16TH STREET NW
TRANSIT PRIORITY
Planning Study

EXISTING CONDITIONS

October 13, 2015

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1.0 INTRODUCTION

The 16th Street NW corridor is a vital transportation route in the District of Columbia. It serves users of all modes and is one of the busiest Metrobus routes in the network, serving an average of over 20,000 passengers per weekday. In fact, Metrobus moves over 50 percent of the people in the morning peak hour using only about 3 percent of the vehicles that operate on the corridor.

In recent years, 16th Street NW has experienced transit service and operational improvements, implemented by the District Department of Transportation (DDOT) and the Washington Metropolitan Area Transit Authority (WMATA). These improvements include the S9 MetroExtra limited stop service and signal timing optimization along the corridor. However, within the existing traffic and roadway conditions, the possibilities for future additional service improvements are available but limited.

The 16th Street NW Transit Priority Planning Study (the Study) aims to evaluate a range of potential service, physical, and operational improvements based on the existing conditions of the corridor by analyzing the impacts to transit performance, multimodal mobility, and safety.

This Existing Conditions Report identifies factors affecting mobility along 16th Street NW and summarizes the elements that define the function and character of the corridor. It uses readily available information which was field verified where possible. Data referenced throughout this report were current as of August 2015, unless otherwise noted.

This Draft Existing Conditions Report summarizes:

- Existing Community
  - Land use;
  - Community facilities;
  - Demographics; and
  - Commuter trends.
- Existing Transportation Infrastructure and Operations
  - Roadway and curbside usage;
  - Safety;
  - Bus stop access and amenities;
  - Traffic operations; and
  - Transit operations.

Understanding these elements will be instrumental in developing effective recommendations for transit service and operational improvements along 16th Street NW. The next section presents further details on the goals and objectives of the Study.

1.A STUDY GOALS AND OBJECTIVES

The main goals of the Study are:

- Improve travel for persons using public transit;
- Develop alternatives based on public and stakeholder input; and
- Evaluate alternatives in terms of their benefits to transit users, possible impacts on users of other transportation modes, and safety.

The anticipated outcome of the Study is a preferred set of improvements between H Street NW and Arkansas Avenue NW that build on the measures implemented to date and achieve the following objectives:

- Improve transit service reliability and travel times by identifying and addressing sources of potential issues (e.g., traffic congestion, signal timing, passenger boarding delays, bus capacity, number and location of bus stops, and/or parking enforcement);
- Prioritize transit while maintaining operations for those traveling by other modes;
- Improve passenger comfort and safety (e.g., overcrowding, street crossings, and bus stop amenities);
- Accommodate current unmet passenger demand for public transit service; and
- Develop an implementation plan that includes costs estimates.

Based on these objectives, the following measures were developed to evaluate the effectiveness of the recommendations:

- Improve transit service reliability and travel times
  - Reduction in end-to-end/segment-by-segment travel times;
  - Improvement in on-time performance;
  - Reduction in dwell time; and
  - Reduction in dwell time as a percentage of run time.
- Optimize operations
  - Multimodal level of service, travel time, queuing, and person throughput.
- Improve passenger comfort and safety
  - Load factor;
  - Number of bus stops at uncontrolled intersections; and
  - Pedestrian crossing improvements.
- Accommodate unmet passenger demand
  - Service capacity.
- Develop a feasible solution
  - Cost;
  - Implementation time;
  - Consistency with bus operating parameters (e.g., bus widths, turning radii, etc.); and
  - Management and enforcement requirements.

1.B STUDY AREAS

Figure 1 shows the Primary Study Area, which encompasses 16th Street NW between H Street NW and Arkansas Avenue NW, and the Secondary Study Area, which maintains H Street NW as the southern boundary while the northern boundary extends to Taylor Street NW. The eastern boundary of the Secondary Study Area is 14th Street NW and the western boundary generally follows the north-south alignment of 18th Street NW.

The Study focused on collecting data collection and analysis within the Primary Study Area since any recommended improvements from the Study would be implemented along 16th Street NW. Data were collected for facilities located within the Secondary Study Area to help build a contextual understanding of the community and the transportation network beyond 16th Street NW.

Primary Study Area:

16th Street NW from H Street to Arkansas Avenue

Secondary Study Area:

Bounded by 14th Street, 18th Street, Taylor Street and H Streets NW

1.C EXISTING STUDIES

This section summarizes three key prior studies related to transit priority along 16th Street NW including:

- Metrobus 16th Street Line Study (2009);
- 16th Street NW Safety and Mobility Study (2013); and
- moveDC (2014).

1.C.1 Metrobus 16th Street Line Study

This 2009 WMATA study developed recommendations for improving the Metrobus S routes operating along 16th Street NW, focusing on issues identified through the use of passenger surveys and community workshops.

Many of the recommendations developed by the Metrobus 16th Street Line Study have been implemented, including operation of the S9 (MetroExtra limited stop service), operation of short-turn service, and operation of additional articulated buses along 16th Street NW. The study also proposed creating bus lanes to improve travel times and service reliability, and to decrease bus bunching occurrences. However, 16th Street NW has no dedicated bus lanes at this time.

Short-turn bus service provides additional buses to alleviate overcrowding on a segment of the existing line.

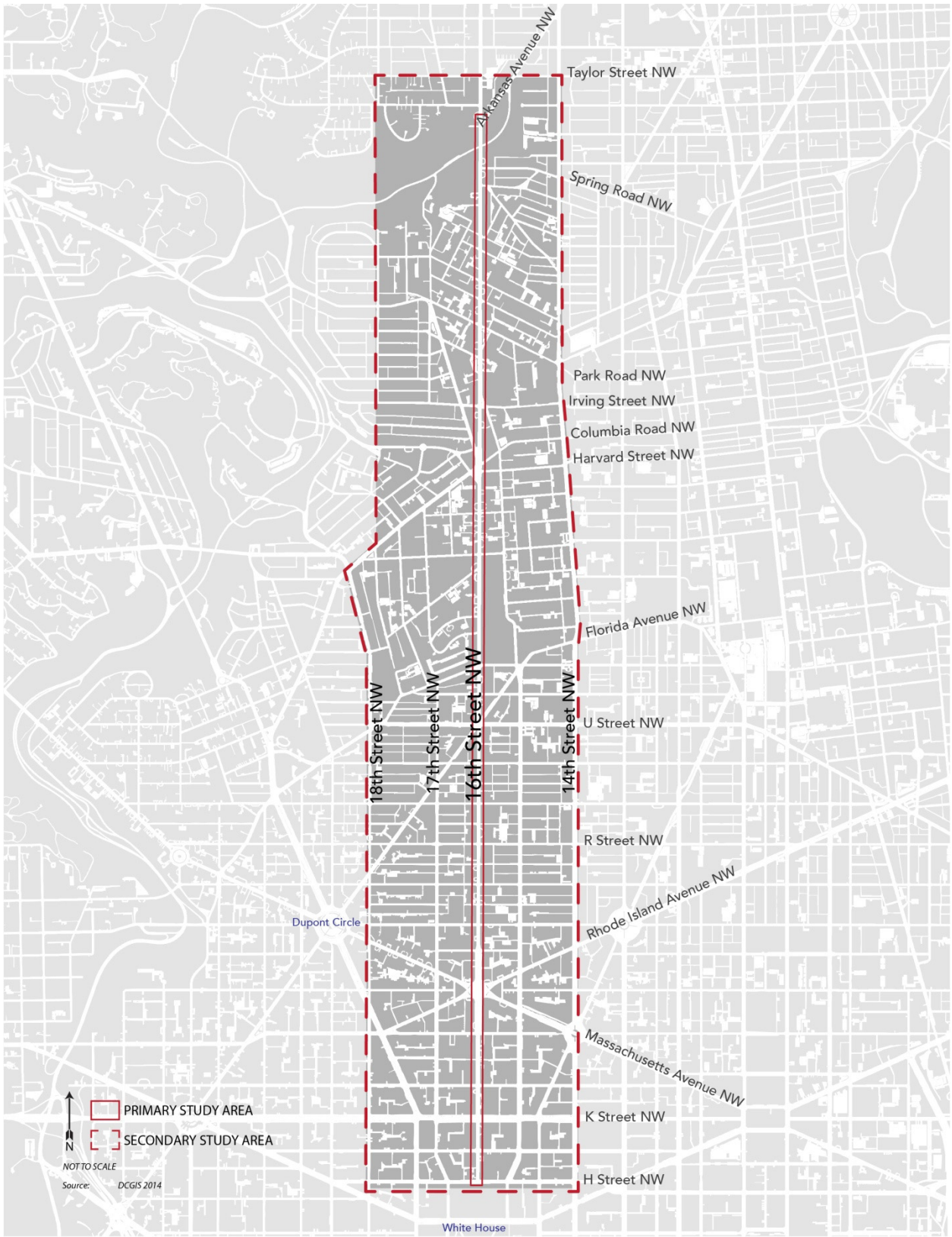
WMATA started S2 short-turn bus service to relieve extreme overcrowding on the southern portion of 16th Street NW during the AM Peak period. The short-turn bus runs every 13 minutes from Harvard Street to Downtown DC, from 7:30 AM to 9:15 AM.

1.C.2 16th Street NW Safety and Mobility Study

The 16th Street NW Safety and Mobility Study is the predecessor to the current Study. Completed by DDOT in 2013, this study focused on improving safety and mobility for pedestrians and transit users. The study performed planning-level feasibility analysis of the corridor, identified key issues and locations of potential concerns, and developed concept-level recommendations for alternatives.

The study's preferred alternative noted the technical feasibility of operating bus lanes along 2.7 miles of 16th Street NW during peak hours and in peak travel directions. The study noted a need for further analysis regarding potential vehicular delays.

Figure 1 – Study Areas



1.C.3 moveDC

In 2014, DDOT released moveDC, the District's Multimodal Long-Range Transportation Plan. moveDC outlines the existing conditions of the District's transportation system and recommends capital improvements and modal priorities to accommodate the District's rapidly growing population and workforce.

By 2040, moveDC aims to increase the share of non-auto commuter trips to 75 percent. To achieve this goal, the plan proposes developing 47 miles of high capacity transit (HCT). moveDC defines HCT as a high frequency, fixed-route transit service that can operate in exclusive right-of-way (dedicated lanes) or mixed traffic. Among the recommended HCT improvements, moveDC highlights 16th Street NW as a Tier 1 priority for capital investment.

This Study includes additional background information from moveDC, most notably in Section 2.A - Land Use and Section 2.C - Demographics.

A peak period is a part of the day during which traffic congestion on roads and crowding on public transit is at its highest. Normally, this happens twice every weekday, once in the morning (7-9:30 AM) and, again, in the evening (4-6:30 PM).

2.0 EXISTING COMMUNITY

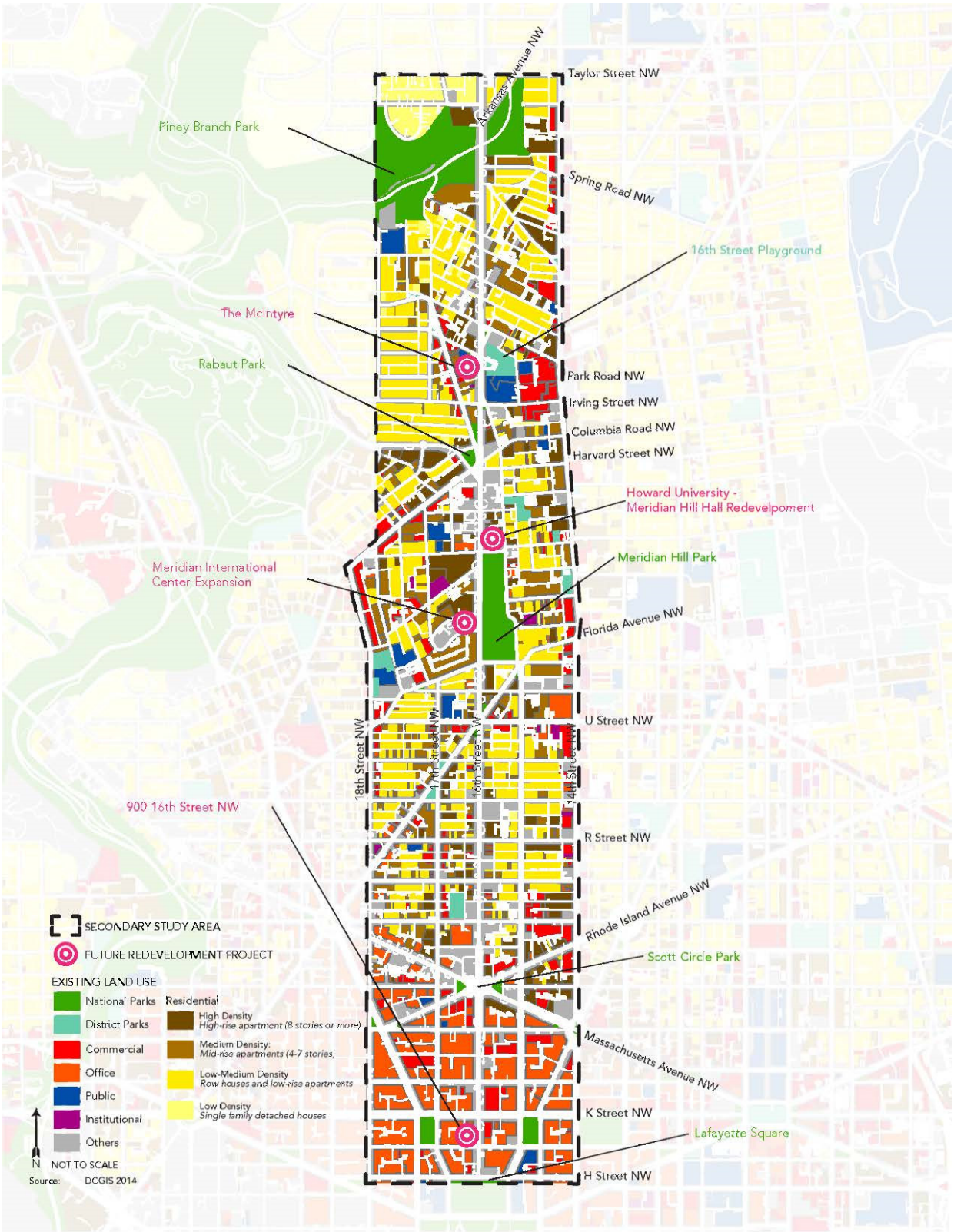
This section summarizes land use, community facilities, demographics, and commuter trends in the Secondary Study Area. These aspects influence the transportation operations and transit demand in the Primary Study Area.

2.A LAND USE

The Secondary Study Area is nearly fully developed. Figure 2 illustrates the areas along the Primary Study Area. North of Massachusetts Avenue is predominantly residential with the notable exception of the Columbia Heights Education Campus and the DC USA retail development, both located just north of Irving Street NW. South of Massachusetts Avenue, 16th Street NW contains mainly office and commercial land uses. Unlike 14th or 18th Streets NW, few retail uses directly face 16th Street NW.

Given the density of housing in the northern portion of the Secondary Study Area and office and commercial land uses in the southern portion, 16th Street NW accommodates heavy southbound travel in the AM peak period (7–9:30 AM) and northbound travel in the PM peak period (4–6:30 PM). Section 3.0 – Existing Transportation Infrastructure and Operations presents additional details on the travel patterns and transportation operations along 16th Street NW.

Figure 2 – Existing Land Use



2.A.1 Future Development Projects

While the Secondary Study Area is nearly fully developed, the following notable development sites along 16th Street NW are proposed for completion in the near future and may generate additional transit demand.

900 16TH STREET NW

Currently under construction, 900 16th Street NW is the future home of a 141,026 square-foot, mixed-use office and commercial building with nine stories above grade and three stories underground for structured parking. The new building will be home to the Third Church of Christ Scientist, which was previously located on the site. The Church will be open on weekends and weekdays. The building will also feature ground floor retail along 16th Street NW and I Street NW.

MERIDIAN INTERNATIONAL CENTER EXPANSION

The proposed Meridian Hill expansion combines two lots owned by the Meridian International Center located at the corner of 16th Street NW and Crescent Place NW to develop a mixed-use building with underground parking. If approved by the Zoning Commission, the development would include a nine-story residential building with approximately 130 residential units, 8,650 square feet of meeting space for the Meridian International Center, and two floors of underground parking located beneath the building. The lots are currently unoccupied.

HOWARD UNIVERSITY – MERIDIAN HILL HALL

Located at 2601 16th Street NW, Meridian Hill Hall—a former 650-student, residential dormitory for Howard University—has been permanently closed and sold for redevelopment. The Historic Preservation Review Board is considering a new 200-unit condominium building—currently in the conceptual design phase.

THE MCINTYRE

Located at 3146 16th Street NW, the McIntyre will be an 85-unit, multi-family residential development in the Mount Pleasant neighborhood. It will maintain and restore the architecture of the Meridian Hill Baptist Church, which was damaged in a fire in 2008. Plans for this development do not include on-site parking.

2.B COMMUNITY FACILITIES

There is a diverse range of educational facilities, places of worship, and embassies located in the Secondary Study Area. These community facilities, comprising trip origins and destinations, highlight potential unmet passenger demands and locations—which may warrant better facilities to improve the comfort and safety of transit users.

These community facilities have associated parking and loading needs that impact transit operations along 16th Street NW. Figures 15-21 under Section 3.A - Roadway and Curbside Usage illustrate the parking and curbside use restrictions along the Primary Study Area.

2.B.1 Educational Facilities

Educational facilities generate vehicular and transit trips throughout the Secondary Study Area. Safe access is very important for students, parents, and teachers who use 16th Street NW to reach these educational facilities, especially during peak periods (e.g., school start and dismissal times).

Figure 3 shows the neighborhood library and several charter schools located along, or near, 16th Street NW. Since charter schools often do not have school bus services of their own, students use the Metrobus to commute to and from schools. In particular, students from the northern portion of the Secondary Study Area use Metrobus to reach the schools located near Park Road NW and Irving Street NW.

