Guidelines

Design and Placement of Transit Stops

Washington Metropolitan Area Transit Authority

DECEMBER 2009

FINAL REPORT

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Guidelines for the Design and Placement of Transit Stops for the Washington Metropolitan Area Transit Authority

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Section 1

Introduction

PURPOSE

The bus stop guidelines provided in this report are intended to provide Metro and its jurisdictional partners specific physical design criteria to be integrated with local comprehensive plan policies, land use ordinances, pedestrian plans, and street design guidelines. The design guidelines may also be used as a basis when working with local jurisdictions in planning access improvements to transit facilities. Developers or builders who are interested in developing transit friendly projects may also make use of these design guidelines.

CONTENTS OF REPORT

The design guidelines developed in this report are based on a review of current guidelines used by the local jurisdictions in the Metro service area, discussions with Metro staff and regional partners, input received at the public open house, a literature review, and review of standards and guidelines used in other metropolitan areas. Appendix A provides a detailed documentation of existing bus stop standards, guidelines, policies, and practices in the local jurisdiction. Appendix B provides a detailed summary of locally and nationally published bus stop design resources and examples of standards and guidelines in other areas.

In addition to the extensive review of existing bus stop standards and guidelines, an effort was also made to solicit input from the public through an Open House. The public, the local jurisdiction, and stakeholders were notified and invited to the Open House. Information collected at the Open House is provided in Appendix C.

The following sections of this report are organized as follows:

- **Section 2: Bus Stop Placement and Type.** This section presents guidelines for improving bus passenger experience at the street level. Provided are discussions of appropriate bus stop placement relative to the intersection and

different types of street-side designs such as on-street stops, curb-bulbs, and bus bays.

- **Section 3: Bus Stop Elements and Passenger Amenities.** This section presents guidelines for improving the accessibility to bus stops and the coordination of bus stop elements such as bus stop signs, bus stop posts, information cases, customer information, bus stop shelters, benches, bus stop lighting, Americans with Disabilities Act (ADA) landing pads, trash receptacles, vendor boxes, and art at transit stops. Also provided in this section are prototypical designs of bus stop facilities that are typical for the Washington Metropolitan region.

- **Section 4 – Bus Stop Spacing:** This section presents guidelines on appropriate spacing between bus stop locations and an analysis of the current spacing between stops for the Metrobus lines. Applying the recommended bus stop spacing, four bus stop consolidation scenarios were developed identifying potential running time and cost savings.

Section 2

Bus Stop Placement and Type

INTRODUCTION

The following guidelines focus on the needs of bus operators and bus passengers in the road right of way. Proper planning for bus facilities should be a major part of most road design. Safety is the most important consideration in planning for pedestrian facilities linking bus stops to passengers' origins and destinations. Therefore pedestrian facilities, such as clear demarcation of pedestrian crossings and the provision of properly designed sidewalks, should be given high priority in the design of streets. Universal design solutions should be utilized so that all people, with the widest range of abilities and circumstances can have equal access to transit. Universal design differs from the ADA Accessible Guidelines (ADAAG) in that while the ADAAG prescribes minimum design criteria to accommodate most persons with disabilities, universal design takes into consideration the broader population (i.e. children, seniors, bicyclists, parents pushing strollers) including persons with disabilities. More information can be found regarding universal design in the *Principles of Universal Design* by the Center for Universal Design at North Carolina State University.

BUS STOP LOCATIONS

The following bus stop configurations are provided as guidelines. Actual bus stop placement should take all location factors into account and be decided on a case-by-case basis. Bus stop locations are generally defined in relation to the intersection. The types of bus stop locations as it relates to the intersections are:

- Near-side (upstream) of the intersection
- Far-side (downstream) of the intersection
- Mid block (midway between intersections)

The relative advantages and disadvantages for each bus stop placement are presented in Table 2-1, in addition to the circumstances under which each location is recommended.

Table 2-1: Bus Stop Locations

Location Related to Intersection	Advantages	Disadvantages	Where Recommended
Far-side	• Minimizes conflicts between right turning vehicles and buses • Provides additional right turn capacity by making curb lane available for traffic • Minimizes sight distance problems on approaches to intersection • Encourages pedestrians to cross behind the bus • Creates shorter deceleration distances for buses • Results in bus drivers taking advantage of gaps in traffic flow created at traffic signals	• May result in intersections being blocked during peak periods by parked buses • May obscure sight distance for crossing vehicles • May increase sight distance problems for pedestrians • Can cause a bus to stop far-side after stopping for a red light • May increase number of rear-end accidents since drivers do not expect buses to stop again after a red light • Could result in traffic queued into intersection	• There is a high volume of turns • Route alignment requires left turn • Complex intersections with multi-phase signals or dual turn lanes • Traffic is heavier on the near-side • Existing pedestrian conditions are better on far-side • Traffic conditions and signals may cause delays if near-side • Intersections have transit signal priority treatments
Near-side	• Minimizes interference when traffic is heavy on the far side of the intersection • Allows passengers to access buses closest to the crosswalk • Results in the width of the intersection being available for the driver to pull away from the curb • Eliminates double stopping • Allows passengers to board and alight while the bus is stopped at a red light • Provides driver with opportunity to look for oncoming traffic	• Increases conflicts with right-turning vehicles • May result in stopped buses obscuring curbside traffic control devices and crossing pedestrians • May cause sight distance to be obscured for cross vehicles stopped to the right of the bus • May block the through lane during peak period with queuing buses • Increases sight distance problems for crossing pedestrians	• Traffic is heavier on the far-side • Existing pedestrian conditions are better than on the far-side • Pedestrian movements are safer on near-side • Bus route continues straight through the intersection
Mid-block	• Minimizes sight distance problems for vehicles and pedestrians • May result in passenger waiting areas experiencing less pedestrian congestion	• Requires additional distance for no-parking restrictions • Encourages jaywalking • Increase walking distance for patrons crossing intersections	• When the route alignment requires a right turn and curb radius is short • Problematic traffic conditions at the intersection • Passenger traffic generator is located mid-block • Compatible with corridor or district plan

Far-Side Stops

Figure 2-1 provides an illustration of a typical far-side bus stop location. For a standard 40′ bus, the stop should be located at least 50′ from the intersection to ensure that the rear of the vehicle does not protrude into the intersection and/or straddles the crosswalk. Far-side bus stop should be used if:

- Primary trip generator is upstream from the intersection
- Existing pedestrian facilities are greater than on the near-side
- High volume of right turns near-side of intersection
- Stop is part of a Bus Rapid Transit (BRT) service
- Pedestrian movements are safer than on the near-side

If curb-side parking is permitted after the stop, adequate clearances must be provided to allow the bus to safely merge back into traffic.

Near-Side Stops

Figure 2-2 provides an illustration of a typical near-side bus stop location. Stops located near-side of the intersection should be placed at least 5 feet from the crosswalk to prevent the bus from straddling the crosswalk while it is stopped to serve the stop.

Near-side bus stop should be used if:

- Primary trip generator is downstream from the intersection
- Existing pedestrian facilities are greater than on the far-side
- Pedestrian movements are safer than on the far-side
- Route requires a right turn at the intersection

If curb-side parking is permitted before the stop, adequate clearances must be provided to allow the bus to align with the curb. Near-side stops at intersections with dedicated right-hand turn lanes where right-on-red turning is permitted should be avoided.

Mid-Block Stops

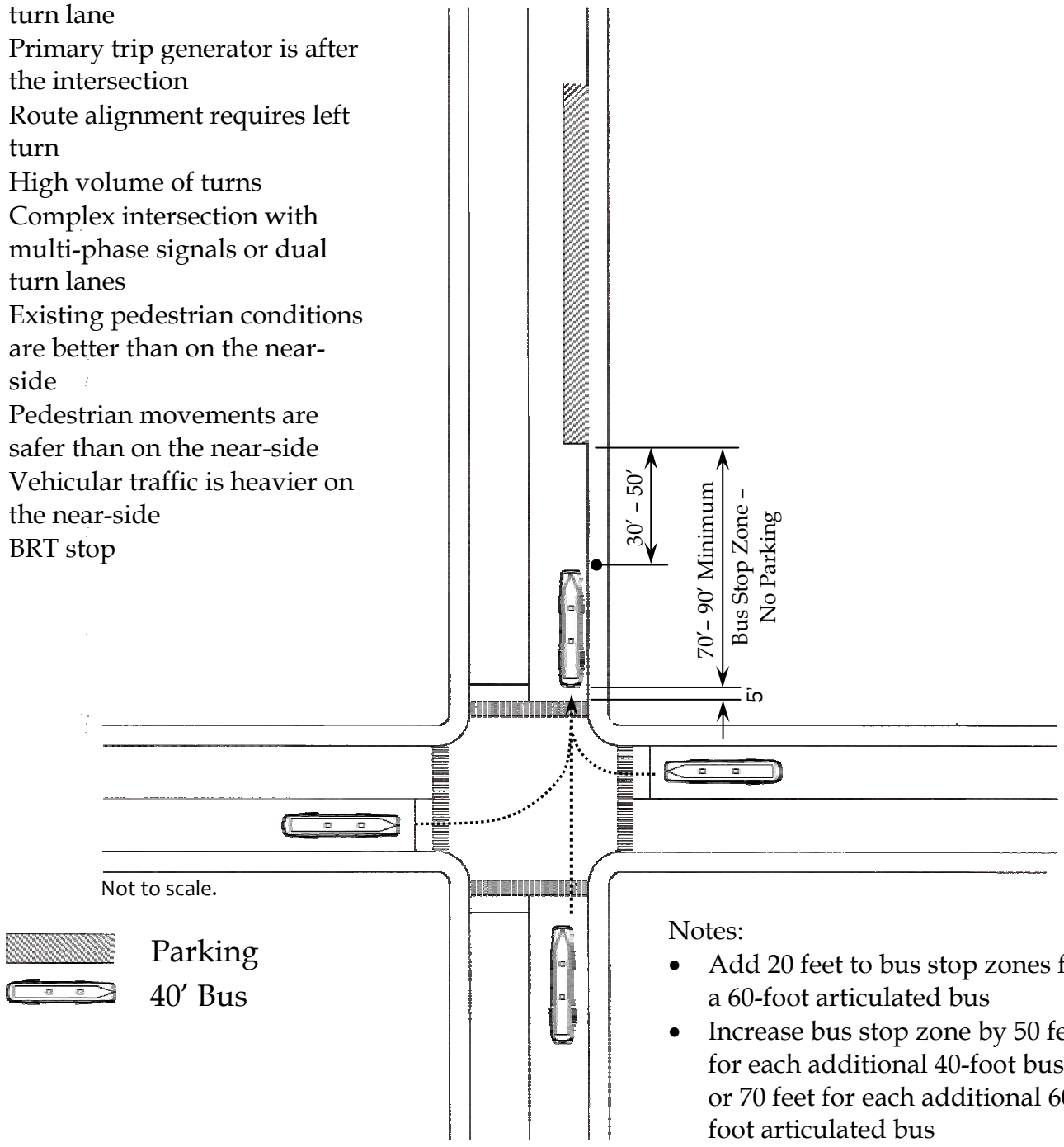
Figure 2-3 provides an illustration of a typical mid-block bus stop. Mid-block stops are generally not preferred and should be avoided when ever possible. Mid-block stops are appropriate when:

- Major trip generators are located mid-block and cannot be served at the nearest intersection

Figure 2-1
Typical Far-Side Bus Stop Placement

Where Recommended

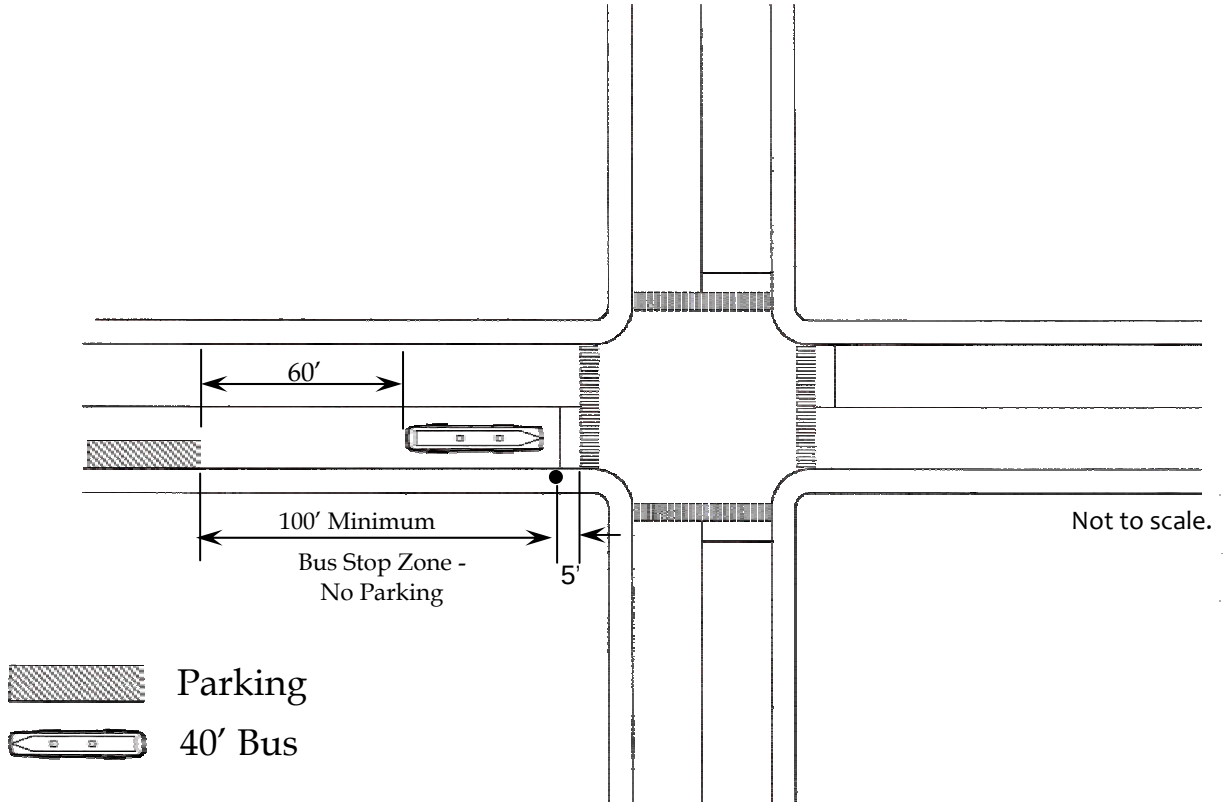
- Near-side stop is in a right turn lane
- Primary trip generator is after the intersection
- Route alignment requires left turn
- High volume of turns
- Complex intersection with multi-phase signals or dual turn lanes
- Existing pedestrian conditions are better than on the near-side
- Pedestrian movements are safer than on the near-side
- Vehicular traffic is heavier on the near-side
- BRT stop



Notes:

- Add 20 feet to bus stop zones for a 60-foot articulated bus
- Increase bus stop zone by 50 feet for each additional 40-foot bus or 70 feet for each additional 60-foot articulated bus

Figure 2-2
Typical Near-Side Bus Stop Placement



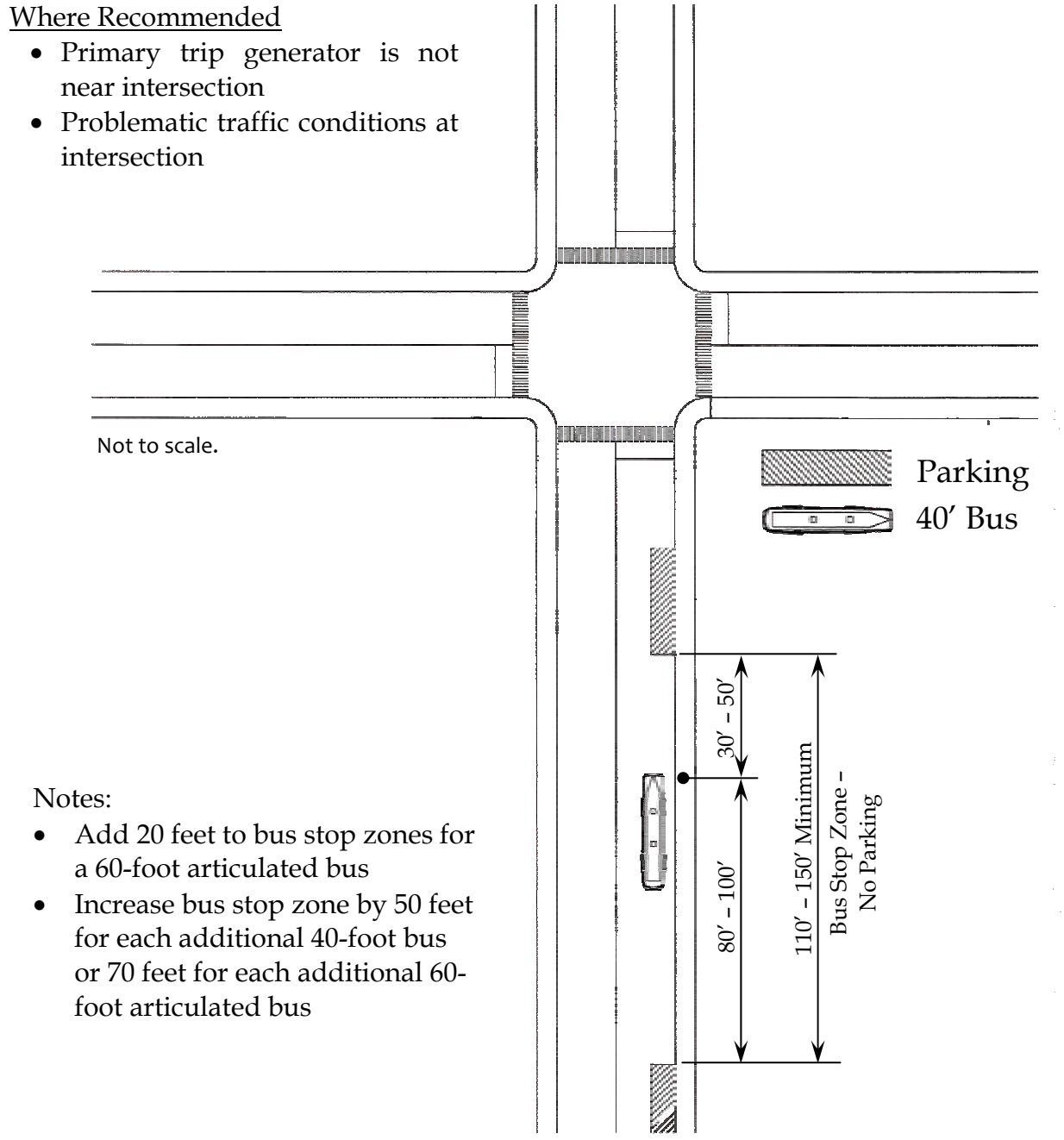
Notes:

- Add 20 feet to bus stop zones for a 60-foot articulated bus
- Increase bus stop zone by 50 feet for each additional 40-foot bus or 70 feet for each additional 60-foot articulated bus

<u>Where Recommended</u>

- Primary trip generator is before the intersection
- Existing pedestrian conditions are better than on the far-side
- Pedestrian movements are safer than on the far-side
- Vehicular traffic is heavier on the far-side

Figure 2-3
Typical Mid-Block Bus Stop Placement



Safety

Far-side, near-side, and mid-block locations all have inherent safety concerns. While far-side locations can be efficient operationally by allowing the bus to clear the intersection before servicing the stop, it unloads passengers further from the intersection where it is safer to cross the street. Near-side locations allow passengers to be unloaded closer to the intersection, but can lead to a situation where pedestrians are crossing the street in front of the stopped bus making it difficult for pedestrians to see on-coming traffic, and vice versa. Mid-block stops are discouraged, as the stops are not in proximity to an intersection where there are likely to be traffic lights and pedestrian crossing amenities, such as crosswalks, curb ramps, or crossing signals. How and where pedestrians will be crossing the street should be factored in when deciding on the appropriate placement of a bus stop.

Special Consideration for Schools

Bus stop locations near schools (particularly primary schools) should be placed in an area where it can be visually monitored by school personnel and/or crossing guards to increase safety and security. Mid block stops near schools are not recommended.

Other Location Considerations

- Locate stops served by multiple routes to minimize or protect (by way of intersection signals) street crossings for passengers making transfers between routes.

- Avoid placement in proximity to driveways; where unavoidable:
  - Attempt to keep at least one exit and entrance driveway open for vehicles to access the site
  - Locate stop where visibility for vehicles leaving the site is not obstructed, minimizing vehicle/bus conflicts (i.e., far side of the driveway).
  - Locate stop so passengers do not wait in the middle of the driveway or board/alight in the driveway
  - It is preferable for the bus to fully rather than partially block a driveway

- Place bus stops where they are easy to see by the bus operator, as well as other drivers and bicyclists. The stopped bus should also be easy to see from a distance by approaching traffic, to reduce the risk that the bus will be struck from behind when stopped in the roadway or pulling back into traffic from an off-street stop. For this reason, stops should not be placed:
  - just over the crest of a hill

- just beyond a curve where traffic is curving right and the far-side of the curve is obscured by trees, buildings, etc.

Bus stops should be clearly marked with signs or pavement markings to indicate that transit vehicles have exclusive use in the bus stop area. The best location will depend on vehicular and pedestrian patterns at the intersection, right-of-way availability, bus routing, roadway conditions, pedestrian facilities, and other conditions found at the site. It is important to note that bus stops are typically located in pairs (one on each side of the street along two-way route segments) and is generally recommended that bus stop pairs be positioned close together along the route to ensure simplicity in planning the return-trip. However, the conditions on one side of the street may lend themselves to a different placement than the stop on the other side of the street, and in such a case, each side of the street needs to be individually considered.

CURB-SIDE BUS STOP

Whether the bus should service a stop from a travel lane, by pulling out of the travel lane, or by exiting the roadway entirely depends on roadway and sidewalk design, posted speed limit, traffic signalization, traffic conditions, on-street parking, the number of buses servicing the stop at a time, length of the stop layover, curb clearance, and position of the stop related to the intersection.

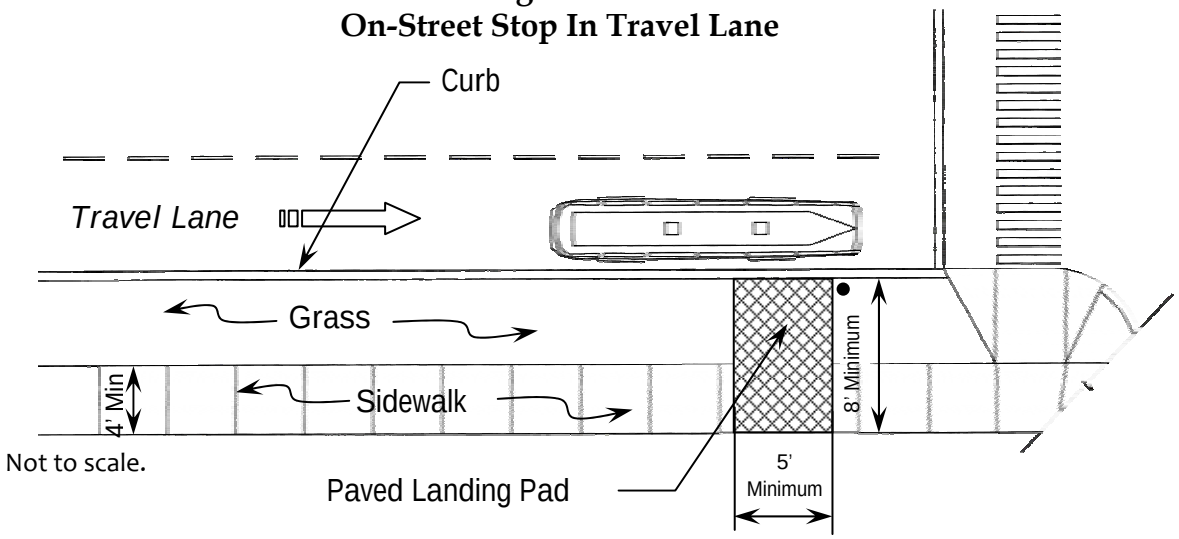
On-Street Stop

On-Street bus stops are the most frequently used curb-side bus stop facilities and is preferred for their operating efficiency. They provide easy access for bus operators and have minimal delays to service. On-street stops can be those where the bus stops in the travel lane, in a parking lane, or on the shoulder.

In Travel Lane

Stops in the travel lane require minimum design and can be easily established or relocated. If the stop can be accomplished with the bus in the travel lane, there is no potential for the bus to be delayed in waiting to re-enter the travel lane, after the stop is completed. However, in areas with high traffic volume, they can result in conflicts with other traffic. If traffic is moving at a relatively rapid pace (e.g., with posted speed limits at 45 miles per hour or more), a stopped bus in the roadway can present a safety hazard. Also, on-street stops should be avoided at stops with high volumes of passenger activity, at which the bus may be stopped for significant periods of time, since under these conditions the stopped bus would significantly disrupt traffic flow. Figures 2-4 illustrates a typical on-street bus stop in the travel lane.

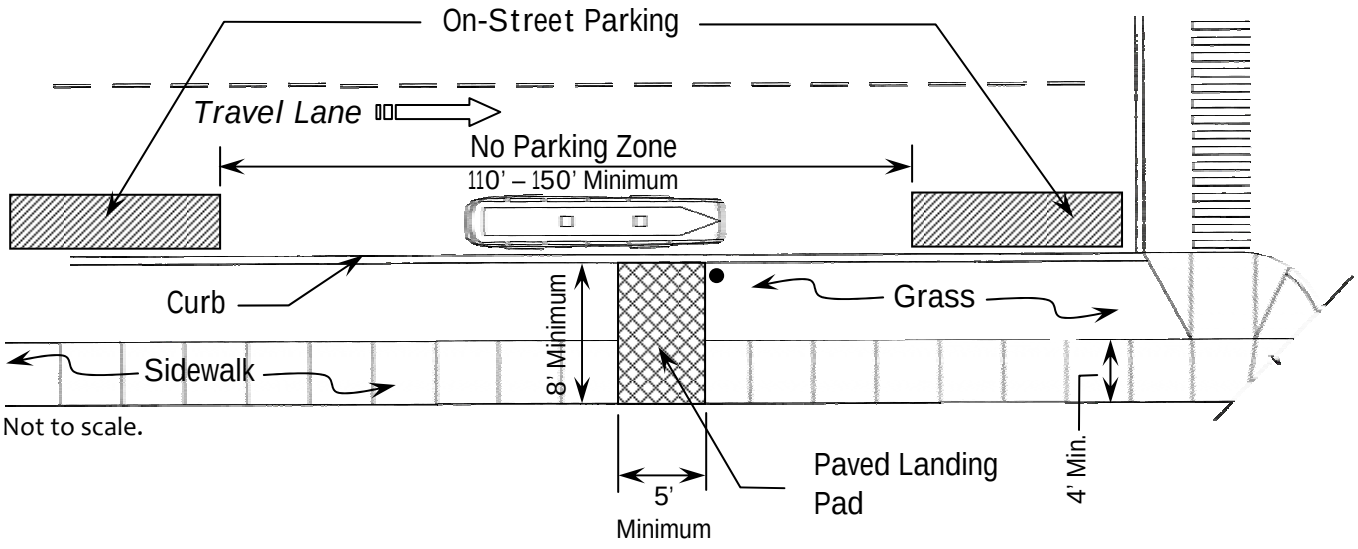
Figure 2-4
On-Street Stop In Travel Lane



In Parking Lane

This type of design is illustrated in Figure 2-5. The bus stopping area and acceleration/deceleration area needs to be designated as "no parking" with enforcement to ensure parked cars do not block bus access to the curb and render the stop inaccessible to customers who use wheelchairs. As a result of the parking capacity that this type of bus stop removes, the jurisdiction may want to consider constructing a curb bulb for stops which otherwise could be made on-street.

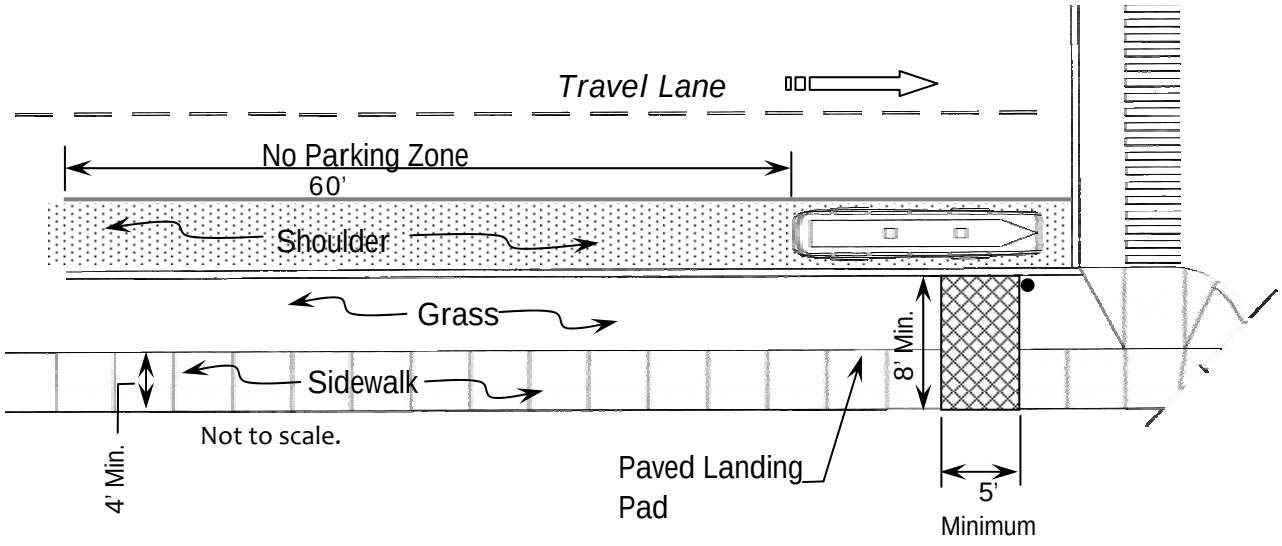
Figure 2-5
On-Street Stop in Parking Lane



On the Shoulder

As with the parking lane, unless the entire shoulder is "no parking at any time," the bus stopping area and acceleration/deceleration area needs to be designated as "no parking" with enforcement, to ensure parked cars do not block bus access to the curb (thereby making the stop inaccessible to customers who use wheelchairs). Also, the pavement under the bus stopping area should be reinforced with a concrete pad. This type of design is illustrated in Figure 2-6.

Figure 2-6
On-Street Stop on the Shoulder



Location Factors

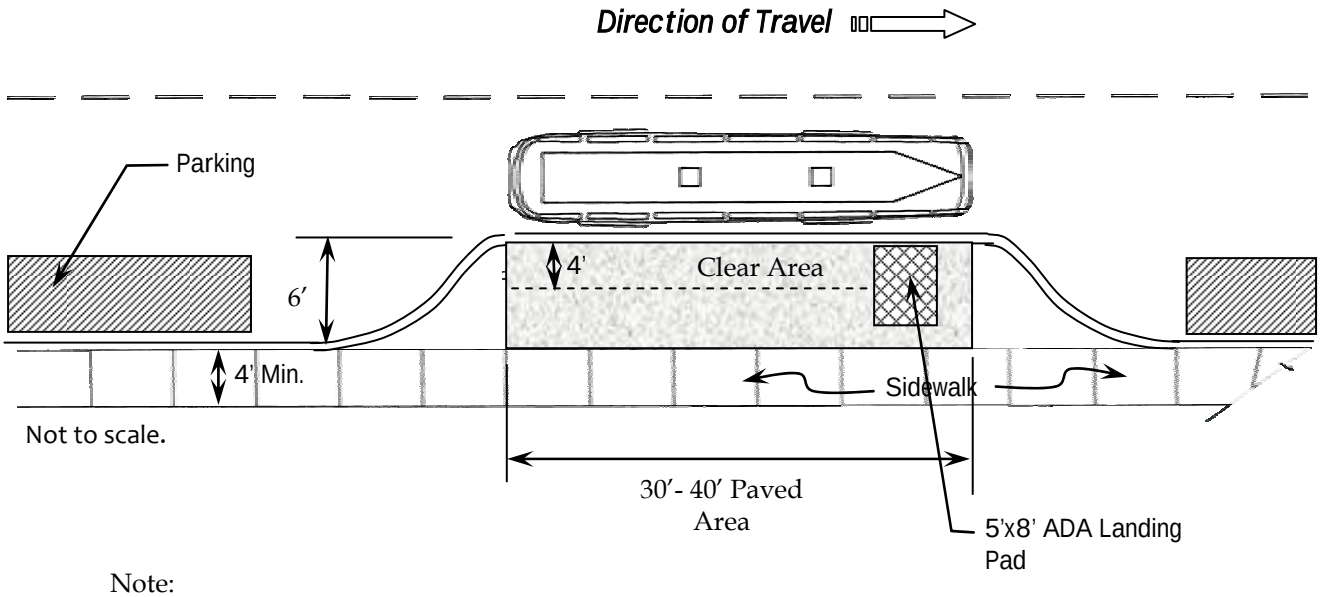
Ideally curb-side bus stops are placed in locations where:

- Travel speed is less than 40 mph
- Access can be provided for passengers with disabilities
- Major trip generators nearby
- Connections exist to pedestrian facilities
- Street lighting exists
- Adequate curb clearance is present to accommodate bus stop zone
- Nearby major intersections are signalized
- Passengers are not forced to wait, board, or alight in a driveway

CURB BULB

These are also sometimes referred to as curb extensions or nubs, sidewalk extensions, or bulb-outs. At locations with curbside parking, extending a portion of the sidewalk out to the travel lane allows most of the curbside parking to remain, while providing a connection between the travel lane and the sidewalk, so waiting passengers can easily access the bus (Figure 2-7). Bulbs maximize the amount of on-street parking around bus stops while minimizing needed curb clearance. Buses will remain in the travel lane while serving the stop and thus traffic will queue behind the bus particularly on single lane roadways.

