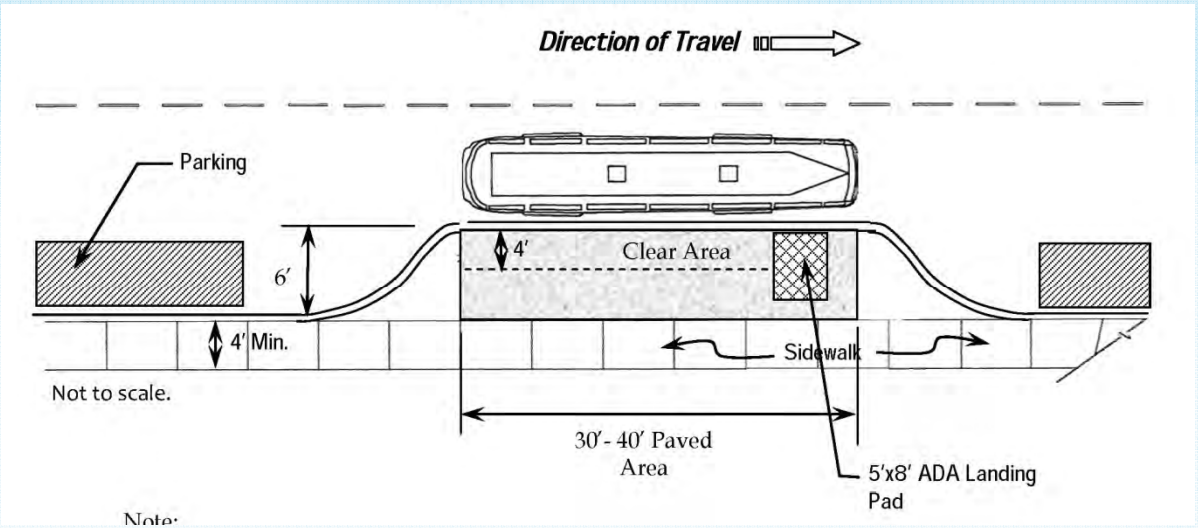
Bus Bulbs



WMATA Bus Bulb Design

- Provide space for shelters without reducing sidewalk width
- Allow buses to remain in moving lane
- Require 2 to 3 curb lane parking spaces

New York Select Bus

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Bus Bulbs

New York City

Select Bus, New York City

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Bus Stop Types

Type of Stop	Advantages	Disadvantages
Curb-side	• Provides easy access for bus driver and results in minimal delay to bus • Is simple in design and easy and inexpensive for a transit agency to install • Is easy to relocate	• Can cause traffic to queue behind stopped bus, thus causing traffic congestion • May cause drivers to make unsafe maneuvers when changing lanes in order to avoid stopped traffic
Busbay	• Allows patrons to board and alight out of travel lane • Provides a protected area away from moving vehicles for both the stopped bus and bus patrons • Minimizes delay to through traffic	• May present problems to bus drivers when attempting to re-enter traffic, especially during periods of high roadway volumes • Is expensive to install compared with curb-side stops • Is difficult and expensive to relocate • May disrupt the urban fabric in central city areas
Open Bus Bay	• Allows the bus to decelerate as it moves through the intersection • See Bus Bay advantages	• May cause delays to right-turning vehicles when a bus is at the start of the right turn lane • See Bus Bay disadvantages
Queue Jumper Bus Bay	• Allows buses to bypass queues at a signal • See Open Bus Bay advantages	• May cause delays to right-turning vehicles when a bus is at the start of the right turn lane • See Bus Bay disadvantages
Bus Bulb	• Removes fewer parking spaces for the bus stop • Decreases the walking distance (and time) for pedestrians crossing the street • Provides additional sidewalk area for bus patrons to wait • Results in minimal delay for bus • Accentuates the streetscape, providing space for shelters, plantings, and street furniture	• Costs more to install compared with curb-side stops • See Curb-side disadvantages • Depending on site conditions, may result in permanent loss of parking

Source: Transit Cooperative Research Program Report 19: Guidelines for the Location and Design of Bus Stops (1996) (adapted)