Figure 3 – Educational Facilities

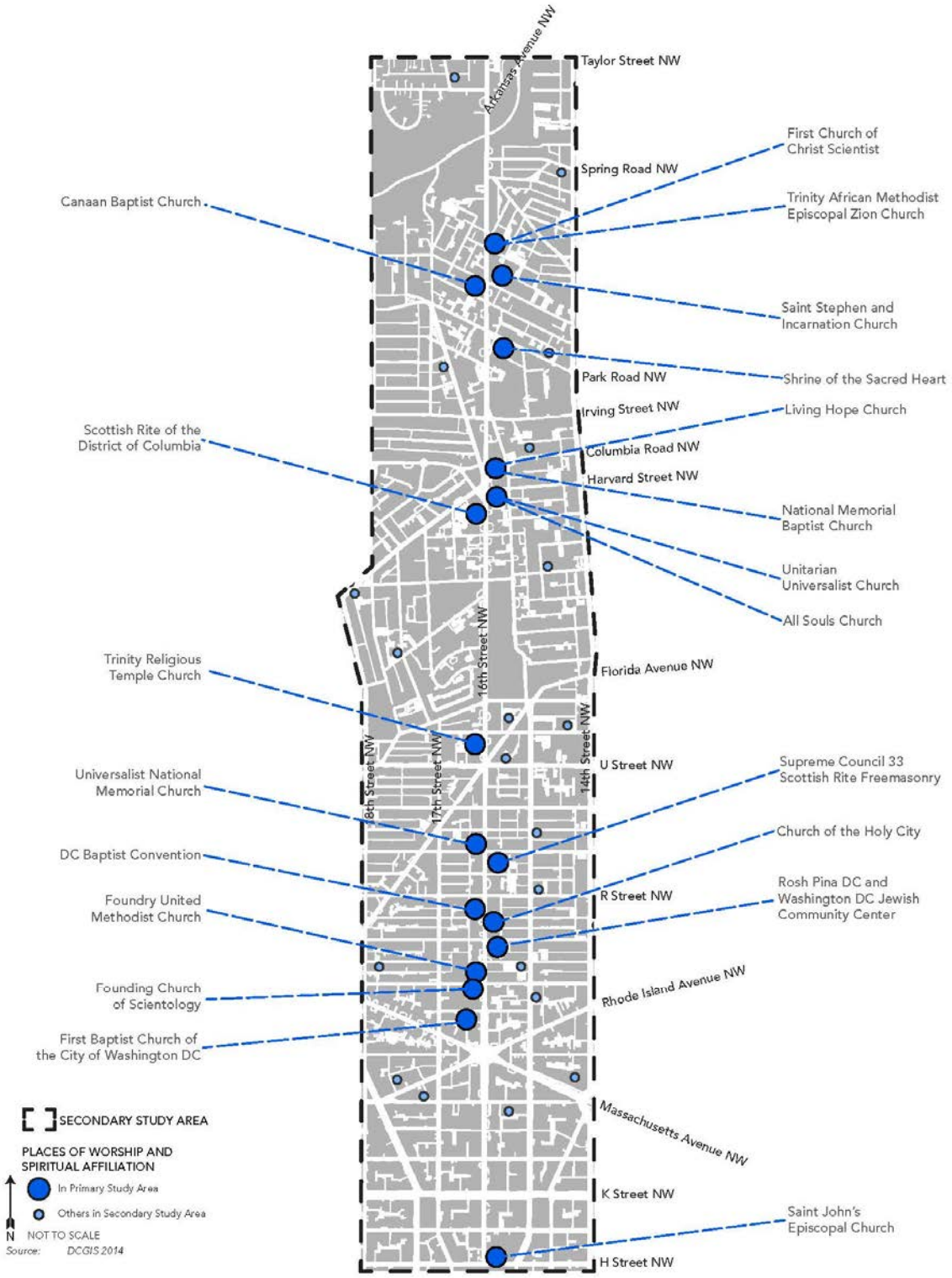
2.B.2 Places of Worship

Places of worship contribute to the number of vehicles on the road, demand for parking, and transit use along 16th Street NW. Figure 4 shows 19 places of worship within the Primary Study Area and approximately 30 additional places of worship within the Secondary Study Area. In addition, many of these places of worship are iconic landmarks that help define the streetscape.

Figures 15-21 under Section 3.A - Roadway and Curbside Usage identifies several locations along 16th Street NW with specific Sunday parking regulations along the Primary Study Area including:

- Northbound (east side) between H and I Streets NW;
- Southbound (west side) between Park Road NW and Monroe Street NW; and
- Southbound north of Irving Street NW.

Figure 4 – Places of Worship and Spiritual Affiliation

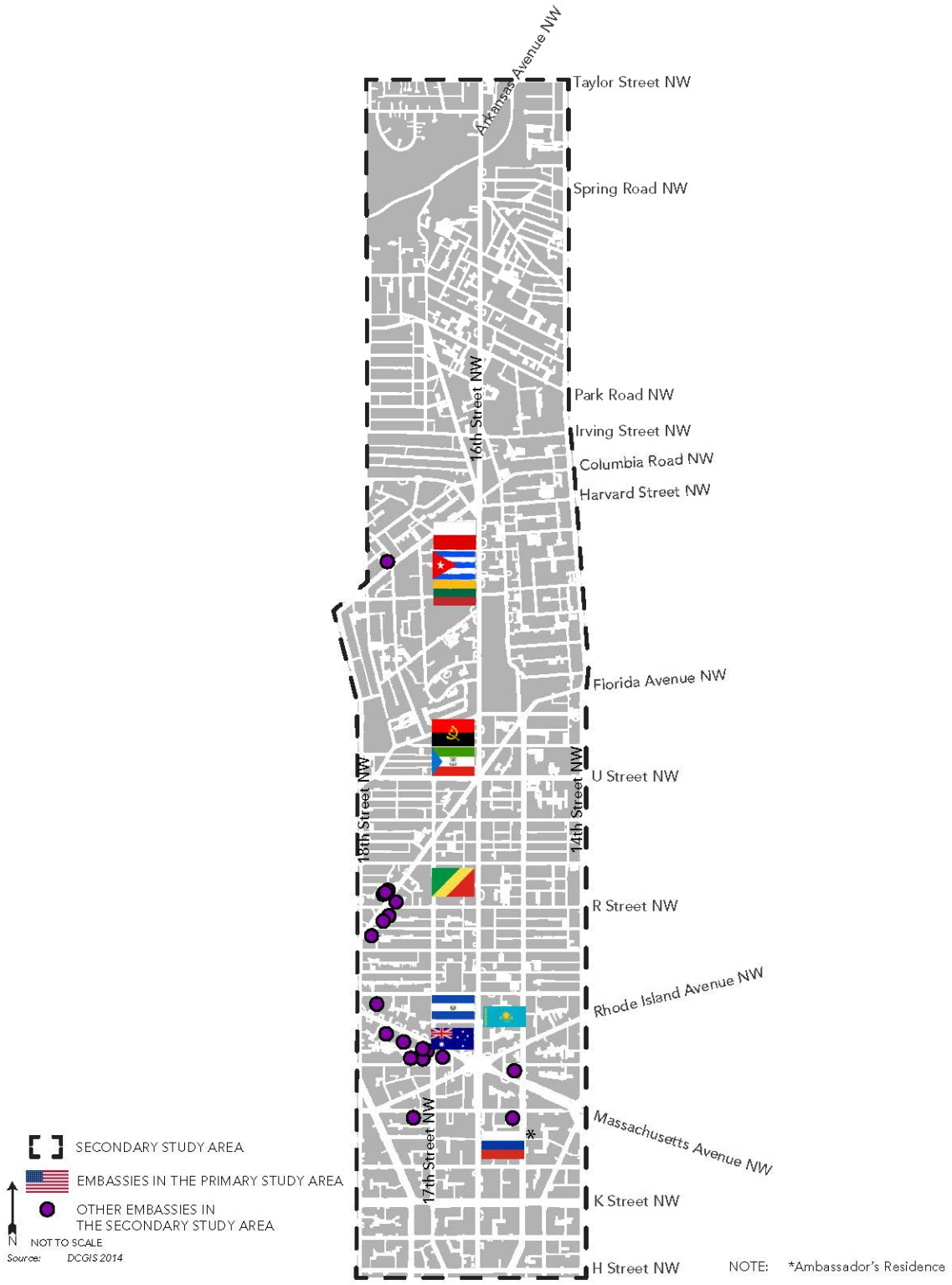


2.B.3 Embassies

The Primary Study Area accommodates eight embassies and the residence of the Russian ambassador. In addition, the Secondary Study Area, which includes part of Embassy Row, has approximately 32 embassies and consulates. Figure 5 indicates the locations of the embassies within the Primary Study Area while Figures 15-21 under Section 3.A - Roadway and Curbside Usage identifies several locations where an embassy currently has dedicated on-street curbside space including:

- Northbound (east side) just north of Fuller Street NW;
- Southbound (west side) between Florida Avenue NW and V Street NW;
- Southbound between V and U Streets NW;
- Northbound just north of O Street NW; and
- Northbound just north of L Street NW.

Figure 5 – Embassies



2.C DEMOGRAPHICS

The demographic characteristics of the Secondary Study Area influence the current and future demand for transit along 16th Street NW. This section provides an overview of the Secondary Study Area's population, employment, share of vulnerable users, income levels, vehicle ownership rates, and commuter trends based on data from the U.S. Census Bureau's American Community Survey (ACS) 5-year estimates and data from moveDC.

2.C.1 Population

Table 1 presents the population for the District and the Secondary Study Area for 2000, 2010, and 2013. In 2013, the population of the Secondary Study Area was approximately 14 percent of the District's population and had a slightly higher growth rate.

Table 1 – District and Secondary Study Area Population Data between 2000 and 2013

	POPULATION			PERCENT CHANGE		
	2000	2010	2013	2000-2010	2010-2013	2000-2013
District of Columbia	572,059	601,723	619,371	5.2%	2.9%	8.3%
Secondary Study Area*	78,039	82,637	85,099	5.9%	3.0%	9.0%

**The U.S. Census Bureau revised block group boundaries between the 2000 and 2010 Census. Therefore, the percent change values for the Secondary Study Area reflect the published U.S. Census data with the adjusted boundaries.*

Based on the ACS 5-year estimates for 2013, the population densities are higher north of Massachusetts Avenue NW, consistent with the predominantly residential land use. Figure 6 presents the population density by block group within the Secondary Study Area. The block groups around Meridian Hill Park, Mount Pleasant, Columbia Heights, and the neighborhood just south of the Piney Branch Park have the highest densities at 100 to 150 people per acre within the Secondary Study Area.

The U.S. Census Bureau defines a block group as an area that contains between 600 and 3,000 residents. The block group is the smallest geographic unit for which the U.S. Census Bureau reports data.

PROJECTED CHANGES

moveDC analyzed possible changes in the District's population using MWCOG's Cooperative Forecasting model to identify potential shifts in trip patterns. Figure 7 presents the change in population density projected between 2010 and 2040 for the block groups within the Secondary Study Area. Areas north of Massachusetts Avenue NW have much higher growth projections than the areas south of Massachusetts Avenue NW, particularly east of 16th Street NW.

Figure 6 – Population Density – 2013
Figure 7 – Projected Population Density Change (Net Increases) 2010 – 2040

2.C.2 Employment

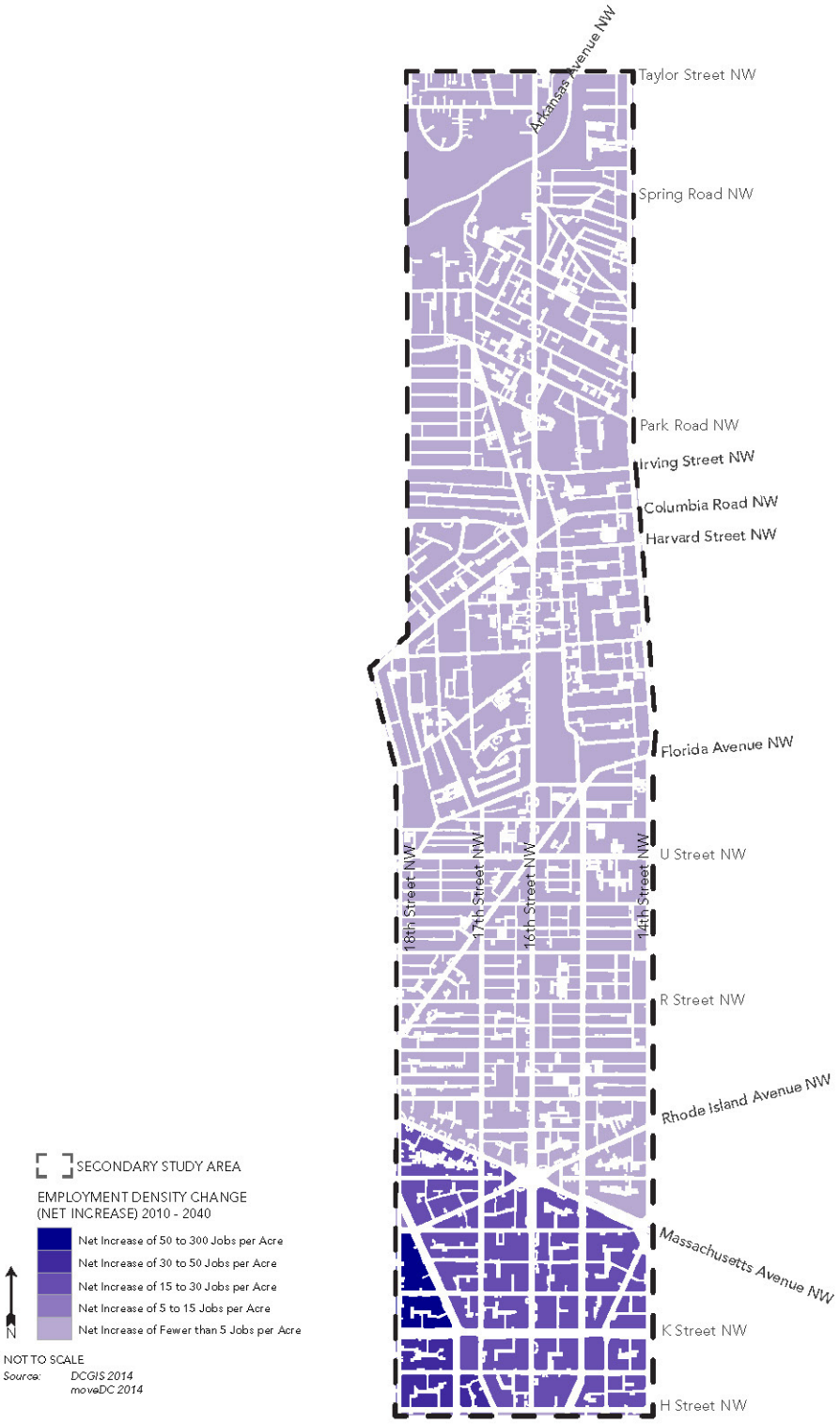
EMPLOYMENT RATE

The employment rate throughout the Secondary Study Area has been constant at about 94 percent from 2010 to 2013. While the population grew by about 3 percent between 2010 and 2013, the number of eligible workers age 17 and older rose by 9 percent. The employment rate throughout the Secondary Study Area is higher than the District average, which was about 89 percent in 2013.

PROJECTED CHANGES IN EMPLOYMENT

Based on projections from MWCOG's Cooperative Forecasting model, moveDC identified the Secondary Study Area as likely to experience major employment growth over the next 30 years, as shown in Figure 8. This projected growth is concentrated south of Massachusetts Avenue NW, with most block groups projected to have a net gain of 10 to 30 jobs per acre.

Figure 8 – Employment Density Change (Net Increase) 2010 – 2040



2.C.3 Vulnerable Users

The Study aims to provide safe and comfortable access and mobility options for vulnerable users, in particular for the elderly population and individuals with disabilities.

ELDERLY POPULATION (AGE 65 AND OLDER)

Based on the 2013 ACS 5-year estimates, approximately 7 percent of residents within the Secondary Study Area are age 65 and older, as compared with 11 percent of the District's population. Figure 9 highlights the areas just south of Meridian Hill Park, northwest of Piney Branch Park, and southeast of Scott Circle with the highest concentration of elderly populations.

POPULATION WITH A DISABILITY

Based on the 2013 ACS 5-year estimates, approximately 5 percent of residents between ages 16 and 64 within the Secondary Study Area have a disability (see Figure 10). The highest percentage of individuals with a disability resides in the area bounded by Euclid Street NW, Columbia Road NW, and 16th Street NW.

YOUTH POPULATION

Based on the 2013 ACS 5-year estimates, 10 percent of the population within the Secondary Study Area were age 17 or younger. This percentage is lower than the District's share at 17 percent.

2.C.4 Low Income Households

Based on the 2013 ACS 5-year estimates, of the approximately 43,000 households in the Secondary Study Area:

- 28 percent earned less than $50,000 annually, compared to 40 percent for the District; and
- 15 percent were classified as living in poverty, compared to 14.8 percent for the District.

2.C.5 Vehicle Ownership

In 2013, 40 percent of households in the Secondary Study Area owned one vehicle and 49 percent did not own a vehicle at all. In the District, only 30 percent of residents did not own a vehicle in 2013. The high percentage of households that do not own a vehicle relates directly to the high demand for transit and non-motorized transportation options.