Figure 2-7: Curb Bulb



Note:
Curb bulb should be 30′ - 40′ wide for standard 40′ bus with front and rear doors (50′ – 60′ for articulated bus)

Location Factors

Bus bulbs should be located:

- In areas where curbside parking is critical
- In areas with limited curb clearance
- In areas where buses experience delays in re-entering the traffic lane
- In areas where traffic calming is desired

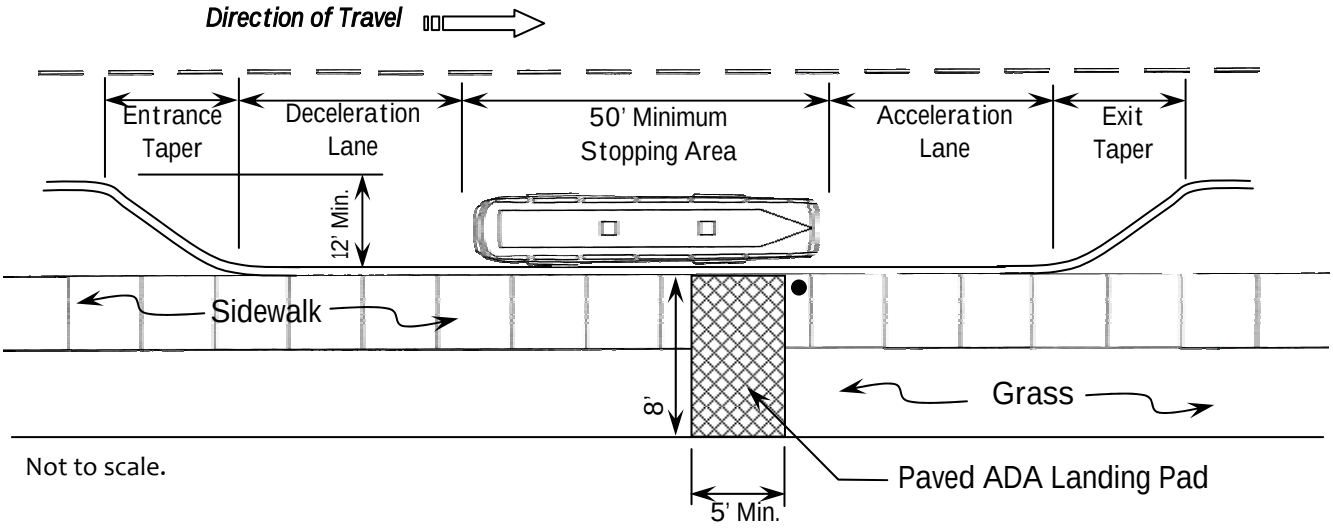
Minimum Clearance Needed

While a 5 feet wide by 8 feet deep sidewalk extension of these dimensions will meet minimum ADA standards, a larger clear curb area or bulb is preferred to ensure both front and rear door access and egress for most buses (for example, 30 feet of curb clearance is needed for rear-door access of 40-foot buses, increasing to 50 feet of clear space for 60-foot articulated buses).

BUS BAY

This type of stop (Figure 2-8) is sometimes called a bus bay, turn-out, or berth. It is constructed as an inset into the curb, typically with tapered ends for acceleration and deceleration. This type of stopping area should be designated and enforced as "no parking" and be reinforced with a concrete pad. This type of structure requires enough right-of-way so that sidewalk capacity would not be adversely affected.

Figure 2-8: Bus Bay



Acceleration and Deceleration Dimensions

Through Speed (mph)	Acceleration Lane Length (feet)	Deceleration Lane Length (feet)	Entrance and Exit Taper Length (feet)
35	250	184	170
40	400	265	190
45	700	360	210
50	975	470	230
55	1400	595	250
60	1900	735	270

Source: TCRP-19: *Guidelines for the Location and Design of Bus Stops.*
Note: Stopping area length is 50′ for each standard 40′ bus and 70′ for each 60′ articulated bus.

Bus bays allow buses to pick up and discharge passengers outside of the travel lanes. As a result, this allows traffic to flow unobstructed while the bus is stopped. Additionally, bus bays increase safety for passengers by increasing the distance between them and traffic. It also lessens the chances of a vehicle rear ending a stopped bus. Figure 2-8 illustrates a typical bus bay that will accommodate one 40′ bus and the appropriate acceleration and deceleration lanes.

Location Factors

Based on TCRP 19, the following locations should be considered for bus bays:

- Traffic speeds exceeds 40 mph
- Average peak-period dwell time exceeds 30 seconds per bus
- Buses are expected to layover
- History of vehicles colliding into back of bus
- Multiple buses serve the stop at the same time

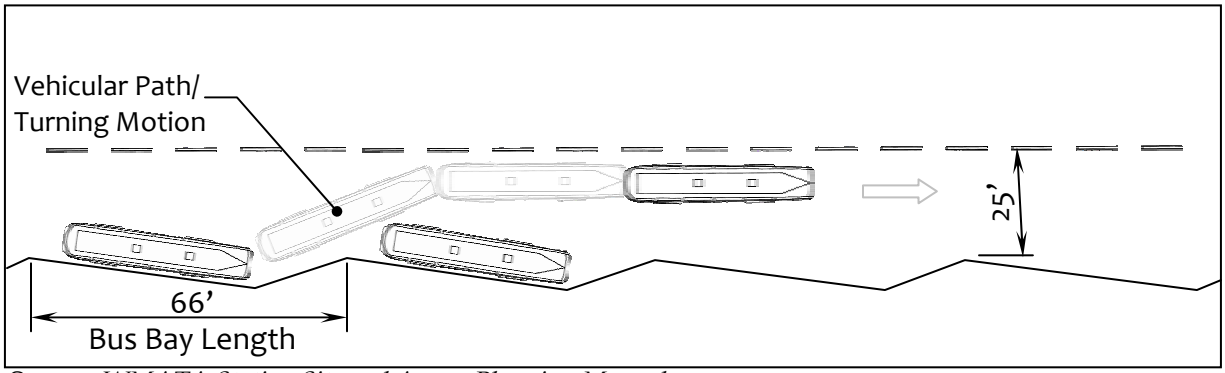
Sawtooth Bus Bays

In off-street bus stopping areas, such as bus transfer centers, rail stations, and park and ride lots, sawtooth bus bays are recommended for their efficient use of constrained curb space. Sawtooth bays are generally wider than parallel bays but require shorter curbside distances. Sawtooth bays can also work effectively along curved lanes and curbside facilities (Figure 2-9).

Washington Metropolitan Area Transit Authority's (WMATA) *Station Site and Access Planning Manual* indicates that sawtooth bays are the standard design for Metro bus facilities.

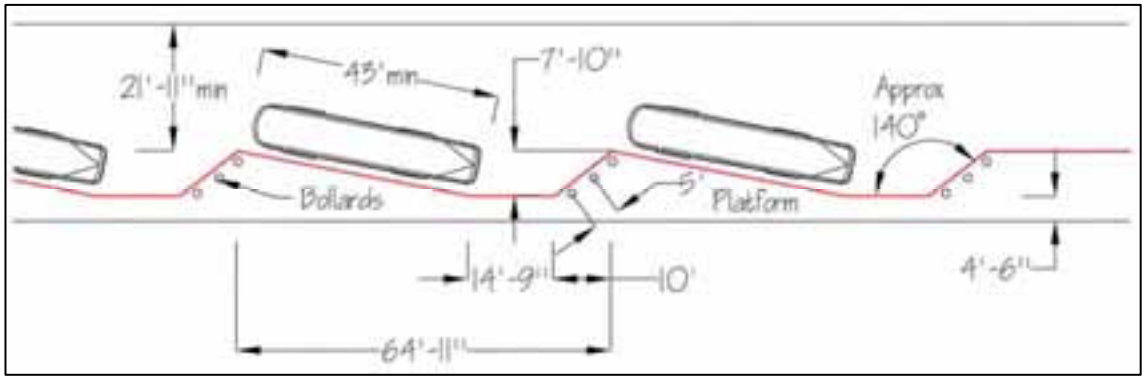
While the design of each off-street facility depends on the individual site characteristics, Figures 2-9 through 2-11 provides examples of other sawtooth bus bays.

Figure 2-9: Metro Sawtooth Bus Bays



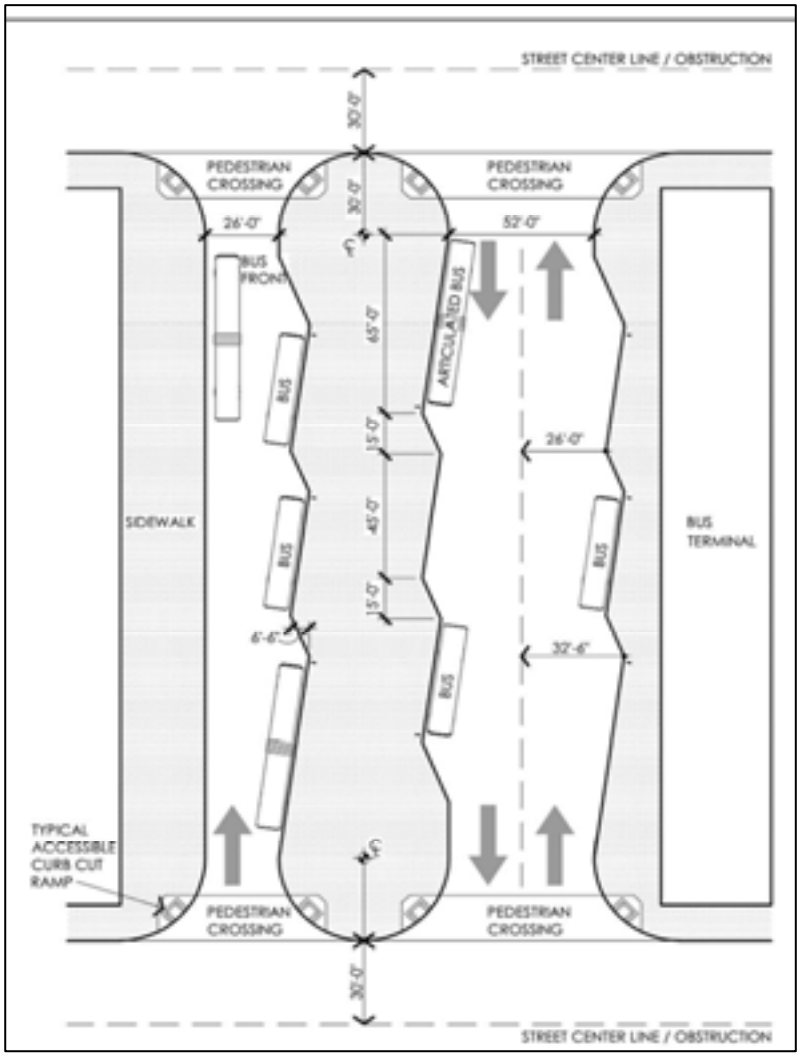
Source: *WMATA Station Site and Access Planning Manual*

Figure 2-10: Sawtooth Bus Bays in Florida



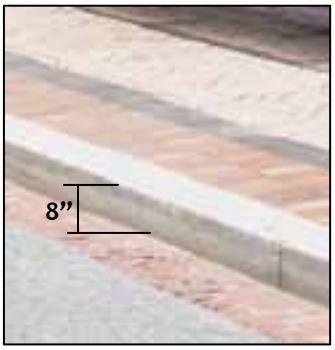
Source: *Accessing Transit – Designing Handbook for Florida Bus Passenger Facilities.*

Figure 2-11: AC Transit Sawtooth Bus Bays



Source: *AC Transit, Alameda-Contra Costa Transit District, California.*

CURB HEIGHT



Appropriate curb height is necessary to allow passengers to safely alight from the bus and the safe deployment of a wheelchair lift. Currently there are no specific national or local guidelines on appropriate curb heights for transit buses. According to TCRP Report 90 - *Bus Rapid Transit, Volume 2: Implementation Guidelines,* low-floor vehicles generally have floors that are approximately 12 to 15 inches above the driving surface. Many standard and low-floor vehicles can be accommodated by the existing conventional street curb height of 8 inches.

Section 3

Bus Stop Elements and Passenger Amenities

INTRODUCTION

One of the main goals of a transit agency should be to provide all transit riders with varying abilities a safe, accessible, and comfortable facility that will provide for an adequate waiting area, accurate bus information, and shelter from elements. Passenger waiting areas that are out of the flow of pedestrian traffic should be provided, and ideally bus stop pads should be provided at all bus stops, and connectivity to sidewalks should be considered when selecting bus stop locations.

BUS STOP HIERARCHY

For many transit agencies and jurisdictions, resources for providing and improving passenger facilities are limited requiring them to prioritize what and where improvements will be made. Table 3-1 provides a hierarchy of bus stop types that will provide a guide on the provision of passenger amenities for the different bus stop types. There are three classes of bus stops: Basic Stop, Enhanced Bus Service, and Transit Center stops.

Basic Stop

The majority of bus stops are considered primary stops. These stops are served by most of the transit agencies' routes and are the primary access point to the MetroBus service. All basic stops should include the following elements and passenger amenities:

Table 3-1
Bus Stop Hierarchy

	Basic Stop	Enhanced Service Bus Stop	Transit Center
Bus Stop Sign	Yes	Yes	Yes
ADA 5'x8' Landing Pad	Yes	Yes	Yes
Sidewalk	Yes	Yes	Yes
Lighting	Evening Service	Yes	Yes
Seating	Trip Generator Based	Yes	Yes
Expanded Boarding & Alighting Area (Rear-door Access)	No	Site Specific	Yes
Bus Bay (Pull Off)	No	Site Specific	Yes
Shelter(s)	1 (50+ boardings/day)	1	2 +
Trash Receptacle	Site Specific	Yes	Yes
Information Case	Yes	Yes	Yes
System Map	Contingent on Shelter	Yes	Yes
Real-time Display (LED + Audio)	Optional	Yes	Yes
Interactive Phone System On-Site	No	No	Yes

- Accurate and up-to-date bus stop sign
- At a minimum, a clear, unobstructed, paved boarding area that is 8 feet wide (perpendicular to the curb) by 5 feet deep (parallel to the curb) and compliant with the ADA Accessibility Guidelines (ADAAG)
- Connected by a paved sidewalk that is at least 4 feet wide
- Adequate lighting either from street lights, lights from an adjacent business, or shelter lighting (particularly stops that are served in the evenings)
- Next Bus real time bus arrival information through an interactive phone system
- Shelter with interior seating if there are 50 or more boardings per day (including transfers)
- Trash receptacle (particularly at locations that are close to fast food establishments and convenient stores)
- Information case with detailed schedule information on services

Enhanced Bus Service Stops

Enhanced bus service stops are stops that are designated limited stop/skip stop service and/or Bus Rapid Transit (BRT). This type of stop serves a select number of bus stops along selected corridors[1] in order to provide a higher level of service. Enhanced bus service stops should have the following passenger amenities:

- Accurate and up-to-date bus stop sign
- At a minimum, a clear, unobstructed, paved boarding area that is 8 feet wide (perpendicular to the curb) by 5 feet deep (parallel to the curb) and compliant with ADAAG, having additional waiting space and a clear alighting area
- Connected by a paved sidewalk that is at least 4 feet wide
- Adequate lighting (either from street lights, lights from an adjacent business, or shelter lighting)
- Shelter with bench (for 300 or more boardings per day provide additional shelter(s))
- Trash receptacle
- Information case with detailed schedule information on services
- System map
- Next Bus real time travel information through an interactive phone and push button audio system

Transit Center

Transit center bus stops are usually stops that serve multiple routes and have over 500 boardings per day. Specific designs and accommodations for transit center stops can be found in the WMATA Station Site and Access Planning Manual. Transit center stops should have an array of passenger amenities.

[1] As of December 2008, MetroBus Express operates along Georgia Avenue and 7th Street NW between Silver Spring, Maryland and the Archives Metrorail station in downtown Washington, but implementation of additional such rapid bus routes is anticipated. This service is designed to serve only limited stops along the route, while a regular, "local" route serves all stops along the corridor.

Considerations for passenger amenities may also include:

- **Number of routes serving the stop and its role as a transfer point.** For example, a stop served by multiple routes, at which more than one vehicle at a time will be servicing the stop, will need unobstructed boarding areas for each vehicle

- **Special populations served by the stop.** For example, a stop located near an organization which serves older people or people with disabilities would be a good candidate for a bench, since the presence of seating at the stop may make a difference as to whether an individual who has difficulty walking can use fixed-route service (instead of the Americans with Disabilities Act (ADA) paratransit)

- **Stop sponsorship.** A stop where an adjacent property owner or other organization is willing to finance and/or maintain a shelter or other types of amenities may be a good candidate for this type of amenity. This includes advertising shelters, which the shelter vendor may wish to place at strategic locations for visibility of the advertisement in the community as part of their contract with the local jurisdiction

BUS STOP SIGNS

A bus stop sign should be securely mounted on its own post, at an angle perpendicular to the street. For bus stops that are served by Metro and other transit agencies, the Metrobus flag shall be placed at the top of the bus stop post above the other transit agency flag as shown in Figure 3-1. Each bus stop should be marked with a bus stop sign indicating to bus operators and customers the location of the bus stop. The sign indicates to passengers and drivers where buses stop, as well as publicizes the availability of the service. Placement of bus stop signs should take into consideration customer convenience, safety, and stop visibility. Bus stop signs should conform to ADAAG requirements for height, width, and visibility. Minimum information on the bus stop sign should include operator name, contact phone number, and route numbers or names.

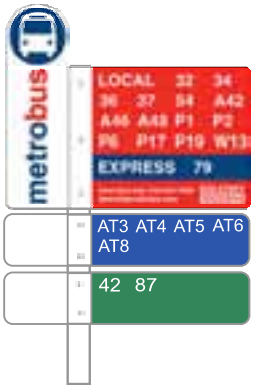


Figure 3-1: Sign Placement for Shared Stops

The sign must be easily visible to the approaching bus driver and be clear of the side mirrors of buses, ideally 2 to 4 feet from the face of the curb. The bus stop sign should neither block nor be blocked by other street signs. The header sign is the point

at which the front of the bus should be aligned when the bus is servicing passengers and thus should be placed approximately one foot beyond the far side of the front door landing area.

The bottom edge of the sign should be positioned at a height of at least 80 inches above the ground, as specified under ADAAG. Measuring from the base of the sign, the Metro header signs are typically positioned 98 inches above the ground. Bus stop signs may also be mounted on bus shelters. Signs mounted on bus stop shelters should also have a space of 80" – 98"from the base of the sign to the ground.

To meet the ADAAG requirements for minimum information-related accessibility, the following standards must be met for visual signage:

- Egg shell finish with no reflectivity
- Characters contrasted with background with either light characters on a dark background or dark characters on a light background – note that signs are more legible for persons with low vision when characters contrast as much as possible with their background
- Characters that are conventional in form (i.e., not italic, oblique, script, highly decorative, or of other unusual forms)
- Fonts with character proportions where the width of the uppercase letter "O" is 55% minimum and 110% maximum of the height of the uppercase letter "I"
- The minimum character height (based on the uppercase letter "I") required depends on the height of the sign and how close a transit customer can get to the sign (horizontal viewing distance):
  - where the height from the ground to the baseline of the character is 70 inches to 120 inches (5 to 10 feet), and the horizontal viewing distance is no greater than 15 feet, the characters must be at least 2 inches tall
  - where the height from the ground to the baseline of the character is greater than 120 inches (10 feet), and the horizontal viewing distance is no greater than 21 feet, the characters must be at least 3 inches tall
  - if obstructions around the sign pole result in a greater viewing distance, the minimum character height increases by 1/8 inch per additional foot of viewing distance
- Stroke thickness of the uppercase letter "I" that is 10% to 30% of the height of the character

- Character spacing (measured between the two closest points of adjacent characters) between individual characters that is 10% to 35% of character height

- Line spacing (measured between the baselines of separate lines of characters within a message) that is 135% to 170% maximum of the character height

While tactile signage (braille or raised lettering) is not a requirement for bus stops, if such signage is installed, it is subject to ADAAG standards.

BUS STOP SIGN POST

It is preferred that all bus stop locations should have their own bus stop posts. Shelters designed to accommodate bus stop signs can be used in lieu of a bus stop post. Using street sign posts, light posts, and other non bus stop posts should be avoided whenever possible. Bus stop posts should be rust resistant, painted white, and distinguishable from other posts in the same area so as to benefit customers with visual impairments. In addition to designing bus stop posts to be more distinguishable from other posts, considerations should be given to other solutions such as a tactile sign or a Remote Infrared Audible System also referred to as a Talking Sign. A diagram of a tactile sign that will be installed at Metrobus stops is shown in Figure 3-2. A tactile sign is less costly and simpler to install and maintain. The tactile sign should be installed between 40" to 54" on-center above the ground.

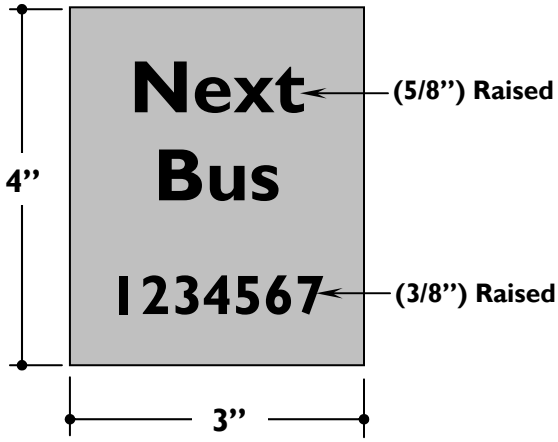


Figure 3-2
Example of Metrobus Tactile Sign

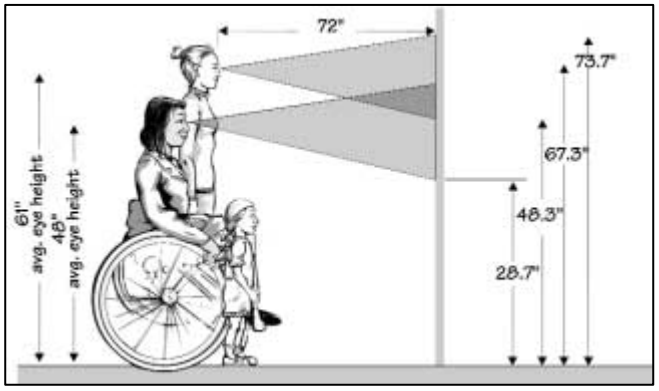
Talking Signs are generally more effective but have a much higher installation and maintenance costs which makes it more difficult to implement system-wide and therefore maybe more viable at select locations.

Bus stop sign posts should be installed at the far side of the landing area. Consistent placement of the sign pole provides the bus driver with a landmark at which to align the front end of the vehicle to make deployment of the lift or ramp possible. It also provides the customers with an indication of where they will be boarding the bus.

INFORMATION CASE

Route maps and schedule information should be provided at all bus stops and at stops that serve as transfer points between routes. Shelters should be designed with panels that will accommodate customer information such as system maps, neighborhood maps, and/or schedule and route information. Customer information at stops without bus shelters can be provided in a case that is attached to the bus stop post. The type of information case may vary by jurisdiction, but a paved access (minimum of 36" wide) should be provided to the information displayed in the case. Bus schedules, timetables, and maps that are posted at the bus stop (the information contained within these cases) are not subject to ADAAG. However, post-mounted objects such as information cases must meet relevant ADAAG requirements to ensure that they do not create a potential hazard for pedestrians. Free-standing objects mounted on posts may overhang circulation up to 12 inches maximum when located 27 to 80 inches above the ground.

While there are no transit relevant guidelines on appropriate heights for information cases, there are suggested viewing heights for items in museums such as exhibits and labels. In the *Design for Accessibility: A Cultural Administrator's Handbook,* and *Smithsonian Guidelines for Accessible Exhibition Design*, wall labels should be at a height that is comfortable for both those seated and standing. Wall labels mounted between 48 inches and 67 inches are in a comfortable viewing location for both those seated and standing as illustrated in Figure 3-3. Wall labels mounted with a centerline at 54 inches above the floor are at optimum height for everyone.



Source Design for Accessibility A Cultural Administrator's Handbook

Figure 3-3
Suggested Viewing Heights

There are several styles of information cases being used depending on the jurisdiction and/or type of service. The two primary styles of post mounted information cases are stationary and those that rotate or spin. An advantage of cases that rotate or spin over stationary cases is that access only needs to be provided on one side of the case. However, it should be noted that circular information cases may distort the text and make it difficult to read for some. Examples of information cases used in the region are shown in Figure 3-4.

Figure 3-4: Examples of Local Information Cases

Stationary (Metro)

Rotational (Pike Ride)

Rotational (Circulator)

Rotational (Metro 30's Line)

Stationary (ART)

Real-time bus information at key stops provides customers with up-to-date bus arrivals. According to TCRP-48 Real Time Arrival Bus Information Systems, most real-time bus information systems use dynamic message signs (DMSs) and liquid crystal displays to present bus arrival information at stops. Other methods to provide real-time information detailed in the report include the Internet, cell phones, and PDAs.

Figure 3-5
Next Bus Decal

Metro has deployed Next Bus real-time bus arrival information across the region at all of their Metrobus stops. This will allow customers access to bus arrival information through the Internet or on their cell phone. Metal decals shown in Figure 3-5 are installed on bus stop posts at each Metrobus stop. The decal has a seven digit identification number unique to the bus stop along with a phone number and web address that will provide real-time bus arrival information.

At select sheltered bus stop locations, a Next Bus push button audio box will also be provided. The push button audio box will allow waiting passengers to obtain an estimated arrival time of the next bus. An example of the Next Bus push button box is shown in Figure 3-6.

Figure 3-6
Next Bus Push Button Audio Box

LIGHTING

Adequate lighting at bus stop facilities allow bus drivers and approaching traffic to see waiting passengers at night. Lighting also provides added security for those waiting at the stop, in addition to illuminating route and schedule information for patrons. Bus stop locations that are served in the evenings should have adequate lighting. Lighting can be provided by a nearby streetlight, ambient light from the adjacent businesses, lighting installed within the shelter, or a stand-alone light pole. Transit stops without sheltered lighting should be located within 30 feet of an overhead light source. Bus stop light fixtures or shelter illumination should be between 2.0 to 5.0 footcandles. However, shelter lighting should be on the lower range as to not create a spotlight affect, where it is difficult for passengers waiting inside the shelter to see outside.

As an alternative to a hard-wired light pole or sheltered lighting, a solar-powered "stop call light" on the bus stop pole or shelter may provide an as-needed source of light. Figure 3-7 provides an example of a solar lighted sheltered in Alexandria, Virginia.

Figure 3-7
Example of Shelter Lighting
Powered by Solar energy

ADA LANDING PADS/PASSENGER WAITING AREA

A leveled and paved waiting area with adequate space provides a safe, secure, non-slippery surface for passengers waiting at the stop. This will provide greater access to transit services to wheelchair users, the elderly, and other encumbered riders such as parents with strollers. Another benefit to providing an adequate waiting area is that passengers waiting for the bus will be set back further from the curb and the flow of traffic.

According to the ADAAG, landing pads (for passengers boarding and alighting) should be:

- Firm and stable
- Clear of obstructions and being at least 96 inches (8 feet) from the curb/roadway and at least 60 inches (5 feet) parallel to the roadway. A landing area of this size or larger is necessary for deployment of the vehicle's ramp and lift and for a customer using a wheelchair to maneuver on and off the lift
- Connected to streets, sidewalks, or pedestrian paths by an accessible route
- Sloped (parallel to the roadway) as the same as the roadway, to the maximum extent practicable. Perpendicular to the roadway, the slope of the landing area shall not be steeper than 1:48

Ideally for urban areas and high volume stops, and where there is adequate right-of-way, landing pads should be a continuous 8-foot wide paved pad along the entire length of the bus stop (40 feet for a standard bus and 60 feet for an articulated bus). Figures 3-8 to 3-10 provides some examples of ADA landing pads. It is also preferred that the landing pad/waiting area be connected to an accessible sidewalk, but separated from the general pedestrian flow. This will allow for safe boarding and alighting from both the front and rear doors of the bus.

The current Federal Transit Administration's (FTA) interpretation of the ADAAG is that the construction of a landing pad is not required unless other improvements such as shelters are constructed (i.e., a stop can be designated by a sign without constructing a new landing pad). All new bus stops should be located in accessible locations to the maximum extent practicable. Stops which are inaccessible obligate the transit provider to offer ADA complementary paratransit for customers who could otherwise use the accessible stop.

Figure 3-8
Preferred Landing Pad for Front/Rear Boarding and Alighting

Figure 3-9
Landing Pad with Sidewalk Set Back from Curb

Figure 3-10
Landing Pad with Sidewalk Adjacent to Curb

FREESTANDING BENCH

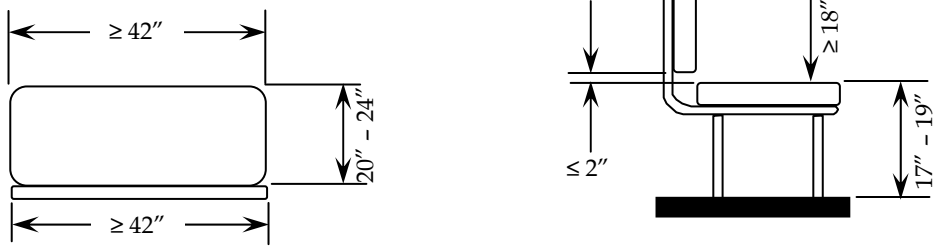
Benches are recommended for bus stop locations that are near sites that attract riders who may have difficulty walking and standing, particularly at stops where headways are longer than 15 minutes.

Benches should be designed to coordinate with shelters along the same corridor, with an appearance appropriate to the neighborhood and fabricated of durable materials resistant to vandalism and weather conditions. The bench should be installed adjacent to (but not impeding) the landing area and connected to a pedestrian pathway. Benches installed within shelters should not obstruct the minimum accessible clear space within the shelter. The ADAAG specifies the following dimensions for bench accessibility as shown in Figure 3-11.

- Seat dimensions: 20 to 24 inches in depth and a minimum of 42 inches in length; back support to be minimum of 42 inches in length

- Back support to be a minimum of 18 inches high, positioned a maximum of 2 inches above seat; seat height to be 17 to 19 inches above ground

Figure 3-11: ADAAG Bench Dimensions



Plan View **Elevation View**

- Structural strength: able to withstand a vertical or horizontal pressure of 250 pounds
- If installed externally, slip-resistance surface which allows for the proper drainage; durable materials resistant to vandalism and weather conditions
- Do not install bench on the 5′x8′ wheelchair landing pad; obstruct sidewalk or access to customer information
- Design should discourage sleeping on bench
- Maintain at least 4′ between the bench and the back-face of the curb (Figure 3-12)

SHELTERS

Shelters are recommended for all stops at which 50 or more passengers board per day, enhanced service stops, and transit centers. Based on the type of facility or location served (i.e. senior communities, universities, hospitals, major trip generators during peak hours service, and major transfer points between routes) exceptions should be made. Currently, each jurisdiction is responsible for installing and maintaining its own shelters. The following will provide some general design factors as well as accessibility requirements for bus stops with shelters. Figure 3-13 provide examples of shelters in the region.