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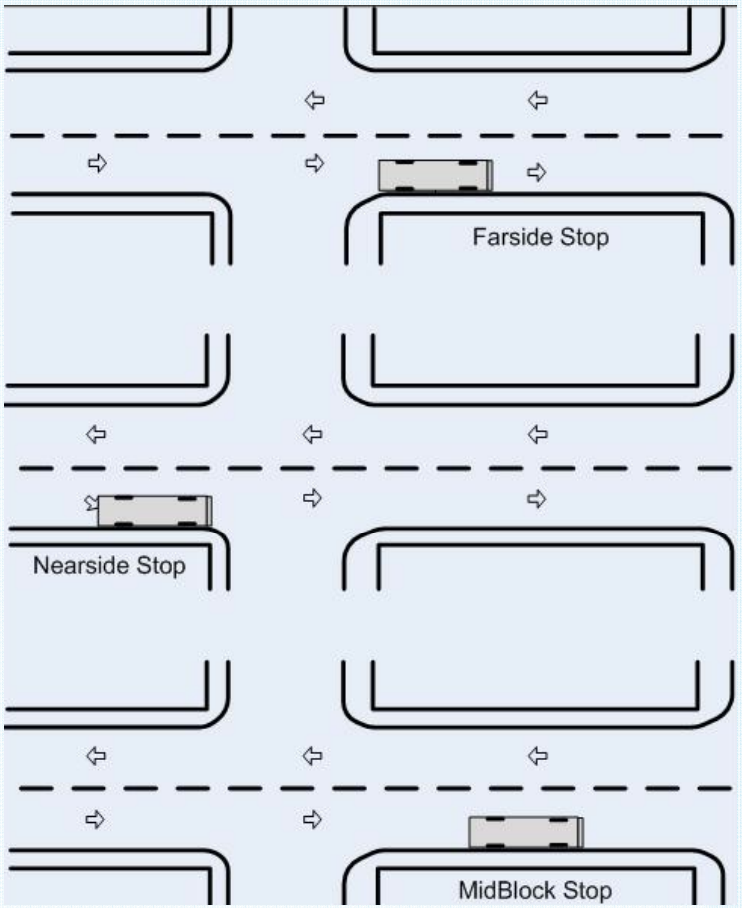
Stop Location Alternatives Factors

- Midblock stops are generally least desirable
- Far or near side stops depend on bus and traffic operations and space availability



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Shelter Design

WMATA

South Miami Busway

Lymmo – Orlando

Select Bus, New York

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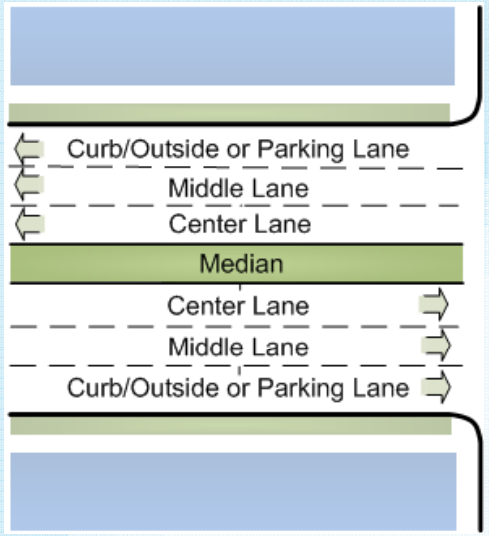
Types of Lane Reservations



Peak Hour Bus Lane (Kansas City Kansas)

Middle Lane Reservation (Cleveland, Ohio)

Curb Lane Reservation (New York, NY)

Median Lane Reservation

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Lane Use Considerations

Lane Used	Pros	Cons	Application
Outside	• Lowest cost of installation • Typically occupies less street space • Lower capital costs associated with bus stops • Easier/Safer Pedestrian Access	• Conflicts with on-street deliveries and other curb access needs • Conflicts with right turns • Conflicts with bicycle travel • Lower transit travel times savings • Requires removal of on-street parking • Does not provide strong image to priority service • Can be difficult to enforce	• Restricted lane use; may permit HOVs, must accommodate turning vehicles, often restricted to peak periods only
Middle	• Allows for on-street parking • Removes conflicts with illegally parked vehicles • Allow bus to avoid delays from turning vehicles	• Conflicts with cars parking • May require bus to pull out of traffic or construction of a bus bulb in order to access passengers • Strict enforcement needed	• Restricted lane use with HOV, turning vehicles, and peak-period only while allowing on-street parking
Center	• Moves bus operations away from the curb and sidewalk	• Conflicts with left turns • May require medians or islands with ample space to accommodate passengers waiting • May require buses with driver-side doors for passenger boarding	• Restricted lane use; may permit HOVs, must accommodate turning vehicles, often restricted to peak periods only
Median	• Clearly separates the bus stop from sidewalk activity • Provides a strong sense of identity to the priority bus • Enables contra-flow bus operation • Best option for future conversion to streetcars / LRT	• Pedestrian access more challenging • Requires the most space and greatest street width • Safety considerations involving wayward vehicles • Conflicts with left turns • Restricts flexibility of bus operation in using general traffic lanes or entering and exiting bus lane	• 24/7 dedicated bus-only with physical separation