Figure 9 – Percentage of Population 65 Years and Older
Figure 10 – Percentage of Population between Ages 16 and 64 with a Disability

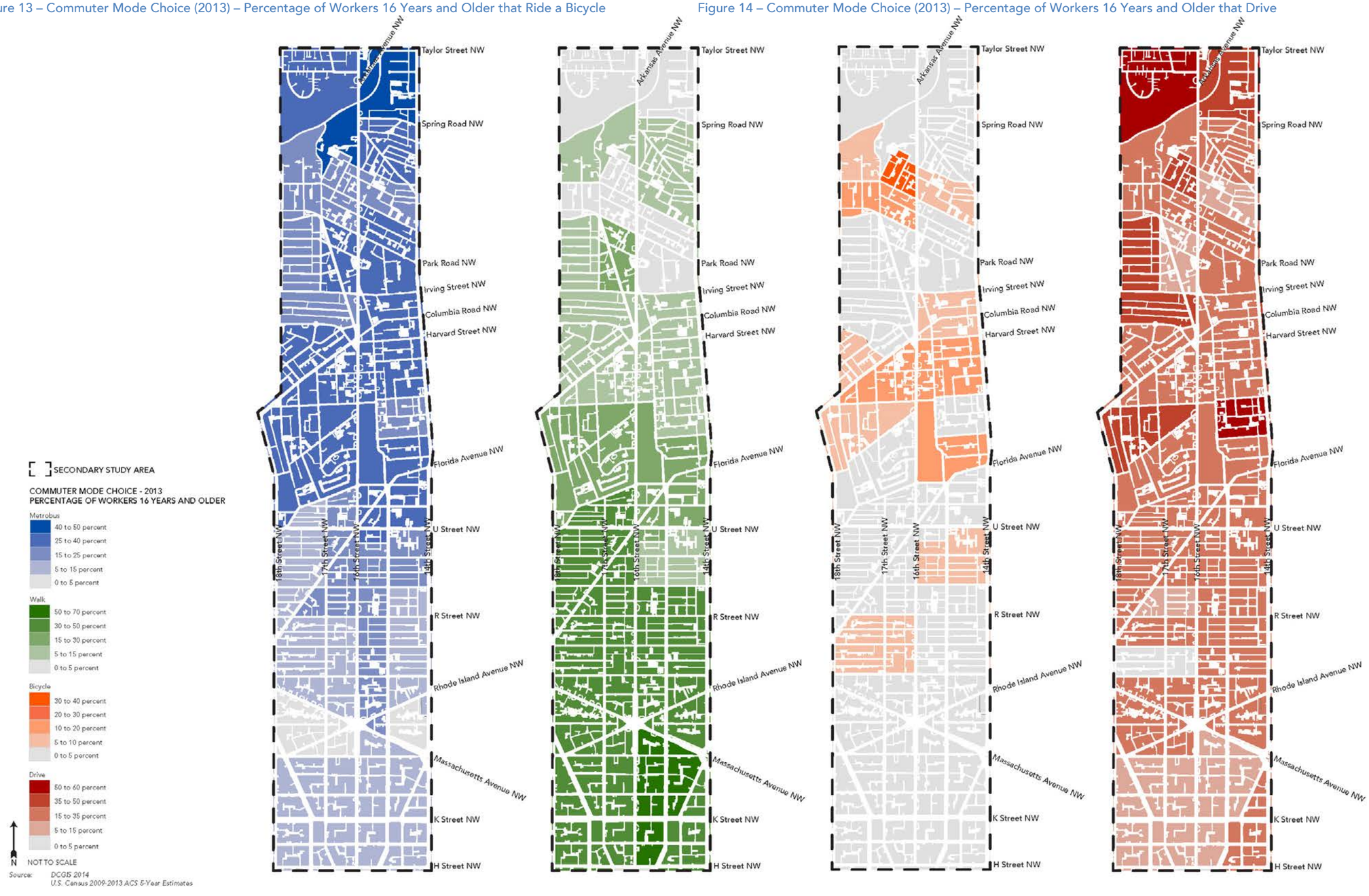
2.D COMMUTER TRENDS

According to the U.S. Census Bureau, the portion of residents in the District who commute to work on public transit rose 5 percent between 2000 and 2010. Correspondingly, the percentage driving alone or carpooling decreased by 9 percent. The number of residents who bike to work rose by 2 percent and the number who walk to work remained constant.

Figure 11 presents the northern portion of the Secondary Study Area, which exhibits the highest share of commuters using Metrobus—as high as 40 to 50 percent in some block groups. As expected, the areas located closer to the downtown core have lower Metrobus ridership and a higher share of people walking to work.

Figure 12 shows that south of Massachusetts Avenue NW, up to 70 percent of residents in select block groups walk to work. Figure 13 shows that, in some pockets within the Secondary Study Area, 5 to 20 percent of commuters bike to work—particularly in the Adams Morgan, Columbia Heights, and Mount Pleasant neighborhoods. The highest percentages of commuters (30 to 40 percent) that bike to work reside south and east of Piney Branch Parkway in the northern portion of the Secondary Study Area. The percentage of commuters that drive to work varies within the Secondary Study Area (see Figure 14).

Figure 11 – Commuter Mode Choice (2013) – Percentage of Workers 16 Years and Older that Ride the Metrobus
Figure 13 – Commuter Mode Choice (2013) – Percentage of Workers 16 Years and Older that Ride a Bicycle
Figure 12 – Commuter Mode Choice (2013) – Percentage of Workers 16 Years and Older that Walk
Figure 14 – Commuter Mode Choice (2013) – Percentage of Workers 16 Years and Older that Drive



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3.0 EXISTING TRANSPORTATION INFRASTRUCTURE AND OPERATIONS

The previous section outlined the community characteristics of the Secondary Study Area, in order to provide context for more detailed information on transportation along 16th Street NW. This section summarizes the existing transportation infrastructure and operations within the Primary Study Area including:

- Roadway and curbside usage;
- Safety;
- Bus stop access and amenities; and
- Traffic operations.

Section 4.0 - Existing Transit Operations presents information regarding current transit operations.

3.A ROADWAY AND CURBSIDE USAGE

Within the Primary Study Area, 16th Street NW extends approximately 2.7 miles between H Street NW and Arkansas Avenue NW. An urban principal arterial, it serves local and regional trips with a public right-of-way (ROW) of 160 feet. Table 2 presents how the curb-to-curb width varies throughout the Primary Study Area, ranging from 45 to 94 feet.

Table 2 – Existing Right-of-way in the Primary Study Area

SEGMENT	ROADWAY ROW (FEET)	TOTAL ROW (FEET)
Arkansas Avenue NW to Spring Road	45	63
Spring Road NW to Park Road NW	50	160
Park Road NW to Irving Street NW	58	160
Irving Street NW to O Street NW	48-50	160
O Street NW to M Street NW*	94	160
M Street NW to K Street NW	60	160
K Street NW to H Street NW	50	160

*The ROW information corresponds to the road sections before the underpass.
Source: DCGIS 2014

Figures 15-21 highlight the roadway configuration and curbside uses, including on-street parking restrictions within the Primary Study Area. Between Arkansas Avenue NW and Irving Street NW, there is a center reversible lane, which operates in the southbound direction during the AM peak period (7–9:30 AM) and the northbound direction all other times. In this section, DDOT's 16th Street NW Safety and Mobility Study (2013) found a lower utilization of the center reversible lane than the outer lanes.

In general, on-street parking is restricted during the AM and PM peak periods north of W Street NW. South of W Street NW, parking is generally restricted in the southbound direction during the AM peak period (7-9:30 AM) and in the northbound direction during the PM peak period (4-6:30 PM). South of Massachusetts Avenue NW, there are several taxi stands, loading zones, and other curbside uses. Figures 15-21 further highlight other curbside uses, including embassy parking and Sunday-only restrictions.

Figure 15 – Roadway Configuration and Curbside Use – Taylor Street NW to Oak Street NW

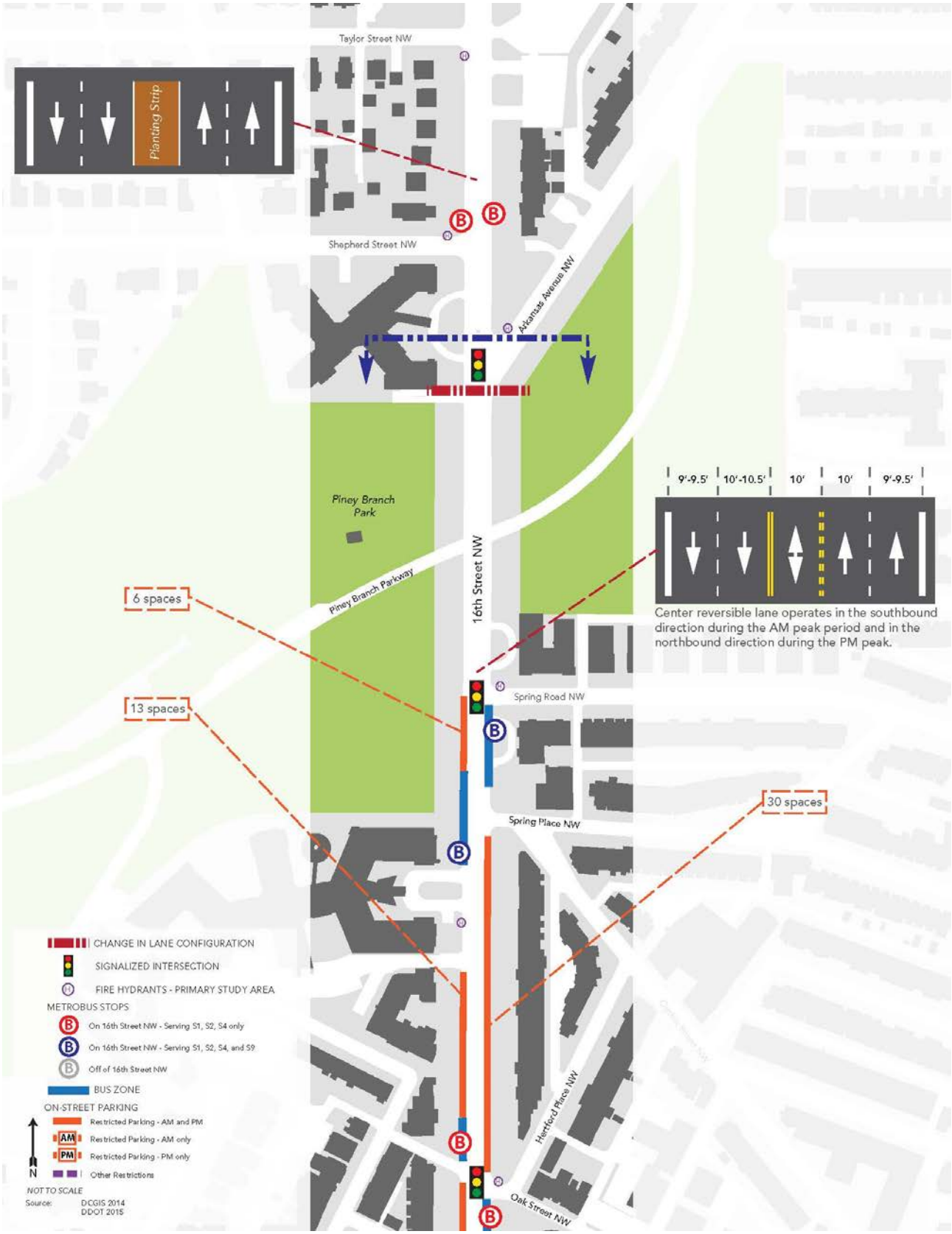


Figure 16 – Roadway Configuration and Curbside Use – Oak Street NW to Irving Street NW

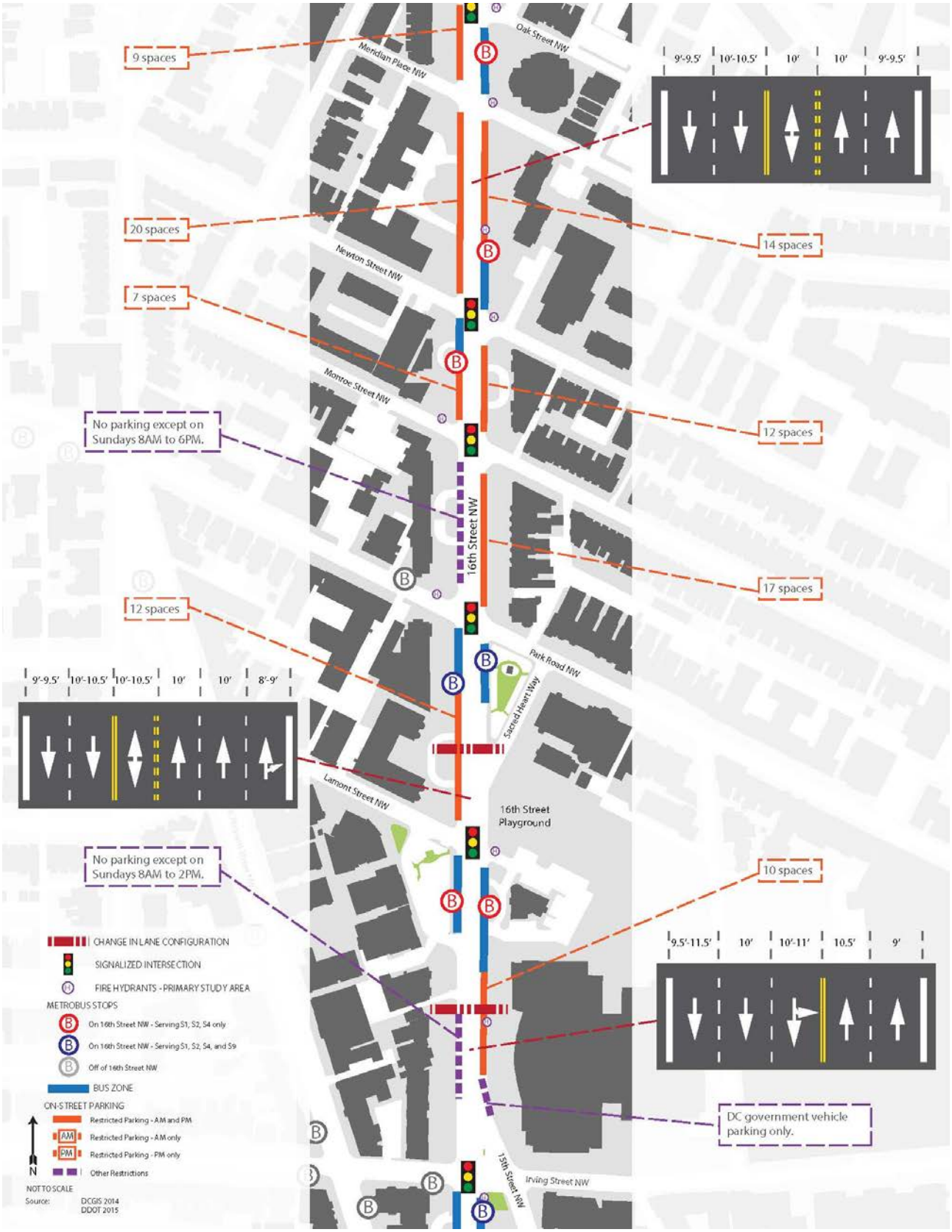


Figure 17 – Roadway Configuration and Curbside Use – Irving Street NW to Kalorama Road NW

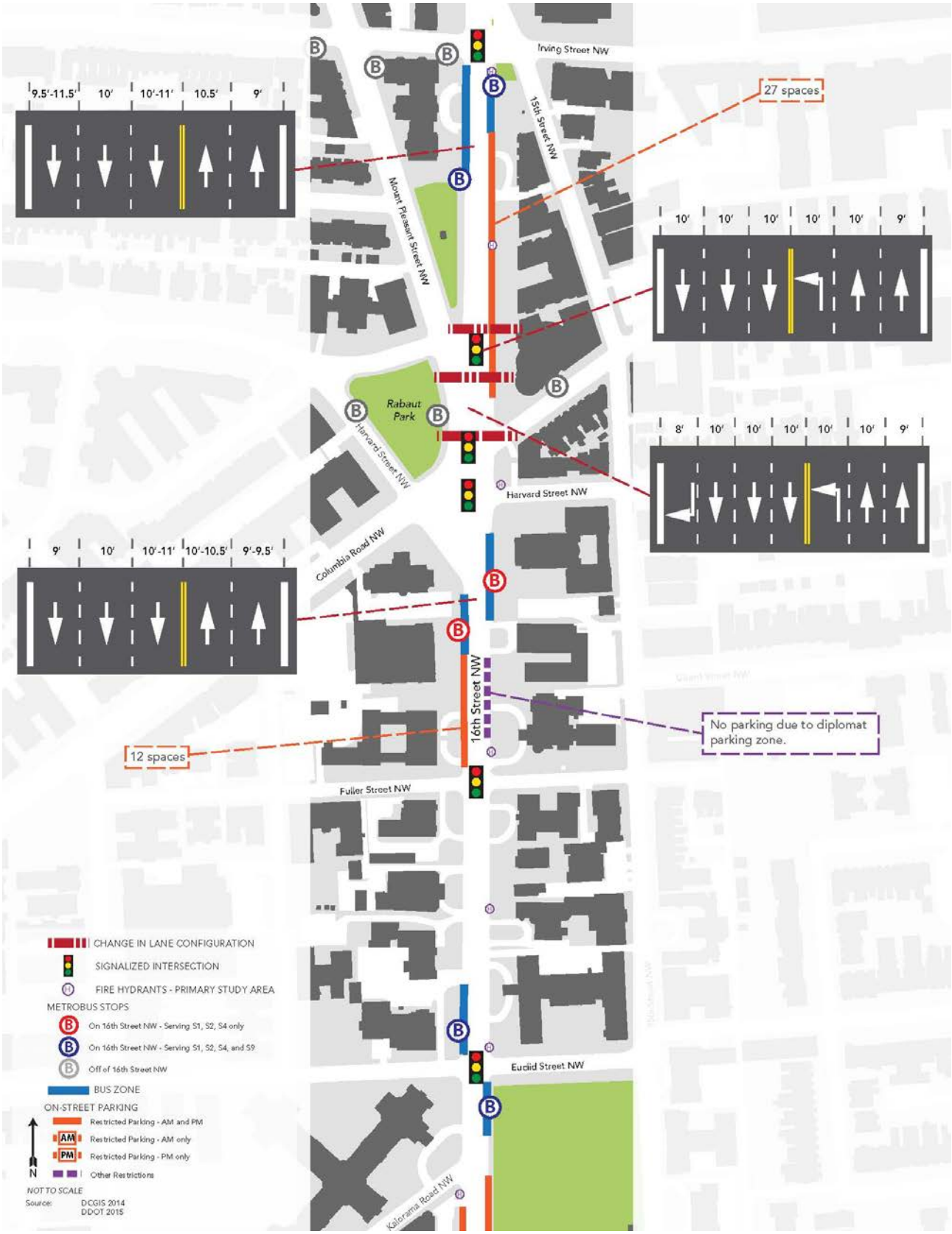


Figure 18 – Roadway Configuration and Curbside Use – Kalorama Road NW to U Street NW