Figure 3-12: Possible Bench Locations

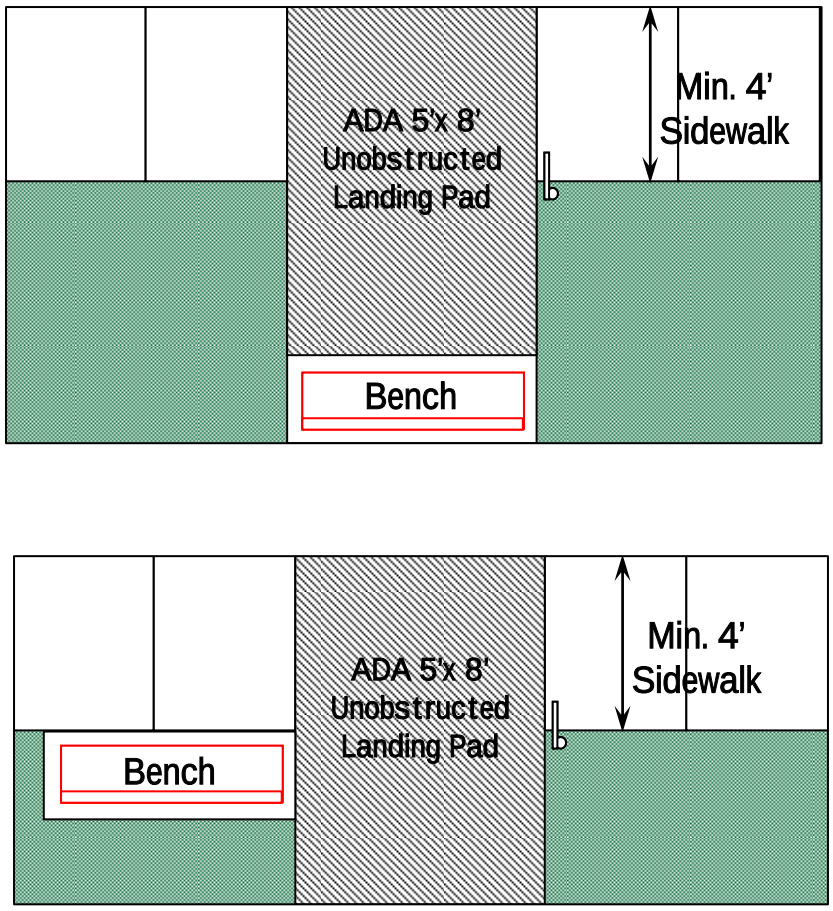


Figure 3-13: Examples of Local Shelter Designs




General Design Factors

Shelters should be oriented so that they are placed facing the travel lane and the location should minimize the walking distances between the shelter and the loading area for passengers. To provide adequate boarding and alighting space for persons in a wheelchair, efforts should be made to place shelters at the nearside of the landing pad. Additional general guidelines to follow in placing shelters are:

- Transparent sides for greater visibility; if glass panels are used, they should be shattered proof and be marked with reflectors or other techniques to indicate their presence (panels should also be resistant to fading and clouding)

- Use durable materials resistant to vandalism and weather conditions

- Place name of stop/stop location on shelter
- Include interior seating (designed to discourage opportunities for sleeping)
- Incorporate lighting in shelter
- Do not place shelters on wheelchair landing pad
- Do not obstruct sidewalk
- Ensure unobstructed adequate access to entrance of shelter
- Ensure shelter opening is at least 36" wide (ADAAG specifies minimum of 30") to allow wheelchair access – open face shelter is preferred
- Provide a usable clear floor or ground space that is at least 36 inches wide by at least 48 inches deep, entirely within the shelter
- Ensure adequate maneuvering space outside of the shelter opening and connection by an accessible route to the landing pad area
- There should be no obstructions or steps between the landing pad and the shelter
- Provide provision for bus shelter maps
- Provide provision for push button audio

The minimum dimensions for the maneuvering space outside of the shelter depend on the placement of the opening and the direction of approach from the sidewalk. If the approach to the shelter opening is perpendicular (i.e., the customer is facing the opening while approaching), the minimum clear space from the opening is 48 inches. If the customer approaches the opening from the side, the minimum clear space from the opening is 42 inches.

Other Considerations

In addition to meeting the minimum dimensions and clearances necessary to be accessible to people who use wheelchairs, shelters should take in account the following:

- Appearance appropriate for the neighborhood

- Advertising placement should not obstruct the view of approaching traffic and buses (if applicable)

- Larger (or have multiple installations) shelters at stops with high ridership (i.e., at least 100 boardings per day)

- Clean and maintained on a regular basis

Seating should be incorporated within the shelter whenever possible, and the layout of the bench within the shelter must still provide for the minimum clear space connected to an access route. The configuration of the interior space must provide for an accessible path of travel to the shelter opening. In addition to incorporating seating within the shelter, route maps and schedules should also be included. The route maps and schedules should be easily readable by wheelchair users and those with visual impairments. The shelter shall have adequate illumination and provide greater visibility for bus operators while providing passenger security in the evenings.

TRASH RECEPTACLES

Trash receptacles at bus stops should resemble other publicly owned and maintained trash cans along the corridor. Considerations should be given to maintenance and trash pick-up when ever trash receptacles are provided.

Trash receptacles should be installed where they do not create an obstruction or interfere with the accessibility of the bus stop or the adjacent sidewalk. Trash receptacles shall not be placed on the wheelchair landing pad. They must not obstruct pathways between the sidewalk, shelter access (when applicable), the landing area, or posted information. The receptacles should be secured to the pavement to prevent accidental tipping or unauthorized movement.

VENDOR BOXES

Vendor boxes (also referred to as newspaper boxes) can provide passengers with reading materials while they wait for a bus. Owners of these vendor boxes generally place their boxes at locations with a high level of pedestrian activity. As with any street furniture, these newspaper

boxes need to comply with the ADAAG with regards to its placement. Vendor boxes cannot reduce the clear spaces required by the ADAAG, and therefore, it cannot be located on the 5'x8' landing pad, or obstruct access to the stop, the shelter, or customer information. In addition, vendor boxes cannot be secured to any bus stop feature such as the bus stop post, trash receptacle, shelter, or bench. Vendor boxes in violation of these guidelines must be removed or relocated.

To ensure that vendor boxes are appropriately placed, the use of "corrals/condos" should be considered. Vendor box "corrals/condos" will provide for a designated location and/or storage of publications. Figure 3-14 below are examples of two different types of "corrals/condos".

Figure 3-14: Examples of Vendor Box Corrals/Condos

BUS STOP PROTOTYPES

The following provides bus stop prototypes that show different combinations of the elements described earlier in this section based on the most common types of bus stop design. Specific combinations will depend on the site, the facility function, the transit agency's operational plans, land availability, and available budget. The prototypes focus on various bus stop designs, and the recommended placements of bus stop elements and amenities. Basic bus stops provide access to transit in a variety of locations. Such locations can be along arterial roadways, collector streets, or local roads and may be adjacent to a variety of land uses. More expansive types of facilities such as intermodal centers and transit centers typically involve the hiring of an architect and/or structural engineer, and represent a significant capital outlay and therefore are not reproduced in these prototypes.

Non-Sheltered Bus Stop

The following prototypes are for basic bus stops with no passenger shelters and minimal passenger amenities.

Sidewalk Adjacent to Curb

Figure 3-15 provides a diagram of a basic bus stop with limited passenger amenities in which a 4′ wide sidewalk is adjacent to the street-curb. The stop can be either a far-side, near-side, or mid block stop. In this prototype, a paved pad extends 4′ deep and 5′ wide from the back of the sidewalk creating a 5′ x 8′ ADA landing pad. The bus stop sign is located between 2′ to 4′ from the back of the curb to avoid being struck by the buses' side mirror. The bus stop post is placed off the sidewalk and ADA landing pad so it does not impede the flow of pedestrians or the deployment of a wheelchair lift. Establish a 40′ wide unobstructed clear zone adjacent to the curb to allow passengers to alight the bus using the rear doors. A clear unobstructed paved access is provided to each side of the information cases that are displaying bus information.

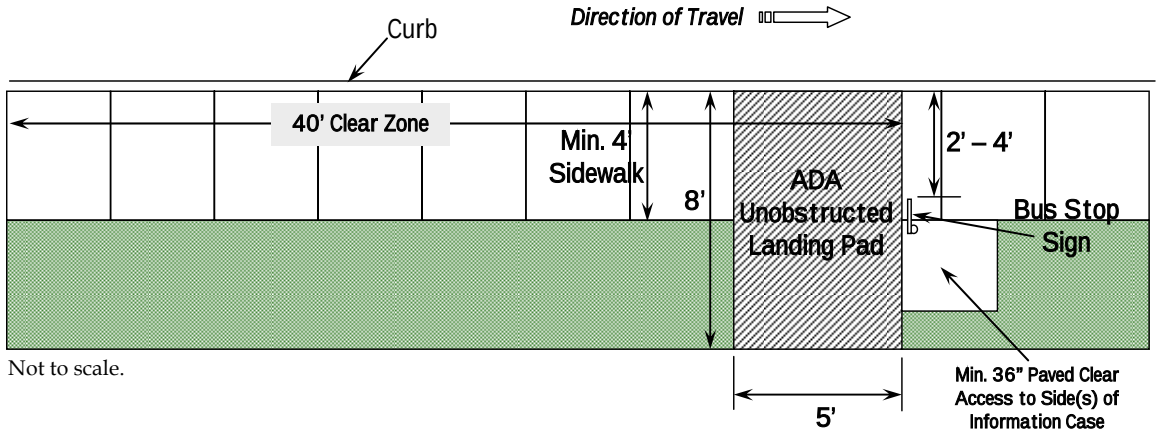


Figure 3-15: Basic Stop with Sidewalk Adjacent to Curb

Sidewalk Setback from the Curb

Figure 3-16 provides a diagram of a primary bus stop in which there is a 4′ wide grass buffer between the 4′ wide sidewalk and the street-curb. The stop can either be a far-side, near-side, or mid block stop. In this prototype, a 4′ deep by 5′ wide paved pad is installed to connect the curb to the sidewalk, thus creating a 5′x8′ ADA landing pad. The bus stop sign is located between 2′ to 4′ from the back of the curb to avoid being struck by the buses' side mirror. A 40′ wide unobstructed clear zone adjacent to the curb is established to allow passengers to alight the bus using the rear doors. The bus stop post is placed off the sidewalk and ADA landing pad so it does not impede the

flow of pedestrians or the deployment of a wheelchair lift. A clear unobstructed paved access is provided to each side of the information cases that are displaying bus information.

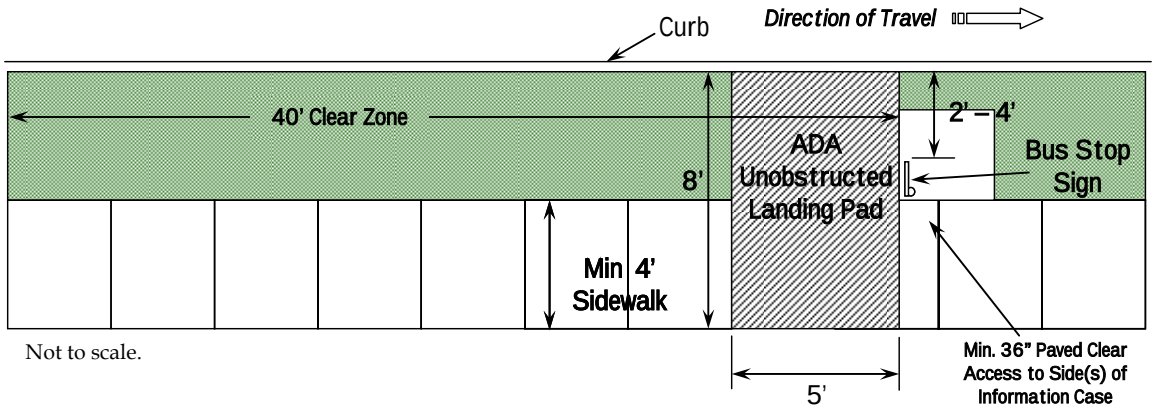


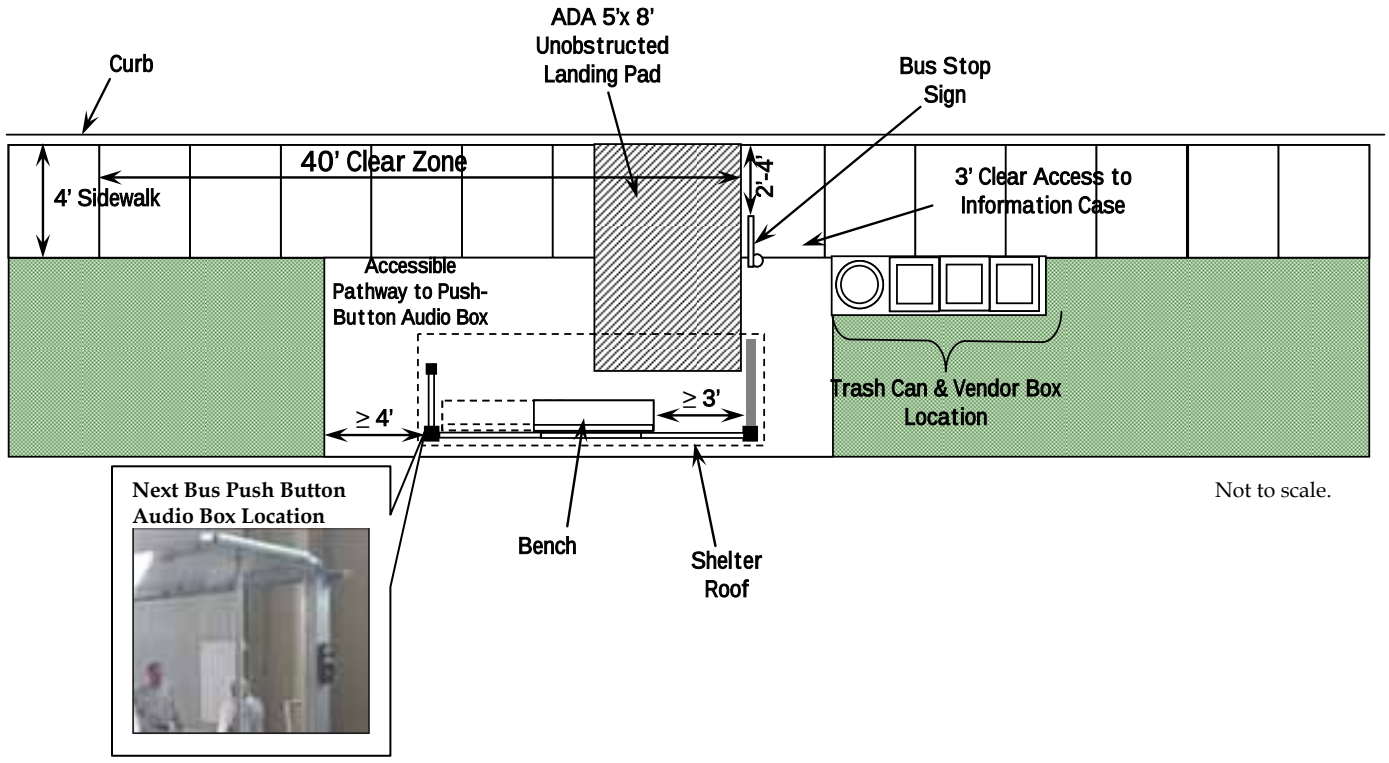
Figure 3-16: Basic Stop with Sidewalk Setback from Curb

Sheltered Bus Stop

Sidewalk Adjacent to Curb

Figure 3-17 provides a diagram of a sheltered bus stop in which the 4′ wide sidewalk is adjacent to the street-curb. The stop can be either a far-side, near-side, or mid block stop. In this prototype, the shelter is located on the backside of the sidewalk with easy access from the sidewalk into the shelter. The 5′x8′ ADA landing pad is located in front of the shelter and overlaps with the sidewalk. The bus stop sign is located between 2′ to 4′ from the back of the curb to avoid being struck by the buses' side mirror. The bus stop post is placed off the sidewalk and ADA landing pad so it does not impede the flow of pedestrians or the deployment of a wheelchair lift. A clear unobstructed paved access is provided to each side of the information case that is displaying bus information. Near-side the shelter is a 4′ wide paved pathway for access to customer information on the side panel and the Next Bus push button audio box installed on the rear support column of the shelter. The trash receptacle and vendor boxes are located adjacent to the sidewalk, but away from any access points.

Figure 3-17: Sheltered Stop with Sidewalk Adjacent to Curb



Sidewalk Setback from the Curb

Figures 3-18 and 3-19 illustrates two types of sheltered bus stop design with the sidewalk setback from the street-curb.

ADA Landing Pad Far-side of Shelter. In Figure 3-18, the 5'x8' ADA landing pad is located far-side of the shelter. Locating the ADA landing pad far-side versus near-side of the stop will allow the bus to fully pull into the bus stop zone and the wheelchair lift (which is typically located on the front door of a standard 40' transit bus) to align with the ADA landing pad. For bus stop locations with a high level of activity, this design will provide more space for wheelchair maneuverability and riders to safely wait for the bus. Access to the shelter is provided on either side of the shelter. The near-side shelter access provides an accessible pathway to customer information on the side panel and the Next Bus push button audio box installed on the rear support column of the shelter. The shelter roof overhang is a minimum of 4' from the back of the curb to avoid being struck by transit or commercial bus side mirrors. The trash receptacle and vendor boxes are located away from any access points but are still accessible by pedestrians and transit patrons.

Figure 3-18: ADA Landing Pad Far-side of Shelter

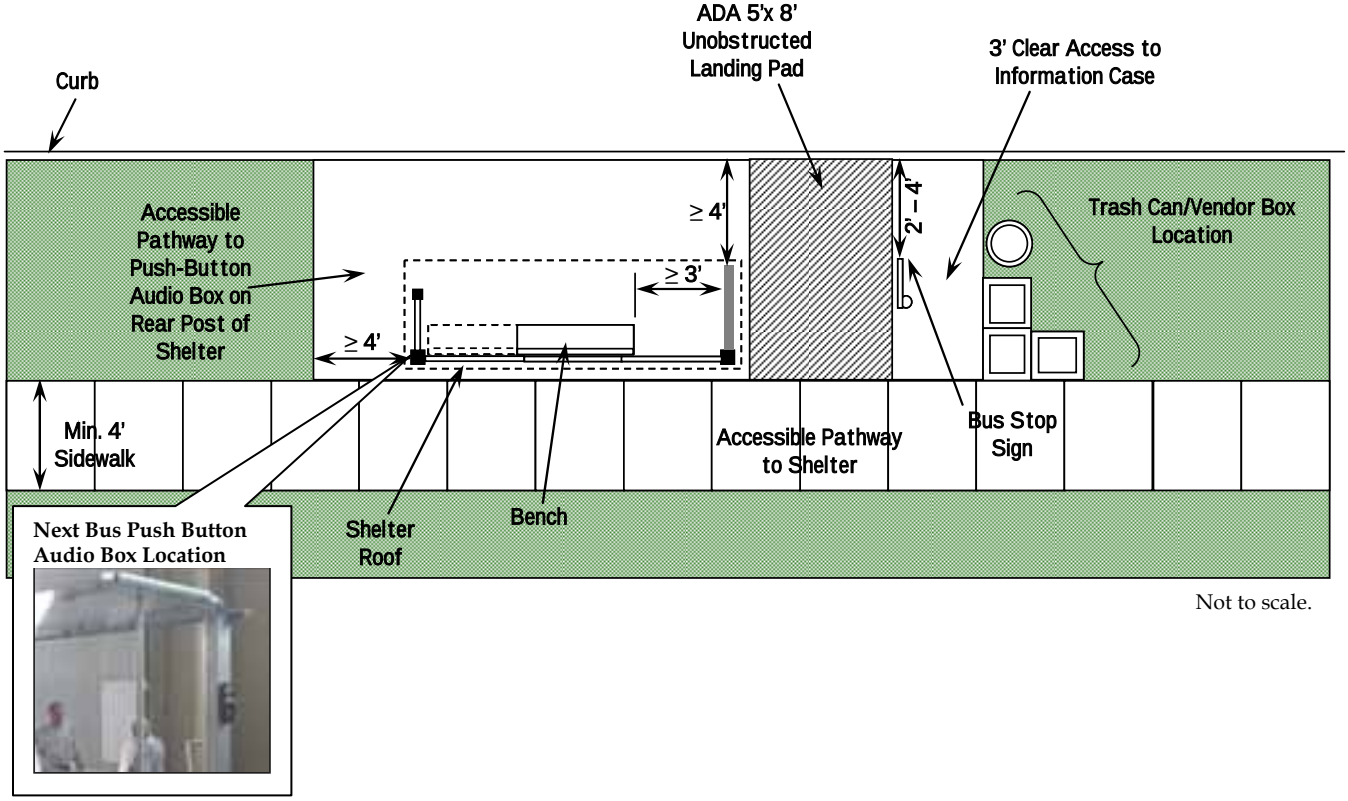
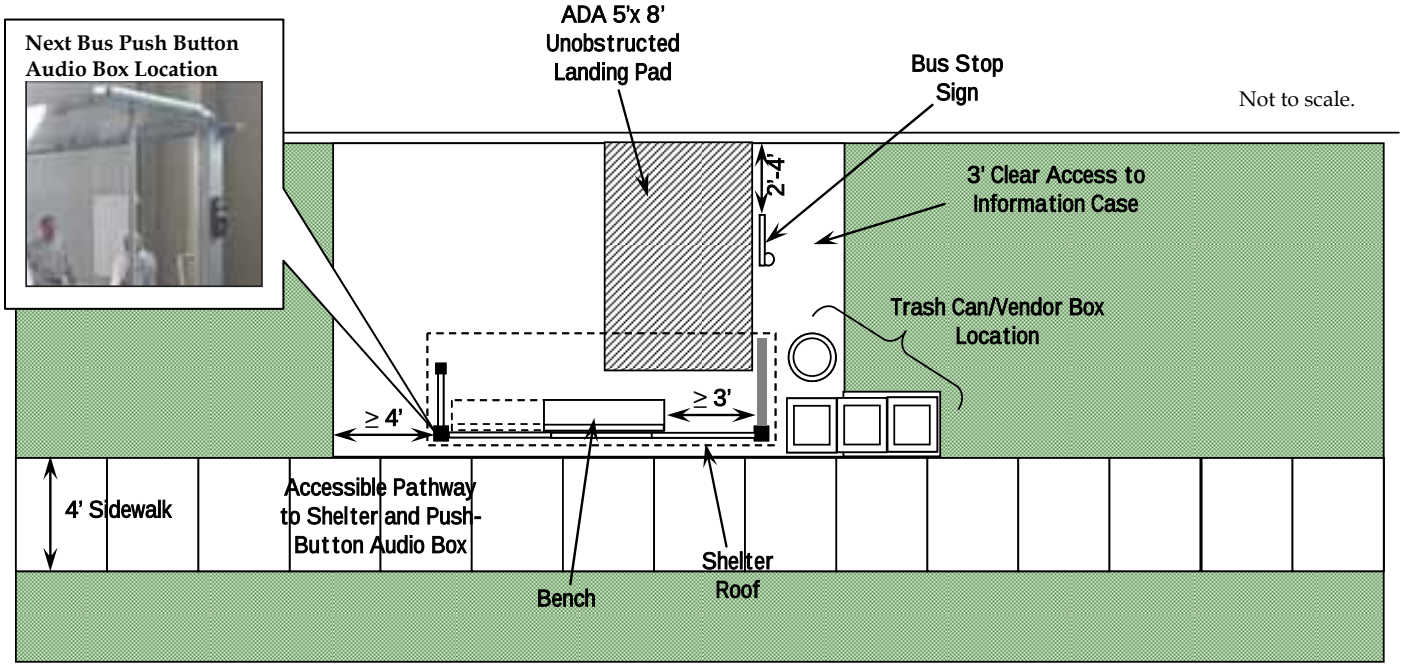


Figure 3-19: ADA Landing Pad in Front of Shelter

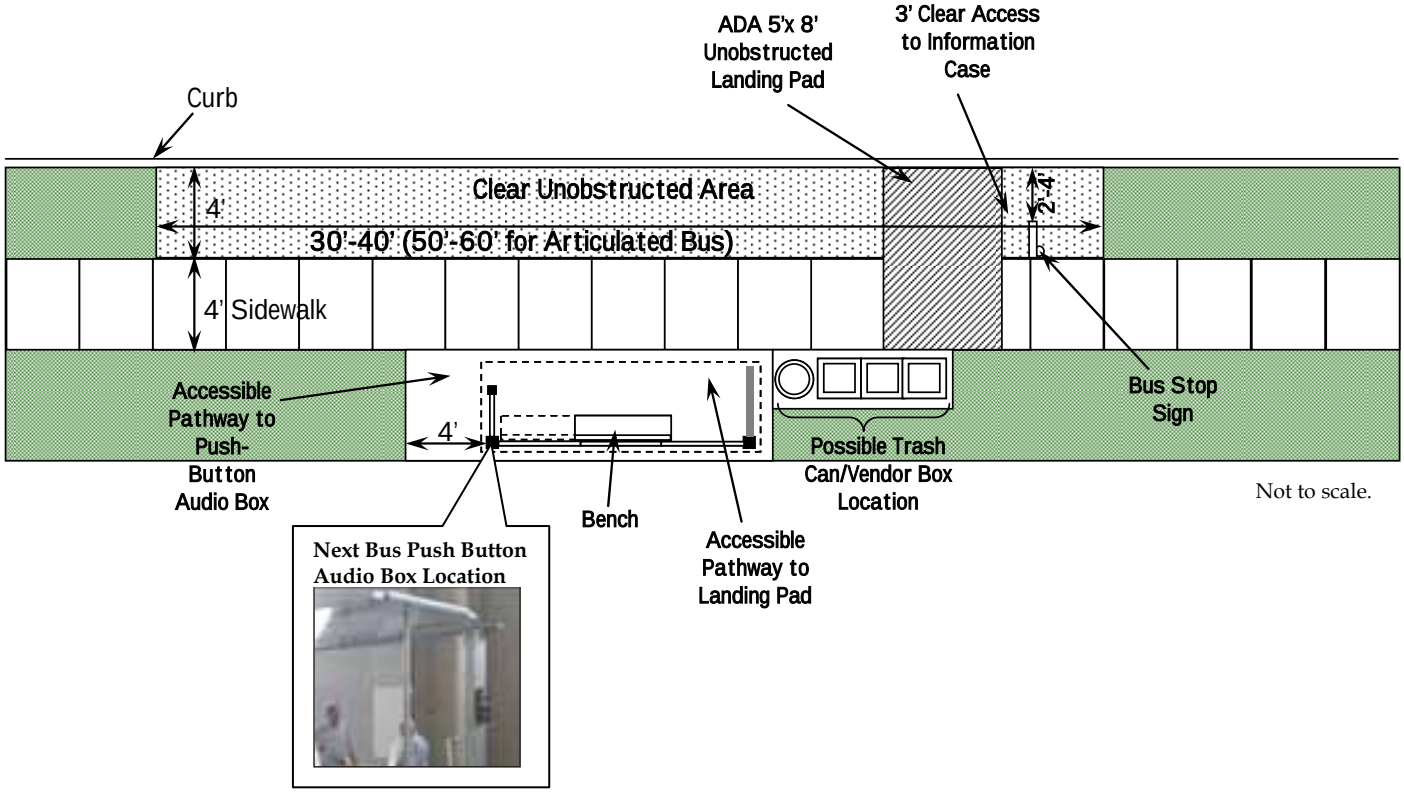


ADA Landing Pad in Front of Shelter. In Figure 3-19, the 5'x8' ADA landing pad is located in front of the shelter. Locating the ADA landing pad in front of the shelter will require greater clearance setback from the curb. This will provide more space between waiting patrons and the flow of traffic. Access to the shelter is provided on the near-side of the shelter. This pathway also allows customers to access bus information installed on the side panels of the shelter, and the Next Bus push button audio box installed on the rear support column of the shelter. The trash receptacle and vendor boxes are located away from any access points, but are still accessible by pedestrians and transit patrons.

Enhanced Service Bus Stop

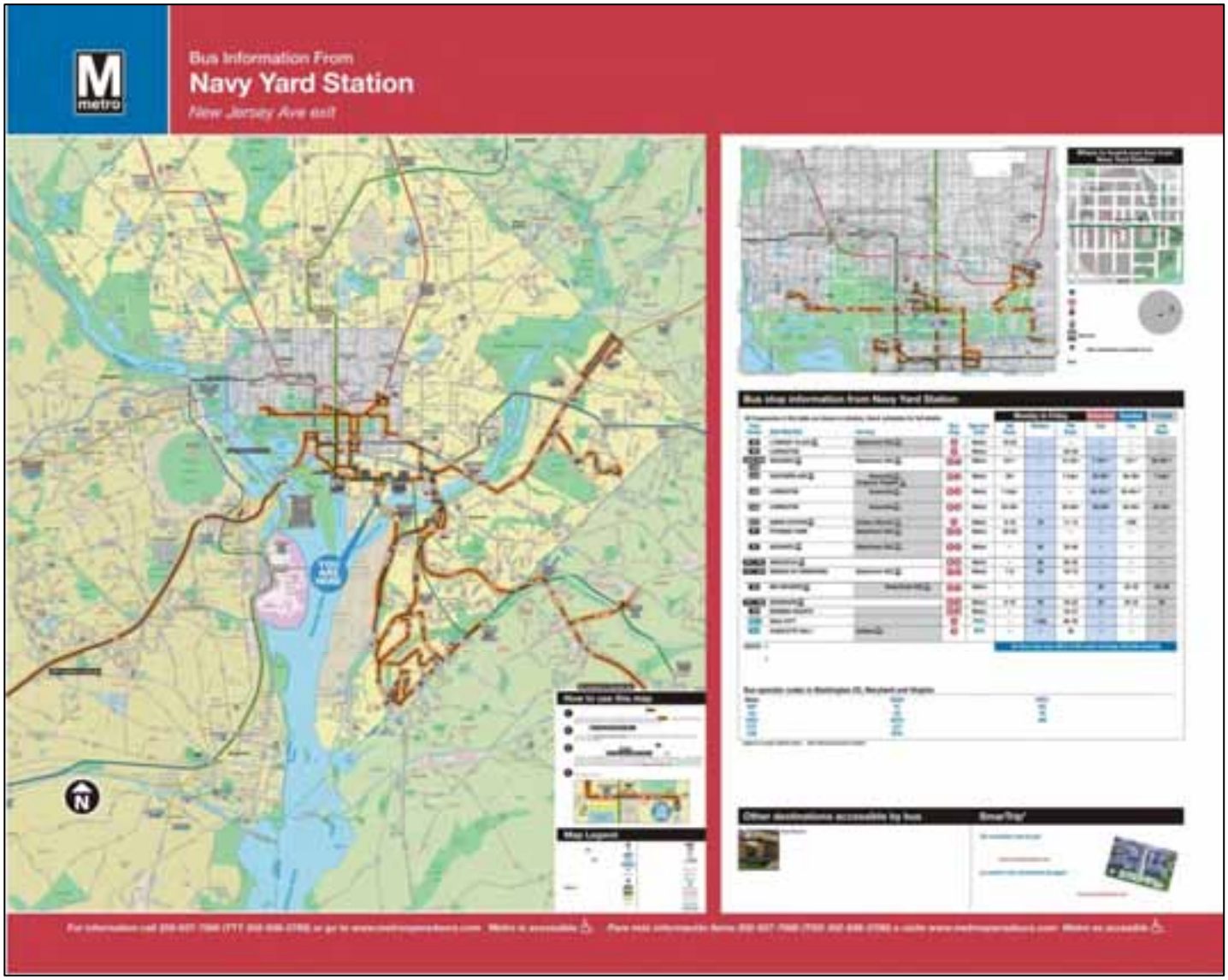
Figure 3-20 provides a bus stop prototype that is served by an enhanced type of bus service (i.e. limited stop service) or experiences a higher level of boardings and alightings and pedestrian flow. This prototype consists of a 30' - 40' (50' – 60' for an articulated bus) paved area adjacent to the curb and sidewalk. This expanded area is intended to provide more space for pedestrian and patron movement and better accommodation for rear door alighting. The expanded paved area should be clear of all possible obstructions (i.e. trash cans, vendor boxes, planter boxes, street lights, etc.).

Figure 3-20: Enhanced Service Bus Stop



BUS SHELTER MAPS

Metro installs information-rich maps on bus shelters at Metrorail stations and other key stops. Shelter maps are strongly recommended for all on-street stops with at least 300 boardings per day as well as those served by enhanced bus service regardless of ridership. A sample of the bus shelter map is shown in Exhibit 3-1.



Layout and Contents

The Metro bus shelter maps are contained in posters which capture customer information, including the following elements:

- A regional map of all Metrobus and Metrorail routes, Metrorail lines and stations, and routes operated by other public transit providers. The rail lines are shown in their respective colors with the stations labeled. The bus routes which serve the station are highlighted in color. The other bus routes are a uniform gray but labeled with their line numbers. Points of interest and major roadways are also included, and a "You are Here" label indicates the station where the map is posted

- A close-up of the central Washington, D.C. area

- A close-up of the immediate neighborhood in a ¼ mile radius around the station. This map includes the locations of bus stops and the elevator entrance to the station

- A table of all transit routes serving the station with the approximate frequency of service (headways) on weekdays (a.m. rush/mid-day/p.m. rush), Saturdays and Sundays. The bus stops served by each route as shown in the Metro bus shelter map, are also labeled, as well as the carrier

Installation Locations

The maps have been installed at all 86 Metrorail stations, inside the stations as well as in the shelters in the bus stops at the station. Approximately 300 shelters are currently equipped with this signage. After installing maps at station shelters, Metro planned to expand the program to on-street shelters. However, during the course of the project, the local jurisdictions had begun contracting with advertising shelter vendors, and on-street Metro-owned shelters are being phased out as the new advertising shelters are replacing the brown Metro shelters.