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Crosswalk Design

- Crossing Considerations
  - Safe crosswalks are needed at every bus shelter
  - Signage and Markings
  - Minimize Crossing Distance
  - Used medians as safe havens
  - Pedestrian Signals are preferred

Val de Marne, France

Chicago, Illinois

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Crosswalk Principles

- Visibility
- Safety
- Minimize Crosswalk Distance
- Signage
- Vehicle Speeds
- Exclusive Pedestrian Phase where necessary

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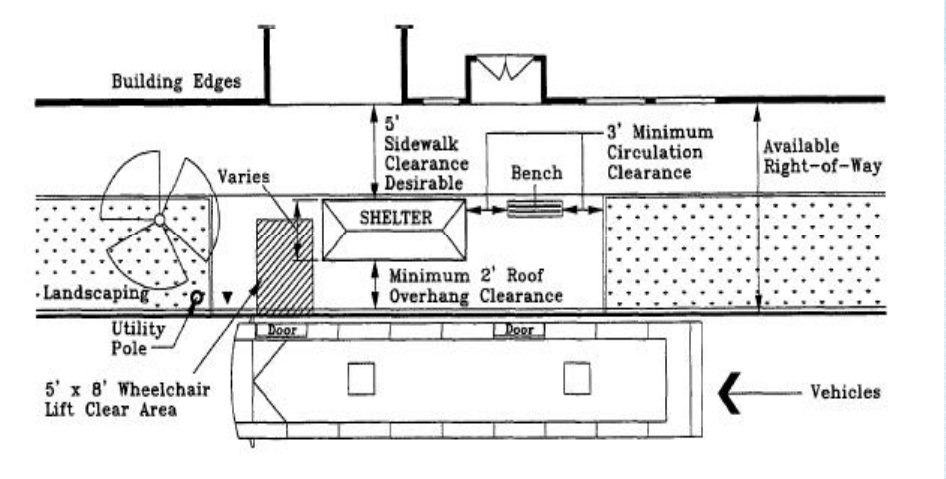
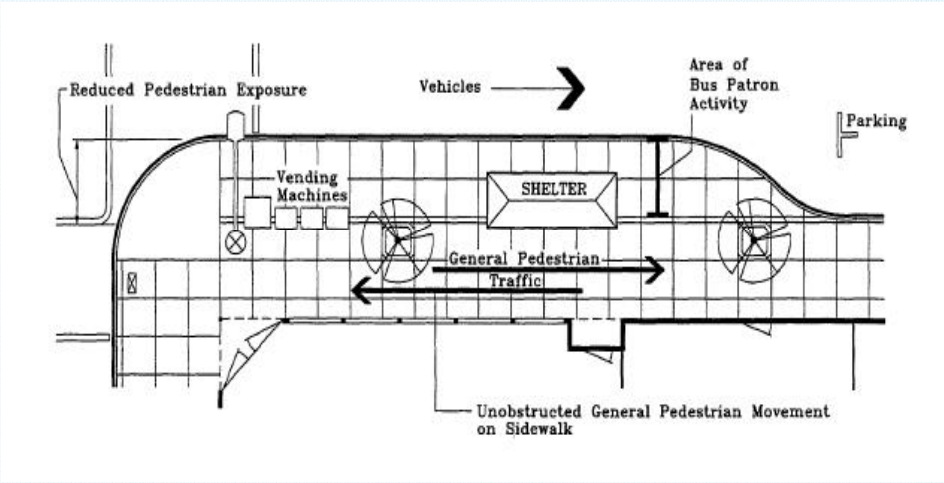
Sidewalk Design

- All transit trips require walking on at least one end of the trip
- Sidewalk design factors
  - Connectivity
  - Sidewalk width
  - Clearances around obstructions
  - ADA compliance



Mid-Block Layout Considerations



End Block Layout Considerations

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Lessons Learned

- Organizing and expressing priority bus concepts from the perspective of the traffic engineer aids communications
- There is broad acceptance of the value of examining capacity in terms of persons and not just vehicles
- Establishing a common vocabulary will assist in advancing priority bus objectives

Next Steps

- TIGER Grants
- Hot Spots Analysis
- WMATA TSP Initiative

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