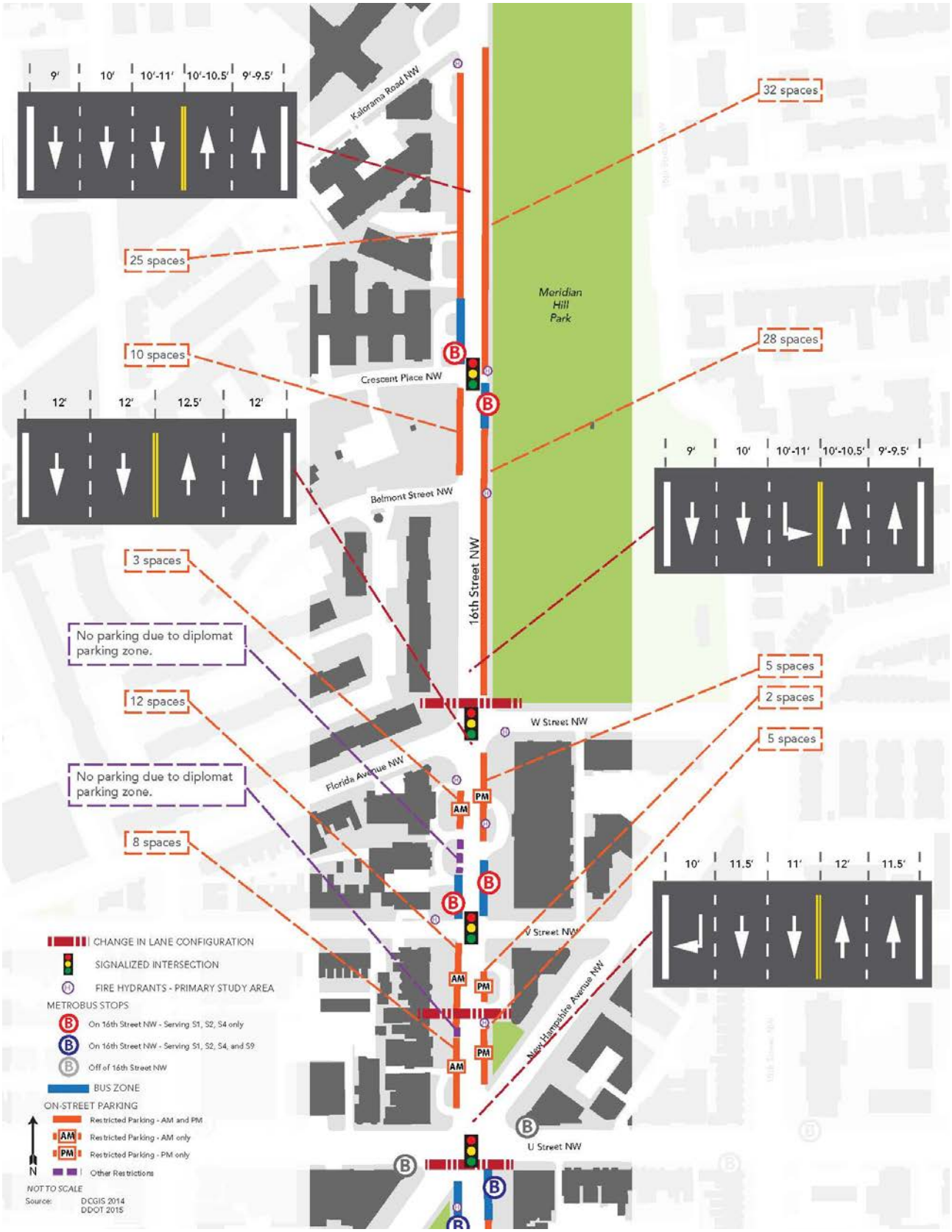


Figure 19 – Roadway Configuration and Curbside Use – U Street NW to Q Street NW

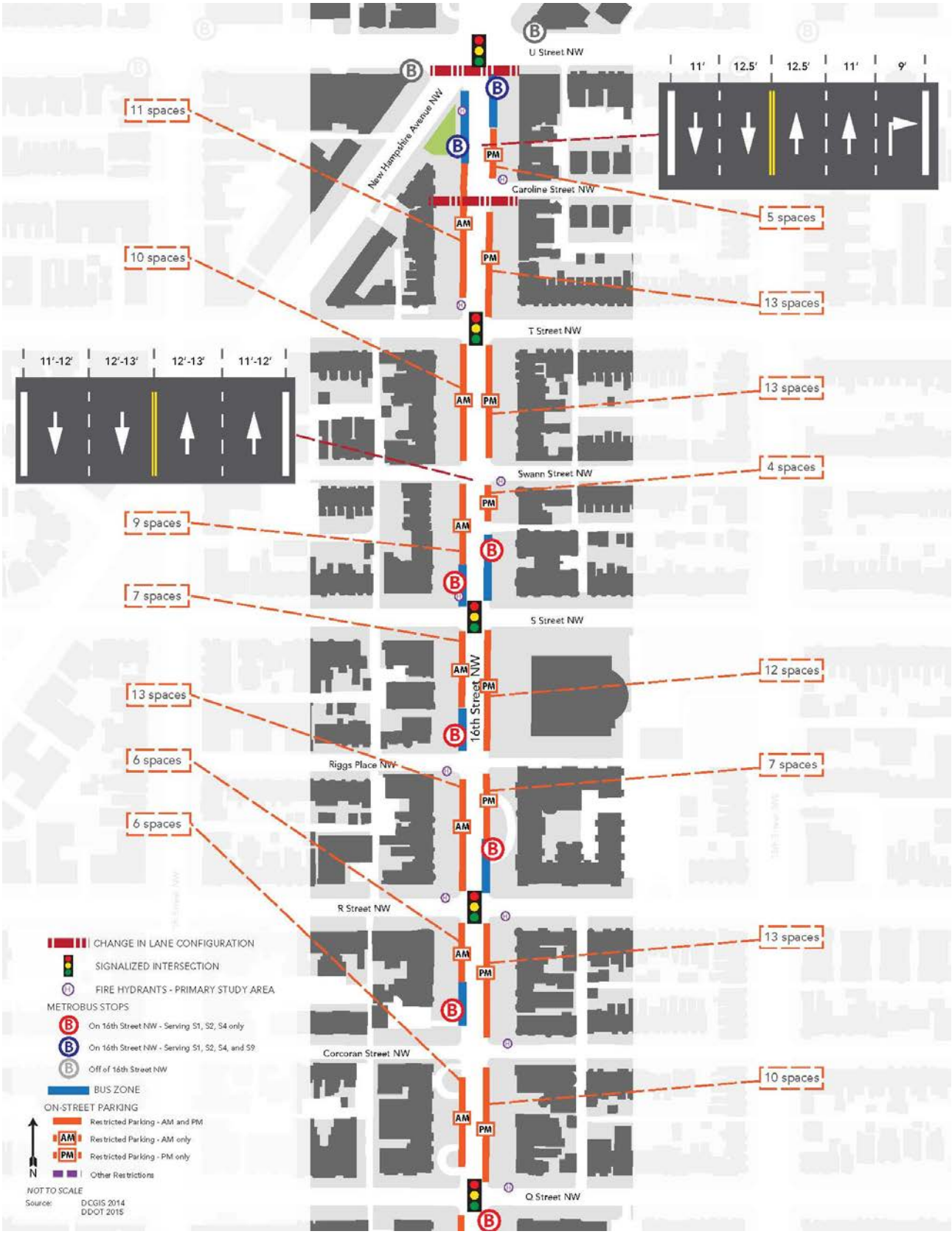


Figure 20 – Roadway Configuration and Curbside Use – Q Street NW to M Street NW

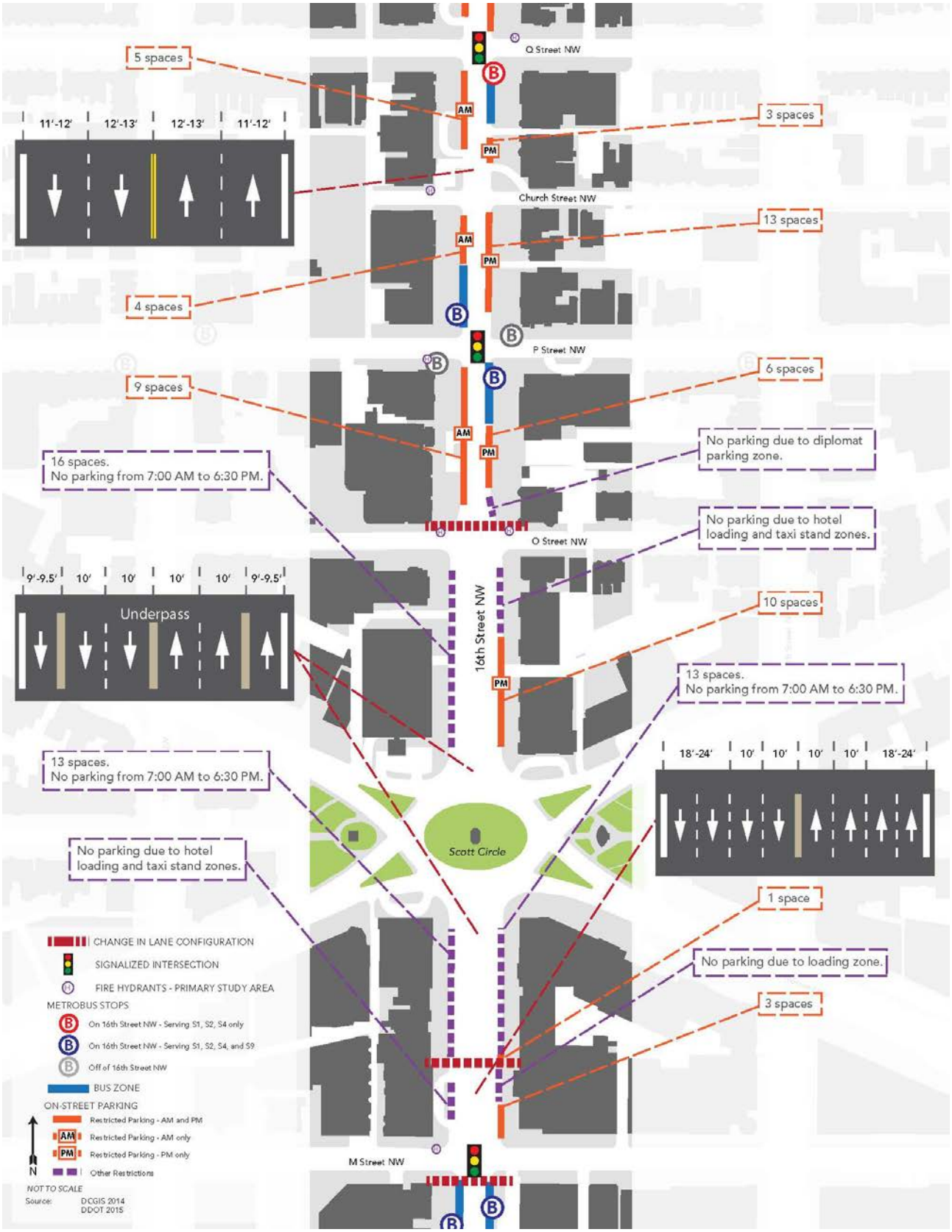
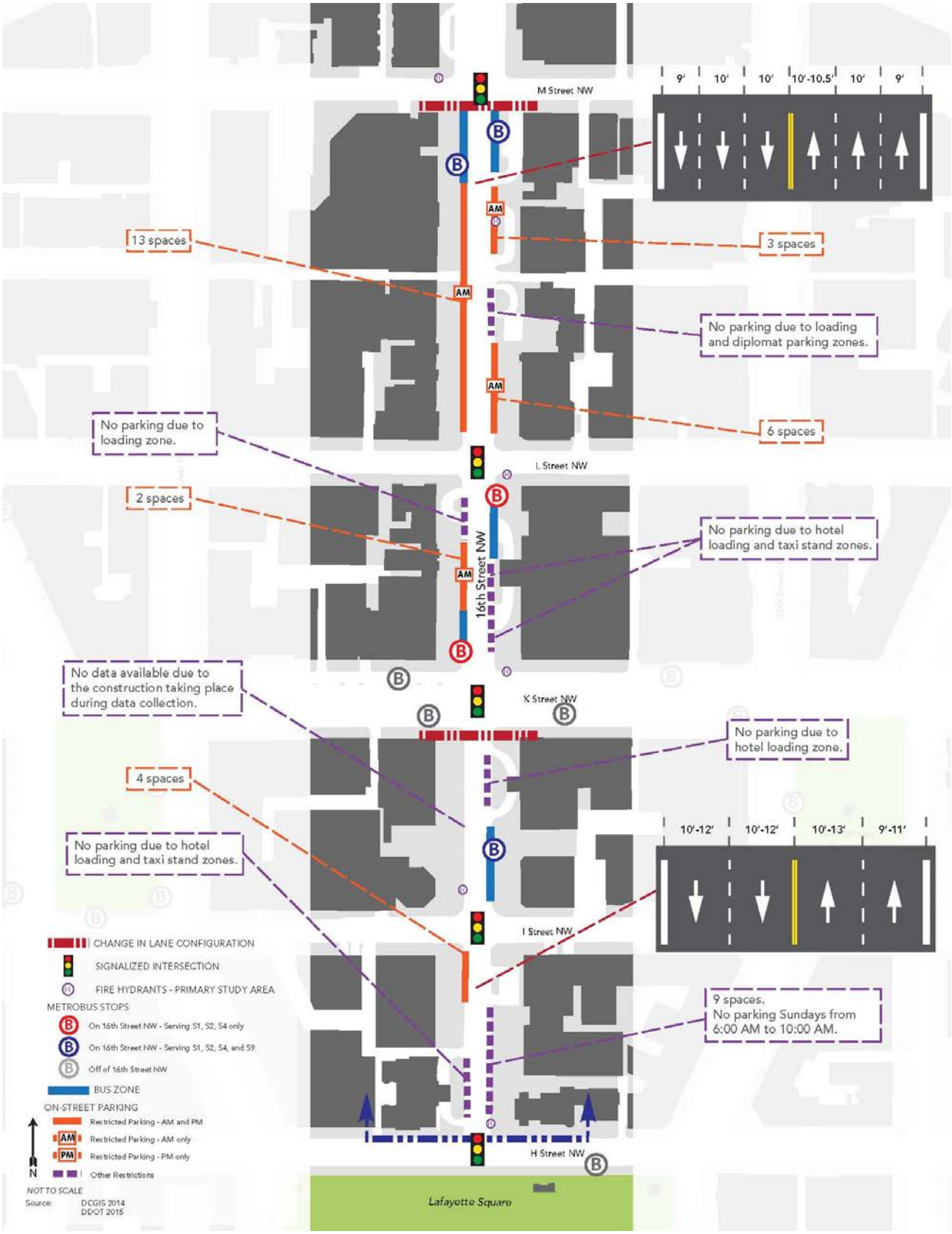


Figure 21 – Roadway Configuration and Curbside Use – M Street NW to H Street NW



3.B SAFETY

3.B.1 Pedestrian Safety and Access

The following section highlights issues within the Primary Study Area regarding pedestrian safety and access to bus stops. Figures 22-29 show locations with access or safety issues, including intersections with large numbers of pedestrians and collisions. In particular, there are several locations with unsignalized marked crosswalks. Almost all intersections have at least one ramp per corner that complies with the Americans with Disabilities Act (ADA), but many lack the required two ramps per corner. Section 4.0 – Existing Transit Operations further discusses the bus stops with large numbers of bus boardings and alightings, which typically overlap with intersections with high pedestrian activity.

Figure 22 – Pedestrian Safety and Access Locations – Legend

LEGEND

Irregular sidewalk surface creates potential trip hazards for pedestrians.

Missing one out of two ADA compliant ramps required per corner.

Missing both ADA compliant ramps required per corner.

Existing ramp missing truncated domes to be ADA compliant.

Missing crosswalk markings.

Unsignalized high visibility crosswalk.

Figure 23 – Pedestrian Safety and Access Locations – Taylor Street NW to Oak Street NW

Figure 24 – Pedestrian Safety and Access Locations – Oak Street NW to Irving Street NW

Figure 25 – Pedestrian Safety and Access Locations – Irving Street NW to Kalorama Road NW

Figure 26 – Pedestrian Safety and Access Locations – Kalorama Road NW to U Street NW

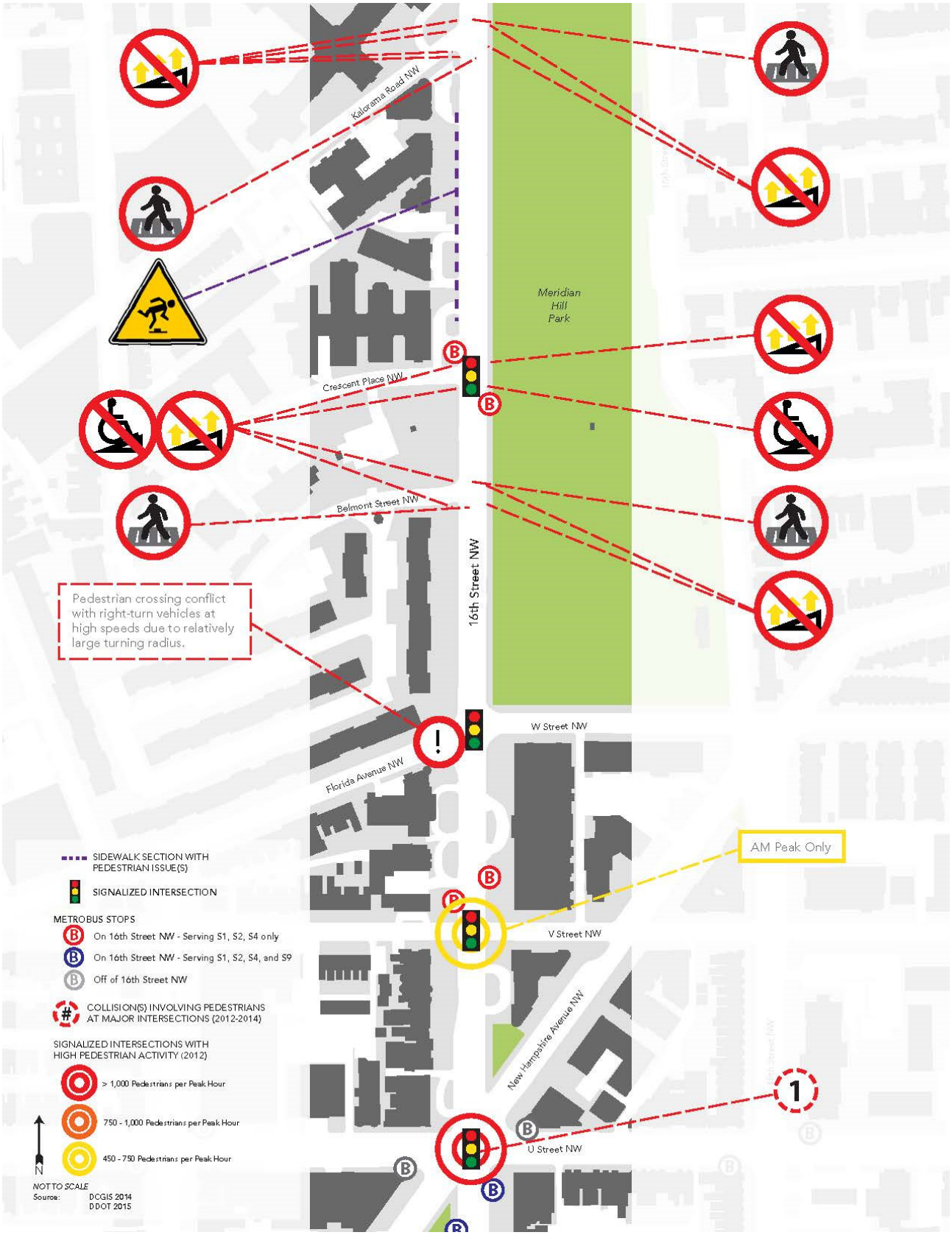


Figure 27 – Pedestrian Safety and Access Locations – U Street NW to Q Street NW

Figure 28 – Pedestrian Safety and Access Locations – Q Street NW to M Street NW

Figure 29 – Pedestrian Safety and Access Locations – M Street NW to H Street NW

3.B.2 Collisions

Table 3 summarizes the traffic collisions that occurred along the Primary Study Area from 2012 to 2014. K Street NW (84 collisions) and U Street NW (75 collisions) had the highest total number of collisions. K Street NW also had the highest number of collisions involving a bus (16 collisions), followed by Euclid Street NW (14 collisions).