Jurisdictional Customization

The jurisdictions have included space for a map in the design of their shelters in the form of a transparent pocket in which the map can be inserted. Each of the jurisdictions has a different shelter design with different dimensions allocated to the map (for example, the D.C. shelters have a 22" by 34" space and the Montgomery County shelters have an 11" x 17" space). To accommodate the varying sizes, Metro

provides the jurisdiction with a PDF of the map (48"x60") which the advertising vendor (CHK America) can then scale to size, print, and insert into the shelter pocket. The jurisdictional maps are customized for the specific service area and provider.

Financial Summary

Funding for the shelter map program began in 2004, with an initial base year of $1.5 million and three additional option years. The program is now in the final option year.

Outcomes

Metro has received very positive feedback on the shelter maps, which have also been used as a basis for other media, such as improved printed regional system maps and station emergency evacuation maps.

Potential Sources for Ongoing Funding

Continuation for the shelter map program is strongly recommended. Where shelters are owned or placed on property owned by the local jurisdiction, the cost to print and mount the map should be borne by the jurisdiction or its advertising shelter as part of the shelter contract (as is the current practice). Updating the contents and design of the maps through a single contract (which Metro currently has in place with CHK America), and maintaining a centralized contract for this aspect of map production is recommended.

This will entail a centralized expense for Metro, and incorporating a line item in Metro's budget on an ongoing basis is recommended. Potential funding sources could include each of the participating jurisdictions, business/neighborhood improvement districts in which the maps have been or will be installed, tourism bureaus, Transportation Management Associations, and/or the FTA Section 5307 funding (if this design service can be considered a capital expense).

INCORPORATION OF PUBLIC ART

Existing Public Art at Transit Facilities in the Region

While arts commissions are in place in most or all of the jurisdictions in Metro's service area, very few public art programs or projects were identified that are affiliated with public transportation services.

Metro

Metro has an Art in Transit program, also known as MetroArts. This program installs artwork throughout the Metrorail system, working with artists, community groups, government agencies, and businesses to install artwork that captures the spirit and vitality of the region. Projects include murals, mosaics, and sculpture, incorporating diverse elements including poetry, neon, and stained glass. A virtual tour of some of the artwork and a list of artwork by Metro line can be found on Metro's website: www.wmata.com.

Montgomery County

As of 2009 two public art projects have been installed at transit facilities as projects of Montgomery County's Public Arts Trust. The Trust is funded through a special yearly appropriation by the County and is administered by the Arts Council of Montgomery County. Installations at transit facilities include:

- Bethesda 8 Poetry Benches – 12 decorative benches were installed at stops along the "Bethesda 8" route in downtown Bethesda. The benches are painted and incorporate poetry.

- Strathmore-Grosvenor Art Walk and Pedestrian Bridge – an animated LED ceiling sculpture is installed at the Grosvenor Metro Station in North Bethesda

Arlington County

Arlington County sponsored two etched glass bus shelters designed by Arlington youth through the ArtsWork summer program (as shown in Exhibit 3-2). Installed at the intersection of N. Glebe Road & N. Pershing Drive as part of the Buckingham Streetscape Improvement Project in 2008, the shelters were installed in conjunction with improved pedestrian and vehicle friendly commercial area, new wider sidewalks, and streetlights.

Arlington County has also partnered with Metro to install several art projects at Metrorail stations, including Ballston Metro elevator improvements and entrance canopy renovation, Clarendon Station/Central Park renovation, Crystal City Metro canopy renovation, and a pedestrian bridge over I-66 at the East Falls Church Station.

Exhibit 3-2: Two Etched Glass Bus Shelters

Source of images: http://www.arlingtonarts.org

The *Arlington County Public Art – Public Places Master Plan* (adopted Dec. 2004) identified four key areas: the Rosslyn–Ballston Corridor, the Four-Mile Run Corridor, Columbia Pike, and the Jefferson Davis Corridor. The plan also notes bus stops and Metro station entrances as among the priority types of locations for public art. The Columbia Pike bus shelter design was cited as one of "the earliest visible changes along the street, presenting a clear opportunity for a strong visual and artistic impact," noting that it could serve as a model for streetscape improvements along other corridors (p. 63). Further, the plan cites any future light rail or bus rapid transit service along the Columbia Pike corridor as a high priority opportunity to incorporate public art (p. 64).

While a budget was not developed for this plan, the following potential funding sources were listed: the Capital Improvements Program (CIP) allocations to the Public Art Fund, County CIP projects that include art projects budgeted within overall projects, public art provided by private entities through the site plan process, "area funds" supported by cash contributions from site plan agreements; Neighborhood Conservation, Park Enhancement Grant, or Commercial Revitalization grants; WALKArlington capital funds, and private or community funds may supplement funding sources.

City of Reston

The City of Reston adopted a public art master plan in 2008 which identifies the Reston Transit Center as an opportunity of public art. Reston's public art goals include creating visual continuity from the Metro station along the Fountain Drive corridor to Baron Cameron Drive as well as along the Library Street corridor to North County Government Center.

For the Metro Silver Line extension, the Master Plan indicates:

> *"Reston's public art initiative will support the integration of artworks into the transit environment and the pedestrian environments that connect to it. This could involve supporting Metro commissions, guiding private development projects to reinforce pedestrian corridors, and commissioning original artworks in key locations when appropriate." (p. 45)*

The plan indicates that artists are already being selected for the Wiehle Avenue station area, with the Reston Parkway station area to be addressed once station design work begins. The plan notes artwork opportunities integrated into the fencing or retaining walls around the station, earthwork/landscape based, pedestrian overpasses, and transitions and connections along pedestrian routes to and from the stations.

City of Silver Spring

The Penguin Rush Hour mural at the Silver Spring Metro station, created through a Metro-sponsored public art contest, is a beloved community landmark. Recently renovated through donations of local residents, the 100-foot mural painted on 25 plywood panels is in storage until completion of the new Paul S. Sarbanes Transit Center in 2010.

Source: http://www.silverspringdowntown.com

Examples in Other Metropolitan Areas

King County Metro Transit, Seattle, Washington

King County Metro Transit, the county-operated transit system based in Seattle, has had a very active community-based bus shelter mural program since 1989. This

program involves youth and other members of the community who volunteer their creativity and time, while Metro contributes the materials (panels and paint).

Diverse groups of volunteers have created the murals: students, scout troops, senior citizens, community groups and individual artists. In addition to becoming a source of community pride, the murals help to deter graffiti. Most murals last from four to six years and then are replaced with a new set. Since the program began, over 1,400 murals have been installed in Metro bus shelters (including replacements). Examples, including an online gallery, a slide show, and video clips, can be viewed through this page on the King County website: http://transit.metrokc.gov.

While most of the bus shelter murals are created by community volunteers, King County Metro Transit also commissions professional artists for bus shelter artworks, and collaborates with cities and developers in improving their streetscapes and pedestrian friendliness. Collaborative projects with cities have also resulted in creative shelter designs, often integrating the artwork into the shelter structure. Examples of these kinds of shelters are on the following page of the King County website: http://your.kingcounty.gov.

For many of its public arts projects, King County Metro Transit works with 4Culture, a tax-exempt public corporation that serves as the cultural services agency for King County. (King County adopted legislation in 1973 creating the 1% for Art Program, where 1% of certain project costs is set aside for public art.)

Sound Transit, Seattle, Washington

The Central Puget Sound Regional Transit Authority (Sound Transit), the regional transit authority connecting three counties surrounding Seattle, Washington, has the STart Public Art Program. Sound Transit allocates one percent of project construction costs to art, includes free-standing art, functional art, and temporary art. STart projects are installed in and around commuter bus, commuter rail, and light rail stations, and public art is incorporated into the design of each new station. Artworks are designed specifically for the community and STart has an active public involvement process to engage community input. Examples of STart projects are available through the following page on the Sound Transit website: http://www.soundtransit.org

Tri-County Metropolitan Transportation District of Oregon (TriMet), Portland

As one program of its public art program, TriMet recycles glass shelter panels which have been damaged by vandals and graffiti by sandblasting and etching them with an artist-designed motif for reinstallation. TriMet reports that this costs under $20 per panel (as compared to $200 per new replacement panel) and adds aesthetic appeal

to bus shelters which deters future vandalism. An image of an etched panel and other public art installations can be found on the TriMet website at http://www.trimet.org.

Los Angeles County Metropolitan Transit Authority (Metro), California

Metro commissions artists to incorporate art into bus stops, rail stations, streetscapes, bus interiors, and even construction fences throughout Los Angeles County. Metro's Art Department was established in 1989 and has since commissioned over 250 artists, selected through a peer review process with community input, to create a wide variety of projects at transit sites. Funding for the program is through an allocation of one half of one percent (0.5%) of rail construction costs.

Of particular relevance to Metro in designing for enhanced bus service are the unique artworks installed at each of Los Angeles County Metro's Orange Line, a 14-mile dedicated busway served by bus rapid transit. At each station, the selected artist designed elliptical terrazzo paving areas and upright porcelain enamel steel panels. Images and information about the artist featured at each station can be found through the following page on Los Angeles County Metro's website: http://www.metro.net.

Metropolitan Transportation Authority (MTA), New York

MTA Arts for Transit program was created in conjunction with a massive rehabilitation program launched in the 1980s. MTA Arts for Transit oversees the selection of artists and the installation of permanent artworks in subway and commuter rail stations. In addition to the installation of permanent artworks, the program administers the following temporary art presentations.

- Music Under New York, a program which presents live performances in subway and train stations, with more than 100 soloists and groups providing over 150 weekly performances at 25 locations throughout the transit system. (In addition to the formal program, street performers are permitted within MTA stations)

- A Transit Poster Program, through which MTA commissions two to three artists each year to create transit-related artwork for poster and "art cards" which are randomly displayed in unused advertising spaces

- The Lightbox Project, a series of photography exhibits within the subway system which showcases the work of primarily New York-based photographers. The photographs are printed on film (donated by local providers) and displayed within illuminated boxes for 12 to 16 months, when the exhibition changes

More information about MTA Arts for Transit, including images, is available on the MTA website at http://www.mta.info.

Public Art Recommendations

Incorporation of public art into Metro's bus stop design process offers exciting opportunities for increasing the appeal of bus shelters and the surrounding pedestrian environment. A logical approach to this would be through an expansion of the existing MetroArts program.

The FTA encourages the incorporation of quality design and art into transit projects and considers public art to be an eligible capital cost as part of planning, design, and construction activities. FTA recommends that no less than one half of one percent (0.5%) and no more than 5% of construction costs be spent on artwork, and includes free-standing sculpture, wall pieces, functional elements such as seating, lighting, or railings, and artists being part of an interdisciplinary team in which the artists contribute to the overall design as potential eligible expenses.

Upgraded stops for enhanced bus service would be good candidates for inclusion of art elements, such as unique shelter designs, integrated two-dimensional mosaics, tiles, or murals, and three-dimensional sculptural elements.

Potential partners could include:

- Several Metro-area jurisdictions already have public art programs and plans in place
- Developers building along existing or planned transit routes
- Local arts commissions
- Other community development organizations

It is strongly recommended that all public artworks be developed with input from the surrounding community, involving them in the creative process to the extent feasible.

Section 4

Bus Stop Spacing and Consolidation Impact Analysis

INTRODUCTION

This section presents the recommendations suggested for the overall spacing of bus stops along a route. In addition to the spacing recommendations for bus stops, an analysis of the existing spacing between bus stops and the potential for consolidation will also be discussed. For the bus stop consolidation, an analysis on the running time and cost savings was also performed.

The distance between stops is of key concern to Metro. More closely spaced stops provide customers with more convenient access as they are likely to experience a shorter walk to the nearest bus stop. However, closely-spaced stops are also likely to result in a longer ride for customers if demand for boarding and alighting is sprinkled across many stops because the number of times it takes the bus to decelerate, come to a complete stop and then accelerate and re-merge into traffic, is increased.

The spacing of bus stops is an optimizing issue that attempts to balance the needs of passengers and operators. The objective for passengers is to minimize the sum of their accessibility, while for agencies the focus is on revenues, operational costs, service reliability, and passenger satisfaction[1], [2]. Having fewer stops along a bus route benefits passengers not only by reducing the time it takes for them to make their trip, but by making the service more reliable and predictable. Therefore, appropriate spacing between bus stops along a route can have positive impacts on passenger experience, quality of service, and operational effectiveness and efficiency.

[1] Murray, A (2003). A Coverage Model for Improving Public Transit System Accessibility and Expanding Access. Annals of Operations Research, 123(1), 143-156.
[2] Van Nes, R., & Bovy, P.H. (2000). Importance of Objectives in Urban Transit-Network Design. Transportation Research Record, 1735, 25-34.

SPACING GUIDELINES

A greater distance between bus stops presents a reduced number of potential occurrences of deceleration/acceleration, and therefore has the possibility to reduce the overall operating time of the route enough to provide customers with a more rapid and consistent ride. If time savings are significant (for example, an overall time savings of at least five minutes per trip), the transit system may be able to reduce the number of buses out on the road needed to meet headway guidelines. The downside to having a greater distance between bus stops is that some customers will be required to walk further to the nearest stop, and may find this inconvenience enough of a deterrent to choose transit, or even a hardship that prevents them from being able to ride (because of a mobility limitation).

The spacing guideline for all local bus services should be established at a consistent distance throughout the length of the bus route, to ensure expedited service through more densely populated areas, and adequate service in less populated areas. Some research has been conducted on the optimal spacing of bus stops, and according to one such study: *Municipal Benchmarks: Assessing Local Performance and Establishing Community Standards* by Ammons, which studied bus stop spacing standards for a number of agencies, the optimal bus stop spacing typically ranged from 656 – 1,968 feet (200-600 meters) in urban areas. The results of optimization studies such as Ammons details that the findings of the research show that the current spacing between bus stops is in contrast to what is found to be optimal. As a compliment to local service, more distantly-spaced stops are recommended for enhanced bus service such as limited stop or bus rapid transit (BRT) type service, which is designed to operate as an enhanced bus service (overlapped by a "local" bus service with more frequent stops for customers who would otherwise have too long of a walk to a bus stop, and correspondingly slower service).

Another optimal spacing case study, this one conducted by Li and Bertini at Portland State University's Department of Civil & Environmental Engineering, examined a route operated by TriMet in Portland, Oregon. The model developed in the case study took into account several variables including the Access Cost (the number of passenger boardings and alightings at each stop, and the passenger access speed versus the stop spacing impacts on passenger walking distance), and the Riding and Stopping Cost (the in-vehicle waiting time for bus passengers during boarding and alighting). The case study determined that the optimal average spacing for the examined route was 1,222 feet (4.3 stops/mile) compared to the existing average spacing of 942 feet.

Additional research titled *Optimal Bus Stop Spacing through Dynamic Programming and Geographic Modeling* by Furth and Rahbee looked at the impacts of changing bus

stop spacing on a bus route. The study modeled a bus route in Boston and determined the optimal spacing for the assessed route to be an average of 1,200 feet (4.5 stops/mile), which was in sharp contrast to the existing average spacing of 600 feet (8 stops/mile).

Although employing bus stop spacing guidelines is fairly common, the guidelines themselves may vary from jurisdiction to jurisdiction. Agencies generally have their own guidelines and operate it based on local needs.[3] Table 4-1 provides a matrix of the different spacing guidelines across the region, as well as the recommended spacing guidelines for the region, which are in step with the mentioned optimization studies. The following guidelines are recommended for spacing of Metrobus service bus stops in the region:

Local Bus Service

- 4-5 bus stops per mile

Enhanced Service/Limited Stop Service

- 2-3 bus stops per mile

Commuter/Express Stop Service

- Vary depending on major employment destinations and high boarding locations

Table 4-1
Existing and Recommended Spacing Guidelines

	Existing Guidelines					*Recommended Guidelines*	
	TCRP Report 19	**Maryland Transit Guidelines**	**Fairfax County**	**Montgomery County**	**Arlington County**	**Regional Guidelines**	**Enhanced Service**
Central Business District (CBD)	300-1,200 ft	10-12 stops/ mile	750 ft	500 ft	600-1,320 ft	4-5 stops/ mile	2-3 stops/ mile
Urban	500-1,200 ft	5-10 stops/ mile	1,000 ft	500 ft	-	4-5 stops/ mile	2-3 stops/ mile
Suburban	600-2,500 ft	4-6 stops/ mile	Vary	500 ft	1,320 – 2,000 ft	4-5 stops/ mile	2-3 stops/ mile

[3] Benn, H. (1995). Bus Route Evaluation Standards (TCRP Synthesis of Transit Practice No. 10). Washington D.C: Transportation Research Board.

It is important to note that these are general guidelines, and closer spacing may be desirable where a concentration of people with mobility disabilities or elderly people live or travel, service is being marketed to tourists, or for particular destinations or intersection conditions.

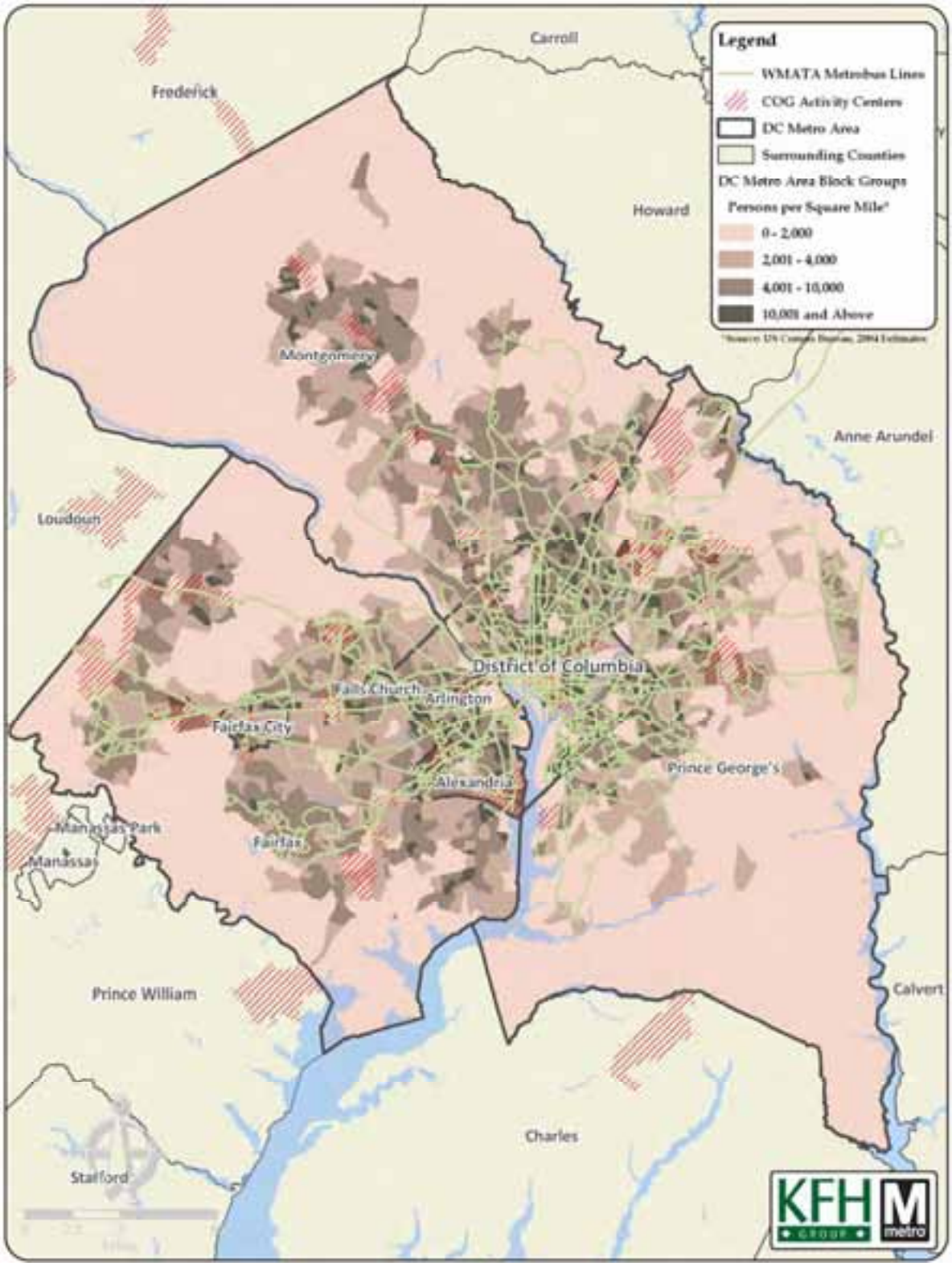
BUS STOP CONSOLIDATION IMPACT ANALYSIS

The implementation of a system-wide bus stop consolidation process will have a great impact upon a variety of aspects, including the riders, and therefore needs to be supported by a well-conceived analysis before any implementation may begin. The following provides a broad level analysis that investigates the potential impacts of consolidating bus stops for 103 Metrobus lines will have on bus running time and operating costs. Figure 4-1 provides a GIS map of the 103 Metrobus lines used in the analysis. The map also illustrates the population centers and the location of Metropolitan Washington Council of Governments' (MWCOG) designated Activity Centers.

Methodology

In conducting this broad-level bus stop consolidation impact analysis, it is important to establish the baseline data so as to ensure that any alterations are proposed in a manner which is mindful of potential adverse affects to the system's transit riders and local community. In order to understand whether any potential consolidation of bus stops would be beneficial to a transit agency and its riders, it is critical to consider a number of factors to better understand the current conditions and environment which the network of buses currently operates within. The factors used in this analysis includes current spacing between stops by line, average running time by line, frequency of service by line, and platform cost per hour. Once these appropriate factors or measurements are considered and the baseline data is established, it is then feasible to forecast suitable changes to the current spacing between bus stops along a bus line and develop ranging scenarios that may be beneficial in both aspects of convenience and operations. The development of such scenarios will then present a number of possibilities to improve either one or both of these aspects, and allow for an analysis of the results and any advantages or disadvantages that may arise with the potential modifications to the spacing between bus stops.

Figure 4-1
Metrobus Lines Used in Analysis



Factors for Analysis

To provide an accurate understanding of the current conditions and operating environments for the Metrobus service, it is vital to collect a range of data that best represents the service area, bus stop locations, and level of bus service. The majority of this data were empirical figures provided by Metro staff, with much of the data being collected in a rudimentary form that needed additional interpretation and processing. The following set of criteria helped in establishing the baseline data and overall sense of the current field conditions.

Bus Stop Spacing

Perhaps the most essential factor to this analysis was the determination of current bus stop spacing conditions along each of the 103 analyzed Metrobus lines. The current spacing conditions for each of the Metrobus lines was determined through the utilization of supplied ride check data to determine the number of bus stops along each bus line and the use of GIS software to determine each line's length by way of merging all the routes representing a specific line and using a measurement tool. In combination, the current average spacing between bus stops for each line was found, and with this central finding, it became possible to categorize the bus lines and the associated current spacing in accordance to the proposed spacing guidelines. For the purpose of these proposed guidelines and other peer studies, the current bus stop spacing may be expressed in terms of bus stops per mile or the average distance (in feet) between two stops.

Running Time

The amount of time a bus takes to complete its route is vital baseline information when calculating any running time or subsequent cost savings derived from the consolidation of bus stops along a bus line. The average running time for each bus line was calculated based upon the March 2009 Line Summary report supplied by Metro. The average running times for each of the 103 analyzed bus lines was utilized in conjunction with measurements in frequency of service (described below) to determine whether the scenarios will provide better service to the riders or true cost savings to Metro.

Frequency of Service

For the purpose of this analysis, frequency of service refers to:

1. The number of trips offered daily on each bus line;
2. The time between two vehicles traveling the same route (or headway);

3. The number of daily trips for each bus provided within Metro's Line Summary report;
4. The average headway between vehicles serving each of the 103 Metrobus lines calculated through the employment of the aforementioned average running time, and
5. The peak vehicle data noted within the Line Summary report. The last factor was the average numbers of vehicles used for each line.

Platform Cost per Hour

The platform cost per hour used for this analysis was $99.10 and was provided by Metro staff. This figure represents the full cost of operating one transit vehicle per hour and was used to estimate the potential cost savings from the consolidation of bus stops.

The four described factors for this impact analysis are important as they demonstrate the current conditions and operating environment of the Metrobus system in regard to the service area, bus stop locations, and frequency of bus service. A detailed summary of these findings for the 103 analyzed Metrobus lines is outlined in Appendix D. The following description will employ these findings, and apply the found variables of two peer case studies in order to develop a number of scenarios pertaining to bus stop consolidation and associated potential running time and cost savings.

Analysis

A consolidation of bus stops has the potential ability to reduce the running time along a bus line where the alterations are implemented, in addition to the subsequent possibility of providing a cost savings to the transit agency and a shortened ride time for the system's users. However, the impact of any reduction or changes in bus stop location or spacing will undoubtedly have some negative impacts as well, which are critical factors to consider when executing any consolidation process. The following scenarios constitute four different combinations of the two aspects of time savings per removed bus stop along a line, and the implementation of new spacing standards outlined in the proposed guidelines.

Through a process of research involving a review of prior studies concentrating on bus stop spacing optimization, it was decided to use two separate values for the amount of time savings achieved by the elimination of a bus stop along a bus line. A value of 10 seconds was used as a figure representing the lower range of potential running time savings for the elimination of one bus stop along a line, which was denoted through the research of San Francisco's Municipal Railway (Muni) findings in

the Office of Transportation for Portland, Oregon's report: *Transit Preferential Streets Program,* (July 1997). While a value of 20 seconds for time savings per the elimination of a bus stop along a line representing a higher range of potential running time savings that is more closely based upon the findings of Robert Bertini and Huan Li in their publication: *Assessment of an Optimal Bus Stop Spacing Model Using High Resolution Archived Stop-Level Data*, (November 2008). The second aspect surrounding the scenario development was the implementation of the proposed guidelines, which denote a range of bus stops per mile. According to the proposed regional bus stop guidelines, a local Metrobus line should offer its riders between four and five bus stops per mile.

Once the average bus stop spacing of the 103 examined Metrobus lines was calculated, it became possible to discover the status of current spacing conditions along each of these bus lines, and whether the appropriate spacing exists. Figure 4-2 provides a geographic illustration of the 67 Metrobus lines where the existing average bus stop spacing exceeds the recommended spacing guideline. Using the recommended average bus stop spacing of 4 to 5 stops per mile across Metro's service, the potential running time and cost savings were determined for the 67 Metrobus lines. As previous research has shown, running time savings from eliminating one stop can save between 10[4] to 20[5] seconds per run.

To estimate potential cost savings two measurements were used. The first measurement of cost savings is a linear cost savings, which simply implies that there is a set cost savings for any shortening of the overall run time of a bus. This figure was computed by subtracting the running time savings, which was calculated through the multiplication of the number of bus stops to be consolidated by seconds assumed to be saved by consolidating one stop, from the current average running time of the Metrobus line and multiplying this difference by the platform cost per hour ($99.10). The average running time varies depending on the day of service, so the figures were determined for Monday through Thursday as well as Friday bus service, in a manner that displays the linear cost savings as an annual weekday cost savings.

The second performed measurement of cost savings is a stepped cost savings, which is a more pragmatic method of calculating the potential cost savings achieved through any bus stop consolidation process. This measurement is more practical since it takes into account that true cost savings can only be achieved through the removal of a vehicle from service along a particular Metrobus line. The deduction of a vehicle was

[4] San Francisco's Municipal Railway (Muni) findings in the Office of Transportation for Portland, Oregon's report: *Transit Preferential Streets Program,* (July 1997).
[5] Robert Bertini and Huan Li, *Assessment of an Optimal Bus Stop Spacing Model Using High Resolution Archived Stop-Level Data*, (November 2008).

determined to be possible only once the attained running time savings equals or surpasses the calculated average headway specific to each Metrobus line.

Figure 4-2
Metrobus Lines with Bus Stops Spacing Exceeding Recommended Spacing

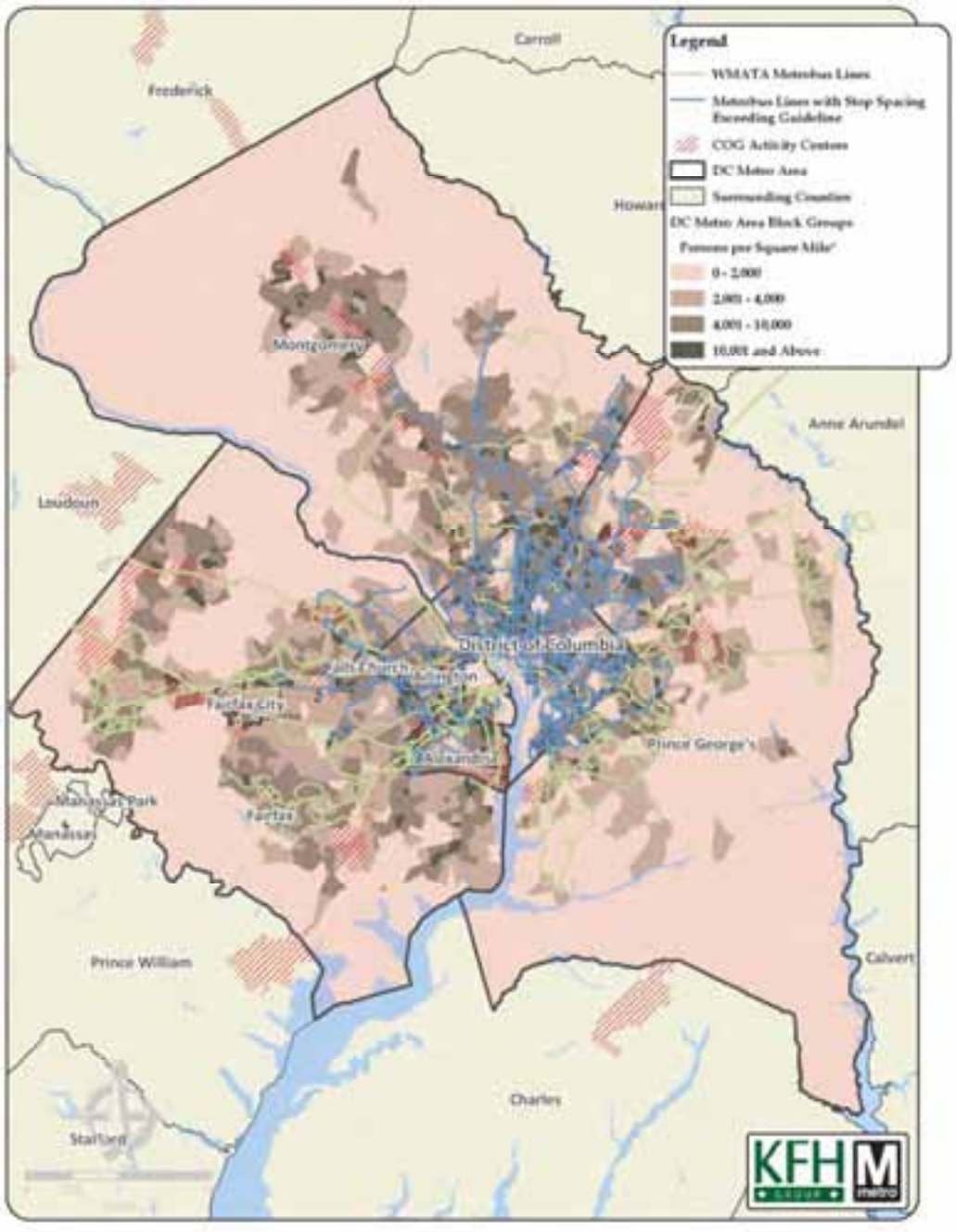
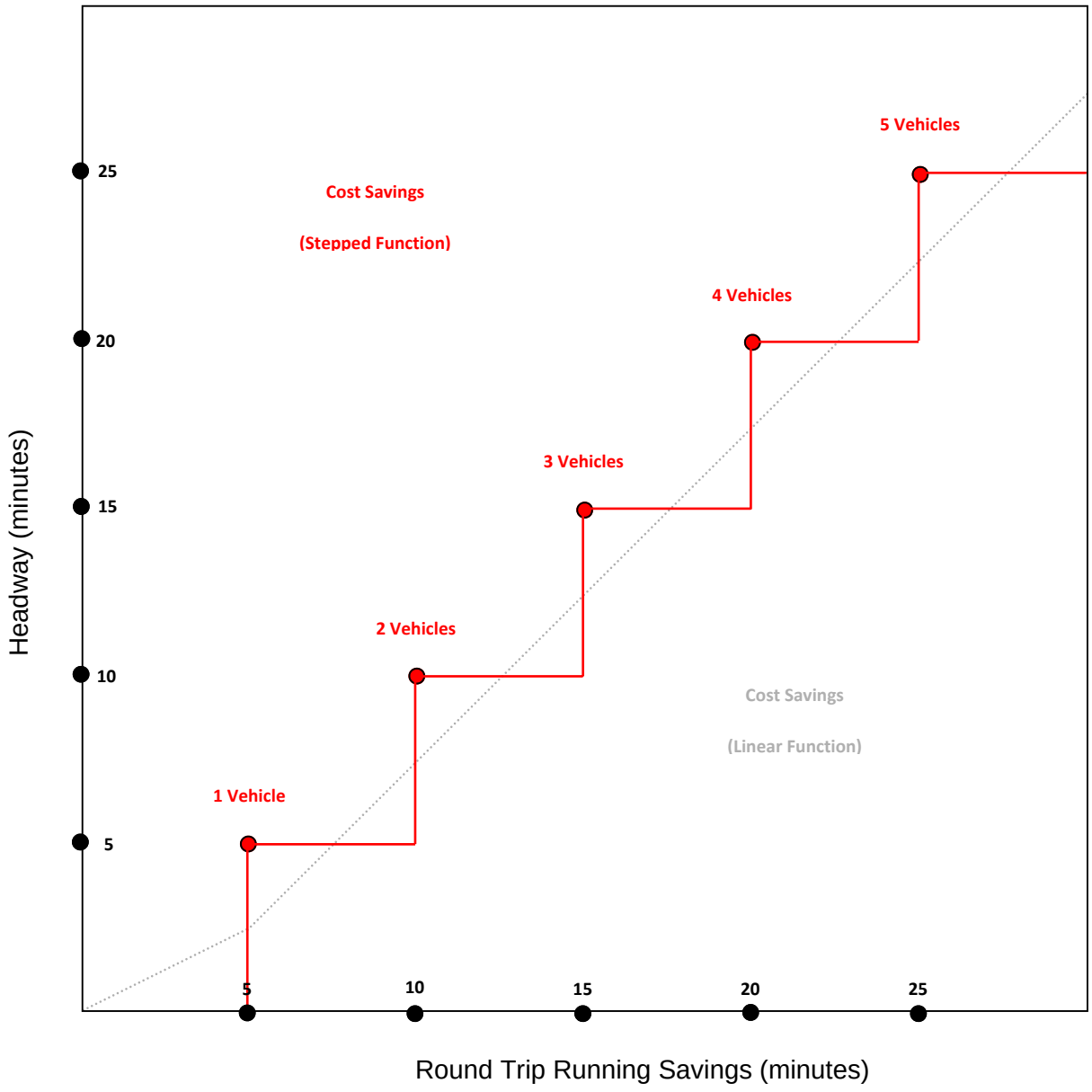


Figure 4-3 provides a visual representation for the comparison of the two different functions of cost savings analyses. As in the analysis pertaining to the linear cost savings, the stepped cost savings figures represent the cost savings annually for all weekdays.