Table 3 – Summary of Traffic Collisions within Primary Study Area (2012 to 2014)

CROSS STREET(S)	COLLISIONS					
	TOTAL	DOMINANT TYPE	PEDESTRIANS INVOLVED	BICYCLES INVOLVED	BUSES INVOLVED	PERCENT BUSES INVOLVED
H Street NW	26	Side Swiped	0	1	9	17.6%
I Street NW	49	Side Swiped	2	0	12	12.5%
K Street NW	84	Side Swiped	5	3	16	10.1%
L Street NW	38	Rear End	9	1	5	7.5%
M Street NW	50	Side Swiped	0	3	11	10.5%
P Street NW	24	Side Swiped	0	2	2	4.0%
Q Street NW	34	Rear End	0	2	5	7.0%
R Street NW	33	Side Swiped	3	4	3	4.8%
S Street NW	18	Side Swiped	1	1	2	5.7%
T Street NW	15	Rear End	1	2	0	0.0%
U Street and New Hampshire Avenue NW	75	Rear End	1	7	9	6.0%
V Street NW	20	Side Swiped	0	0	1	2.4%
W Street NW	20	Side Swiped	0	0	1	2.4%
Kalorama Road NW	14	Side Swiped	0	0	2	6.9%
Euclid Street NW	47	Side Swiped/ Rear End	1	3	14	15.2%
Fuller Street NW	18	Side Swiped	4	1	2	6.3%
Columbia Road NW	36	Rear End	3	5	6	9.0%
Harvard Street NW	31	Rear End	2	2	8	12.9%
Irving Street NW	57	Rear End	4	2	12	10.4%
Lamont Street NW	26	Side Swiped	0	1	1	1.8%
Park Road NW	32	Side Swiped	5	1	9	15.0%
Monroe Street NW	32	Rear End	0	1	5	7.5%
Newton Street NW	28	Rear End	1	0	1	1.7%
Meridian Place NW	15	Side Swiped	1	0	1	3.0%
Oak Street NW	39	Rear End	3	1	9	11.3%
Spring Place NW	37	Side Swiped	2	1	5	6.5%
Spring Road NW	35	Side Swiped	2	1	8	10.8%
Arkansas Avenue NW	17	Rear End	0	1	5	14.7%

3.C BUS STOP ACCESS AND AMENITIES

The S1, S2, and S4 routes are served by 35 bus stops within the Primary Study Area, 15 of which also serve the S9 route. Five of those stops are shared with the Maryland Transit Administration's (MTA) 305, 315, and 325 commuter bus routes. As part of the Study, all 35 stops were inventoried, focusing specifically on sign placement, zone location and length, accessibility, and amenities. The inventory found that all 35 stops have at least one issue which conflicts with WMATA's Guidelines for the Design and Placement of Transit Stops, as shown in Figures 30-37 and discussed below.

3.C.1 Bus Stop Signs

According to WMATA's Guidelines for the Design and Placement of Transit Stops, the bus stop sign should be mounted on its own post, ideally 2 to 4 feet from the curb and at least 80 inches off the ground. It should be unobstructed and placed approximately 1 foot beyond the far-side of the bus front door landing area. For near-side bus stops, the bus stop sign should be placed 5 feet from the crosswalk. For far-side bus stops, the guidelines recommend bus stop sign placement at least 45 feet beyond the crosswalk.

While all bus stops have signs that are placed at least 80 inches off the ground, several bus stops have noncompliant bus stop sign placement, even where there is sufficient space for compliance. Figures 30-37 provide the locations of non-compliant bus stop sign placement in the Primary Study Area.

3.C.2 Bus Stop Zones

A bus stop zone provides a clear area for a bus to operate where curbside parking is prohibited. All of the bus stop zones in the Primary Study Area serve articulated buses. For a near-side bus stop, the zone should start 5 feet behind the crosswalk (typically marked by the bus stop sign) and extend a minimum of 120 feet back. For a far-side bus stop, the zone should start 5 feet beyond the crosswalk and extend at least 90 to 110 feet forward. A mid-block bus stop should provide a 130 to 170-foot minimum clearance zone. If the zone needs to serve more than one bus, each additional 40-foot bus requires an additional 50 feet.

The main issues regarding bus stop zones in the Primary Study Area are incorrect or missing bus stop signs marking the zone limits and insufficient clearance length. Only four of the 35 bus stops have correct signs and correct zone clearance lengths.

A near-side bus stop is located at the side of a block before crossing an intersection. A far-side bus stop is positioned at the side after you cross the intersection. A mid-block bus stop is located in between intersections.

3.C.3 Accessibility

WMATA requires all stops to have an ADA-compliant, paved landing pad that is 8-feet-wide (perpendicular to the curb) by 5-feet-deep (parallel to the curb) and is connected to a 4-foot-wide minimum paved sidewalk. The bus stops in the Primary Study Area exhibited several recurring issues that may result in non-compliance with the ADA:

- For a majority of bus stops with shelters, the ADA landing pad is located at the shelter. However, since the shelters are too close to the curb, the shelter bench encroaches within the 8-foot width required for the ADA landing pad.

An ADA landing pad provides greater access to transit services for wheelchair users, the elderly, and other encumbered riders such as parents with strollers. An ADA landing pad is a clear, level passenger waiting area located adjacent to a bus stop sign which must comply with the federal Americans with Disabilities Act (ADA).

- Trees, trash bins, and vendor boxes often obstruct either the ADA landing pad, the connection to the 4-foot sidewalk, or rear door bus access.
- The bus stop sign locations at many bus stops do not line up with the ADA landing pad location.

The locations of these potential issues are highlighted on Figures 30-37. The potential compliance issues need further review, as compliance is impacted by where the bus stops at the curb and the location of related facilities (e.g., location of publisher boxes and other site specific features).

3.C.4 Amenities

WMATA's Guidelines for the Design and Placement of Transit Stops recommend bus stop amenities based on the type of bus stop and the number of daily boardings at the stop. These amenities include benches, shelters, information cases, system maps, LED and audio displays, lighting, bus schedules, and trash receptacles.

The S9 is a limited stop route, and therefore its stops are designated as Enhanced Bus Stops. Enhanced Bus Stops require a shelter with bench (WMATA recommends additional shelters for 300 or more passenger boardings per day), as well as an information case, system map, real-time LED, and audio displays. Information cases and displays must be 48 to 60 inches off the ground (to case center) and have a 3-foot clearance around them.

Basic Bus Stops comprise the remainder of bus stops in the Primary Study Area. Basic Bus Stops require a shelter with a bench if there are 50 or more passenger boardings per day, and the shelters require an information case and system map. Real-time LED and audio displays and system map are optional.

Please refer to Figures 30-37 for the locations of bus stops in the Primary Study Area with a range of non-compliance issues, varying from missing amenities to access obstructions.

Figure 30 – Bus Stop Access and Amenities – Legend

Figure 31 – Bus Stop Access and Amenities – Taylor Street NW to Oak Street NW

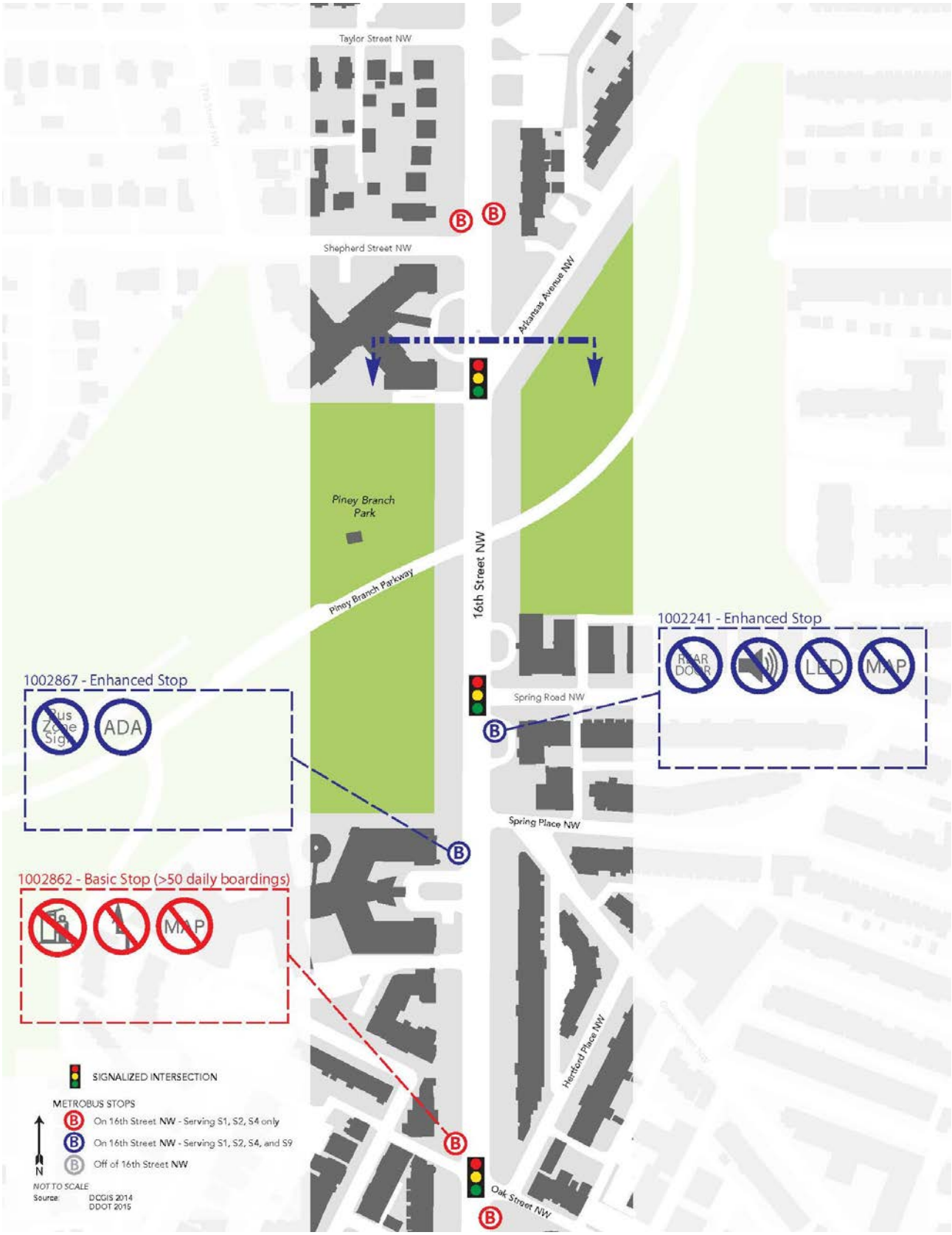


Figure 32 – Bus Stop Access and Amenities – Oak Street NW to Irving Street NW

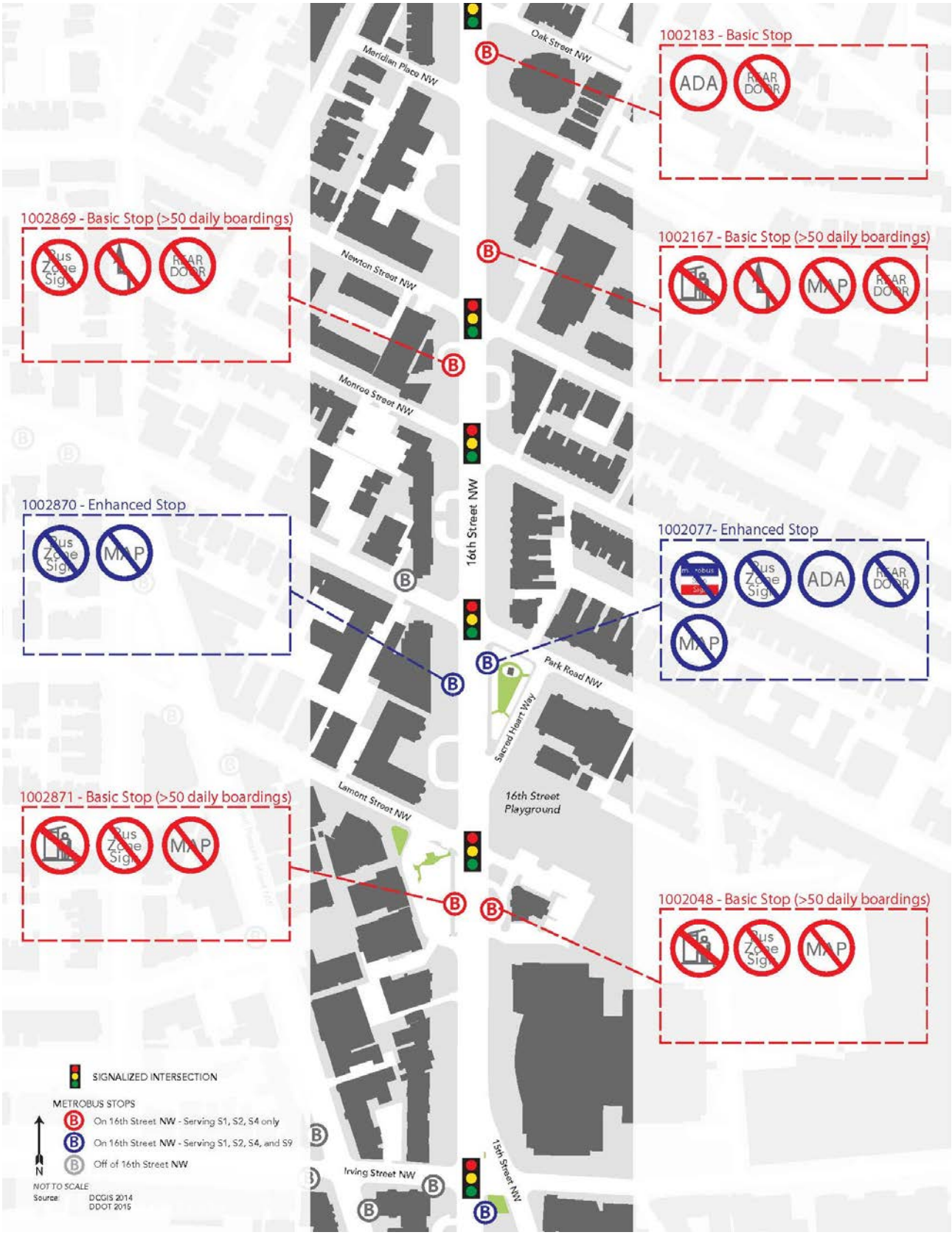


Figure 33 – Bus Stop Access and Amenities – Irving Street NW to Kalorama Road NW

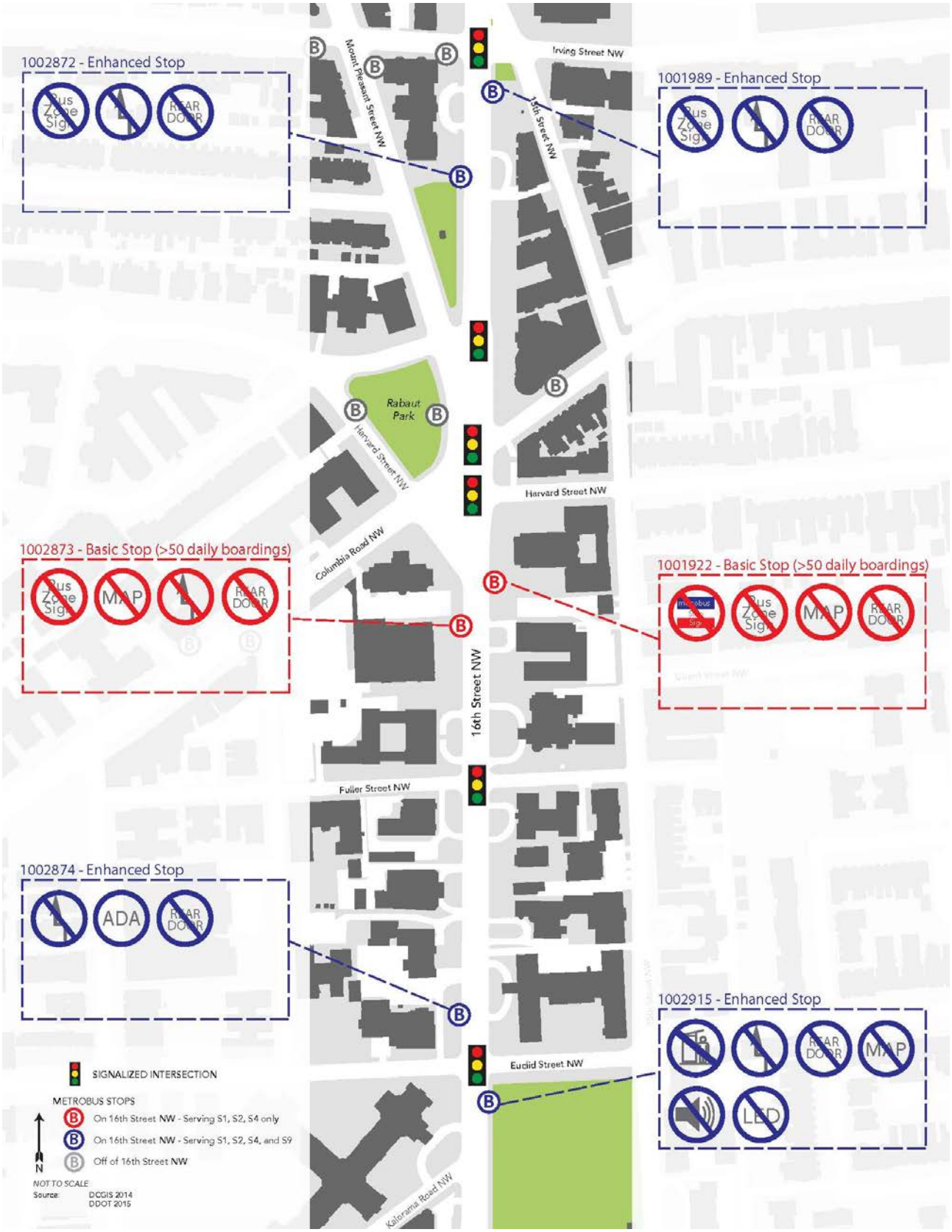


Figure 34 – Bus Stop Access and Amenities – Kalorama Road NW to U Street NW

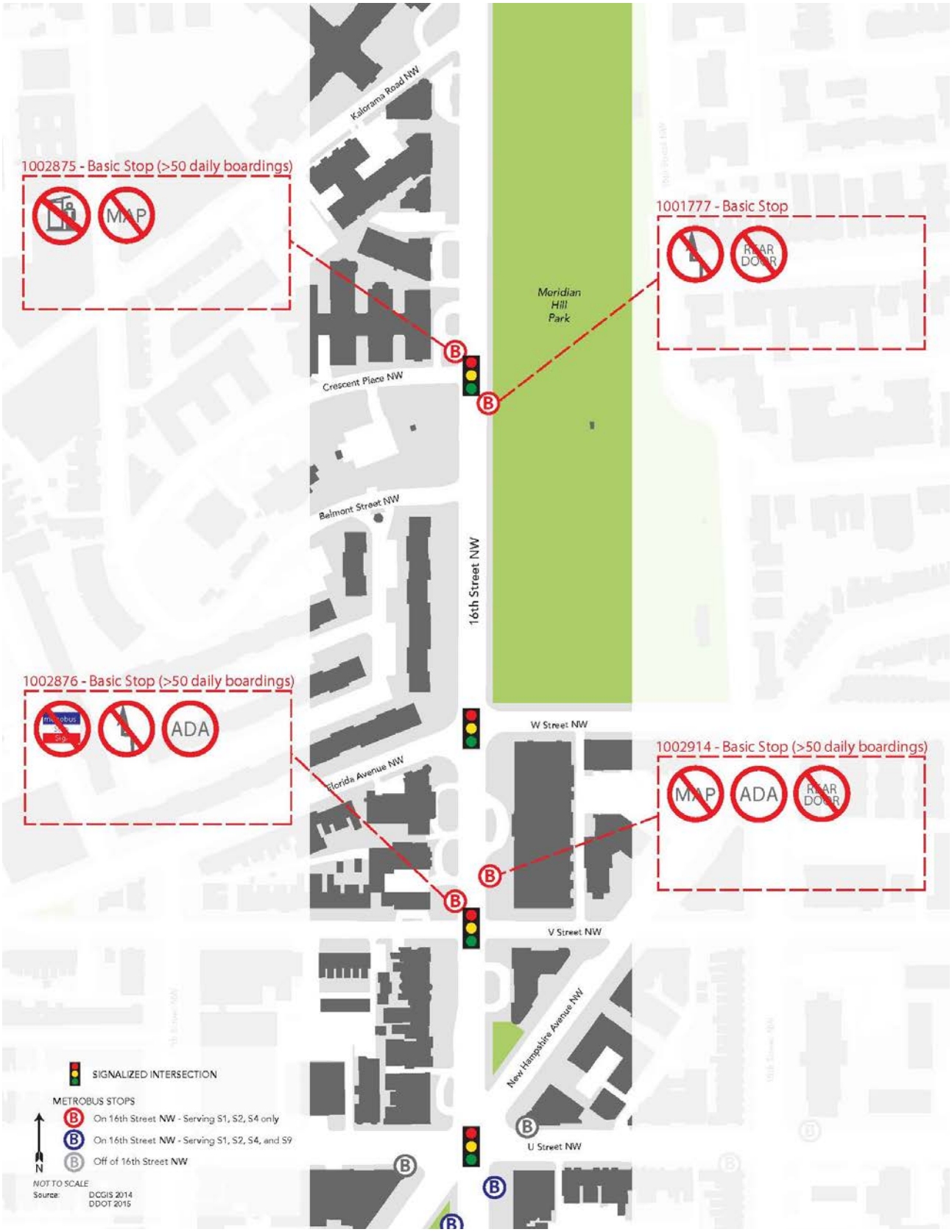


Figure 35 – Bus Stop Access and Amenities – U Street NW to Q Street NW

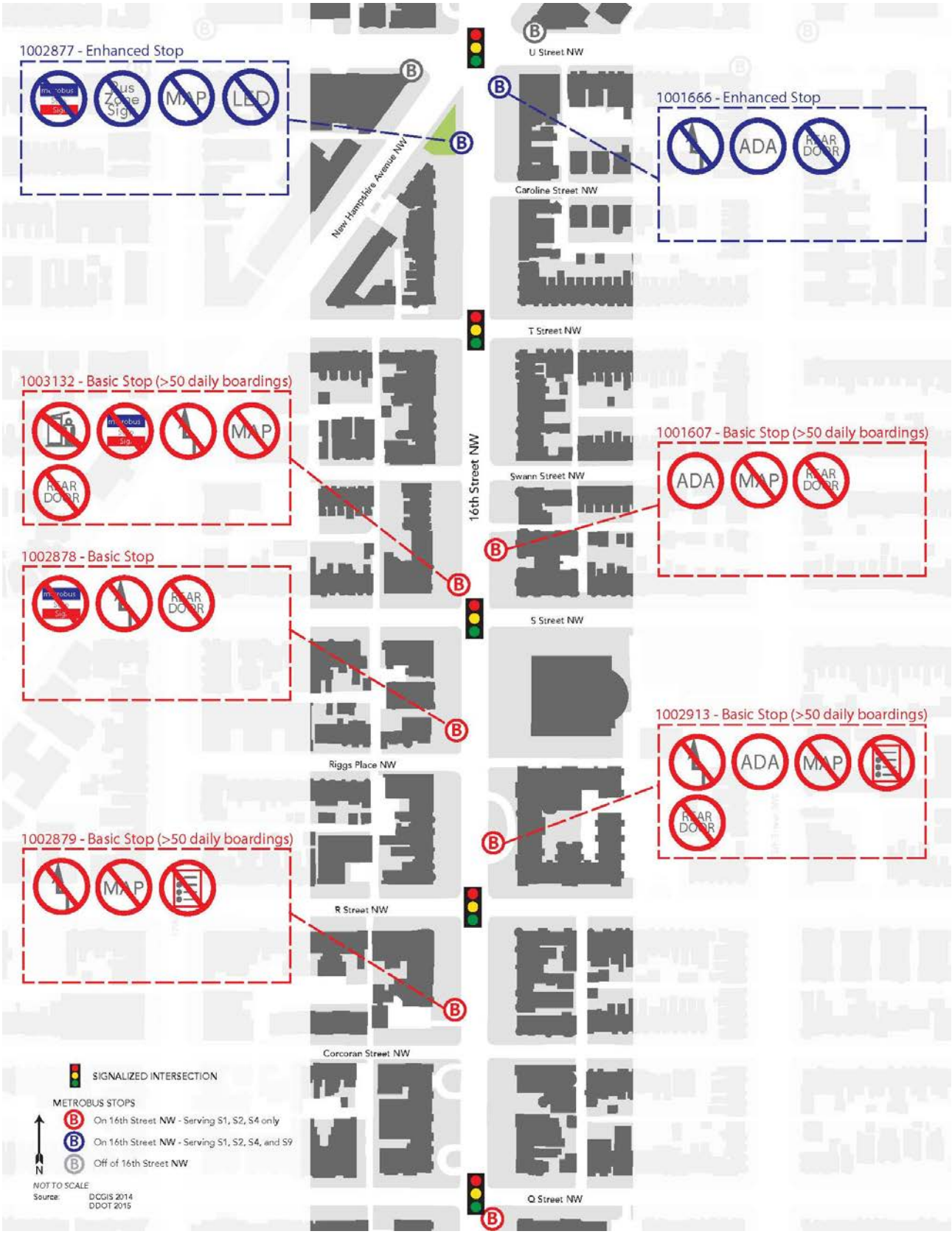


Figure 36 – Bus Stop Access and Amenities – Q Street NW to M Street NW

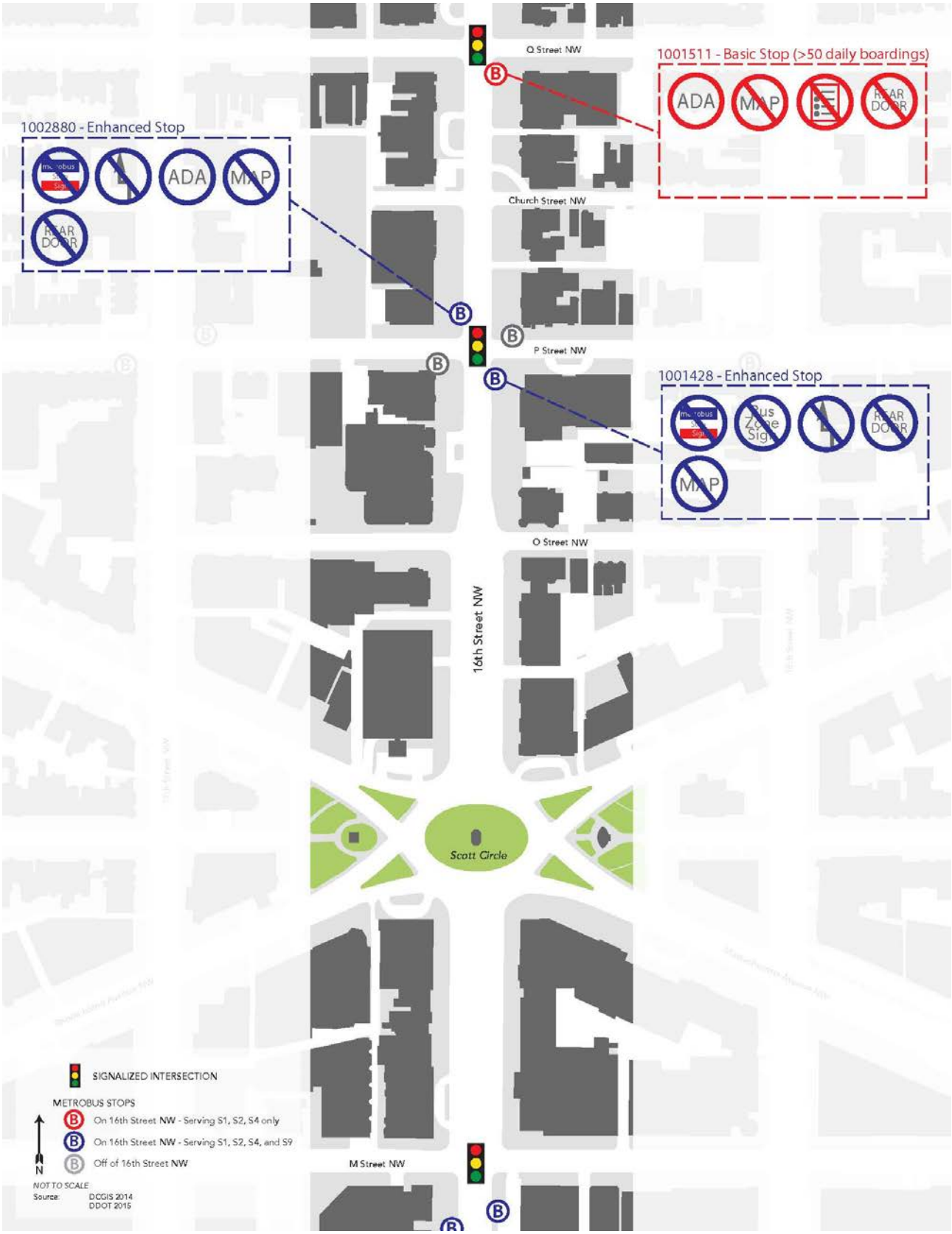
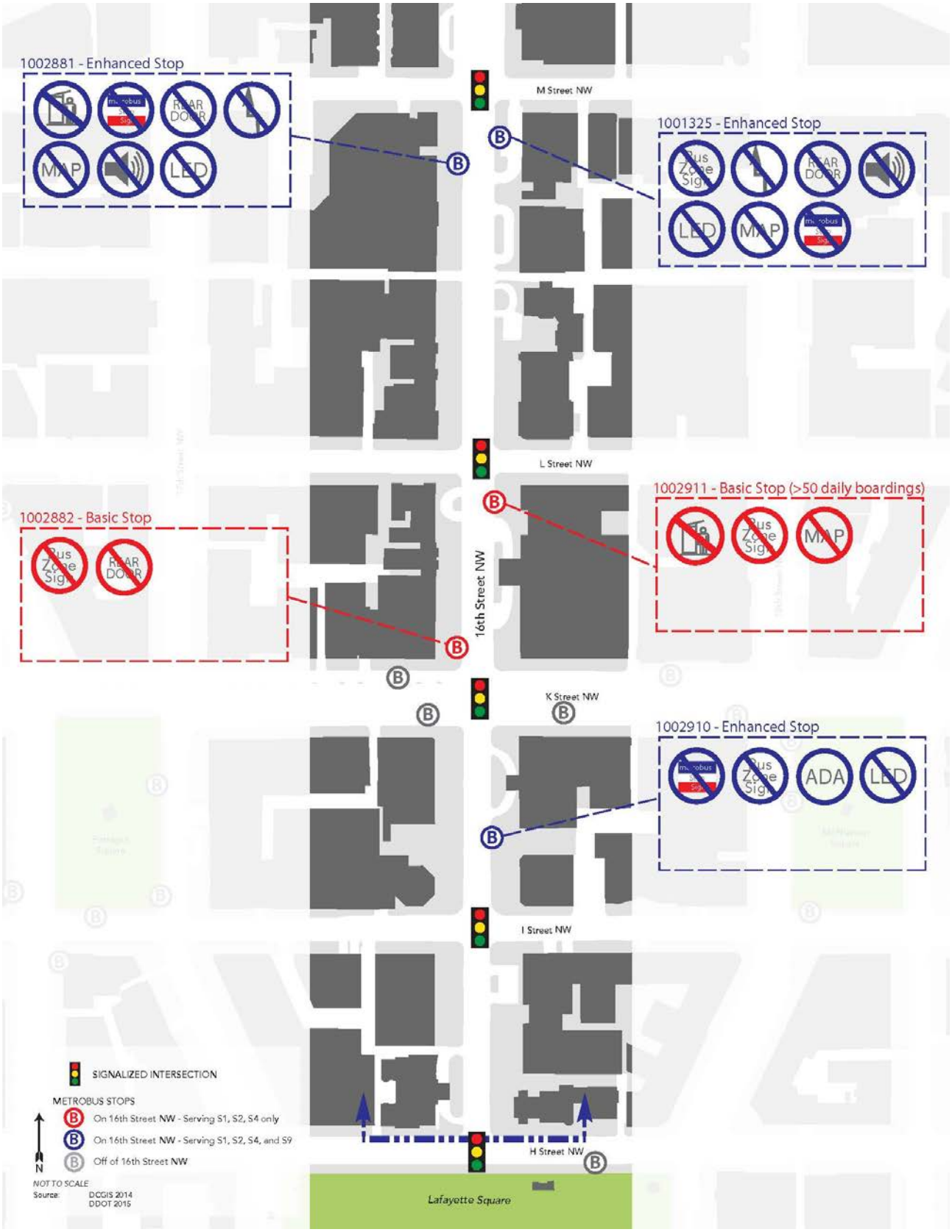


Figure 37 – Bus Stop Access and Amenities – M Street NW to H Street NW



3.D TRAFFIC OPERATIONS

A multimodal VISSIM traffic model was developed to highlight existing traffic operations along 16th Street NW from Taylor Street NW to H Street NW. The model included outputs for the AM Peak, PM Peak, and Midday periods.

VISSIM is a software tool used to model the movement of vehicles, bicycles, pedestrians, and buses.

The inputs for the VISSIM model included the roadway configuration, turning movement counts of various modes, traffic signal timing, bus schedule information, and bus stop dwell times. The bus stop dwell times were drawn from the on-board transit data, which was collected in March and June 2015. Section 4.E.1 – Sources of Delay provides the findings from the on-board data collection.

As the Study progresses and alternatives are developed to improve bus reliability and travel speeds along the Primary Study Area, any proposed changes to 16th Street NW will be analyzed using the VISSIM model in order to anticipate impacts on traffic operations.

DDOT has made recent improvements to the traffic signal timing in the Secondary Study Area, which the VISSIM model analyzed. In 2014, a quick signal optimization was implemented along 16th Street NW, followed by the Downtown Signal Optimization project in April 2015, which included 16th Street NW from H Street to Crescent Place.

3.D.1 Model Outputs

LEVEL OF SERVICE, QUEUE LENGTH, AND DELAY

The Highway Capacity Manual defines one of the main outputs of the VISSIM traffic model—level of service (LOS)—as a measure of average total vehicle delay of all movements through a particular intersection.
Table 4 presents the LOS criteria for signalized intersections.

Table 4 – LOS Criteria and Description

LOS	AVERAGE CONTROL DELAY (SEC/VEHICLE)	GENERAL DESCRIPTION
A	≤10	Free Flow
B	>10 - 20	Stable Flow (slight delays)
C	>20 - 35	Stable flow (acceptable delays)
D	>35 - 55	Approaching unstable flow (tolerable delay, occasionally wait through more than one signal cycle before proceeding)
E	>55 - 80	Unstable flow (intolerable delay)
F	>80	Forced flow (jammed)

Source: Highway Capacity Manual, 2010

Table 5 summarizes the LOS, average queue lengths, and delay in the dominant traffic direction for the AM Peak and PM Peak periods. The dominant traffic direction is southbound in AM Peak period and northbound in the PM Peak period. The table also presents the average queue length and delay and Midday period.