Figure 4-3
Cost Saving Functions



Using the spacing recommendation of 4 and 5 bus stops per mile combined with the 10 and 20 seconds running time saving per consolidated stop, four possible scenarios were developed. Both the linear and stepped cost savings were performed to the four possible scenarios, with the findings specified in Table 4-2 (Scenarios 1 and 2) and Table 4-3 (Scenarios 3 and 4). The first set of scenarios depict the running time and cost savings associated with the more conservative option of consolidating the average spacing along the analyzed Metrobus lines to five bus stops per mile. Within the selected piece of analysis related to the average number of bus stops per mile, the running time and cost savings were calculated in regards to the two distinct values for time savings earlier described. The linear cost savings is estimated as $8,231,195 for a scenario in which all the analyzed Metrobus lines have the spacing of their bus stops consolidated to an average of five stops per mile, with the applied factor of a ten second savings associated with each stop removal. Through application of the identical guidelines and time savings, the more realistic measurement of stepped cost savings determined an annual savings for all weekdays of $4,108,633. A second scenario for cost savings utilizes the same suggested guideline of five bus stops per mile, but applies the previously founded time savings of 20-seconds per eliminated bus stop, instead of the aforementioned 10-second time savings. For this particular scenario, the linear cost savings was determined to be $16,462,390, while the stepped cost savings was calculated as an annual weekday savings of $11,610,895. To briefly summarize the results for the two scenarios concerning a consolidation effort by Metro to reduce the average spacing of bus stops within the analyzed Metrobus lines to five stops per mile, it was discovered that an annual weekday cost savings in the range of $4,108,633 and $11,610,895 could be achieved by the transit service.

The second set of scenarios illustrate the running time and cost savings associated with the more aggressive option of consolidating the average spacing along the analyzed Metrobus lines to four bus stops per mile. Though, the Metrobus lines whose current conditions specify an average spacing within the proposed guidelines of four to five bus stops per mile were not adjusted down to a spacing of four bus stops per mile. As in the previous circumstances, both the 10-second and 20-second values for time savings derived from an eliminated bus stop were applied. The linear cost savings for four bus stops per mile with an average time savings of ten seconds per deducted stop is $13,095,500. The annual weekday cost savings utilizing the more pragmatic stepped cost function was determined to be $8,153,274. The final scenario depicts the most aggressive approach of the four and executes a circumstance in which the Metrobus lines exceeding the proposed spacing guidelines were consolidated to an average spacing of four stops per mile, under the assumption of a 20-second time savings resulting from the removal of a bus stop. A linear cost savings of $26,191,000 was calculated as the annual weekday cost savings for the more rudimentary function, while a cost savings of $21,147,768 was determined through the application of the

Table 4-2 – Scenarios 1 and 2

							5 Bus Stops per Mile					
							10 Seconds			20 Seconds		
Line ID	Name of Bus Line	Routes	Line Length (miles)	Average One-Way Run Time (minutes)	Bus Stop Spacing (Stops per Mile)	Average Headway (minutes)	Run Time % Savings (weekday)	Cost Savings (weekday) Linear (annual)	Cost Savings (weekday) Stepped (annual)	Run Time % Savings (weekday)	Cost Savings (weekday) Linear (annual)	Cost Savings (weekday) Stepped (annual)
130	UStreetGarfieldLine	90,92,93	11.64	54.32	8.59	9.01	9.07%	$634,576	$583,206	18.13%	$1,269,153	$1,166,413
135	MayfairMarshallHeightsLine	U5,6	7.21	56.64	10.95	18.77	17.61%	$320,603	$301,390	35.22%	$641,207	$664,203
44	CapitolHeightsBenningHeightsLine	U8	6.19	55.85	9.53	14.85	13.48%	$317,647	$313,406	26.96%	$635,295	$626,812
52	14thStreetLine	52-54	10.84	44.26	7.38	3.85	5.68%	$372,654	$285,319	11.36%	$745,308	$570,638
59	TakomaPetworthLine	62	3.48	29.11	8.34	16.42	9.06%	$178,963	$0	18.12%	$357,926	$560,942
15	GarfieldAnacostiaLoopLine	W6,8	6.77	37.24	8.42	22.17	10.83%	$190,349	$418,711	21.66%	$380,698	$525,946
54	McLeanCrystalCityLine	23A,C	17.14	71.53	7.29	11.92	8.73%	$273,454	$261,095	17.46%	$546,909	$522,191
581	AnacostiaCongressHeightsLine	A2,3,6,7,8,42,46,48	15.26	25.30	7.14	2.81	7.13%	$333,712	$260,117	14.25%	$667,424	$520,235
89	PStreetLeDroitParkLine	G2	4.68	34.22	8.12	21.47	6.77%	$106,945	$506,114	13.54%	$213,890	$506,114
108	16thStreetLine	S2,4	11.04	45.68	6.34	3.15	3.80%	$265,026	$240,533	7.60%	$530,051	$481,066
84	NebraskaAveLine	M4	6.55	45.47	9.16	21.25	14.26%	$125,274	$209,195	28.52%	$250,548	$418,391
55	SibleyHospitalStadiumArmoryLine	D1,3,6	16.30	66.73	7.06	5.56	5.21%	$240,837	$192,619	10.42%	$481,675	$385,237
118	GeorgiaAvenue7thStreetLine	70,71	12.11	57.47	6.44	7.18	3.62%	$193,660	$0	7.23%	$387,321	$334,743
53	GeorgiaAveMarylandLine	Y5,7-9	14.79	54.12	6.56	12.03	6.65%	$198,266	$0	13.30%	$396,532	$331,294
41	EastoverAddisonRoadLine	P12	14.31	68.92	6.85	15.31	6.77%	$192,463	$0	13.55%	$384,927	$315,681
86	NorthCapitolStreetLine	80	9.70	65.99	7.32	9.43	5.34%	$230,223	$0	10.69%	$460,446	$307,689
78	SheriffRoadRiverTerraceLine	U4	3.37	28.31	10.39	20.76	17.91%	$137,428	$0	35.83%	$274,856	$281,923
74	CollegeParkLine	81-83,86	20.41	51.68	6.32	8.61	5.49%	$178,370	$0	10.99%	$356,740	$270,493
51	GloverParkDupontCircleLine	D2	3.78	37.14	9.78	17.01	12.20%	$143,330	$269,471	24.40%	$286,660	$269,471
46	FairfaxVillageLine	M6	3.29	31.14	9.13	19.16	13.57%	$116,122	$267,456	27.14%	$232,243	$267,456
43	FortTottenPetworthLine	60,64	4.75	31.72	7.36	6.34	6.08%	$157,723	$0	12.15%	$315,445	$259,618
137	WilsonBlvdLine	1A,B,E,F,Z	16.56	46.08	6.40	10.24	5.55%	$125,529	$0	11.09%	$251,058	$251,448
77	MilitaryRoadCrosstownLine	E2-4	11.21	42.58	7.05	6.55	6.55%	$213,255	$0	13.10%	$426,511	$250,393
150	BladensburgRoadAnacostiaLine	B2	8.78	48.05	6.49	6.01	4.25%	$160,392	$0	8.50%	$320,785	$235,915
158	SoutheastCommunityHospitalAnacostiaLine	W2,3	12.16	50.01	7.56	10.00	8.39%	$196,047	$0	16.78%	$392,094	$233,663
81	MountPleasantLine	42	3.97	30.21	7.56	3.78	5.08%	$185,235	$0	10.16%	$370,471	$227,814
101	RhodeIslandAvenueLine	G8	7.23	43.31	7.61	8.66	6.94%	$151,983	$0	13.89%	$303,966	$218,899
114	MinnesotaAveMStreetLine	V7-9	11.73	44.72	6.56	6.88	4.81%	$130,326	$0	9.63%	$260,652	$208,275
582	AnacostiaFortDrumLine	A4,5	6.84	24.70	6.87	7.06	7.81%	$112,392	$0	15.61%	$224,785	$205,699
75	MassachusettsAveLine	N2-4,6	12.82	38.21	6.86	5.46	5.36%	$144,269	$0	10.72%	$288,539	$192,233
3	LandmarkBallstonLine	25B	12.47	56.53	5.45	22.61	1.60%	$17,447	$0	3.19%	$34,894	$0
5	AlexandriaTysonsCornerLine	28A-B	22.02	69.77	5.09	13.95	0.32%	$7,847	$0	0.64%	$15,694	$0
9	AnnapolisRoadLine	T18	9.45	42.44	5.82	14.15	3.03%	$43,657	$0	6.06%	$87,314	$0
13	GreenbeltTwinbrookLine	C2,4	23.99	67.16	5.50	5.84	1.87%	$110,187	$0	3.75%	$220,374	$0
14	BenningRoadHStreetLine	X2	5.85	35.45	5.47	4.73	1.11%	$46,197	$0	2.22%	$92,393	$0
18	EastCapitolStreetCardozoLine	96,97	13.79	54.59	5.22	7.28	0.66%	$25,081	$0	1.32%	$50,162	$0
25	MarylandAveLine	X8	2.69	15.86	5.21	10.57	0.54%	$2,858	$0	1.09%	$5,715	$0
28	ChillumRoadLine	F1,2	12.12	52.77	6.85	21.11	7.14%	$92,287	$0	14.29%	$184,573	$0
32	ConnecticutAveLine	L1,2,4	11.19	33.46	5.54	5.58	1.40%	$36,320	$0	2.81%	$72,641	$0
33	ConnecticutAveMarylandLine	L7,8	12.46	33.66	5.94	8.42	4.40%	$67,359	$0	8.79%	$134,718	$0
34	BrooklandandFortLincolnLine	H6	3.56	32.13	7.86	16.06	9.91%	$121,094	$0	19.82%	$242,189	$0
37	MacArthurBlvdGeorgetownLine	D5	8.06	40.46	6.20	26.97	4.00%	$9,038	$0	8.00%	$18,076	$0
45	HospitalCenterLine	D8	7.14	44.24	6.44	8.04	3.64%	$106,944	$0	7.29%	$213,888	$0
56	IvyCityUnionStationLine	D4	3.82	18.37	6.80	12.25	5.40%	$53,231	$0	10.80%	$106,463	$0
62	BrooklandPotomacParkLine	H1	6.49	46.67	6.16	31.11	2.65%	$7,978	$0	5.31%	$15,955	$0
64	FairfaxVillageNaylorRoadLine	M2	1.91	15.43	8.39	20.26	10.17%	$14,153	$0	20.34%	$28,305	$0
69	LeeHighwayLine	3A,B,E	15.53	42.70	6.18	9.49	4.67%	$89,859	$0	9.33%	$179,719	$0
71	ChevyChaseLine	E6	4.24	17.16	7.55	17.16	9.69%	$48,583	$0	19.39%	$97,165	$0
79	VanNessWesleyHeightsLoopLine	N8	6.20	49.75	7.58	33.17	8.60%	$73,455	$0	17.19%	$146,910	$0
85	NewHampshireAveMarylandLine	K6	9.05	37.60	6.07	8.35	4.07%	$78,379	$0	8.14%	$156,758	$0
91	ParkRoadBrooklandLine	H8,9	6.33	34.39	6.00	6.25	2.69%	$53,808	$0	5.38%	$107,616	$0
94	PershingDriveArlingtonBlvdLine	4A,B,E,H,S	12.81	28.64	5.78	8.18	3.14%	$45,603	$0	6.28%	$91,207	$0
95	DeanwoodAlabamaAveLine	W4	16.11	59.75	5.59	8.54	2.02%	$56,488	$0	4.04%	$112,976	$0
96	PrinceGeorgesLangleyParkLine	F8	12.87	59.67	5.91	23.87	3.32%	$38,278	$0	6.64%	$76,555	$0
97	PrinceGeorgesSilverSpringLine	F4,6	21.64	57.29	5.78	7.64	2.96%	$112,295	$0	5.93%	$224,590	$0
123	VeirsMillRoadLine	Q2	13.80	57.67	5.58	8.24	2.29%	$95,678	$0	4.58%	$191,356	$0
134	MinnesotaAveAnacostiaLine	U2	4.30	26.58	7.44	17.72	6.37%	$53,045	$0	12.73%	$106,090	$0
140	McLeanHamletEastFallsChurchLine	24T	7.88	28.27	5.58	28.27	2.73%	$7,305	$0	5.47%	$14,610	$0
146	CalvertonWestfarmLine	Z6	15.85	47.30	5.05	18.92	0.22%	$3,104	$0	0.44%	$6,208	$0
147	FairlandLine	Z8	12.50	39.57	5.36	13.19	1.64%	$25,675	$0	3.27%	$51,349	$0
151	BenningRoadPotomacParkLine	X1,3	12.47	47.82	6.50	15.94	3.67%	$21,120	$0	7.35%	$42,240	$0
542	RhodeIslandAvenueNewCarrolltonLine	84	11.39	45.32	7.03	18.13	8.05%	$92,444	$0	16.10%	$184,889	$0
544	AnacostiaEckingtonLine	P1,2,6	12.20	42.74	6.56	8.55	4.25%	$112,211	$0	8.50%	$224,422	$0
551	TakomaWalterReedLine	K1	3.49	25.00	6.31	25.00	3.43%	$9,213	$0	6.86%	$18,425	$0
583	TakomaFortTottenLine	K2	2.81	15.86	10.67	19.47	15.95%	$47,814	$0	31.90%	$95,628	$0
800	RiggsRoadLine	R1,2,5	14.71	46.65	5.44	11.66	1.81%	$34,544	$0	3.63%	$69,088	$0
802	QueensChapelRoadLine	R4	5.92	27.32	6.59	13.66	5.71%	$43,561	$0	11.42%	$87,122	$0
	TOTALS						-	**$8,231,195**	**$4,108,633**	-	**$16,462,390**	**$11,610,895**

Table 4-3 – Scenarios 3 and 4

							4 Bus Stops per Mile					
							10 Seconds			20 Seconds		
Line ID	Name of Bus Line	Routes	Line Length (miles)	Average One-Way Run Time (minutes)	Bus Stop Spacing (Stops per Mile)	Average Headway (minutes)	Run Time % Savings (weekday)	Cost Savings (weekday) Linear (annual)	Cost Savings (weekday) Stepped (annual)	Run Time % Savings (weekday)	Cost Savings (weekday) Linear (annual)	Cost Savings (weekday) Stepped (annual)
130	UStreetGarfieldLine	90,92,93	11.64	54.32	8.59	9.01	11.59%	$811,279	$583,206	23.18%	$1,622,558	$1,166,413
44	CapitolHeightsBenningHeightsLine	U8	6.19	55.85	9.53	14.85	16.45%	$387,771	$313,406	32.91%	$775,542	$877,509
52	14thStreetLine	52-54	10.84	44.26	7.38	3.85	8.06%	$529,168	$285,319	16.13%	$1,058,337	$855,958
54	McLeanCrystalCityLine	23A,C	17.14	71.53	7.29	11.92	12.53%	$392,666	$261,095	25.07%	$785,332	$783,286
581	AnacostiaCongressHeightsLine	A2,3,6,7,8,42,46,48	15.26	25.30	7.14	2.81	10.45%	$489,424	$260,117	20.91%	$978,847	$780,352
108	16thStreetLine	S2,4	11.04	45.68	6.34	3.15	6.64%	$463,009	$481,066	13.28%	$926,017	$721,599
118	GeorgiaAvenue7thStreetLine	70,71	12.11	57.47	6.44	7.18	6.13%	$328,067	$334,743	12.25%	$656,135	$669,487
135	MayfairMarshallHeightsLine	U5,6	7.21	56.64	10.95	18.77	20.57%	$374,482	$362,813	41.13%	$748,964	$664,203
53	GeorgiaAveMarylandLine	Y5,7-9	14.79	54.12	6.56	12.03	10.92%	$325,643	$331,294	21.84%	$651,286	$662,587
86	NorthCapitolStreetLine	80	9.70	65.99	7.32	9.43	7.65%	$329,452	$307,689	15.30%	$658,905	$615,378
55	SibleyHospitalStadiumArmoryLine	D1,3,6	16.30	66.73	7.06	5.56	7.74%	$358,021	$192,619	15.49%	$716,042	$577,856
59	TakomaPetworthLine	62	3.48	29.11	8.34	16.42	11.78%	$232,567	$0	23.55%	$465,134	$560,942
74	CollegeParkLine	81-83,86	20.41	51.68	6.32	8.61	9.66%	$313,581	$270,493	19.32%	$627,163	$540,986
15	GarfieldAnacostiaLoopLine	W6,8	6.77	37.24	8.42	22.17	14.00%	$245,930	$525,946	27.99%	$491,859	$525,946
13	GreenbeltTwinbrookLine	C2,4	23.99	67.16	5.50	5.84	5.60%	$329,435	$255,793	11.20%	$658,870	$511,586
89	PStreetLeDroitParkLine	G2	4.68	34.22	8.12	21.47	8.94%	$141,173	$506,114	17.87%	$282,346	$506,114
97	PrinceGeorgesSilverSpringLine	F4,6	21.64	57.29	5.78	7.64	6.79%	$257,121	$252,564	13.57%	$514,241	$505,128
77	MilitaryRoadCrosstownLine	E2-4	11.21	42.58	7.05	6.55	9.75%	$317,299	$250,393	19.50%	$634,598	$500,785
51	GloverParkDupontCircleLine	D2	3.78	37.14	9.78	17.01	14.75%	$173,299	$269,471	29.51%	$346,597	$486,065
150	BladensburgRoadAnacostiaLine	B2	8.78	48.05	6.49	6.01	7.09%	$267,711	$235,915	14.18%	$535,422	$471,829
158	SoutheastCommunityHospitalAnacostiaLine	W2,3	12.16	50.01	7.56	10.00	11.66%	$272,531	$233,663	23.32%	$545,062	$467,327
81	MountPleasantLine	42	3.97	30.21	7.56	3.78	7.06%	$257,504	$227,814	14.13%	$515,008	$455,629
101	RhodeIslandAvenueLine	G8	7.23	43.31	7.61	8.66	9.61%	$210,300	$218,899	19.21%	$420,601	$437,799
84	NebraskaAveLine	M4	6.55	45.47	9.16	21.25	17.69%	$155,408	$209,195	35.38%	$310,816	$418,391
114	MinnesotaAveMStreetLine	V7-9	11.73	44.72	6.56	6.88	7.89%	$213,620	$208,275	15.78%	$427,241	$416,550
75	MassachusettsAveLine	N2-4,6	12.82	38.21	6.86	5.46	8.24%	$221,687	$192,233	16.47%	$443,374	$384,466
41	EastoverAddisonRoadLine	P12	14.31	68.92	6.85	15.31	10.44%	$296,506	$315,681	20.87%	$593,013	$315,681
34	BrooklandandFortLincolnLine	H6	3.56	32.13	7.86	16.06	13.37%	$163,395	$0	26.74%	$326,789	$305,456
123	VeirsMillRoadLine	Q2	13.80	57.67	5.58	8.24	6.26%	$261,161	$0	12.51%	$522,321	$298,186
78	SheriffRoadRiverTerraceLine	U4	3.37	28.31	10.39	20.76	21.24%	$162,927	$0	42.48%	$325,854	$281,923
14	BenningRoadHStreetLine	X2	5.85	35.45	5.47	4.73	3.47%	$144,392	$0	6.95%	$288,783	$277,099
46	FairfaxVillageLine	M6	3.29	31.14	9.13	19.16	16.85%	$144,239	$267,456	33.71%	$288,477	$267,456
45	HospitalCenterLine	D8	7.14	44.24	6.44	8.04	6.18%	$181,282	$0	12.35%	$362,564	$266,826
544	AnacostiaEckingtonLine	P1,2,6	12.20	42.74	6.56	8.55	6.98%	$184,354	$0	13.96%	$368,709	$264,076
43	FortTottenPetworthLine	60,64	4.75	31.72	7.36	6.34	8.65%	$224,448	$0	17.29%	$448,896	$259,618
28	ChillumRoadLine	F1,2	12.12	52.77	6.85	21.11	11.01%	$142,222	$0	22.02%	$284,444	$258,347
18	EastCapitolStreetCardozoLine	96,97	13.79	54.59	5.22	7.28	3.67%	$139,399	$0	7.34%	$278,797	$253,217
137	WilsonBlvdLine	1A,B,E,F,Z	16.56	46.08	6.40	10.24	9.51%	$215,133	$0	19.01%	$430,266	$251,448
800	RiggsRoadLine	R1,2,5	14.71	46.65	5.44	11.66	5.96%	$113,419	$0	11.92%	$226,837	$237,906
542	RhodeIslandAvenueNewCarrolltonLine	84	11.39	45.32	7.03	18.13	12.03%	$138,092	$0	24.05%	$276,183	$229,661
32	ConnecticutAveLine	L1,2,4	11.19	33.46	5.54	5.58	3.99%	$103,283	$0	7.99%	$206,567	$215,540
85	NewHampshireAveMarylandLine	K6	9.05	37.60	6.07	8.35	7.86%	$151,308	$0	15.72%	$302,615	$213,953
69	LeeHighwayLine	3A,B,E	15.53	42.70	6.18	9.49	8.61%	$165,784	$0	17.22%	$331,568	$213,953
94	PershingDriveArlingtonBlvdLine	4A,B,E,H,S	12.81	28.64	5.78	8.18	7.19%	$104,386	$0	14.38%	$208,772	$207,355
582	AnacostiaFortDrumLine	A4,5	6.84	24.70	6.87	7.06	11.98%	$172,565	$0	23.97%	$345,130	$205,699
95	DeanwoodAlabamaAveLine	W4	16.11	59.75	5.59	8.54	5.47%	$152,838	$0	10.94%	$305,676	$199,594
33	ConnecticutAveMarylandLine	L7,8	12.46	33.66	5.94	8.42	9.07%	$138,919	$0	18.13%	$277,838	$191,527
583	TakomaFortTottenLine	K2	2.81	15.86	10.67	19.47	18.77%	$56,249	$0	37.53%	$112,499	$187,340
91	ParkRoadBrooklandLine	H8,9	6.33	34.39	6.00	6.25	5.38%	$107,578	$0	10.76%	$215,156	$181,736
3	LandmarkBallstonLine	25B	12.47	56.53	5.45	22.61	5.14%	$56,110	$0	10.27%	$112,220	$0
5	AlexandriaTysonsCornerLine	28A-B	22.02	69.77	5.09	13.95	4.03%	$99,130	$0	8.07%	$198,260	$0
9	AnnapolisRoadLine	T18	9.45	42.44	5.82	14.15	6.73%	$96,842	$0	13.45%	$193,684	$0
25	MarylandAveLine	X8	2.69	15.86	5.21	10.57	3.13%	$16,398	$0	6.25%	$32,795	$0
37	MacArthurBlvdGeorgetownLine	D5	8.06	40.46	6.20	26.97	7.32%	$16,540	$0	14.64%	$33,080	$0
56	IvyCityUnionStationLine	D4	3.82	18.37	6.80	12.25	8.39%	$82,728	$0	16.78%	$165,456	$0
62	BrooklandPotomacParkLine	H1	6.49	46.67	6.16	31.11	4.94%	$14,857	$0	9.88%	$29,714	$0
64	FairfaxVillageNaylorRoadLine	M2	1.91	15.43	8.39	20.26	13.17%	$18,325	$0	26.34%	$36,649	$0
71	ChevyChaseLine	E6	4.24	17.16	7.55	17.16	13.49%	$67,599	$0	26.98%	$135,198	$0
79	VanNessWesleyHeightsLoopLine	N8	6.20	49.75	7.58	33.17	11.92%	$101,879	$0	23.84%	$203,757	$0
96	PrinceGeorgesLangleyParkLine	F8	12.87	59.67	5.91	23.87	6.98%	$80,474	$0	13.96%	$160,947	$0
134	MinnesotaAveAnacostiaLine	U2	4.30	26.58	7.44	17.72	8.98%	$74,773	$0	17.95%	$149,546	$0
140	McLeanHamletEastFallsChurchLine	24T	7.88	28.27	5.58	28.27	7.41%	$19,800	$0	14.83%	$39,599	$0
146	CalvertonWestfarmLine	Z6	15.85	47.30	5.05	18.92	4.82%	$68,480	$0	9.63%	$136,960	$0
147	FairlandLine	Z8	12.50	39.57	5.36	13.19	6.19%	$97,137	$0	12.38%	$194,275	$0
151	BenningRoadPotomacParkLine	X1,3	12.47	47.82	6.50	15.94	6.13%	$35,239	$0	12.26%	$70,478	$0
551	TakomaWalterReedLine	K1	3.49	25.00	6.31	25.00	6.06%	$16,257	$0	12.11%	$32,515	$0
802	QueensChapelRoadLine	R4	5.92	27.32	6.59	13.66	9.30%	$70,905	$0	18.59%	$141,811	$0
	TOTALS						-	**$13,095,500**	**$8,153,274**	-	**$26,191,000**	**$21,147,768**

stepped cost savings function. To outline the established results for the last two scenarios concerning an implementation of a spacing guideline of four stops per mile to Metrobus lines with a current bus stop spacing condition above those detailed in the guidelines, it was determined that an annual weekday cost savings in the range of $8,153,274 and $21,147,768 could be achieved by Metro.

SUMMARY

Table 4-4 provides a summary of the results for the four scenarios. Scenario 4 is the most aggressive of the four scenarios and has the greatest running time (18.43%) and cost savings ($21,147,768). The most conservative scenario is the first scenario with an average running time savings of 5.96% and a total stepped cost savings of $4.1 million.

Table 4-4
Running Time and Cost Savings Summary

Scenarios	Average Number of Stops per Mile	Time Savings per Consolidated Stop	Average Running Time Savings (weekday)	Total Linear Cost Savings	Total Stepped Cost Savings
Scenario 1	5	10 sec.	5.96%	$8,231,195	$4,108,633
Scenario 2	5	20 sec.	11.92%	$16,462,390	$11,610,895
Scenario 3	4	10 sec.	9.21%	$13,095,500	$8,153,274
Scenario 4	4	20 sec.	18.43%	$26,191,000	$21,147,768

The listed four scenarios detail the possible time and cost savings that Metro may achieve through consolidation of their current bus stop composition in an effort to meet the recommended regional bus stop spacing guidelines. Eliminating bus stops along a Metrobus line will undoubtedly be beneficial from an operations standpoint, as buses will move quicker through their respected routes with fewer bus stops to slow the succession of the bus along its route of service, in addition to the established cost savings attributed to removal of vehicles from a Metrobus line. However, a number of adjustments are needed to ensure that such a consolidation process does not simply tack on additional slack or idle time to the Metrobus route, such as alterations in scheduling to account for quickened route completion and appropriate schedule modifications to facilitate timely transfers. In addition to the operations perspective, it is also vital to consider the aspect of convenience to the bus rider. Any consolidation

process will undoubtedly cause a greater inconvenience to some of the system's riders, as they will have to walk further from their respected origins and/or destinations to reach the suitable bus stop. Yet, many of these current riders may adapt to this inconvenience, since the deletion of bus stops along a Metrobus route will likely lessen the overall travel time for the potential rider.

The removal of any bus stops as a result of a system-wide consolidation effort will certainly have a great impact upon the transit network. The four scenarios this study has provided outline the potential running time and cost savings that may result from the implementation of a holistic consolidation effort. However, it is of great importance for the affiliated parties to investigate all possible impacts at a more local or stop-by-stop basis. From an operational viewpoint, a bus stop consolidation effort that provides running time and cost savings to a transit agency should be sought out, as long as the convenience to the public rider is not greatly jeopardized. It is of great significance for any transit agency to provide a dependable and valuable service to the public, and a well-intended, planned bus stop consolidation process has the potential to improve upon this provided bus service, while minimizing any adverse impacts.

Appendix A

Local Jurisdiction Standards and Guidelines

Appendix A
Local Jurisdiction
Standards and Guidelines

The standards, guidelines, policies, and practices which the jurisdictions and transit systems shared with the study team were reviewed. The information available from each entity is described below, first for those jurisdictions within which Metrobus operates (most of which also operate their own local service), followed by transit systems which are based outside of the Metro service area, but which operate service into the area.

JURISDICTIONS WITHIN THE METRO SERVICE AREA

Metro's service area encompasses eight local jurisdictions, most of which operate their own local transit services in addition to being responsible for roads, sidewalks, and transit stops.

City of Alexandria / DASH

The City of Alexandria, Virginia Department of Transportation & Environmental Services provides developers with guidelines titled "Alexandria Bus Stops & Bus Shelter Conditions." These guidelines address factors to be considered in determining the stop location, minimum requirements for a landing pad, sidewalk and amenities, dimensions for curb bulbs or clearances, and the placement of a concrete pad in the roadway where the bus stops.

If there is construction at or near a bus stop, the city places a condition on the developer to improve the bus stop or add a new stop. As part of the development review process, representatives of Transportation & Environmental Services, Planning, the developer, and others try to create a well functioning and compliant bus stop. Staff indicated that Alexandria is currently in the process of developing more guidelines in a process that includes most offices in the City.

The City owns approximately 40% of shelters, private developers own another 40%, and Metro owns 20%. City owned shelters are maintained by the City. Private developer shelters are maintained by the developer; however, some of these shelters are maintained by the City. Shelters that are owned by Metro are maintained by Metro.

Alexandria generally recommends the placement of bus stops every two blocks (approximately 600 feet).

Arlington County / ART

The bus stop standards and guidelines of Arlington County, Virginia are documented in "Arlington County Bus Stop Design Standards" developed in 2002 as part of a project conducted by KFH Group to inventory and assess all bus stops in the County. The standards address stop spacing (ranging from 600 feet to 2,000 feet) depending on the density of the area served, location considerations, curb clearances, pull outs, landing area and adjacent pedestrian environment, passenger amenities and criteria for choosing installation locations, signage, maintenance, and other concerns. An appendix to these standards is a list of guidelines to provide to developers. Most of the shelters within Arlington County are owned and maintained by the County, with developers encouraged to install concrete pads for new shelter installation. At the time these standards were being developed, the County was planning express bus service along Columbia Pike, and enhanced bus stop amenities (including Intelligent Transportation Systems (ITS) features) were included for express stops as well as high-volume/transfer stops.

A discussion with Arlington County staff indicated that the county wishes to eliminate pull-outs except on roadways where the posted speed limit exceeds 40 miles per hour. Another standards change the county is considering is to reduce the minimum curb space needed along curb bulbs.

The District of Columbia / DC Circulator

The District does not have established bus stop design standards. The recommendations of the Transit Cooperative Research Program (TCRP) Report 19: *Guidelines for the Location and Design of Bus Stops* are generally followed, with the exception of minimum curb clearances. Because of the frequency of stops, the small dimensions of blocks, and the demand for on-street parking, bus stops located in the District tend to have shorter curb clearances.

The District has an advertising shelter program, through which shelters are installed and maintained by Clear Channel. The advertising shelter program will be

replacing many of the Metro shelters. To date approximately 300 new shelters have been installed.

The DC Circulator is operated by Metro under contract to the District. Location and features at these bus stop locations are determined by Metro and the District of Columbia staff.