During the AM Peak period, the 16th Street NW intersection with W Street NW operates at LOS E. This is a result of the reduction of the number of southbound through lanes from three to two north of the W Street NW intersection. The center through lane transitions to a left turn only lane and does not extend south of W Street. The intersections of V Street NW and Crescent Place NW operate at a LOS D. The output is consistent with the congestion observed in the dominant traffic direction (southbound) during the AM peak period.

Table 5 – AM Peak, PM Peak, and Midday Periods, LOS, Queue Length, and Delays in the Dominant Traffic Direction

CROSSING STREET(S)	INTERSECTION LOS			DOMINANT TRAFFIC DIRECTION					
				QUEUE LENGTH (FT)			DELAY (SEC)		
	AM PEAK	PM PEAK	MID DAY	AM PEAK	PM PEAK	MID DAY	AM PEAK	PM PEAK	MID DAY
H Street NW	C	C	C	5	N/A	35	7	N/A	25
I Street NW	C	C	B	43	4	27	28	7	23
K Street NW	C	C	C	51	58	58	19	37	37
L Street NW	C	D	C	29	127	24	9	58	17
M Street NW	C	C	B	98	91	18	45	28	11
P Street NW	C	C	B	25	64	15	4	17	8
Q Street NW	A	B	B	8	39	17	4	10	11
R Street NW	B	B	B	8	18	27	4	5	10
S Street NW	B	B	B	17	8	160	4	4	22
T Street NW	B	B	A	8	26	86	3	9	6
U Street and New Hampshire Avenue NW	C	C	C	58	95	106	25	27	20
V Street NW	D	B	A	239	20	80	43	7	8
W Street NW	E	C	B	606	29	132	84	9	17
Crescent Place NW	D	A	A	329	26	39	77	4	6
Euclid Street NW	C	B	B	139	78	32	24	10	11
Fuller Street NW	B	A	A	51	13	18	12	3	8
Harvard Street NW	C	C	C	87	154	30	18	15	25
Mt. Pleasant Street NW	B	B	C	97	19	61	20	3	24
Irving Street NW	C	C	C	62	187	86	4	28	21
Lamont Street NW	A	A	A	3	21	19	1	2	8
Park Road NW	C	B	C	143	65	60	19	12	18
Monroe Street MW	A	A	A	40	18	25	6	3	9
Newton Street NW	A	A	A	28	5	15	6	1	5
Oak Street NW	B	A	A	64	14	15	9	2	6
Spring Road NW	A	A	A	0	22	13	1	3	6
Arkansas Avenue NW	B	B	C	94	27	60	13	7	20

All other intersections operate at LOS C or better in the AM Peak period. The average travel time for all types of vehicles during the AM Peak period along 16th Street NW from Taylor Street NW to H Street NW is about 14.5 minutes, including 8.2 minutes of delay.

In the PM Peak period, the intersection of 16th Street NW and L Street operates at a LOS D, while all other intersections in the Primary Study Area operate at LOS C or better. The average travel time during the PM Peak period along 16th Street NW from H Street NW to Taylor Street NW is approximately 11.6 minutes including 5.2 minutes of delay.

All intersections in the Primary Study Area operate at LOS C or better in the Midday period, indicating stable traffic flows and minor delays.

Additional scenarios were run to test the sensitivity of the model and the traffic operations along 16th Street NW. For example, the model tested the impact that illegally parked cars in key locations within the Primary Study Area have on the overall performance of traffic operations. One scenario showed that a car parked north of T Street NW in the northbound curbside lane of 16th Street NW in the PM Peak, when parking is prohibited, would result in the T Street NW, S Street NW and R Street NW intersections falling from a level of service B to F.

CORRIDOR THROUGHPUT

Table 6 identifies the number and type of vehicles that enter the Primary Study Area at the north end during the AM peak period, as well as the south end in the PM peak period. While the buses comprise only 2 percent of vehicles, they transport a large number of people, as discussed in Section 4.E - Transit Operations Findings.

Table 6 – Traffic Throughput within the Primary Study Area

PERIOD AND DIRECTION	NUMBER OF VEHICLES	PERCENT BUSES	PERCENT TRUCKS	PERCENT AUTOMOBILES
AM Peak Period Southbound	1,770	2%	5%	93%
PM Peak Period Northbound	1,740	2%	5%	93%

LANE UTILIZATION

While not included in the VISSIM model, utilization of the reversible lane running along 16th Street NW between Arkansas Avenue and Irving Street is an important consideration. The 16th Street NW Safety & Mobility Study determined that, compared to the center reversible lane, more vehicles used the curb lane in both the AM and PM peak periods. In some cases, twice as many vehicles were observed in the curb lane as the reversible lane. This is an important factor to note as the removal, or repurposing, of the reversible lane in order to improve transit may impact traffic operations less than the removal of a regular travel lane.

4.0 EXISTING TRANSIT OPERATIONS

This section describes transit operations including:

- Metrobus 16th Street Line service;
- Additional transit services;
- Ridership;
- Transit issues; and
- Sources of delays.

4.A ROLE OF METROBUS 16TH STREET LINE

WMATA operates four Metrobus routes along 16th Street NW—the S1, S2, S4, and S9—commonly referred to as the 16th Street Line. The 16th Street Line provides mobility and accessibility to many District residents, including the 49 percent of households in the Secondary Study Area that do not own a car. The S routes create a critical connection between the residential neighborhoods along 16th Street NW, which may be located beyond the Metrorail service area, and activity centers such as Downtown DC and Silver Spring. In addition, the 16th Street Line:

- Supports a broad range of trip purposes;
- Reduces the District's carbon footprint and conserves natural resources;
- Reduces the number of vehicles along 16th Street NW; and
- Improves mobility.

4.B METROBUS 16TH STREET NW LINE SERVICE

The S1, S2, and S4 are regular stop services. The S9 is a MetroExtra limited stop service. WMATA operates a schedule-based service, and on a typical weekday, over 230 bus trips occur in each direction within the Primary Study Area. On weekdays, WMATA operates 35 buses per hour southbound in the AM peak period and 29 buses per hour northbound in the PM peak period (see Appendix A for trips per hour). These exceed the typical threshold of 25 buses per hour for providing a dedicated bus lane. When considering all four routes, the headway averages approximately 2.1 minutes during the AM Peak period in the southbound direction and 2.6 minutes during the PM Peak period in the northbound direction (see Appendix B).

The headway is the time between bus arrivals.

Following the 2009 16th Street Line Study, WMATA implemented multiple service improvements including:

- Introduction of the S9 limited stop service on weekdays in 2009;
- Assignment of articulated buses to the S1 route in 2012;
- Addition of peak period trips to, and adjustment of run time on, the S9 route in 2012;
- Addition of short-run service from Harvard Street to the S2 route in 2013;
- Increase of frequency of S2 and S4 routes on Saturdays in 2013; and
- Increase in number of trips operated with articulated buses during peak periods.

The 16th Street Line operates out of the Northern Division Bus Garage on 14th Street NW and Buchanan Street NW. WMATA maintains 21 articulated buses at the garage, the majority of which serve on the 16th Street Line. The capacity of the existing garage limits the number of articulated buses that can be operated on the 16th Street Line. At this time, the articulated buses are allocated to the S1, S2, and S4 routes. Currently, the fleet is made up of high-floor articulated buses, but WMATA is upgrading this fleet in January 2016 to include low-floor, articulated buses. This will reduce boarding and alighting times per passenger within the Primary Study Area. The S9 route operates all low-floor buses.

A standard bus is 40 feet long and holds 46-48 total passengers, including 39-40 seated.

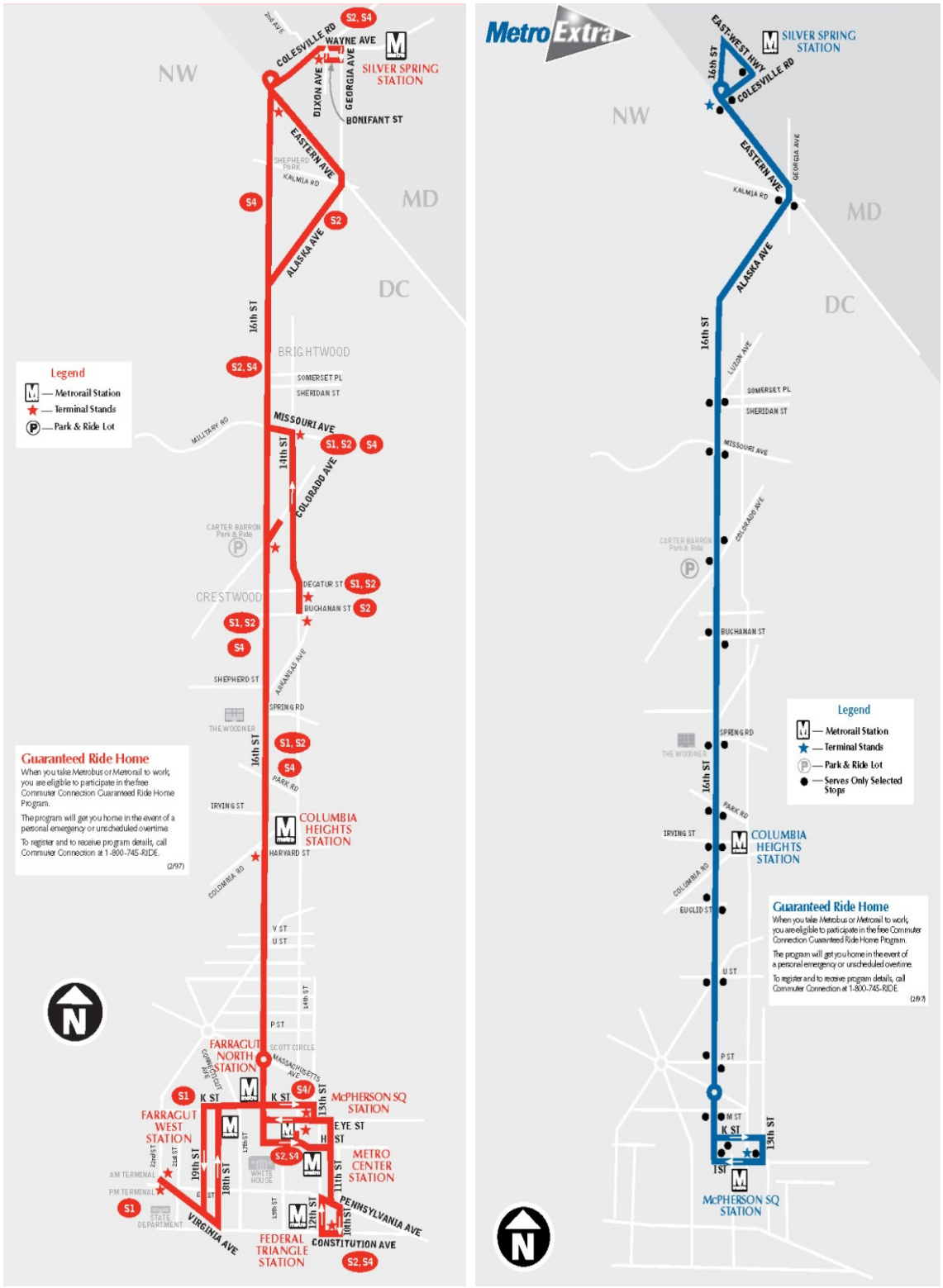
An articulated bus is 60 feet long and holds 70-72 total passengers, including 59-60 seated.

Note: WMATA calculates total bus capacity based on 120 percent of seated capacity. Bus capacity varies by manufacturer and seating

While the S routes generally run north-south along 16th Street NW, they follow 12 service patterns with varying termini and routes, as shown in Figure 38.

- S1 buses operate between the Northern Bus Garage (at 14th Street NW and Buchanan Street NW) and Potomac Park (at Virginia Avenue NW and 22nd Street NW). Within the Primary Study Area, the S1 route operates between Arkansas Avenue NW and K Street NW.
- S2 buses operate multiple service patterns with varying termini. Some S2 buses start at Silver Spring and travel down Eastern Avenue NW and Alaska Avenue NW. Others start at the Northern Bus Garage or Colorado Avenue NW. During the AM Peak period, a short-run S2 service travels southbound starting at Harvard Street NW. The S2 route terminates in Downtown DC at the McPherson Square Metrorail Station or the Federal Triangle Metrorail Station depending on the service pattern. In the northbound direction, S2 buses enter the Primary Study Area at I Street NW and exit at Arkansas Avenue NW.
- S4 buses operate between Silver Spring and Downtown DC. Within the Primary Study Area, southbound S4 buses operate between Arkansas Avenue NW and K Street NW or H Street NW. Northbound S4 buses operate between I Street NW and Arkansas Avenue NW within the Primary Study Area.
- S9 buses operate between Silver Spring and Downtown DC, traveling down Eastern Avenue NW and Alaska Avenue NW just south of Silver Spring. Within the Secondary Study Area, southbound S9 buses operate between Arkansas Avenue NW and K Street NW. Northbound buses enter the Secondary Study Area at I Street NW and exit at Arkansas Avenue NW.

Figure 38 – S1, S2, S4, and S9 Route Maps



Source: WMATA 2015

4.C ADDITIONAL TRANSIT SERVICES

In addition to the 16th Street Line, the Secondary Study Area is served by MTA commuter bus, Metrorail, WMATA Metrobus, and the DC Circulator. Figure 39 shows the bus and Metrorail transit network within the Secondary Study Area.

All six Metrorail lines serve the Secondary Study Area with four stations:

- Columbia Heights (Green and Yellow Lines);
- Farragut North (Red Line);
- Farragut West (Blue, Orange, and Silver Lines); and
- McPherson Square (Blue, Orange, and Silver Lines).

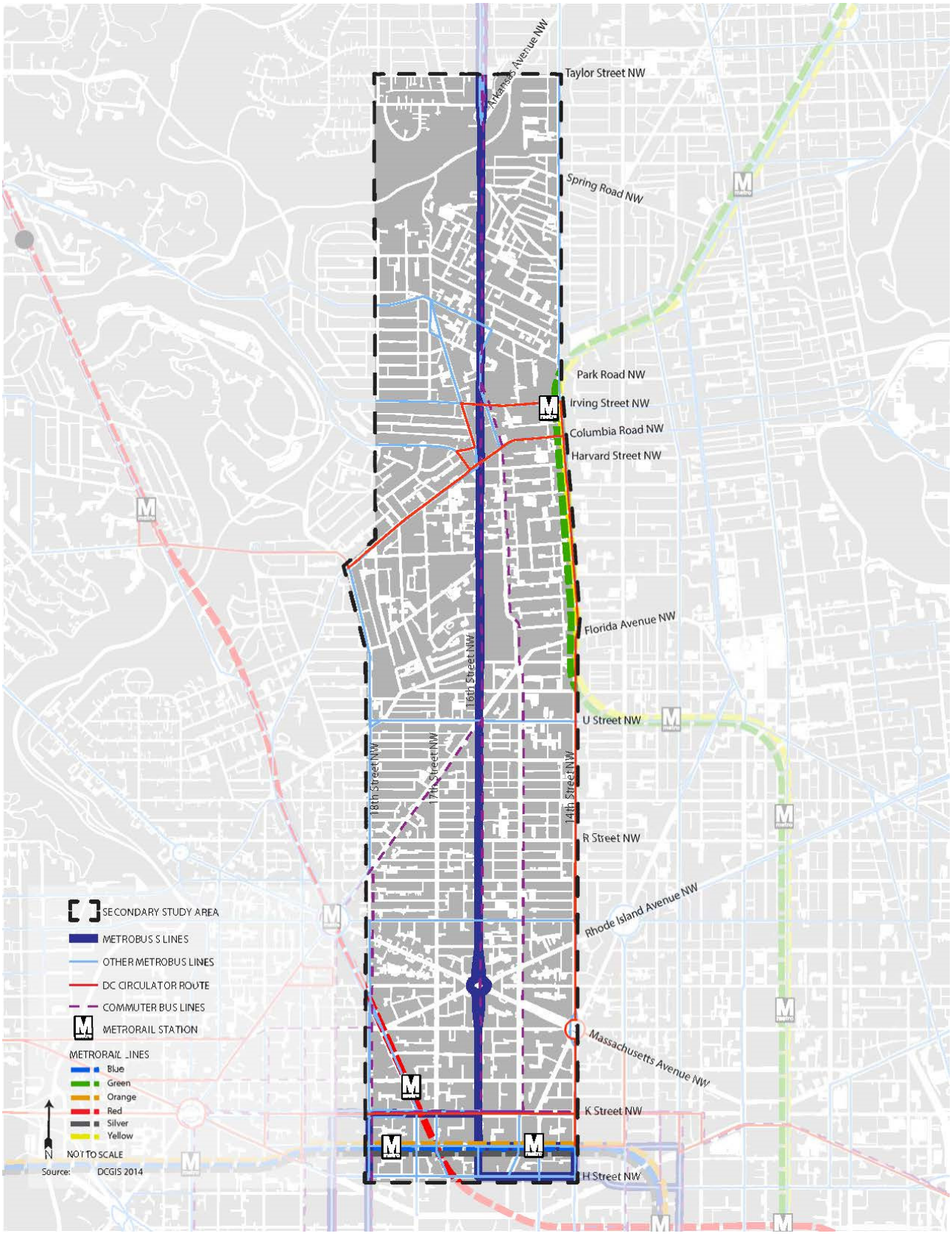
Many passengers on the 16th Street Line transfer to and from other bus and Metrorail services in the Secondary Study Area. In 2014, approximately 10 percent (586,683) of passengers transferred between buses and
8.3 percent (488,162) of passengers transferred between the 16th Street Line and rail (and vice versa). The most popular transfer point is Irving Street NW to access the H Line buses and Columbia Heights Metrorail Station.

The DC Circulator has two routes that serve the Secondary Study Area:

- The Georgetown-Union Station route, which runs along K Street NW; and
- The Woodley Park-Adams Morgan-McPherson Square Metro route, which runs along 14th Street NW to Columbia Road NW.

Three MTA commuter bus routes operate along 16th Street NW from various locations in Montgomery and Howard counties. MTA's 315 bus route has stops within the Secondary Study Area on P Street NW, M Street NW, and K Street NW. MTA's 305 and 325 bus routes stop at Harvard Street NW.