City of Fairfax / CUE

The CUE Bus service of the City of Fairfax, Virginia, does not have specific local design standards for bus stops. However, when selecting new locations or installing shelters, the city follows Federal Transit Administration (FTA) and American Disabilities Act Accessible Guidelines (ADAAG) guidance for compliance with the Americans with Disabilities Act (ADA). The city's Public Facilities Manual, provided to developers, includes a diagram with minimum dimensions for sideways and shelter dimensions.

Fairfax County / Fairfax Connector

Fairfax County, Virginia's "Fairfax County Bus Stop Guidelines" were developed in 2004 as part of a project contracted to PBS&J to conduct a county-wide inventory and assessment of bus stops. The guidelines address stop spacing (ranging from 750 feet in dense urban areas to more than 1,000 in low density areas), curb clearances, pull outs, landing area and adjacent pedestrian environment, passenger amenities, a hierarchy for which amenities are to be included based on ridership and service levels, signage, maintenance, and other concerns.

City of Falls Church / GEORGE

The City of Falls Church, Virginia, funds the operation of the local GEORGE service operated by Metro. Falls Church does not have bus stop standards. Until recently, all shelters had been installed and are still owned and maintained by Metro. The newest shelter was a replacement of a Metro shelter (Metro is no longer installing shelters). Its installation was required of a developer during the site review process. It is a custom shelter with a roof and two side panels; the back is open to allow for accessibility within limited right-of-way. The shelter is owned by the developer and maintained by the City of Falls Church. Two additional shelters are also being built at other developments and will also be maintained by the City. Falls Church is interested in purchasing shelter maintenance from Metro.

Montgomery County / Ride On

Montgomery County, Maryland bus stop standards are documented in "Standards for the Installation of Bus Stops Montgomery County." This document indicates recommended stop spacing (at least 500 feet in between), factors to be considered in determining stop locations in relations to intersections and other roadway characteristics, and minimum curb clearances.

In 2004-2005, Montgomery County underwent a county-wide inventory and assessment of bus stops. This project, conducted by KFH Group, identified safety and accessibility conditions at all stops and recommended improvements based on the County standards as well as ADAAG requirements and the recommended guidelines within TCRP Report 19. A second phase of the project, currently underway, is to implement the recommended improvements, working with contractors to install landing pads, sidewalk connections, and amenities.

The County has an advertising shelter program, through which shelters are installed and maintained by Clear Channel. The County has been replacing older Metro shelters with new Clear Channel shelters. Metro shelters that have yet to be replaced continue to be maintained by Metro. Takoma Park, Gaithersburg, and Rockville install and maintain their own shelters.

Discussions with county staff for this project indicated a preference for more widely spaced stops (i.e., more than 500 feet).

Prince George's County / The Bus

Prince George's County uses a criteria checklist to determine appropriate locations for bus stops and/or shelters. A point is assigned if each criterion is met. The sum of those points is used if the location is appropriate for a bus stop and/or shelter.

Metro

Metro does not have formal standards for Metrobus stops. Working in coordination with the jurisdictions, Metro generally follows the guidelines of TCRP Report 19 and the ADAAG in establishing stops.

OTHER TRANSIT SYSTEMS THAT OPERATE WITHIN THE METRO SERVICE AREA

In addition to the transit systems of the local jurisdictions served by Metro, there are several other transit systems in the region which makes stops within the Metro service area.

Loudoun County Transit Commuter Bus

Loudoun County, Virginia, operates commuter bus service to Rosslyn, Pentagon, and Washington, D.C., with stops in Purcellville, Leesburg, the Dulles North Transit Center, and the Dulles South area. Loudoun Transit does not have formal bus stop guidelines. Most of the commuter bus stops are located at Metrorail stations or Metrobus stops, though a few are at locations without signage. Loudoun Transit would like to be able to legally place commuter bus stop signs in the District of Columbia.

Maryland Transit Administration (MTA) Commuter Bus

MTA Commuter Bus service operates 15 routes from Central and Southern Maryland into the Metro service area, including the Maryland suburbs and downtown D.C. Most routes are operated inbound to D.C. in the morning peak and outbound in the afternoon/evening peak, and stops are served every five to seven minutes at the most frequent times. Vehicles operated on these routes are typically over-the-road motor coaches 45 feet in length.

While MTA Commuter Bus does not have formal bus stop standards, they would like at a minimum 60 feet of clearance per bus (i.e., 120 feet if two routes serve a stop), enough sidewalk space for waiting passengers at heavily used stops (State Department, L'Enfant Plaza, Air & Space Museum), lighting, and signage.

MTA Commuter Bus has very limited influence over bus stops within the District of Columbia, and has experienced difficulty in establishing stop locations and placing bus stop signs.

Approximately one-half of MTA's bus stops in the District are currently designated by signage. MTA indicated that requests to the District for commuter bus stop sign placements have met with limited success. Loss of revenue on metered streets appears to be a District concern, even if the stop is only served during peak hours when metered parking is prohibitive. MTA indicated that several years ago, they hired a contractor to post bus stop signs at commuter bus stops, but without prior approval from the District, and the District took most of them down. Signs have also been

removed due to construction and not replaced. While ideally MTA would like to have signs installed at all bus stops, one advantage to an absence of sign is the flexibility in being able to change the routes and stop locations depending on current conditions.

One issue of concern is that District police sometimes discourage MTA Commuter Bus drivers from making stops, even at stops with actual MTA commuter bus signs, so designated stops cannot always be made. Many of the commuter buses look like charter buses instead of transit vehicles, so the police don't always recognize them as transit. MTA staff report that drivers have had to relocate stops if an adjacent property complains about the waiting crowds.

MTA Commuter Bus indicated that sharing stops with Metro or other entities is undesirable because of the overcrowding of people and vehicles it would create. Approximately five years ago, MTA and Metro consolidated some stops, but found the overcrowding to be a problem, so they separated their stops back out.

Potomac and Rappahannock Transportation Commission (PRTC) OmniRide

OmniRide is a commuter bus service of the PRTC, with route service from Gainesville, Manassas, and Prince William County into the Metro service area, including Arlington County and downtown D.C. OmniRide routes are generally operated inbound to D.C. in the morning peak and outbound in the afternoon/evening peak.

PRTC has guidelines for placement of shelters and benches on local bus routes, though not for the OmniRide stops outside of the local service area. Most of the OmniRide stops are co-located with Metrobus stops, with OmniRide signs sharing the same sign poles. Ideally, PRTC would like to be able to install signs and establish right-of-way at the curb for any new commuter bus stops, and install shelters, route, and schedule information at key stops.

Corridor Transportation Corporation (CTC)

CTC operates the Connect-A-Ride service in the Laurel area of Montgomery and Prince George's Counties. CTC does not have formal bus stop locations and design standards.

SUMMARY OF STANDARDS, GUIDELINES, POLICIES, AND PRACTICES CURRENTLY FOLLOWED IN THE REGION

While few jurisdictions have comprehensive standards or guidelines, many have guidelines or typical practices for a subset of the possible areas to be defined. Each of these areas is summarized for those jurisdictions which indicated guidelines in that particular area.

Spacing of Stops

Current jurisdictional guidelines related to spacing range from at least 500 feet to up to 2,000 feet in suburban areas (Table A-1).

Table A-1: Spacing

	Spacing
City of Alexandria - DASH	Generally every two blocks (typically 600 feet)
Arlington County - ART	• High density areas (major employment centers and/or > 4,000 persons per square mile): 600′ to 1,320′ • Suburban areas: 1,320′ to 2,000′
Fairfax County – Fairfax Connector	Three transit density classes: • High (750′ spacing). Primarily commercial with high concentration of employment, or >5 people per acre • Moderate (1,000′ spacing). 2-5 people per acre • Low (spacing based on activity centers rather than distance). <2 people per acre
Montgomery County – Ride On	At least 500 feet in between recommended; currently considering increasing the recommended minimum

Location Considerations

Table A-2 presents other location considerations, including placement in relation to the nearest intersection (near-side, far-side, or mid-block), driveways, and major activity centers, and pre-existing passenger amenities.

Table A-2: Location Considerations

Location Considerations	
City of Alexandria - DASH	Formulation of these guidelines is underway. Current case-by-case criteria include: • Availability of space in the public right-of-way to meet ADA • Potential ridership • Transfer activity • Proximity of major activity centers • Adjacent land use • Community interest • Existing street furniture • Pedestrian crossing • Street lighting • Availability of electric source (for shelter) • Footprint of amenities • Relationship of intersection, signal lights and sightlines • Funding for landing pads
Arlington County - ART	<u>Near-side recommended where:</u> • Traffic is heavier on the far-side • Pedestrian access and existing landing area conditions on the near-side are better • Street crossings and other pedestrian movements are safer on the near-side • Bus route continues straight through the intersection <u>Far-side recommended where:</u> • Traffic is heavier on the near-side • Heavy left or right turns occur • Pedestrian access and existing landing area conditions are better on the far-side • Traffic conditions and signal patterns may cause delays • Intersections have transit signal priority treatments <u>Mid-block (>300 feet from intersection) recommended where:</u> • Traffic or street /sidewalk conditions at the intersection problematic • Passenger traffic generator is located mid-block • Interval between adjacent stops exceeds stop spacing standards • Compatible with corridor or district plan <u>Other considerations:</u> • Driveways should only be blocked at stops if very brief dwell times, preferably fully, rather than partially • Should not be located over the crest of hill, immediately after a right-hand curve in road, or other locations with limited visibility to oncoming traffic • Should be located close to activity center expected to generate most ridership

Location Considerations	
District of Columbia	Uses the standards in TCRP Report 19 except curb clearances (full clearances not feasible)
Fairfax County – Fairfax Connector	Near-side/far-side choice depends on geometric design of roadway, local orientation of passenger arrival and departure, vehicle turning movements and other factors. Additionally, location-specific factors include two-lane streets, driveways, traffic signals, departing bus turning maneuver needs • Far side stops can improve pedestrian safety • Near side locations are effective where there are not heavy volumes of right turning vehicles at the intersection • Mid-block is generally recommended only where far-side or nearside stop locations are not feasible • Generally should not be placed near driveways or on steep grades • ≥ 5' feet clearance between crosswalk and bus
Montgomery County – Ride On	Based on engineering judgment of specific factors <u>Near-side favored where:</u> • Traffic is heavier on far-side • Cross street is one way from right to left • Cross street traffic turns onto the bus route street • Passengers alight close to crosswalk and area is cleared of snow during winter • Intersection controlled and transit traffic is critical, but other vehicular traffic flows and parking are not critical • Route turns right and curb space critical, all traffic not critical <u>Far-side favored where:</u> • Heavy right turns from the route street at the intersection • Traffic is heavier on near-side • Cross street is one way from left to right • Bus turns left at the intersection • Less of an obstruction of sight distance • Turning movements from the side street are not heavy • Sidewalk is less crowded • Clearance is adequate so intersection would not be blocked • Heavy turning movements are prevalent on the bus route street • Bus routes and heavy traffic movements diverge • Intersection controlled and traffic flows and parking are critical, but transit is not • Bus route turns right and all is traffic critical, curb space not critical <u>Mid-block stops favored where:</u> • Traffic or physical characteristics prohibit stops adjacent to intersection and large passenger generators exist <u>Additional considerations:</u>

Location Considerations	
	• Location of major generators and configuration of side streets • Whenever practical, stops should be located at intersections with signals or stop signs • Proximity of shelter and adequate lighting • Set back of sidewalks, if existing; if not, consider constructing slab or sidewalk • Avoidance of · locations with drop curbs or curb depressions • Where pavement is substantially wider on one side of an intersection, the bus stop may be best located that side if .traffic volumes are comparable on both sides
Prince George's County – The Bus	• Within 100′ of traffic control device • Existing sidewalk • Proximity to street light • Clear line of sight for motorist • Near-side • Curb cut access within one block

Curb Clearances, Extensions, and Pull-Outs

Guidelines related to interface between the roadway and the landing area is presented in Table A-3. This table includes amount of clear space needed along the curb, curb extensions (sometimes call curb nubs or curb bulbs, which minimize the impact on on-street parking and allow the bus to stop in the travel lane), and pull-outs (into which the bus would pull out of the travel lane).

Table A-3: Curb Clearances, Extensions, and Pull-Outs

Curb Clearances, Extensions, and Pull-Outs	
City of Alexandria – DASH	• Curb extensions: parallel to roadway, min. 8′x8′, 30′wide preferred • Where bulb outs/curb bulbs are not feasible and there is curbside parking, red curb or "no parking" signs required at bus stop zones, minimum 120′
Arlington County - ART	Curb Clearances: Near-side: • 100' of curb clearance prior to header sign 30-50' from the intersection Far-side: • 75-80′ after intersection with header sign 50' from intersection. • Additional clearance for stops following right- and possibly left-hand turns. Mid-block: • 90' with header sign 25' from far end of pull-out area • If mid-block crosswalk, header sign should be ≥ 30' before or 50' after crosswalk Minimum curb clearance should have at least two "no parking" signs, one at each end of the no-parking zone, with additional sign for longer zones.

Curb Clearances, Extensions, and Pull-Outs	
	Curb extensions: Min. 5′ wide, 30′ preferred for stops served by 40′ buses and 50′ preferred for stops served by 60′ articulated buses for rear-door access. (p. 6) (Note: App. A: 30-40′, min. 4′ deep.) (County is currently considering reducing) Pull-outs recommended where traffic ≥40 mph, ≥ 12′ wide. (County is currently considering increasing mph.)
Fairfax County – Fairfax Connector	Typical clearances: Near-side: • 100' of curb clearance prior to header sign, which should be 5' from corner radius Far-side: • 95′ after crosswalk with header sign 45 from crosswalk • After right turn, 95′ after corner radius with header sign 45 from radius • Typical far-side shelter stops are illustrated in Figures 9-11 (pp. 25-27) Mid-block: • ≥150' with header sign 50' from front end. (Fig. 6, p. 22) Bus pullouts should be considered only for safety or to reduce significant delay for vehicular traffic, where: • ≥45 mph • Horizontal or vertical curves with limited sight distance or at the bottom of a steep grade. • Buses wait for a significant amount of time (where there is high transfer activity or especially high ridership – typically dwell times over 10 seconds/stop), and the queue behind the bus would lead to safety hazards If deemed necessary, should: • Have tapered deceleration and acceleration lanes • Be located at the far side of a signalized intersection • See Fig. 7 for taper of acceleration and deceleration portions of the bus bays. Dimensions from TCRP Report 19: • Stopping area: 50′ per 40′ bus and 70′ per 60′ articulated bus • 12′ width desirable • Desirable taper length = mph x width of turnout bay. A taper of ≥ 5:1 is desirable for entrance taper, ≥3:1 for merging or re-entry taper • Minimum design for a bus bay does not include acceleration or deceleration lanes According to the Fairfax County code, all bus stops are "No Parking" zones; post "No Stopping, Standing or Parking" signs where problems exist
Montgomery County – Ride On	Near-side: • 100 feet from the front of stopped bus (P.C. of curb radius) to the front of preceding parking stall Far-side: • Through movement or after left turn: 80 feet from rear of stopped bus (P.C. of curb radius) to end of first parking stall

Curb Clearances, Extensions, and Pull-Outs	
	• After right turn: 140 feet from outside edge of lane of the street from which bus is turning to end of first parking stall Mid-block: • 140 feet (60′ pull-in, 40′ bus, 40′ pull-out) Stops served by multiple buses: • Additional 45 feet for each additional bus Bus stopping areas should be designated "No Parking Bus Zone" or "No Parking Any Time" Bus pull-outs should be established at points of high passenger activity, especially in mid-block situations
Prince George's County – The Bus	• 70′ bus stop zone
MTA Commuter Bus	No formal standards; recommends at least 60′ clearance per bus (i.e., 120′ if two routes serve a stop)

Types / Hierarchy of Stops

Existing guidelines related to different kinds of bus stops are presented in Table A-4. Fairfax County's standards designate a hierarchy of stops, with passenger amenities increasing with the number of riders and the importance of the stop as a transfer location or activity center. The simplest kind of stop is installed in residential areas, with off-street transit centers and park and ride lots having the greatest number of amenities.

Table A-4: Types / Hierarchy of Stops

Types / Hierarchy of Stops	
Arlington County - ART	Transfer or high volume stops: • Close to intersection and crosswalk • Shelter (>40 boardings per day) • Route information for all routes • Extra waiting space (8-10 sq.′ per peak load passenger) Key or express stop (major stops on routes, usually several blocks apart): same as above plus: • Shelter designed to cover a 10′x20′ area, with seating and overhanging roof • Visibility of bus approach route • Lighting • Public information display systems, including route maps, transit information • Stop request / security call mechanisms • Radiant heaters • Ticket vending machines

Types / Hierarchy of Stops	
	• Advertisements • Solar technology where feasible.
Fairfax County – Fairfax Connector	Residential stops to include: • Loading pad (5'x8') • Bus stop sign • Two "No Stopping, Standing or Parking" signs where problems exist • Lighting • Shelter (as appropriate) • Bench (as appropriate) Minor collector, all of above plus: • Bus bay (as appropriate) Arterial/major collector – lower ridership (<50 boardings per day), all of above plus: • Customer information displays (schedule, system map) Both Arterial/major collector –higher ridership (50-100 boardings/day) and Major activity center (>100 boardings/day), usually on arterial or major collector), same amenities as above Transit center / park and ride area (at area dedicated exclusively to transit), includes: • Shelter • Bench • Loading pad extending full length of bus(es) • Bus stop sign • Two "No Stopping, Standing or Parking" signs where problems exist • Customer information displays (schedule, system map) • Lighting

Passenger Boarding Areas

Minimum specifications for passenger boarding areas include dimensions and surface characteristics (Table A-5). The ADAAG of the U.S. Access Board requires that pads installed at bus stops must be at a minimum 5 feet parallel to the curb by 8 feet perpendicular to the curb.

Table A-5: Passenger Boarding Areas

Passenger Boarding Areas	
City of Alexandria - DASH	• 8′x8′landing pad, never placed on storm drains, catch basins, uneven surfaces, water accumulation areas, overgrown bushes and grass, other obstacles • Additional boarding and alighting areas needed where multiple buses stop at a time, to be determined by size and placement of buses serving each stop
Arlington County - ART	• Min. 5′x8′ • 25′ wide preferred for ART rear-door access • 30′ for stops served by 40′ buses • 40′ for stops served by 60′ articulated buses • Slope parallel to the slope of the roadway • Firm, stable, and slip-resistant, concrete preferred • Elevated 6″-7″ above street level preferred • Pad connected to sidewalk that is ≥3′ wide
Fairfax County – Fairfax Connector	• At curbed area ≥5′x8′ • At uncurbed area on ≥8′ wide shoulder • Stable, firm, slip resistant surface • Well-drained surface • Cross-slope <2% • No amenities located within loading pad • No storm drains or catch basins within loading pad • Access to sidewalk/ trail • 45′ wide typical at transit center/park & ride lot (Fig. 9, p. 25)

Shelters

Table A-6 presents the shelter installation guidelines currently in place in the jurisdictions. Several jurisdictions have advertising shelter programs, including the District of Columbia, and Montgomery and Prince George's Counties, Maryland.

Table A-6: Shelters

Shelters	
City of Alexandria – DASH	• All shelters must include a bench and be illuminated and meet City standards (not defined) as well as ADA requirements
Arlington County - ART	• Standard shelter design: 8′ tall x 12′ wide x 4′8″ deep on concrete pad 13′ feet wide x 13′6″ deep • Shelter pad: 5′ x 13′, 6″ inches concrete (may be re-enforced with wire grid). Sub base of blue stone. Should be located ≥8′ from curb if at landing area (≥4′ if beside landing area) • An additional 4-6′ wide extension recommended to accommodate newspaper boxes, trash can, etc.
District of Columbia	• Uses the standards in TCRP Report 19 • Shelters installed and maintained by Clear Channel • Some shelter locations have power conduit
City of Fairfax – CUE Bus	• Follow latest FTA guidelines in regard to bus shelters and ADA compliance • Shelter installation recommendations are included in the Public Facilities Manual
Fairfax County – Fairfax Connector	• On waiting pad, not loading pad • > 2′ between back face of curb and the front face of roof of shelter • If pedestrian facilities are present between back face of curb and shelter, refer to Section A for guidelines • >1′ between shelter and nearest building • >3′ either in front or behind shelter for access
City of Falls Church - GEORGE	• Designed on a case-by-case basis as part of the site review process • Developer pays for installation of custom shelter
Montgomery County	• Shelters installed and maintained by Clear Channel • 42″ clear space inside shelter for wheelchair users • Overall dimensions are approximately 9′ tall, 12′ wide, and 6′ deep. • Power conduit is included in all new shelter installations
Prince George's County	• 20 patrons/hour or 100 patrons/day • Available ROW; 8′x14′ • Located ¼ mile from major trip generator • Serves 2 or more bus routes

Signage

Bus stop signage guidelines are summarized in Table A-7. These include sign design and placement specifications for bus stop location signs.

Table A-7: Signage

Signage	
Arlington County – ART	• On own post or light standard • Perpendicular to street • Placed where front of bus should stop • 2′-4′ from curb edge (Note: App. A says 18″-2′) • Metro header sign: 14″x14″, typically 98″from ground • ART header sign: 18″x18″, typically 88″ from ground • Should contain route names / numbers and phone number • Route, schedule and fare info should be posted at stops near major trip generators • Metro display case: 7″ square x 23″ tall mounted on sign pole approx. 44″ (at base) from ground • ART rotating display tube: 26″ circ. x 30″ tall, mounted on sign pole approx. 38″ (at base) from ground • Accessible to passengers with schedules mounted away from street • Signs must conform to neighborhood zoning requirements
Fairfax County – Fairfax Connector	The characters and background of all new bus route identification should follow standard bus stop signage practices. Signs that are sized to the maximum dimensions permitted under legitimate local, state or federal regulations or ordinances shall be considered in compliance

Lighting

Guidelines and specifications related to lighting of bus stops are presented in Table A-8. It should be noted that advertising shelter vendor agreements may include lighting as well.

Table A-8: Lighting

Lighting	
Arlington County – ART	• Stops served after dark should be located where illuminated, preferably from an overhead street light, or lighting should be installed at the stop • Backlighting from advertising installed at shelters and "stop call" are other options. Interior lighting is recommended for shelters • Solar technology is an alternative to hardwiring for new installation • Internal to shelter: 5-10 foot candles • External to shelter: 2-5 foot candles • Optional stop call or sign illumination mechanism for signaling driver which route needs to stop
Fairfax County – Fairfax Connector	• Bus stops should be located near existing street lighting, where possible • All lighting at stop should meet current IES Standards as specified in the Fairfax County Public Facilities Manual (PFM) Chapter 7.1000, based on road classification • The loading pad, waiting pad, sidewalk access, and intersection crosswalk should have the minimum specified illumination per PFM Chapter 7.1000
District of Columbia	• New shelter locations will be hard wired for shelter lighting

Technology Infrastructure

Two jurisdictions currently have standards for the installation of infrastructure to install ITS technology features. Table A-9 summarizes these standards.

Table A-9: Technology Infrastructure

Technology Infrastructure	
City of Alexandria - DASH	• Electrical and communication conduits are required at all shelters for installation of ITS features
Arlington County - ART	• In preparation for ITS technologies, whenever feasible, new bus stop locations and improvements to existing stops should provide for electrical conduits • 1" conduit to junction box at rear corner of shelter pad (circuit breaker). Connect to building power (if possible) or nearest signal control box or electric power junction box. Electricity (120 volts/20 amp circuits) and communications to support ticket vending machines, real-time passenger information, lighting of stop, security cameras, and emergency call boxes. Also for cleaning purposes and landscape maintenance. Provide outlet for maintenance equipment

Other Passenger Amenities

In addition to shelters, lighting, and informational signage, passenger amenities at bus stops include benches and trash cans. Table A-10 summarizes existing guidelines for these kinds of amenities.

Table A-10: Other Passenger Amenities

Other Passenger Amenities	
Arlington County – ART	<u>Street Furniture:</u> • Benches are installed inside shelters .and freestanding at some locations based on boardings and site conditions. Recommend 1' x <7' interior benches with arms, to one side of shelter • Benches should be >4' from curb (and not blocking landing pad) • Ornamental shelters and benches used in selected communities. (pp. 15-16, App. F) • Trash cans are installed with County shelters and recommended at stops where litter is frequently a problem • Trash cans should be placed after pole, behind pad or sidewalk, or at the end of the clear space • Must conform to neighborhood zoning policies
Fairfax County – Fairfax Connector	<u>Benches (free standing) on waiting pad</u> • Offset from the back face of curb >2', 4' preferred, increased depending on speed • If pedestrian facilities are present between back face of curb and bench, refer to Section A for guidelines

Maintenance

Bus stop maintenance includes trash removal, shelter cleaning, landscaping, snow removal, and repair of shelters and other amenities in the event of damage. Those jurisdictions which indicated maintenance standards are included in Table A-11.

Table A-11: Maintenance

Maintenance	
Arlington County - ART	• Tree branches that extend into roadway < 11′ should be trimmed to >2′ from curb. • "Adopted" stops are maintained by adoptive organization or individual. (App. A) • Metro maintains Metro-provided shelters; property owner maintains developer-provided shelters; County maintains others (approx. 2 cleanings per year)
Fairfax County – Fairfax Connector	• Maintain path of travel to prevent overgrown shrubs, bushes, uneven surfaces, etc. • Trim tree branches: on roadway side to ≥132" high and ≥24" from back of curb inside bus stops ≥77" high • Consider snow removal to keep pads accessible • Implement a regularly scheduled maintenance and trash removal program for shelters and pads
District of Columbia	• Advertising shelter vendor performs routine maintenance, repairs, and cleaning • Snow removal of bus zone is performed by shelter company • DC DPW performs the trash collection

Other Stop Design Considerations

Table A-12 summarizes bus stop design considerations which did not fall into any of the preceding categories.

Table A-12: Other Stop Design Consideration

Other Stop Design Considerations	
City of Alexandria - DASH	• Concrete pad required in travel lane
Arlington County - ART	• Crash barrier: Installation of a crash barrier is recommended in advance of bus stops and shelters on roads ≥45 mph without sidewalks, street parking, or other natural barriers to protect bus riders, especially where passengers have to stand ≤6 feet of curb line
Fairfax County – Fairfax Connector	• Intersection turning radius should be considered to eliminate wide swinging buses • Concrete pad -- Reinforced pavement recommended in roadway at stop

Existing Jurisdictional Standards

- There is a wide variety of scope and level of detail of existing guidelines among the jurisdictions within the Metro service area.
  - Arlington County and Fairfax County have comprehensive guidelines for bus stops.
  - The City of Alexandria has a list of specifications pertaining to bus stop and shelter location and design which is provided to developers.
  - The Facilities Manual provided to developer by the City of Falls Church includes a diagram of recommended shelter installation.
  - Montgomery County has standards primarily pertaining to placement related to an intersection.
  - The other jurisdictions noted that the minimum requirements under the ADA and the recommendations of TCRP Report 19 were followed in locating new stops.

- Other transit operators with stops in the Metro service area (primarily commuter bus service) indicate a desire to be able to legally install commuter bus stop signage within the District of Columbia. One operator expressed a strong preference for keeping commuter bus stops separate from local Metro stops as well as other commuter operators (to minimize congestion of vehicles and passengers) while the other two have stops comfortably co-located with Metrobus stops. None have developed standards for commuter bus, though the local bus service with which the commuter routes connect outside of the Metro service area may have bus stop standards.

- The Mass Transit Authority of the District of Columbia Department of Transportation is working with the commuter bus operators and Metro on stop locations and commuter bus routing within the district. This appears to be part of an effort of the district to get a handle on charter buses, which many of the commuter buses resemble.

Appendix B
Other Resources Reviewed

Appendix B
Other Resources Reviewed

The project team also reviewed resources and examples outside of the Metro service area. These include nationally published resources and examples of standards and guidelines in other areas.

LITERATURE REVIEW

Guidelines and recommendations for bus stop location and design were reviewed from the following resources:

- Easter Seals Project ACTION's (ESPA's) *Toolkit for the Assessment of Bus Stop Accessibility and Safety*
- MTA's *Maryland Transit Guidelines*
- TCRP Report 19: *Guidelines for the Location and Design of Bus Stops*
- *WMATA Regional Bus Study*
- *WMATA Station Site and Access Planning Manual*

Table B-1 presents the recommendations found in these documents related to:

- Spacing of Stops
- Location Considerations
- Curb Clearances, Extensions and Pull-Outs
- Types / Hierarchy of Stops
- Passenger Boarding Areas
- Shelters
- Signage
- Lighting
- Other Passenger Amenities
- Maintenance
- Other Stop Design Considerations

Table B-1: Bus Stop Guidelines Recommended in State, Regional, and National Guidebooks and Manuals

Spacing of Stops	
Maryland Transit Guidelines	The placement of bus stops along transit routes requires balancing of passenger convenience and speed of operation • Downtown Core: 10-12 stops per mile, about 450 feet apart • Urban: 5-10 stops per mile, about 750 feet apart • Suburban: 4-6 stops per mile, about 1,000 feet apart • Rural: as needed
TCRP Report 19: Guidelines for the Location and Design of Bus Stops	Impacts transit vehicle and system performance, along with demand for transit • Central core areas of CBDs: 300-1,200 feet with typical spacing of 600 feet • Urban areas: 500-1,200 feet with typical spacing of 750 feet • Suburban areas: 600-2,500 feet with typical spacing of 1,000 feet • Rural area: 650-2,640 feet with typical spacing of 1,250 feet
WMATA Regional Bus Study	FOR TRANSIT CENTERS: • Transit centers should be spaced at equal intervals, based on bus run times • The transit center 'catchment areas' have sufficient population and commercial development to support a reasonably high level of transit service through or originating at the center
Location Considerations	
Maryland Transit Guidelines	Off-Street Bus Stops: • Should be used when large travel generators are set back from the roadway • Should be used when the location of the bus stop would cause unsafe pedestrian crossings On-Street Bus Stops: • Flag Stops should not be used on roads with a posted speed limit > 40 mph • Stops must be visible to traffic and in place where people can board and alight safely • Bus Stops must comply with ADA Standards • Stops should be placed at intersections to increase access to service and reduce mid-block crossings • At transfer points, stops should be located so that transferring passengers do not need to cross street • On roadways > 48 feet wide and speed limit > 35 mph and traffic volumes > 5000 vehicles per lane per day, bus stops should be located as close to the intersection as possible with a maximum of 250 feet to the signalized pedestrian crossing Far-side Bus Stop: • ≤ 30 mph and bus length is ≤ 30 feet, stop length is 80 feet • ≤ 30 mph and bus length is 30-45 feet, stop length is 90 feet • ≤ 30 mph and bus length is 60 feet, stop length is 110 feet • > 30 mph and bus length is ≤ 30 feet, stop length is 120 feet • > 30 mph and bus length is 30-45 feet, stop length is 130 feet • > 30 mph and bus length is 60 feet, stop length is 150 feet Near-side Bus Stop: • ≤ 30 mph and bus length is ≤ 30 feet, stop length is 100 feet • ≤ 30 mph and bus length is 30-45 feet, stop length is 110 feet • ≤ 30 mph and bus length is 60 feet, stop length is 130 feet • > 30 mph and bus length is ≤ 30 feet, stop length is 120 feet • > 30 mph and bus length is 30-45 feet, stop length is 130 feet • > 30 mph and bus length is 60 feet, stop length is 150 feet Mid-Block Bus Stop: • ≤ 30 mph and bus length is ≤ 30 feet, stop length is 140 feet • ≤ 30 mph and bus length is 30-45 feet, stop length is 150 feet • ≤ 30 mph and bus length is 60 feet, stop length is 170 feet

	• > 30 mph and bus length is ≤ 30 feet, stop length is 240 feet • > 30 mph and bus length is 30-45 feet, stop length is 250 feet • > 30 mph and bus length is 60 feet, stop length is 270 feet
TCRP Report 19: Guidelines for the Location and Design of Bus Stops	Far-Side Bus Stop: • Advantages: o Minimizes conflicts between right turning vehicles and buses o Provides additional right turn capacity by making curb lane available for traffic o Minimizes sight distance problems on approaches to intersection o Encourages pedestrians to cross behind the bus o Creates shorter deceleration distances for buses o Results in bus drivers taking advantage of gaps in traffic flow created at traffic signals • Disadvantages: o May result in intersections being blocked during peak periods by parked buses o May obscure sight distance for crossing vehicles o May increase sight distance problems for pedestrians o Can cause a bus to stop far side after stopping for a red light o May increase number of rear-end accidents o Could result into traffic queued into intersection Near-side Bus Stop: • Advantages: o Minimizes interference when traffic is heavy on the far side of the intersection o Allows passengers to access buses closes to the crosswalk o Results in the width of the intersection being available for the driver to pull away from curb o Eliminates double stopping o Allows passengers to board and alight while the bus is stopped at a red light o Provides driver with opportunity to look for oncoming traffic • Disadvantages: o Increases conflicts with right-turning vehicles o May result in stopped buses obscuring curbside traffic control devices and crossing pedestrians o May cause sight distance to be obscured for cross vehicles stopped to the right of the bus o May block the through lane during peak period with queuing buses o Increases sight distance problems for crossing pedestrians Mid-Block Bus Stop: • Advantages: o Minimizes sight distance problems for vehicles and pedestrians o May result in passenger waiting areas experiencing less pedestrian congestion • Disadvantages: o Requires additional distance for no-parking restrictions o Encourages jaywalking o Increase walking distance for patrons crossing intersections Bus stops should not be located close to a driveway, but in such situations: • Attempt to locate at least one exit and entrance driveway open for vehicles • Locate stop to allow good visibility for vehicles leaving development and to minimize vehicle/bus conflict • Locate stop so passengers are not standing in middle of a driveway • Locate stop so patrons board or alight directly from the curb rather than driveway
Curb Clearances, Extensions and Pull-Outs	
ESPA Toolkit for the Assessment of Bus Stop Accessibility and Safety	• Advantages and disadvantages of bus bays and bus bulbs discussed, no specifics • Painting guidance lines on road recommended
Maryland Transit Guidelines	Pull-Off Bus Stop: • ≤ 30 mph and bus ≤ 30 feet, stop length is 140 feet (50 entrance taper + 40 curb stop area + 50 exit taper) • ≤ 30 mph and bus 30-45 feet, stop length is 150 feet (50 entrance taper + 50 curb stop area + 50 exit taper)

	• ≤ 30 mph and bus 60 feet, stop length is 170 feet (50 entrance taper + 70 curb stop area + 50 exit taper) • > 30 mph and bus ≤ 30 feet, stop length is 240 feet (100 entrance taper + 40 curb stop area + 100 exit taper) • > 30 mph and bus 30-45 feet, stop length is 250 feet (100 entrance taper + 50 curb stop area + 100 exit taper) • > 30 mph and bus 60 feet, stop length is 270 feet (100 entrance taper + 70 curb stop area + 100 exit taper) • Desirable width is 12 feet and the minimum width is 10 feet Sawtooth Bus Stop: • ≤ 30 mph and bus ≤ 30 feet, stop length is 55 feet (40 entrance taper + 5 curb stop area + 10 exit taper) • ≤ 30 mph and bus 30-45 feet, stop length is 65 feet (40 entrance taper + 15 curb stop area + 10 exit taper) • ≤ 30 mph and bus 60 feet, stop length is 85 feet (40 entrance taper + 35 curb stop area + 10 exit taper) • > 30 mph and bus is ≤ 30 feet, stop length is 55 feet (40 entrance taper + 5 curb stop area + 10 exit taper) • > 30 mph and bus 30-45 feet, stop length is 65 feet (40 entrance taper + 15 curb stop area + 10 exit taper) • > 30 mph and bus 60 feet, stop length is 85 feet (40 entrance taper + 35 curb stop area + 10 exit taper) Bus Bulbs: • Should be designed to allow adequate turning radius for right-turn vehicles and considered at sites with high pedestrian activity, crowded sidewalks, difficult pedestrian street crossings, and stops in travel lanes
TCRP Report 19: Guidelines for the Location and Design of Bus Stops	Bus Stop Zone: • Far-side and near-side stops a minimum of 90 and 100 feet • Mid-Block stops a minimum of 150 feet • Bus stop zones are extended 20 feet for articulated buses • Number of bus-loading positions required at a given location depends on: o Rate of bus arrivals o Passenger service time at the stop Bus Bays: • Should be constructed at locations where: o Traffic in the curb lane exceeds 250 vehicles during the peak hour o Traffic speed > 40 mph o Bus volumes > 10 per peak hour on the roadway o Passenger volumes exceed 20-40 boardings an hour o Average peak-period dwell time > 30 seconds per bus o Buses are expected to layover at end of trip o Potential for auto/bus conflicts warrants separation o History of repeated accidents o Right-of-way width is adequate to construct without constricting pedestrian movement on sidewalks o Sight distances prevent traffic from stopping safely behind a stopped bus o Right-turn lane is used by buses as a queue jumper lane o Appropriate bus signal priority treatment exists at an intersection o No bus parking in curb lane o Improvements are planned for new roadway • Guidelines to locate bay: o Far-side intersection placement is desirable o Near-side and Mid-Block bays to be avoided o Bus bay has a stopping area of 50 feet for 40-foot bus and 70 feet for articulated buses o Bus bay width is desirably 12 feet; for traffic speeds < 30 mph, 10 feet is acceptable o Desirable taper length = major road through speed x width of turnout bay o Minimum design for a busy bay does not include acceleration or deceleration lanes Open Bus Bays: • Advantages: o Allows the bus to move efficiently into the bay o Allows the bus to stop out of the flow of traffic • Disadvantages: o Re-entry difficulties are not eliminated o Pedestrian crossing distance at an intersection increases with an open bus bay design because intersection width has been increased Queue Jumper Bus Bay: Provide priority treatment for buses

	• Advantages: o Removes stopped buses from traffic stream o Guides moving buses through congested intersections o Should be considered: o High frequency bus routes where average headway is < 15 minutes o Traffic volume exceeds 250 vehicles per hour in the curb lane during peak hour o Intersection operates at a level of service of "D" or worse o Land acquisitions are feasible and costs affordable Nubs: Should be considered at sites with high patron volumes where parking along the curb is permitted
WMATA Station Site and Access Planning Manual (only for Transit Stations)	Sawtooth Bus Bays: • Should be designed for passenger boarding and alighting on the right side of the bus, where the doors are located • Sawtooth bays are the standard design for WMATA • Designed to allow buses to pull into a space parallel with the curb so passengers can easily step onto platform and the bus's wheelchair lift has adequate lay down area Angled or Diagonal Bays are prohibited Off-Street Bus Bays: • Preferred when multiple bus bays are required and significant number of terminating routes and bus-to-bus transfers • One-way counter-clockwise loop is preferred layout for bus facilities • Center island bus bays should be used for facilities with significant bus-to-bus transfers On-Street Bus Bays: • Acceptable for mid-line stations in an urbanized area where re-circulation of buses is possible on local streets • Should be located as close to station entrance as possible • Should be located to avoid or reduce needless route diversions
WMATA Regional Bus Study	Off Street Bus Bays: • Provide comfortable and efficient boarding area for riders • Provide a layover space that does not negatively impact local traffic operations or create undue negative environmental impacts (noise or exhaust fumes) • Add to role of transit center as a focal point for transit system and as means of providing system identity
Types / Hierarchy of Stops	
Not addressed by the resources in this literature review	
Passenger Boarding Areas	
ESPA Toolkit for the Assessment of Bus Stop Accessibility and Safety	Bus Stop Site: Site specifics must meet ADAAG by: • Having a firm, stable surface • Minimum clear length of 96 inches, measured from the curb or vehicle roadway edge and a minimum clear width of 60 inches, measured parallel to the vehicle roadway Bus Stop Area: Guidelines are not required, but recommended, in accordance to TCRP Report 19 • Door clearances: front and back doors should be clear of trees, utility poles, wires, hydrants and other infrastructure or street furniture (Province of Alberta, Transportation & Utilities, 1996)
Maryland Transit Guidelines	Pedestrian Surfaces: must comply with ADA requirements and should: • Be 5 feet wide by 8 feet deep • Consist of a hardened material (i.e , concrete, asphalt, pavers) • Provide adequate visibility to approaching buses • Connect to adjacent sidewalks or other hardened surface to provide pedestrian accessibility to and from stop
TCRP Report 19: Guidelines for the Location and Design of Bus Stops	Waiting or Accessory Pads: • Waiting pads are usually separated from the sidewalk to preserve general pedestrian flow • Recommended that 5 feet of clearance be preserved on sidewalks to reduce conflicts • Pad can be located on either side of sidewalk • Paved surface should be provided from waiting pad to back-face of curb to enhance access and comfort • ADA mobility guidelines should be followed when street furniture is to be included on waiting pad area • Should accommodate a 5 foot (measured from back face of the curb) by 8 foot (measured parallel to the street) wheelchair landing pad that is free of all street furniture and overhangs Bus Stop to Sidewalk Connections:

	• Waiting area and an accessway from the pad should be installed directly behind the sidewalk • When sidewalk is parallel and adjacent to curb, waiting pad should be installed directly behind sidewalk • When the sidewalk is far from the curb, paved access from the waiting pad to the curb is necessary
WMATA Station Site and Access Planning Manual (only for Transit Stations)	Waiting Areas: To calculate minimum size for waiting area: 1. Estimate the maximum demand of passengers waiting for a bus during p.m. peak 2. Multiply average passenger space by max. passenger demand 3. Calculate total required waiting area by adding a 1.5 foot buffer width from the roadway and any walls to the effective waiting area • Calculation for waiting areas does not include sidewalks, and the total space for waiting areas must include walkways required to access waiting areas Sidewalk Width along Bus Platforms: • 1-2 Bays = 6 feet • 3-4 Bays = 8 feet • 5 Bays = 10 feet • 6 Bays = 12 feet
WMATA Regional Bus Study	A level concrete pad should be provided for waiting passengers at all bus stops
Shelters	
Maryland Transit Guidelines	• 25 daily boarding passengers is recommended to warrant the installation of a shelter • Minimum design specifications include 3 walls (a rear and 2 sides) with a minimum covered area of 48 square feet. For shelters with four walls, the front must have 2 entrances • Seven feet minimum clearance • Should have interior seating • Should have a display case • Should have a minimum front clearance of 3 feet from the shelter to the edge of curb • Must comply to ADA guidelines • Placement near the front of the stop and be visible to vehicle and pedestrian traffic • Should be visually compatible with adjacent surfaces • Side panel at the end where the bus approaches should be free of obstruction that blocks view • Clocks are a desirable feature, but installation is left to the discretion of the agency

TCRP Report 19: Guidelines for the Location and Design of Bus Stops	• Constructed on clear side-panels for clear visibility
	• Suggested boardings per day for shelter installation:
	  o Rural = 10
	  o Suburban = 25
	  o Urban = 50-100
	• Criteria to evaluate for inclusion of shelter include:
	  o The number of transfers at a stop
	  o Availability of space to construct shelter
	  o Number of elderly or physically challenged individuals in area
	  o Proximity to major activity centers
	  o Frequency of service
	  o Adjacent land use compatibility
	  o Other factors can include:
	  o Right-of-way width availability
	  o Existing street furniture
	  o Utility poles
	  o Landscaping
	  o Existing structures
	  o Maintaining proper circulation distances around existing site features
	• Final Location Determination:
	  o Should enhance circulation patterns of patrons, reduce congestion, and reduce conflict with nearby activities

	o Should not be placed in 5 foot by 8 foot landing pad o ADA mobility clearance guidelines should be followed around the shelter and other street furniture o Clearance of 3 feet should be maintained around the shelter and an adjacent sidewalk o Minimum distance of 2 feet between the back-face of the curb and the roof or panels of the shelter o Locate as close as possible to the end of the bus stop zone to promote visibility o Avoid location in front of store windows o A 1 foot clear space should be preserved to an adjacent building to permit removal or cleaning of shelter
WMATA Station Site and Access Planning Manual (only for Transit Stations)	• For weather protection, provide shelter in all pedestrian waiting areas • Should be designed and located to accommodate all types of users • Shelters under canopies should provide protection from wind and made of transparent materials for security and visibility
WMATA Regional Bus Study	• Standard shelter provided for any bus stop with > 50 boardings per day (including transfers) • Larger shelter, or two standard shelters, for any bus stop with > 100 boardings per day (including transfers) FOR TRANSIT CENTERS: • Providing sheltered areas, where a majority of riders can wait for their bus protected from the elements, is an essential means of improving patrons' overall transit experience • Specifically designed shelters can also help to make the transit center a focal point for the transit system as well as provide an overall transit identity
Signage	
ESPA Toolkit for the Assessment of Bus Stop Accessibility and Safety	• Signage: Bus stop must provide signage with accommodations according to ADAAG, including: o Width-to-height ratio of letters and numbers must be between 3:5 and 1:1, while stroke width-to-height ratio must between 1:5 and 1:10 o Characters are sized to viewing distance o Minimum height is measured using an uppercase X and lowercase is permitted o Pictograms have verbal description below, with the minimum of a 6 inch border o Characters and background in a non-glare finish, with characters and symbols contrasting o Follows protruding objects requirements • Placement must meet TCRP Report 19 • Route & Timetable Information: Accessibility must meet ADA requirements and the design must meet guidelines of TCRP Report 19
Maryland Transit Guidelines	Should be provided at all bus stops and positioned at a safe location that is visible to traffic, with these physical recommendations: • Measure 18 inches wide and 24 inches high • Only display transit information • Color contrast between lettering and background • Parking regulations for the area on a separate sign • Individual transit agencies may use any color scheme, as long as contrast is met • In compliance to ADAAG, signs must be > 80 inches from the bottom of the sign to the sidewalk • If roadway has curb or gutter, pole should be > 2 feet from inner face of the curb (TCRP Report 19); If no curb is present, pole should be > 2 feet from the edge of the shoulder or > 6 feet from the edge of the travel lane • On the sign: the top section defines that it is a bus stop, middle section lists bus information, and bottom section includes contact information
TCRP Report 19: Guidelines for the Location and Design of Bus Stops	• Actual displays mounted on the sign can include: o Agency logo o Route numbers available at stop o Type of route o Destination for a limited number of routes o TCRP Report 12 • Interior panels can post entire system map and can include backlighting • Shelters that lack side panels can display information on interior of roof of shelter • Provide updated information when changes occur

	• Consider the quality and appearance of information displays • Make information displays permanent • Follow ADA clearance, mobility and visual guidelines
WMATA Station Site and Access Planning Manual (only for Transit Stations)	FOR METRORAIL: • Wayfinding: o Create a sense of arrival and clear visual orientation within the Station Area o Clear and visible signage o Post signage for bus routes, timetables, and provide maps of the station area and vicinity (one LED dynamic-display sign at each bus bay) o Signs should be legible and clear of obstructions, follow consistent hierarchy, provide increasingly detailed info as passenger nears mode, use recognizable symbols o Use innovative wayfinding techniques (i.e. painting arrows on floors) • Signage should be consistent on a system-wide level • Traffic signs must be in accordance to the Manual on Uniform Traffic Control Devices (MUTCD)
WMATA Regional Bus Study	• Up-to-date and accurate bus stop signs must be included at all bus stops • Including an accurate listing of routes using the stop and an accurate information telephone number • Detailed schedule information on services at the bus stop, including scheduled times of arrival for each line serving the stop, should be provided at stops with > 100 boardings per day (including transfers) FOR TRANSIT CENTERS: • Dynamic Signage/Information: • Fundamental method for enhancing the overall ride experience for transit patrons is to provide detailed info on transit options, service frequencies, and arrival times • Real time info on bus arrivals and parking availability at regional park and rides is proposed as part of the project ITS recommendations • At larger centers, this can be supplemented by a kiosk with timetables, system maps, and passes displayed
Lighting	
ESPA Toolkit for the Assessment of Bus Stop Accessibility and Safety	• There are no minimum standards according to ADAAG. • Placement must meet TCRP Report 19: o Light provides 2-5 footcandles worth o Illuminate the person's face in a manner that isn't distracting
Maryland Transit Guidelines	• Suggests the minimum threshold for sufficient light at stops to range from 2-5 candles, in accordance to TCRP Report 19 • Stops should be placed near existing lighting sources whenever possible • Recommendations to use vandal-resistant fixtures • Should be accessible for repair and maintenance • Solar-powered transit stop lighting should be investigated and used when appropriate
TCRP Report 19: Guidelines for the Location and Design of Bus Stops	• Installing lighting that provides between 2-5 footcandles is the general recommendation • Fixtures should be vandal-proof, but easily maintained • Cost-effective approach is to locate bus stop near existing street lights • When coordinating with other amenities, minimum clearance guidelines for accessibility must be followed
WMATA Station Site and Access Planning Manual (only for Transit Stations)	• Meet the standards of the Illuminating Engineering Society of North America • Ensure that all areas of the site accessed by passengers are well lit and visible from other areas of the site
WMATA Regional Bus Study	Adequate lighting, based on existing light standards, should be included at all bus stops
Other Passenger Amenities	
ESPA Toolkit for the Assessment of Bus Stop Accessibility and	Benches: Minimum requirements must meet ADAAG for • Clear floor for wheelchair • Seat dimensions • Seat height

Safety	• Back support • Structure supporting vertical or horizontal forces of 250 pounds • Exposed benches must be slip resistant and able to shed water • Placement per TCRP Report 19 Vending Machines: per TCRP Report 19 Bicycle Storage Facilities: per TCRP Report 19 Trash Receptacles: per TCRP Report 19 Shopping Cart Storage: per TCRP Report 19 Public Telephones: Minimum requirements must meet ADAAG: • One phone accessible to persons using a wheelchair • Specifics on height, volume and cord length • Placement per TCRP Report 19 Police Call Boxes: Must not obstruct access to the stop
Maryland Transit Guidelines	Seating: • Stops with daily boardings of at least 10 passengers warrants the installation of a bench • Should be at least 6 feet wide • Should be mounted and secured on a concrete surface • Minimum front clearance of 4 feet is recommended between street curb and edge of seat • Should be visible to traffic and near front of stop • Agencies should use materials that minimize maintenance and vandalism Landscaping: • Shade trees should optimize shading protection for the waiting customer at the bus stop • Avoid planting shallow-rooted trees that will damage sidewalks and surfaces • Shrubbery should be planted at discretion of local jurisdiction • Shrubbery should be kept low to ensure visibility between patron and transit operator • Encourage local jurisdictions for right-of-way maintenance to groom and maintain trees, shrubbery, and grass Information boxes: • For stops with > 10 boardings and no shelter, it's recommended that the box be mounted on the sign pole below the bus stop sign • At a minimum, box should include a route map for the route serving the stop, a schedule/timetable for the route, and fare information Trash Receptacles: • Agencies will determine applicability on a case-by-case basis • Should be secured to ground • Trash should be removed at least once a week Bicycle Storage: Agencies should install U-channel bicycle rack whenever a stop is near a bike trail and at locations where bike use by transit passengers is expected Telephones: Agencies should encourage telephone companies to install and maintain telephones at major stops
TCRP Report 19: Guidelines for the Location and Design of Bus Stops	Benches: • Factors determining bench-only locations: o Width of location o Bus stops with long headways and little weather protection o Locations where landowner has denied shelter o Sites frequently used by elderly people or people with disabilities o Evidence of patrons sitting or standing on nearby land or structures o Avoid completely exposed locations o Coordinate locations with existing street lights • Locate benches on a non-slip, properly drained, concrete pad • Locate benches away from driveways • Maintain a minimum separation of 2 feet between bench and back-face of curb, distance should increase as speed of traffic increases • Maintain general ADA mobility clearances between the bench and other street furniture or utilities at stop • Do not install on landing pad

	• At bench-only stops, additional waiting area should be provided to encourage waiting at stop Vending Machines: Transit agencies have limited regulatory authority concerning the placement of vending machines Bicycle Storage Facilities: • Provide paved access to bus stop and provide non-slip concrete or asphalt surface that is properly drained • Locate storage area away from other activities • Coordinate location with existing on-site lighting • Do not locate where views into the area are restricted Trash Receptacles: • Anchor securely to the ground to reduce movement • Locate away from landing pad areas and allow at least 3 feet of separation from other street furniture • Locate at least 2 feet from back of the curb • When adjacent to roadway, does not obstruct vision of driveways or land uses • Avoid installing receptacles that have ledges that permit liquids to pool or remain near receptacle • Avoid locating the receptacle in direct sunlight Phones: • Separate from bus stop waiting area by distance when possible • Follow general ADA site circulation guidelines • Remove the return phone number attached to phone • Limit phone to outward calls Shopping Cart Storage Area: Proper storage for shopping carts at bus stops adjacent to shopping centers is needed

WMATA Station Site and Access Planning Manual (only for Transit Stations)	Bicycle Facilities:
	• Include information about bicycle routes in the area on posted signs and with wayfinding info
	• Provide direction to bicycle parking
	• Racks and lockers should be provided at all stations where demand exists
	• Number of racks should be based on existing demand and recommendations from the local jurisdiction bicycle coordinator
	• Provide cover over racks with a canopy or under structure
	• Lockers should not be placed under bridges or buildings
	• Racks and lockers are not permitted in WMATA parking structures
	Landscaping and Amenities:
	• Context-sensitive to reflect character of the area
	• Retaining walls and guardrails should be designed to reduce the aesthetic/visual impact to structural and/or natural features
	• Install new or replacement trees using a planting ration with a low-maintenance program that will ensure plant establishment and long-term success
	• Coordinate landscape design with WMATA and local jurisdictional authorities
	• Species do not obscure views or negatively impact wayfinding and security
	• Landscaping does not interfere with drivers' sight lines (limit height of shrubs and hedges to 3 feet)
	• Re-vegetate all slopes with trees and shrubs where appropriate
	• Grade landscaped areas to following min/max slopes:
	  • Grassy Lawn: (min=50:1 and max=4:1)
	  • Ground Cover: (min=50:1 and max=1.5:1)
	  • Dumped Rip-Rap: (min=3:1 and max=1)
	  • Paved Block: (min=3:1 and max=1:1)
	• Landscaping stones or crushed rock in planters is prohibited adjacent to a station entrance, bus facility, or Kiss & Ride facility where glazed structures are located
	• Storm management system should meet current "best practice" standards in environmental design
	• Plant trees along pedestrian paths to provide a pleasant walking experience (lowest branch>8 feet above ground)
	• Design landscaped areas where they will not be used as pedestrian paths (hedges>5 feet width and/or use 4 foot high chain-link fencing); provide a 6 inch high curb around landscape areas or planter boxes next to walking surfaces

	Benches: • Two benches per bus stop • Provided along pedestrian path, but not in travel path Trash Receptacles, Newspaper Stands, and Wayfinding Info: Provided along but not in pedestrian path Pay Phones: Minimum of 2 pay phones at station entrance
WMATA Regional Bus Study	Benches: should be in shelter at any bus stop with > 50 boardings per day (including transfers) Trash Receptacle: Should be provided at any bus stop with >50 boardings per day (including transfers) System Map: Should be provided, in addition to real time travel information in the longer term, for any bus stop with >300 boardings per day (including transfers) FOR TRANSIT CENTERS: Depending on the scale and purpose of the proposed transit center, additional amenities can be provided for the convenience of riders, including: Public Telephones, Vending Machines, Newspaper Machines, and in some instances a Small News and Candy Stand
Maintenance	
ESPA Toolkit for the Assessment of Bus Stop Accessibility and Safety	• Maintenance: Incentives for participation • Adopt-a-Stop programs with King County Metro in Seattle and Tri-Met in Portland • Database: Suggests creation of database to track the condition of facilities, including age of the facilities, but cites no specifics
Maryland Transit Guidelines	Shelters: • Surfaces should be cleaned at least once every 6 months • Graffiti should be removed and any broken equipment should be repaired as soon as possible • Materials that minimize maintenance and vandalism should be used • Agencies are encouraged to establish "Adopt-a-Shelter" programs, that encourage local businesses and organizations to maintain the shelter (Recognition should be given to party adopting shelter) Trash Receptacles: • Transit organizations are encouraged to work with local jurisdictions, community groups, and neighborhood organizations to establish trash removal responsibilities • "Adopt-a-Stop" programs are written agreements with civic groups, businesses, or community organizations to help maintain cleanliness
TCRP Report 19: Guidelines for the Location and Design of Bus Stops	• Trash and graffiti should be removed as soon as possible • Database containing maintenance schedules can be created to track condition • Working agreements with local businesses or commercial centers can reduce financial strain attributed to maintenance • For stops next to convenient stores, agency should obtain agreement with the local store or business to provide trash removal and general maintenance at bus stop, including snow removal • Agreements with commercial centers should be obtained to remove used shopping carts from bus stop
Other Stop Design Considerations	
Maryland Transit Guidelines	Roadway Pavements: • Locations where vehicles brake, accelerate, and turn should be paved with materials of sufficient strength to accommodate repetitive loads of a bus • Pad should be the width of the curbside lane for bus stops • Sizes of the pads vary between agencies based upon the type of bus stop: curbside, open bus bay, queue jumper bus bay, or nubs • Pad should be 11 feet (preferably 12) wide for bus bays • Pad length should accommodate the maximum number of buses stopping simultaneously and provide adequate distance for entrances and exit tapers • If on private property, agency should propose options to owner and discuss responsibility for installation and maintenance • In urban environments, reinforced concrete pads • In suburban environments, asphalt or reinforced concrete based on volume, service frequency, and stop type. Pads at transfer centers and multi-route locations should receive high priority • In rural environments, asphalt may be used unless high volume or stop significance warrants the installation of a concrete pad

TCRP Report 19: Guidelines for the Location and Design of Bus Stops	Roadway Design: Buses generally travel in the traffic lane closest to the curb, considerations: • Overhead obstructions should be minimum of 12 feet above street surface • Obstructions should be located within 2 feet of the edge of the street to avoid being struck by a bus mirror • Traffic lane used by buses should be no narrower than 12 feet in width • Desirable curb lane width is 14 feet • Maximum grade for 40-foot bus is between 6-8 percent • Grade change between street and driveway < 6 percent • Appropriate curb height is between 6-9 inches Pavement: • Need to accommodate repetitive bus axle loads of up to 25,000 pounds • Exact pavement designs depend on site-specific soil conditions • Reinforced concrete pavement pads reduces pavement failure problems common with asphalt • Minimum width of 11 feet, 12 feet desirable, including pavement section designed for anticipated loadings • Length should be based on anticipated length of the bus using particular stop

EXAMPLES OF BUS STOP LOCATION AND DESIGN STANDARDS IN OTHER AREAS

Examples are provided both for other metropolitan areas of the U.S. as well as for cities in other nations.

Other Metropolitan Areas of the United States

Bus stop standards and guidelines were reviewed for the following transit organizations in other areas of the county:

- Transit Authority of River City (TARC), Louisville, Kentucky (over 7,000 stops)
- Chicago Transit Authority, Chicago, Illinois (over 12,000 stops)
- Pace, Arlington Heights, Illinois (six counties around Chicago) (total stops not indicated)
- Orange County Transportation Authority (OCTA), Los Angeles, California (6,000 stops)
- Tri-Met, Portland, Oregon (8,200 stops)

Table B-2 presents a summary of the standards in these areas.

Table B-2: Examples of Bus Stop Location and Design Standards in Other Metropolitan Areas

Spacing of Stops	
TARC	600 to 1,250 feet apart, with additional stops placed at major activity generators
CTA	• Normally located at major cross-street intersections and/or traffic generators. Normally 1/8 mile, about one standard Chicago block apart, depending on the neighborhood density. For limited-stop service, stops are made at widely spaced stops (e.g. ½ mi for neighborhood express routes) • Balance customer convenience, effect on average bus speed, and safety. Max. spacing: 1,320', except where pedestrian access is not provided such as on or under a viaduct.
Pace	• High density (>4,000 people/square mile): 660' • Medium density (2,000-4,000 people/square mile): 1,320' • Low density (<2,000 people/square mile): flag stops
OCTA	Provide stops at major generators, all transfer points, and intermediary stops at these intervals: • Central Business Districts or Major Commercial District: Maximum 500 feet • High-medium density: 750- 900 feet • Medium-low density: 900-1,300 feet • Low density to rural: 1,500-2,500 feet
TriMet	• Transfer locations • Designated pedestrian crossings • Other major transit trip generators Locations based on stop spacing: • Dense areas 3 blocks/780 feet • Medium to low density areas: 4 blocks/1,000 feet • Low to rural density area: As needed ≥ every 1,000 feet
Location Considerations	
TARC	Far-side: • where high volume of right turns • route alignment requires a left turn (stop is after the left turn) • at complex intersections with multi-phase signals or dual right or left-turn lanes Near-side: • In combination with far-side stop if transfer activity shows strong directional pairing to minimize pedestrian crossings Far-side after turn: • In combination with near-side stop. if substantial transfer activity between two bus routes on opposite sides of a street, placing one stop nearside of the intersection and one stop farside, respectively Mid-block: • When the route alignment requires a right turn and curb radius is short. Avoid placement in proximity to driveways; where unavoidable • Keep at least one exit and entrance driveway open for vehicles to access the site

	• Locate stop for visibility for vehicles leaving the site and minimize vehicle/bus conflicts (i.e., far side of the driveway) • Locate stop so passengers do not wait in the middle of driveway or board/alight in it
CTA	• CTA's 2001 Service Standards indicated that because Chicago's bus stop system uses predominantly nearside stops, additional stops also should be nearside for consistency, unless a farside stop is more feasible due to the geometry of the intersection, traffic flow, or convenience to passengers • However, in the past 5-6, CTA has been relocating stops to farside locations, which are preferred at signalized intersections. (Nearside stops continue to be preferred at intersections with stop signs)
Pace	Majority are near-side
OCTA	Considerations related to use, traffic and rider safety, bus operations Relationship to intersection: near-side, far-side, mid-block, before and after turns Avoid placement in proximity to driveways; where unavoidable: • Attempt to keep at least one exit and entrance driveway open for vehicles to access the site • Locate stop for visibility for vehicles leaving the site and minimize vehicle/bus conflicts (i.e., far side of the driveway) • Locate stop so passengers do not wait in the middle of driveway or board/alight in it • It is preferable to fully rather than partially block a driveway
TriMet	Preferred placement matrix on p. 9
Curb Clearances, Extensions and Pull-Outs	
TARC	<u>Curb Clearances:</u> • Far-side min.90′ curb clearance (> 5′ beyond turning radius/crosswalk) incl. 50′ acceleration lane • Near side min. 100′ curb clearance incl. 50′ deceleration lane (> 5′ prior to turning radius/crosswalk) • Mid-block min. 150′ curb clearance inc. 50′ acceleration lane <u>Pull-Outs:</u> Three types of pull-outs indicated: • Bus Bay with acceleration/deceleration lane: • Open Bus Bay (far-side) • Queue Jumper Bus Bay (far-side; deceleration lane begins nearside Use where: • no on-street parking; • high volume of traffic; • > 40 mph; traffic • > 250 vehicles during peak hour; • bus needs layover time at end of route. <u>Curb extensions:</u> Use where adequate space in the right of way and sidewalk can be altered

Pace	Curb Clearance: • Near-side: 85′ including 10′ from corner tangent point to sign • Far-side: 85′ beyond corner tangent point including 25′ from sign to parking • Mid-block: 175′ including 65′ from sign to parking Bus Turnouts: • Recommended only for midblock stops, where boardings are high and flow of traffic could be significantly impeded by stopped vehicles • Recommended width: 15′ for arterials and 20′ for highways • Acceleration/deceleration lane length 100′-250′ each based on mph plus 50′ stopping zone for one bus Bus Berths: (turnouts to accommodate more than one bus) • Recommended only for midblock stops transit centers, and park and ride lots • Parallel design: 80′ per 40′ bus • Sawtooth design: 65′ per 40′ bus
OCTA	Dimensions for pullouts: • Farside: min. 80′ plus 60′ to reenter traffic • Nearside: min. 60′ plus 60′ to exit traffic plus additional variable space before crosswalk • Midblock: min. 60′ plus 40-60′ each to exit and reenter traffic Bus turnouts recommended where ≥ 40 mph plus one of following: • Peak period boarding average > 20 boardings /hour • Average peak period dwell time > 30 seconds per bus or high frequency of accidents involving buses and/or pedestrians occurred within past year • When traffic in the curb lane > 250 vehicles during the peak hour and the curb lane < 20 feet wide • When bus volumes > 10 or more per peak hour • Where bus stops in the curb lane are prohibited • where sight distances are problematic • Where there are 2 or more consistent wheelchair lift boardings • Where buses are expected to layover at the end of a trip Design guidelines: • 10-14′ wide • See above nearside/farside guidelines • Add 60' for each additional pass-through bus • If turnout will be used as a layover zone, add an additional 80' (100' for articulated buses). Design guidelines are illustrated on pages 48-54 Curb extensions are not used in Orange County.
TriMet	Curb Clearances: • Nearside – min. 80′preferred; 60′ in some circumstances. Pole/sign should be 15′-25′ from pedestrian crossing at signalized intersections, ≥1′from crosswalk at uncontrolled intersections • Farside – min. 80′preferred; 60′ in some circumstances. Rear of bus must clear crosswalk (Pole/sign should be > 50′ clear of crosswalk)

	• Midblock – min. 90′ preferred, determined on site-by-site basis. Infrequently used, found on "super-blocks" often opposite of 'T' intersections in high-density areas and along mid- and lower density area roadways with few intersections Pullouts considered: • At bus layovers • Here at least two of the following: o ≥ 45 mph o ridership > 35 daily boardings (or 6 daily lift boardings) o potential safety issues Also Appendix A. Construction Specifications, Sheets 25 & 26, and Appendix C. Additional Stop and Zone Materials, Diagram 5. Curb extensions: • Paired with curb extension across the travel street • Marked/designated for visibility • Min. 32′ (42′ farside) of curb line free of ramps, wings and curb returns • Must define 6′x 8′ clear space at front and rear door locations (indicated by curb tape or paint). • Bus shelters, poles, trees, benches, trash cans and other amenities ≥ 3.5′ clear of curb face • Made on a case-by-case basis
Types / Hierarchy of Stops	
TARC	• TARC Stop - basic bus stop on all routes o convenient access o visible sign o restricted auto zone • TARC Site - multi-route stop with higher usage. includes TARC Stop facilities, plus: o benches and/or shelter o garbage can o route and schedule information o potential for real time "next bus" arrival information • TARC Hub - major transfer and route coordination point includes TARC Site facilities, plus: o real time "next bus" arrival information o dedicated, sheltered platform area o full information services o staffed information center o security personnel o potential for park and ride facility • TARC Center - major community destination includes TARC Site facilities, plus: o formal pedestrian connections and access to destination facilities o park and ride to be coordinated with destination facilities o possible connections with other travel modes o greatest potential for development of transit oriented development

OCTA	• OCTA does not categorize bus stop locations per se, but new stops are placed based on potential passenger activity and the type of service (fixed route vs. express route) • Forthcoming bus rapid transit station/stops will be categorized "small, medium, and large", but that will be based on the size of the bus zone, not the ridership or amenities
TriMet	• Underdeveloped – does not meet basic TriMet criteria • Basic – pavement meets ADA clearances; bus stop sign on dedicated pole • Level 1 – High use stops (> 35 boardings/day); significant employer program participant; apartments; institutions; hospitals; shopping centers; major business; minor park & ride lots (shared use); stops with significant usage by riders who are disabled or elderly; preceding features plus shelter, lighting, BCID in shelter, trash can, bench, pad for rear door when physically possible • Level 2 – Major stops (≥ 200 boardings /day); transit mall; major park & ride lot; all transfer points; stops with active lift or ramp usage; preceding features plus higher capacity shelter; bike rack; public telephone; art work • Level 3 – Bus Rapid Transit service; transit centers; high volume park & rides; major transfer hubs; "Station" style shelter; bike lockers, lids or other long-term storage; operator building and restroom as needed; ticket vending machine
Passenger Boarding Areas	
TARC	• A firm, stable surface • Min. clear length of 8′ from curb or roadway edge • Min. clear width of 5′ parallel to roadway • Max. slope of 1:50 (2%) for drainage (see pages 13 & 15 for details)
Pace	Paved pad recommended for all stops For high-volume stops, 25′ wide from corner tangent point at nearside stops x 12′ back from curb is recommended, min. 4″ deep. (p. 33 & 27, Fig V-3)
OCTA	• Front door: min. 5′ x 8′ • Rear door : min. 10′ x 8′ • Distance bet. front & rear boarding areas: 18′ • stable, firm, and slip resistant surface • Max. slope of 1:20 (5%) • Max cross slope of 1:50 (2%) • Horizontal clearance of 48″ maintained in boarding area • Vertical clearance of 84″ maintained in boarding area (see page 59-62 for details) Rural stops: Every effort should be made to find a flat level area to place the stop. Concrete or asphalt passenger pad, up to 8′ wide and 35′ in length recommended if funding is available. On roads without curbs, a tactile warning device between the road's shoulder and the passenger waiting area recommended
TriMet	• Min. 5′x 8′ (10′ x 8′ preferred) adjacent to bus stop sign. Pad recommended at all stops, required at new stops (min. 8′x8′at new construction), prioritized for >20 boardings/day or lift usage

	• At new construction sites, required to be min. 8'x 8', pursued where connection to pedestrian pathway is possible • When >8 daily alightings, an additional > 4'x 6' rear door landing pad is preferred, must be accompanied by a front door ADA landing area
Shelters	
TARC	Placed where passenger activity levels are high or where customer requests have shown a demonstrated need or desire to have a shelter. Guidelines: • Should be well lit when existing street lights do not provide adequate lighting, following Ch. 4, Part 1 of the Land Development Code • Should not be placed in the 5 foot by 8-foot landing pad • ADA requirements must be followed around the shelter and between the shelter and other street furniture • Min. 2' between the back-face of the curb and the roof or panels of the shelter (greater distances are preferred) • Should be located at the end of bus stop zone • Should not be located directly in front of store windows • Min. 12" clear space around shelter walls for cleaning/trash removal • Min. 32" clear entrance (doorway) • Entrance may be constructed as part of the "path of travel" if min. 36" wide. • Min. clear floor area 30" wide by 48" long accessible to mobility aid user • Min. 7.5" clearance between underside of roof and sidewalk surface desired
CTA	Amenities are distributed by factors that consider equity in distribution throughout the service area, the utility of the benefit to the user and site-related constraints. Additionally, high consideration is given to stops on key bus routes due to a generally higher level of demand. Priority for amenities is given to stops that have: • Large numbers of passengers who board at the location, • Lengthy wait times between buses, • High percentage of transfer passengers, and • High percentage of seniors or disabled persons using it. CTA works with an advertising shelter firm for shelter installation
Pace	• Recommended for high volume sites • Size/type/location of shelter depends on space available, boardings, visibility • Standard is 13.5' by 6.5' • Min. 5' setback from the street • When possible, bus stop information is provided on shelter rather than on freestanding sign. • Pace provides shelters to communities • Anodized aluminum frames and either safety glass or polycarbonate glazing • Electricity is not encouraged inside shelters
OCTA	Criteria for selection for amenities are listed on page 63. OCTA uses a scoring system in which stops with 10+ points may be considered for shelters. (Installed by jurisdiction not OCTA) Shelter designs pp. 65-78

	OCTA does not own or maintain any benches or shelters, though this will change when they begin BRT service next year. They will be purchasing up to 150 benches and/or shelters. The current benches and shelters belong to private advertising companies, and they are usually placed at locations based on average daily traffic
TriMet	Placement criteria: • ≥35 boardings / weekday preferred • >30 boardings / weekday on routes where peak headways > 15 minutes Lift usage – > 15 weekday boardings and 4% lift usage • Proximity to senior housing > 20 daily boardings • Shelters funded and maintained by others • Development of large new activity centers adjacent to transit where ridership is projected to meet criteria • Consolidated bus stops – combined ridership totals increase likelihood of shelter placement Design guidelines: See Diagrams 3 & 4 for 12 different site configurations (pages 23-24 in PDF), • Min 10′x6′ or 14′x6′ shelter pad depending on shelter type (8 types described on p. 12) • 5′ of pedestrian passby • ADA landing pad adjacent to sign and outside of shelter • Clear pathway from the ADA waiting area inside the shelter to the ADA landing pad • Clear pathway from the rear door landing area to the pedestrian path. • Min. 2′ clearance between shelter and edge of curb • Min. 12″ from buildings, fences, and other structures to allow room for maintenance • Min. 2′6″ x 4′ clear space inside • Shelters must not block lines of sight • Shelter should be within a compact space, close to landing area for access to bus (generally within 25′)
Signage	
TARC	• 14″ wide x 15.5″ high • Made of reflective materials • Can be placed on an existing utility pole (preferred), an existing standard, or on an exclusive standard • No closer than 24″ from the curb face • Bottom should be 7′ above ground level, and the top should be ≤ 10′ • Placed at far end of no parking zone
Pace	Min. 2′ from curb; Designs for basic signs and informational signage are shown on pp. 34-35 (Figs. V-2 and V-4)
OCTA	• ≤ 24″ from curb face • At front of bus zone, 40-60′ from end of zone • Square uninstructed posts. • Independent of other street signs • Bottom of sign 7′-10′ from ground • Top of informational cassette ≤ 60″ above grade

	• Schedule information and hardware / display cases are determined by the number of routes serving a stop
TriMet	• Phasing out placement on non-dedicated poles • 2′ from curb with info signs flag-mounted away from street or pole behind sidewalk and info signs flag-mounted towards street • Farside stops: min. 50′ clear from pedestrian crossings • Nearside stops at controlled intersections: 15′ -25′ from pedestrian crossings • Nearside stops at uncontrolled intersections: ≥1′ from crosswalk
Lighting	
TARC	Shelters should be well lit when existing street lights do not provide adequate lighting. All lighting standards should follow Ch. 4, Part 1 of the Land Development Code
Pace	Recommends freestanding municipal lighting fixtures Local municipalities establish lighting standards for their jurisdictions
OCTA	2-5 foot candles recommended
TriMet	1.5-2 foot candles recommended
Other Passenger Amenities	
TARC	Trash receptacles placed because of surrounding uses (e.g. fast food restaurant). Guidelines: • Anchor securely to ground • Locate away from landing pad areas and allow for > 3′ separation from other street furniture • Locate > 2′ from the back of the curb • Ensure that it does not visually obstruct nearby driveways or land uses • Avoid design features that permit liquids to pool or remain near receptacle • Avoid locating in direct sunlight
Pace	Benches: • Can be located at stops with moderate use, where shelters cannot fit, or within shelters • Should be vandal-resistant and compatible with environment Landscape features, convenience amenities (such as ATMs or pay phones) and bicycle storage are discussed without specific standards
OCTA	Criteria for selection for amenities are listed on page 63. OCTA uses a scoring system in which stops with 6+ points may be considered for benches and trash receptacle. (Installed by jurisdiction not OCTA) Bench and trash receptacle designs pp. 64-65 OCTA does not own or maintain any benches, though this will change when they begin BRT service next year. They will be purchasing up to 150 benches and/or shelters. The current benches and shelters belong to private advertising companies, and they are usually placed at locations based on average daily traffic
TriMet	• Criteria & dimensions for 5 types of benches are in a matrix on p. 13; additional guidelines on p. 17 • Trash cans are placed in areas of high ridership, transfer locations. places where the potential for accumulating trash is apparent (e.g., near fast food restaurants and convenience stores) and at stops by request. Must not compromise accessibility

Maintenance	
TARC	A shelter outdoor advertising company and Metro Solid Waste maintain bus stop shelters. TARC has a Passenger Facilities Coordinator that works with these agencies along with Metro Public Works and the Kentucky Transportation Cabinet
CTA	Shelter advertising company maintains shelters. CTA has two sign crews which maintain the signs
Pace	Pace encourages municipalities to maintain standard Pace shelters. Maintenance of custom shelters is usually the responsibility of developer, municipality, or other appropriate party
OCTA	Street furniture owners obligated to maintain; jurisdictions responsible for monitoring. At least weekly: • Wash down shelter and accessories • Remove dirt, graffiti, and pasted material • Wipe down glass surfaces • Remove & replace trash bags • Pick up litter within 10 feet • Remove weeds • Prune obstructing foliage • Touch up marred paint • Verify shelter lighting levels and replace bad bulbs and ballasts • Repair items that pose a safety problem within 24 hours of notification. Repair other items within 3 days
TriMet	Guidelines for cleaning: • Pick-up trash and debris within a 15' radius of bus stop areas (no blowers) • Remove graffiti, stickers and unauthorized signs and posters • Power wash all amenities with water. Using a ladder, clean the shelter roof inside and outside with a soft bristled brush. Clean and flush gutters and drain holes. Clean the shelter frame, bench and windows using soft bristled brush and pressure washer. Dry windows with a squeegee. Wipe benches completely dry after cleaning or graffiti removal • Emergency cleanings completed within 4 hours of notification • Broken glass replaced within 2 hours of notification Community partnerships: • Adopt-A-Stop –a customer agrees to pick up litter, clean stop amenities and report any items needing repair in exchange for gloves, cleaning supplies and a steady supply of bus tickets Keep-A-Can – customers or local businesses agree to empty and provide service for a trash can in exchange for can, liner, and soda can recycling container
Other Stop Design Considerations	
TARC	Roadway pavements must accommodate repetitive bus axle loads of 40,000 pounds, with exact pavement designs dependent on site specific soil conditions. Concrete pavement is desirable in these areas to avoid failure problems that are experienced with asphalt
Pace	Concrete pavement should cover entire turnout / berth area
OCTA	Concrete pad recommended for all stops. 12' -14' wide including monolithic curb - 9" deep without re-bar, or 8" deep with #3 re-bar at 18" on center. Exact pad placement will vary by location. Min. 80' long plus 60' for each additional pass-through bus. If bus stop will be used as a layover zone, add an additional 80' (100' for articulated buses). See Figures 22, 22A, and 23 (pages 55-58).

TriMet	Concrete bus pads considered on a case-by-case basis, generally found at stops with frequent service, significant ridership, or where heavy bus braking and acceleration is necessary. Also Appendix A. Construction Specifications, Sheets 25 & 26, and Appendix C. Additional Stop and Zone Materials, Diagram 5.

International Examples

Three international examples of bus stop location and design standards were reviewed. These were:

- BC Transit, Vancouver, Canada
- Transport for London, United Kingdom
- State Transit, Sydney, Australia

Table B-3 summarizes the relevant bus stop standards of these agencies. It is important to note that, because the ADA is limited to the United States, dimensions of passenger boarding areas were not reviewed for these systems.

Table B-3: Bus Stop Design Standards of Selected International Transit Systems

Transit System	BC Transit	Transport for London	State Transit
Location	Vancouver, BC	London, UK	Sydney, Australia
Population	> 2 million	7.5 million	4.3 million
Document reviewed	Design Guidelines for Accessible Bus Stops and Transit Stop Installation Checklist	Accessible Bus Stop Design Guidance	Bus Stop Style Guide (1999 edition is currently being revised)
Spacing	• Central Business Districts: 90-300m (295-984′) / typically 185 m (607′) • Urban Areas:150-365 m (492-1,198′) typically 230 m (755′) • Suburban Areas: 185-760 m(607-2.493′)/typically 300 m (984′) • Rural Area: 200-800 m (656-2,625′)/typically 380 m (1,247′)	• Ideal: 400 m (1,312′), closer if necessary in town centers and residential areas • Locations served by more than 25 buses per hour should be split	Not indicated
Other Location Considerations	• Convenient location to major land uses • Convenient to transfer movement • Pedestrian access • Adjacent, or as close as possible to stop going in the opposite direction • Visibility • Proximity to crosswalks and driveways - Avoid locating stop close to driveways especially those with high traffic volumes • Mid block, locate stop on far-side of crosswalk	Not indicated	Generally far-side but should relate to passenger destinations and pedestrian facilities

Transit System	BC Transit	Transport for London	State Transit
Types of Facilities	Not indicated	Not indicated	Operational categories: • Terminus – stops at the beginning or end of a route • Interchange Stop – both bus-bus interchange and intermodal interchanges. Passengers may transfer between bus routes or between buses and other modes. Intermodal interchanges (bus-rail, bus-ferry) often have a higher standard of design and are often off-street • Limited/Express Stops – used in skip-stop operations • Standard Stop – provides for passenger pick up and set down for most bus services, but may be skipped by limited stops or express services • Part-Time Stops –only operate during certain periods of the day • Special Stops – include stops for special services • Set-Down Only Stop –usually towards the end of a bus route, a stop where passengers are dropped off, but not picked up Location/Situation-based hierarchy: • Town Centres/CBDs • Regional Shopping Centres –often in residential areas or on the fringes of CBDs or town centres). • Neighbourhood Shopping Centres – usually with a lower level of intensity and competition for curb space than town centres or regional shopping centres. Often strip development on a main street, with less intense levels of bus activity and limited night-time activity • Residential Areas • Rural, Semi-Rural • Special Events
Curb Clearances, Bus Turnouts, Curb Extensions	• Crosswalk min. 10m (33") from stop if in front of bus (nearside); preference is behind the bus (far-side), 2 m (6.5'). • For far-side, min. 46' clear zone for pull-in • Red paint on curb, to include clear zones - 33.5 m (110 ') total length	Bus turnouts: referred to as "lay-bys" in London, not recommended unless there are compelling safety or capacity reasons, because of operating delays and potential problems with autos parking, blocking	• Nearside stop > 9 m (30') clear of the crossing or stop line • Indented Bus Bay – Bus fully out of traffic stream (see Fig. 2). Used where >60 km/h (37 mph), or where high occupancy lanes in operation (transit lanes), > 10 buses and 40 passenger boardings per hour.

Transit System	BC Transit	Transport for London	State Transit
		access to the curb, and length of dedicated curb needed Curb extensions: Referred to as "boarders" in London. Angled or wedged-shaped extensions (resembling what are referred to in the U.S. as "sawtooth" bays) recommended for stops where the approach is preceded by parked cars and where the road naturally widens leading up to the intersection stop line.	Should not be used where traffic in adjacent lane delays buses leaving stop. Acceleration and deceleration tapers based on adjacent road's speed limit. • Generally 1:5 pull-out length and 1:5-1:10 pull-out length • Open Bus Bay – Variant of indented bus bay, used at intersections (Fig. 2), allows bus to drive straight into, or out of, bay. Can be used as part of bus priority measures (such as a queue jump). Bus Stop Blister – Curb extension for length of bus stop (Fig. 2 p. 11), should be used where bus numbers are high and loss of curbside parking needs to be minimized. Suitable for CBD applications in association with bus lanes.
Identification (signage)	• Installation of pole 2-2.5 m from curb recommended where practical (far side of sidewalk) (per checklist) • Min. 600 mm (24") from curb • Base of sign min. 2.5 m from sidewalk surface • Sign should align with bus corner post • Minimum 2 m. (6.5') from curb. • Tactile warning strip indicated in some diagrams to determine boarding location	• A yellow footway guidance line or edge marking, offset 450mm (18") from the curb edge and 100mm (4") in width can provide drivers with a stopping reference point, and encourage pedestrians to stand away from curb edge. • A bus stop "cage" is marked on the pavement to define unobstructed area for bus to approach, straighten up, stop, and exit. Coloring bus stop cage red recommended.	• "Tombstone" plate on inverted J (Fig. 6a, p. 23) or U (Fig. 6b, p. 24, where more information is need) pole, standalone or on shelter in special circumstances, black lettering on yellow field for most services. • Place min. 4 m (13') from head of bus zone and min. 400 mm (16") from edge of curb. • Where installed on shelter, shelter should be placed so that head coincides with proposed stop sign location. • Signs placed at front and rear of zone to designate clear zone for bus stopping. Agency is also exploring on-road markings
Passenger amenities (shelters, benches, other street furniture)	Guidelines are typical shelters used widely across Canada. • Footprint: (4.2 x 7.9' to 11.62'). • Openings min. 2.62' wide. • Safety striping applied vertically to doorways and horizontally on transparent panels, • Min. 3" wide in contrasting colors. Stripe should be at the mid-point of transparent shelter panel, 55"-63" above ground level. Garbage receptacles: • locate away from landing pad • maintain regularly	Not indicated.	Lighting: Avoid strong variations to avoid shadows. ≤300 lux (30 foot candles) in shelters or at transport information points, streetside illumination to ≤200 lux (20 foot candles). 15 m (49') spacing in vicinity of bus zone.

Transit System	BC Transit	Transport for London	State Transit
	• animal/ vandal proof • bolted down • avoid direct sunlight • not allow pooling of liquids (insects)		

Appendix C

Public Input

Appendix C

Public Input

An Open House was held Wednesday, December 17, 2008 at Metro from 6:00 p.m. to 8:00 p.m. The Open House was advertised in the Washington Express newspaper for two consecutive days prior to the day of the open house in addition to the project website www.metrobusstopguidelines.com. The local jurisdictions and stakeholders were also notified and invited to attend the open house. The open house provided information about the bus stop guidelines and the customer information and advertising effort. The topics discussed at the Open House are:

Discussion Following the KFH Group, Inc. Presentation:

- What is the fraction of pedestrians exiting the rear door of a bus? What are the concerns in selecting nearside or farside bus stop locations? Will this be considered in your study?
- In a suburban setting, it is presumed that not every bus stop will have people boarding. How does this affect the scheduling of bus routes?
- The elimination of sparsely used bus stops in a suburban setting will not speed up service that much.
- Will the bus stop guidelines look at street lighting surrounding the bus stop?
- Will the bus stop guidelines discuss encouragement for pedestrian crossings at a safe location? There is a great concern towards allowing pedestrians to unsafely cross busy roads.

Discussion Following the Pulsar Advertisement Presentation:

- An assortment of signage questions concerning issues such as: font size used for bus stop signs, avoiding undesired subtlety in sign visibility (i.e. Union Station's north Metro entrance), and information to be displayed (i.e. phone number).
- Ride-On bus stop signs have graffiti on them and Metro bus stop signs do not. Be sure to continue to use flags having a surface where stickers cannot stick to the sign.
- Do certain posts better serve the visually impaired? White signs work best by standing out when surrounded by aluminum and gray bus stop posts.

- Spacing discussion when Jim Hambre was holding 'Bus Stop Spacing' board.
  - Convenient with slower service versus inconvenient with faster service
  - Safety concerns over walking along busy roads for longer stretches
  - Concerns over missing bus, because frequency is poor and spacing is too far apart
- In scheduling located at bus stops, there is a decision of whether to use complete schedules or partial schedules with timed stops.
- Discussion surrounding the amount of information to be presented at a bus stop.
  - Bus stop guidelines should determine the minimal amount of information to be displayed at a bus stop.
- Should there be a unified bus stop sign, and discussion surrounding the idea of 'branding' at bus stops.

In addition to the general discussion, attendees were also given a survey regarding the bus stop amenities and spacing. The survey was also made available online at the project website listed above for those that were unable to attend. A copy of the survey is provided in Exhibit C-1. Four surveys were completed. In terms of preferred amenities, customer information such as schedule and route information ranked the highest as the most important feature at a bus stop. The average walking distance based on the survey responses is approximately 8 minutes. The survey results also indicated that some riders are willing to walk approximately 12 additional minutes to a bus stop with real-time bus arrival information.

Appendix D

Findings for the 103 Analyzed Metrobus Lines

Appendix D
Metro Bus Lines Utilized in the Spacing Analysis

Line ID	Name of Bus Line	Routes	Line Length (miles)	Total # of Bus Stops	Average Population Density within 1/4 Mile of Line	% of Line Serving an Activity Center	Average Spacing Between Bus Stops (feet)	Bus Stop Spacing (Stops per Mile)
135	[illegible]	U5,6	7.21	80	9,855.29	0.00	442.17	10.95
583	[illegible]	R2	2.81	51	9,743.06	0.00	434.93	12.17
78	SheridRoadRiverTerraceLine	U4	3.37	36	9,342.34	0.00	508.21	10.39
52	GloverParkDupontCircleLine	D2	3.78	68	16,298.66	24.55	553.73	9.73
44	CapitolHeightsBenningHeightsLine	U8	6.19	60	9,553.97	0.00	554.05	9.53
64	[illegible]	V4	8.55	61	7,633.88	12.34	577.55	9.16
46	FairfaxVillageLine	M6	3.29	31	10,461.79	0.00	578.32	9.13
130	[illegible]	90,97,93	11.54	103	16,941.86	18.70	514.56	8.59
15	GarfieldAnacostiaLoopLine	W6,8	6.77	58	13,706.04	0.00	626.71	8.42
64	FairfaxVillageNaylorRoadLine	V2	1.91	17	7,546.80	0.00	503.15	8.59
59	TakomaPetworthLine	62	3.48	30	16,777.90	0.00	623.20	8.34
93	[illegible]	93	4.68	39	21,514.15	48.36	549.88	8.12
34	BrooklandandFortLincolnLine	H6	6.56	29	6,337.19	27.56	671.52	7.86
131	[illegible]	82	7.13	55	15,862.88	28.80	554.18	7.61
79	VanNessWesleyHeightsLoopLine	N8	6.20	48	12,459.31	20.05	696.17	7.58
138	SoutheastCommunityHospitalAnacostiaLine	W13	12.15	95	11,522.62	0.00	558.11	7.76
81	MountPleasantLine	42	3.97	31	29,873.77	60.61	698.12	7.56
71	ChevyChaseLine	E6	4.14	33	6,945.15	3.31	558.85	7.55
134	MinnesotaAveAnacostiaLine	U2	4.30	33	12,051.08	0.00	709.55	7.44
52	[illegible]	57,64	10.84	81	22,358.85	55.53	715.85	7.56
43	FortTottenPetworthLine	60,64	4.75	36	16,294.98	0.00	717.02	7.36
86	NorthCapitolStreetLine	80	5.72	77	15,681.74	47.36	721.50	7.31
54	McLeanCrystalCityLine	23A,C	17.14	126	9,269.23	13.55	723.90	7.29
581	AnacostiaCongressHeightsLine	42,3,5,1&,8,96,48	15.25	112	12,476.48	22.15	719.17	7.31
55	SibleyHospitalStadiumArmoryLine	D1,3,6	16.30	116	17,002.86	35.56	748.38	7.06
73	MilitaryRoadCrosstownLine	52-4	11.21	80	11,881.81	15.71	746.57	7.06
542	RhodeIslandAvenueNewCarrolltonLine	B4	11.39	81	7,628.42	12.67	751.58	7.03
581	[illegible]	44,5	5.64	43	11,158.75	2.00	756.80	6.97
75	MassachusettsAveLine	N2-4,6	12.83	89	14,264.97	54.46	769.28	6.86
42	[illegible]	P32	14.31	99	8,800.14	2.00	770.62	6.85
28	ChillumRoadLine	P1,2	12.12	84	7,817.92	0.00	771.01	6.85
56	IvyCityUnionStationLine	D4	3.63	27	13,579.71	58.22	775.64	6.80
802	QueensChapelRoadLine	R4	5.92	40	8,303.87	0.00	800.84	6.59
114	[illegible]	V7-9	11.79	78	9,956.33	36.13	804.31	6.56
53	GeorgiaAvenueMarylandLine	Y5,7-9	14.79	98	8,344.97	5.03	805.30	6.56
548	AnacostiaEckingtonLine	P1,2,9	11.20	81	14,635.46	37.79	805.44	6.56
151	BenningRoadPotomacParkLine	X1,3	12.47	82	19,891.21	34.55	812.83	6.50
150	BladensburgRoadAnacostiaLine	B2	5.76	55	14,130.50	7.77	814.39	6.48
118	GeorgiaAvenue7thStreetLine	70,71	12.11	79	16,868.88	52.01	819.77	6.44
45	HospitalCenterLine	D9	7.14	47	14,099.13	59.40	820.26	6.44
137	WilsonBlvdLine	1A,B,E,F,2	16.56	107	8,951.68	39.17	824.88	6.40
136	[illegible]	52,4	11.26	71	23,091.09	45.27	812.99	6.34
74	CollegeParkLine	81-83,86	20.41	130	6,063.75	36.16	835.55	6.32
551	[illegible]	B7	3.49	23	3,898.05	5.12	837.07	6.31
37	MacArthurBlvdGeorgetownLine	D5	8.06	51	10,021.60	20.67	850.97	6.20
56	LeeHighwayLine	[illegible]	15.55	97	7,685.73	3.15	853.88	6.18
62	BrooklandPotomacParkLine	H1	6.49	41	26,099.83	37.75	857.19	6.16

Appendix D
Metro Bus Lines Utilized in the Spacing Analysis

Line ID	Name of Bus Line	Routes	Line Length (miles)	Total # of Bus Stops	Average Population Denisty within 1/4 Mile of Line	% of Line Serving an Activity Center	Average Spacing Between Bus Stops (feet)	Bus Stop Spacing (Stops per Mile)
85	NewHampshireAveMarylandLine	K6	9.05	56	15,010.40	17.97	869.17	6.07
91	ParkRoadBrooklandLine	H8,9	6.33	39	21,569.67	10.33	879.90	6.00
33	ConnecticutAveMarylandLine	L7,8	12.46	75	8,235.90	1.33	888.70	5.94
56	PrinceGeorgesLangleyParkLine	F8	12.87	77	10,556.99	0.00	893.83	5.91
9	AnnapolisRoadLine	T18	9.45	56	8,412.64	13.70	907.08	5.82
54	PershingDriveArlingtonBlvdLine	4A,9,F,H,S	12.91	75	12,567.95	21.21	914.16	5.78
97	PrinceGeorgesSilverSpringLine	F4,6	21.64	126	8,891.25	18.86	914.23	5.78
95	DeanwoodAlabamaAveLine	W4	16.11	91	10,277.47	0.00	945.17	5.59
140	McLeanHamletEastFallsChurchLine	24T	7.88	45	4,430.70	6.92	945.44	5.58
123	VeirsMillRoadLine	Q2	13.80	78	7,822.69	25.25	946.55	5.58
32	ConnecticutAveLine	L1,2,4	11.19	63	18,193.60	54.06	952.66	5.54
13	GreenbeltTwinbrookLine	C2,4	23.99	133	8,821.90	28.68	959.55	5.50
14	BenningRoadHStreetLine	X2	5.85	33	16,242.08	42.49	965.18	5.47
3	LandmarkBaltonLine	25B	12.47	69	16,514.33	32.63	968.58	5.45
800	RiggsRoadLine	R1,2,5	14.71	81	12,392.30	7.03	970.95	5.44
147	FairlandLine	Z8	12.50	68	8,651.88	12.73	985.21	5.36
18	EastCapitolStreetCardozoLine	96,97	13.79	73	19,025.64	19.85	1,011.61	5.22
25	MarylandAveLine	X9	2.69	15	17,342.50	17.09	1,013.23	5.21
5	AlexandriaTysonsCornerLine	28A-B	22.02	113	10,285.88	35.98	1,038.15	5.09
148	CalvertonWestfarmLine	Z6	15.85	81	8,298.56	20.13	1,040.07	5.05
142	ColumbiaPikeLine	16A,B,D-F,J,P	19.42	96	11,601.21	21.82	1,079.27	4.89
31	HuntingtonPentagonLine	9A,F	7.44	37	10,009.97	57.32	1,091.79	4.84
511	PentagonArmyNavyDriveShirleyParkLine	22B	3.54	18	12,255.58	33.11	1,100.51	4.80
109	16thStreetPotomacParkLine	S1	7.70	37	26,005.04	45.77	1,128.81	4.68
103	CollegeParkWhiteFlintLine	C8	17.59	82	8,707.86	20.74	1,146.67	4.60
580	RockRoadLine	W13,14	19.75	91	10,054.33	18.62	1,158.59	4.56
122	TysonsCornerWestFallsChurchLine	28T	7.09	33	5,058.24	68.94	1,169.42	4.52
125	WashingtonBlvdLine	2A-C,G	22.65	102	6,867.94	36.08	1,183.98	4.46
512	BarcroftSouthFairlingtonLine	22A	9.56	43	13,298.49	17.45	1,201.83	4.39
16	BethesdaSilverSpringLine	J1-3	15.09	67	8,503.79	47.08	1,207.30	4.37
[illegible]	[illegible]	T2	14.90	66	5,308.14	14.00	1,210.34	4.36
70	LincolniaNorthFairingtonLine	7A-F,H,P,W,X	18.25	78	15,910.56	33.51	1,251.28	4.22
[illegible]	[illegible]	3T	10.74	46	5,299.95	59.53	1,259.97	4.19
57	FairfaxVillageLEnfantPlazaLine	W5	5.90	25	10,737.16	31.93	1,297.74	4.07
111	SouthCapitolStreetLine	A9	6.79	28	11,434.33	26.85	1,326.86	3.98
124	ViennaDaltonLine	Z9	7.95	32	6,422.92	0.00	1,354.03	3.90
106	FoxhouseSeminaryValleyLine	8S,W,X,Z	14.52	57	14,173.51	7.81	1,368.65	3.86
143	ColumbiaHeightsWestPentagonCityLine	16G,H,K,W	9.41	37	14,528.13	33.56	1,379.40	3.83
27	ChainBridgeRoadLine	15K,L	29.34	112	6,418.52	26.60	1,395.40	3.78
139	FairOaksDunnLoringLine	2C	10.99	37	6,588.31	67.58	1,524.04	3.46
522	ColumbiaPikeFarragutSquareLine	16Y	7.59	27	16,556.90	34.39	1,542.19	3.42
87	OrangeHuntLine	18G,H,J	26.75	91	10,852.58	11.30	1,568.25	3.36
642	GreenbeltGlenmontLine	C7,9	28.86	96	4,541.25	19.18	1,604.24	3.29
116	SpringfieldLine	18E,F	19.22	64	12,461.08	22.25	1,611.10	3.28
8	AnnandaleLine	29C,E,G,H,K	30.21	98	10,357.80	9.62	1,644.48	3.21
88	DeckHillFortWashingtonLine	P17-19	21.22	67	10,829.75	25.58	1,697.34	3.11
521	AnnandaleSkylineCityPentagonCityLine	16L	11.36	35	12,037.06	26.23	1,764.42	2.99

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10	ColesvilleAshtonLine	Z2	11.11	86	6,618.51	10.63	1,932.72	2.73
26	PointerRidgeLine	C28	15.24	33	2,441.67	1.67	2,513.94	2.10
629	CollegeParkBethesdaLine	J4	12.48	26	12,447.76	37.10	2,634.93	2.00
60	ChantillyGreenbriarLine	20F,W,X,Y	21.83	44	5,095.90	32.67	2,680.29	1.97
154	SullyStationViennaLine	128,S	28.35	49	5,634.58	33.29	3,118.19	1.69
153	LittleRockyRunViennaLine	12L,M	17.13	26	5,771.67	29.13	3,617.54	1.46
145	CentrevilleNorthLine	12C,D	21.56	29	5,585.32	14.57	4,064.83	1.30
155	CentrevilleSouthLine	12A,E,G	25.00	26	5,916.40	20.03	5,279.51	1.00
129	DCDullesLine	5A	30.43	7	6,947.08	37.22	26,782.62	0.20