Figure 39 – Existing Bus and Metrorail Transit Network



4.D RIDERSHIP

The 16th Street Line served nearly 6 million passengers in 2014. As shown in Table 7, total ridership on the 16th Street Line rose approximately 18 percent between 2010 and 2014. On Saturdays, ridership increased by 24 percent during the same time period.

Table 7 – 5-Year Bus Ridership on 16th Street Line by Day and Year

YEAR	WEEDAY	SATURDAY	SUNDAY	TOTAL
2010	4,211,458	413,506	372,207	4,997,171
2011	4,748,197	500,366	407,115	5,655,678
2012	4,916,270	518,187	436,760	5,871,217
2013	5,073,422	531,614	443,584	6,048,620
2014	4,938,004	513,924	433,126	5,885,054

Source: WMATA Farebox System

Ridership declined slightly in 2014 from a peak of over 6 million passengers in 2013. The decline in ridership may be partially due to a reduction in the federal commuter pre-tax benefit, implemented on January 1, 2014. The benefit allows participating employees to deduct the cost of their commuting expenses, tax-free, from salaries. The transit benefit was reduced to a level for transit ($130 maximum per month) that is nearly half that allowed for parking ($250). This disparity likely induced some individuals to drive rather than use transit.

Table 8 shows that just over 20,000 passengers ride the 16th Street Line on a typical weekday. Table 9 shows that the 16th Street Line—consistently one of the busiest in the Metrobus system—had the highest ridership system-wide in May 2014.

Table 8 – 16th Street Line Ridership by Day

DAYS	S1	S2, S4	S9	ALL S ROUTES
Weekday Average	2,073	14,274	3,747	20,094
Saturday Average	N/A	10,298	N/A	10,298
Sunday Average	N/A	8,125	N/A	8,125

Source: WMATA Metrobus Monthly Ridership Bus Line, Sector and Jurisdictional Summary – Preliminary (May 2014)

Table 9 – WMATA Bus Routes with Highest Monthly Ridership - May 2014

RANK	ROUTE	TOTAL RIDERSHIP - MAY 2014
1	S1,S2,S4,S9	514,087
2	70,79	510,154
3	52,53,54	412,912
4	32,36	379,813
5	C2,4	343,620
6	X2	336,874
7	90,92,93	331,826

Source: WMATA Metrobus Monthly Ridership Bus Line, Sector and Jurisdictional Summary - Preliminary (May 2014)

The current level of ridership exceeds typical thresholds for investments in dedicated transit facilities such as Bus Rapid Transit (BRT), streetcar, or light rail. For example, the number of passengers per revenue mile on the 16th Street Line is higher than on a number of successful light rail systems in the United States. Typically, light rail lines are implemented when the demand for transit services exceeds capacity thresholds for BRT. Table 10 compares passenger trips per revenue mile along the 16th Street Line and select light rail systems. The productivity of the 16th Street Line supports investment in additional bus facilities and services to accommodate the existing and future demand for transit services.

Table 10 – Comparison of Passenger Trips per Revenue Mile along the 16th Street Line and Select Light Rail Systems

SYSTEM	UNLINKED PASSENGER TRIPS PER REVENUE
16th Street Line(Bus Only)**	6.34
Phoenix, AZ (Valley Metro)	5.56
Portland, OR (TriMet)	5.45
Minneapolis-St. Paul, MN (Metro)	5.10
Los Angeles, CA (METRO)	4.83
Seattle, WA (Sound Transit)	3.41
Salt Lake City, UT (UTA)	2.93
St. Louis, MO (METRO)	2.69
Denver, CO (RTD)	2.44

Sources: WMATA APC, 2014; USDOT National Transit Database, Transit Profiles 2012 Full Reporters, October 2013

*Unlinked passenger trips per revenue mile for light rail only
**Average passenger trips per revenue mile for the 16th Street Line

A revenue mile is the distance a transit vehicle travels while "in service" (i.e., carrying passengers). Passengers per revenue mile refers to the number of passengers who travel along a particular transit route divided by the number of miles that the transit vehicle is available ("in service") to carry passengers. It is a measurement that evaluates the overall productivity of each transit route.

Unlinked passenger trips refers to the number of passengers who board a transit vehicle no matter how many transit vehicles they may use to travel from their beginning location to their destination.

4.E TRANSIT OPERATIONS FINDINGS

In many ways, the 16th Street Line is a victim of its own success. It frequently suffers from overcrowding, bus bunching, and delays. This section summarizes the operations of the 16th Street Line and highlights key issues based on a broad range of bus performance data. The primary sources of the data include:

- WMATA's Automated Vehicle Location (AVL) and Automated Passenger Count (APC) raw data and quarterly report for Fall 2014; and
- On-board data collection conducted by DDOT and its consultant (described below).

See Appendices A-K for more detailed data.

4.E.1 Sources of Delay

In order to better understand the sources of delay affecting bus travel times and reliability, additional data was collected while riding the bus. This "on-board data" recorded the time that passengers were boarding and alighting the bus ("doors open" time), time delays due to traffic congestion, time waiting at traffic signals, and time delayed due to other random conditions (such as an illegally parked vehicle). The on-board data also recorded the number of passengers entering and exiting the bus at each bus stop.

The on-board data collection was performed in mid-March and early June 2015. Ten total runs were recorded for the S9 and the combined S1, S2, and S4 routes in the southbound and northbound peak periods, totaling 40 runs. Additional data was collected during the weekday Midday period and on Saturday. In the southbound direction, data was collected between Taylor Street NW and H Street NW. In the northbound direction, data was collected between I Street NW and Shepherd Street NW. Table 11 summarizes the results of the on-board data collection.

Table 11 – Average On-Board Trips: Time Breakdown

TIME BREAKDOWN	S9 SOUTBOUND AM PEAK PERIOD		S9 NORTHBOUND PM PEAK PERIOD		S1, S2, S4 SOUTHBOUND AM PEAK PERIOD		S1, S2, S4 NORTHBOUND PM PEAK PERIOD	
	TIME*	PERCENT **	TIME	PERCENT	TIME	PERCENT	TIME	PERCENT
Total Trip Time	21:33	100%	17:59	100%	24:25	100%	19:36	100%
Doors Open Time	3:04	14%	3:34	20%	5:07	21%	4:37	24%
Signal Delay	5:00	23%	3:54	22%	5:41	23%	3:30	18%
Before Loading Delay	0:20	2%	0:11	1%	0:15	1%	0:07	1%
Congestion Delay & Other Delays	2:08	10%	0:24	2%	0:58	4%	0:24	2%
Bus in Motion	11:01	51%	9:56	55%	12:24	51%	10:58	56%

Source: DDOT On-Board Data Collection March 12-26 and June 2-18, 2015

*Time is in minutes and seconds
**Percentages are rounded to the nearest whole number

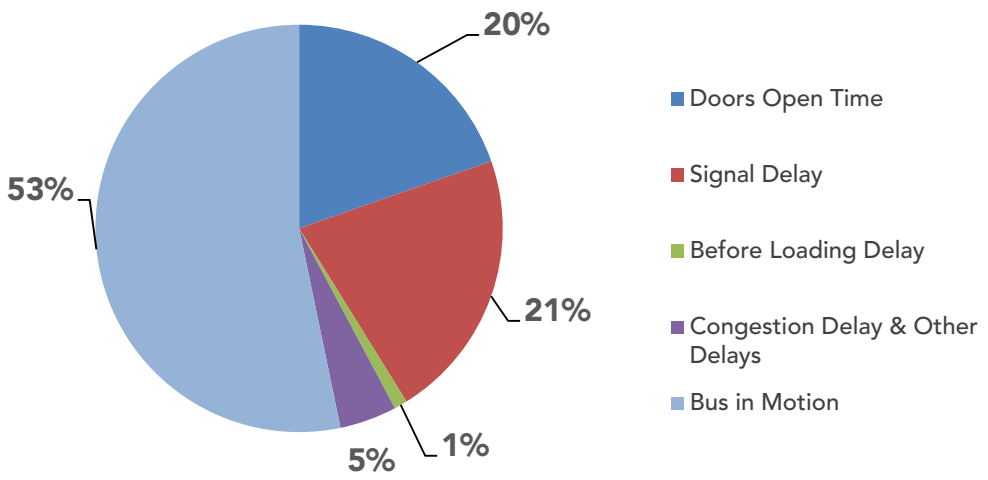
Figure 40 shows that buses travelling within the Primary Study Area are typically moving more than half of overall trip time. However, travel speeds while moving are often slow as discussed in Section 4.E.2 below. Average delays due to traffic congestion were a small share of the overall delay, though congestion also factors into the slow travel speeds. Doors open time and time waiting at traffic signals comprised the majority of the delay.

Figures 41-48 show the locations where buses are consistently delayed due to traffic congestion. Traffic congestion typically occurs at locations with changes in lane configuration.

WMATA Reporting Periods:

Early AM 4–5:59 AM
AM Peak 6–8:59 AM
Midday 9 AM – 2:59 PM
PM Peak 3–6:59 PM
Early Night 7–10:59 PM
Late Night 11 PM – 3:59 AM

Figure 40 – Average Overall Peak Hour Operations



4.E.2 Overall 16th Street Line Issues

Based on the analysis of the AVL and APC and the on-board data, the following issues affecting the overall 16th Street Line were identified:

BUNCHING

Bunching is a service reliability issue and refers to a group of two or more buses that arrive at a bus stop at the same time. Due to the operational delays that result from bunching, a ripple effect can occur whereby additional buses accumulate in the bunched group. Bunching can also contribute to "leap frogging" whereby a bus operator passes the bunched buses at a stop.

On the 16th Street Line, buses already exhibit bunching in the AM Peak and PM Peak periods before they reach the Primary Study Area, as shown in Appendix C. Given the high frequency of buses and multiple service patterns, it is difficult to maintain the scheduled arrival times prior to, and within, the Primary Study Area, as each pattern is subject to potential delays.

A measurement for the degree of bunching occurring on the individual lines and the four routes combined, the coefficient of variation of headways, is presented in Appendix B. The analysis indicates the following:

- Overall, the four S routes frequently exhibit bunching during the AM Peak, Midday, PM Peak, and Early Night periods; and
- The S2 route has the poorest headway adherence in the AM Peak and PM Peak periods.

Within the Primary Study Area, delays due to traffic congestion, limited bus zone capacity, and illegally parked vehicles exacerbate bunching. When a bus is delayed, an increased number of passengers will be waiting to board at the next stop. The extra time it takes to board the additional passengers can cause the next bus (or buses) to arrive at the stop while the first bus is still boarding passengers. This extra time is reflected in higher average doors-open times or a wide range doors-open times (see Appendix D for additional information regarding averages and ranges of doors open times, organized by bus stop).

SERVICE PATTERNS

The four S routes that comprise the 16th Street Line operate according to multiple service patterns (see Section 4.B). A pattern refers to the origin and destination of the bus trip. Of note, the S2 route follows nine southbound patterns and three northbound patterns. The southbound patterns originate at six different locations including one within the Primary Study Area at Harvard Street NW.

Multiple service patterns for the four S routes converge prior to the Primary Study Area, which, when combined with the frequency of service, contribute to bunching. The S2 route has the poorest headway adherence and the highest number of service patterns.

TRAVEL TIME AND SPEED

For all four S routes, the actual travel times are longer than the scheduled trip times, and the recovery time at the end of each trip is inadequate to allow the buses to catch up to their schedules. Over the course of an operator's daily run (the trips that an individual bus driver operates), the bus begins to arrive at the end of a trip after the time it was scheduled to begin the next trip. This leaves no schedule recovery or layover time which forces the driver to immediately turn around and begin service on the next trip. This results in cascading delays, in which the buses eventually fall so far behind that the bus skips one or more of its scheduled trips and begins operating a later trip in its schedule. This phenomenon reduces the capacity of the system and contributes to bus bunching. Appendix E summarizes the scheduled and actual average trip times.

WMATA also uses time-point observations to monitor on-time route performance. WMATA considers a bus on-time if it arrives no more than 2 minutes before or 5 minutes after its scheduled arrival time. In general, the S9 has the best on-time performance and the S1 has the poorest, as shown in Appendix E. The performance of the S1 may be in part due to the congestion along K Street NW outside of the Primary Study Area. It is also important to note the S2 and S4 routes perform at similar levels in the Early Night period as during the PM Peak period.

Table 12 compares average travel time and travel speed by route and time of day between Spring Road NW and M Street NW. In general, bus speeds decrease during the AM Peak and PM Peak periods. Notably, the total trip time for all routes is longer in the southbound AM Peak period than in the northbound PM Peak period. The S9 route is faster than the S1, S2, and S4 in both the AM Peak southbound and PM Peak northbound periods. This is due, in part, to the limited stop service on the S9 route.

Table 12 - Comparison of Average Travel Times and Travel Speeds

ROUTE	EARLY AM		AM PEAK		MIDDAY		PM PEAK		EARLY NIGHT		LATE NIGHT	
	AVG TRAVEL TIME (MIN)	AVG TRAVEL SPEED (MPH)	AVG TRAVEL TIME (MIN)	AVG TRAVEL SPEED (MPH)	AVG TRAVEL TIME (MIN)	AVG TRAVEL SPEED (MPH)	AVG TRAVEL TIME (MIN)	AVG TRAVEL SPEED (MPH)	AVG TRAVEL TIME (MIN)	AVG TRAVEL SPEED (MPH)	AVG TRAVEL TIME (MIN)	AVG TRAVEL SPEED (MPH)
S1, S2, S4 (SB)	12.3	10.7	17.2	7.6	15.7	8.4	16.5	8.0	13.8	9.5	9.0	14.6
S9 (SB)	--	---	15.0	8.7	14.6	9.0	14.0	9.3	13.2	9.9	---	---
S1, S2, S4 (NB)	9.3	14.2	13.0	10.2	14.7	9.0	16.2	8.2	18.0	7.4	16.4	8.1
S9 (NB)	---	---	11.2	11.8	10.4	12.8	13.1	10.1	14.6	9.1	---	---

Source: WMATA AVL, October 2014

*Small numbers of records northbound during the Late PM period.

For northbound S1, S2, and S4 buses, the slowest period during the day is not the PM Peak, but instead the Early Night. This is likely attributable to the fact that parking is allowed along much of the Primary Study Area after 6:30 PM, so the number of travel lanes is reduced. The average bus speeds for S1, S2, and S4 during the Midday period are only slightly faster than the AM Peak and PM Peak periods in the dominant travel directions. Off-peak parking and signal timing changes that occur during the Midday period along 16th Street contribute to these delays. Appendix F provides additional information regarding average bus travel speeds between bus stop by time of day and by route.

BOARDINGS AND ALIGHTINGS

Bus stops located between Euclid Street NW and P Street NW exhibit the longest times per passenger during the AM Peak period in the southbound direction, as shown in Appendix G. As shown in Table 13, bus stops between P Street NW and V Street NW generally exhibit the longest times during the PM Peak period in the northbound direction. These segments and times of day likely reflect delay caused by fully loaded buses. The doors open time per passenger is lower for the S9 route, as compared to the S1, S2, and S4. This may reflect the use of all low-floor buses on the S9.

Boardings refer to passengers getting on the bus. Alightings refers to passengers getting off the bus.

Table 13 - Average Time Boarding or Alighting per Passenger by Route

S9 SOUTHBOUND/ AM PEAK (SECONDS)	S1, S2, S4 SOUTHBOUND/ AM PEAK (SECONDS)	S9 NORTHBOUND/ PM PEAK (SECONDS)	S1, S2, S4 NORTHBOUND/ PM PEAK (SECONDS)
3	4.5	2.9	4

Appendix H and Appendix I provide additional information regarding boardings and alightings, organized by bus stop. Appendix H illustrates the average daily number of boardings and alighting the S routes by bus stop based on data provided by WMATA. Appendix I summarizes the average number and range of boardings and alighting each bus stop based on the on-board data collection described in Section 4.E.1. Figures 41-48, in part, incorporate findings from these two appendices.

LOADS

All four S routes exhibit frequent maximum loads in which the number of passengers exceeds seating capacity, as shown in Appendix I. Fully loaded buses incur delays at bus stops as it takes more time to board and alight passengers when people are standing in the aisle. When a bus is fully loaded, the operator may pass by stops where passengers are waiting to board. The S2 has the highest percentage of maximum loads during the AM Peak period and the S4 route has the highest during the PM Peak period.

The S9 route typically reaches peak load at U Street NW in the southbound direction during the AM Peak period, as shown in Appendix K. For the S1, S2, and S4 routes in the southbound direction during the AM Peak period, peak load is typically reached at S Street NW. In the northbound direction during the PM Peak, the peak load is at U Street NW for the S9 and O Street NW for the S1, S2, and S4 routes.

4.E.3 Segment by Segment Findings

Figures 41-48 map the existing conditions transit operations findings as they pertain to individual bus stops or blocks along the Primary Study Area.

Figure 41 – Transit Operations Findings – Legend

LEGEND

Blue Icons ..... Findings related to Metrobus S9.

Red Icons ..... Findings related to Metrobus S1, S2, and S4.

Blue + Red Icons ..... Findings related to Metrobus S1, S2, S4, and S9.

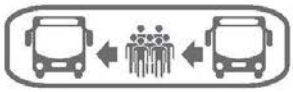
Icon	Finding	Criteria
	Delays or operational issues caused by bus bunching.	Top three largest ranges of doors open times.
	Delays or operational issues caused by limited bus zone space available at far-side bus stop.	Proximity to intersection allows enough bus zone space for only one bus at a time.
	Delays or operational issues caused by close proximity of two bus stops.	Located within one block of another stop.
	Delays or operational issues caused by high boardings at stop.	An average of five or more boardings.
	Delays or operational issues caused by high alightings at stop.	An average of five or more alightings.
	Delays or operational issues caused by traffic congestion and/or intersection operation.	Level of Service D or worse.
	High bus-to-bus transfer activities at stop.	Monthly bus to bus transfers greater than 1500 passengers.
	Delays caused by high doors-open times.	Average doors open time of 20 seconds or greater.
NO ICON (Blue and red lines on maps)	Slow bus operations.	Average travel speed of less than 8.0 mph.
NO ICON (Call-out on maps)	Poor headway adherence.	Levels of service E and F per the Transit Capacity and Quality of Service Manual.

Figure 42 – Transit Operations Findings - Peak Periods – Taylor Street NW to Oak Street NW

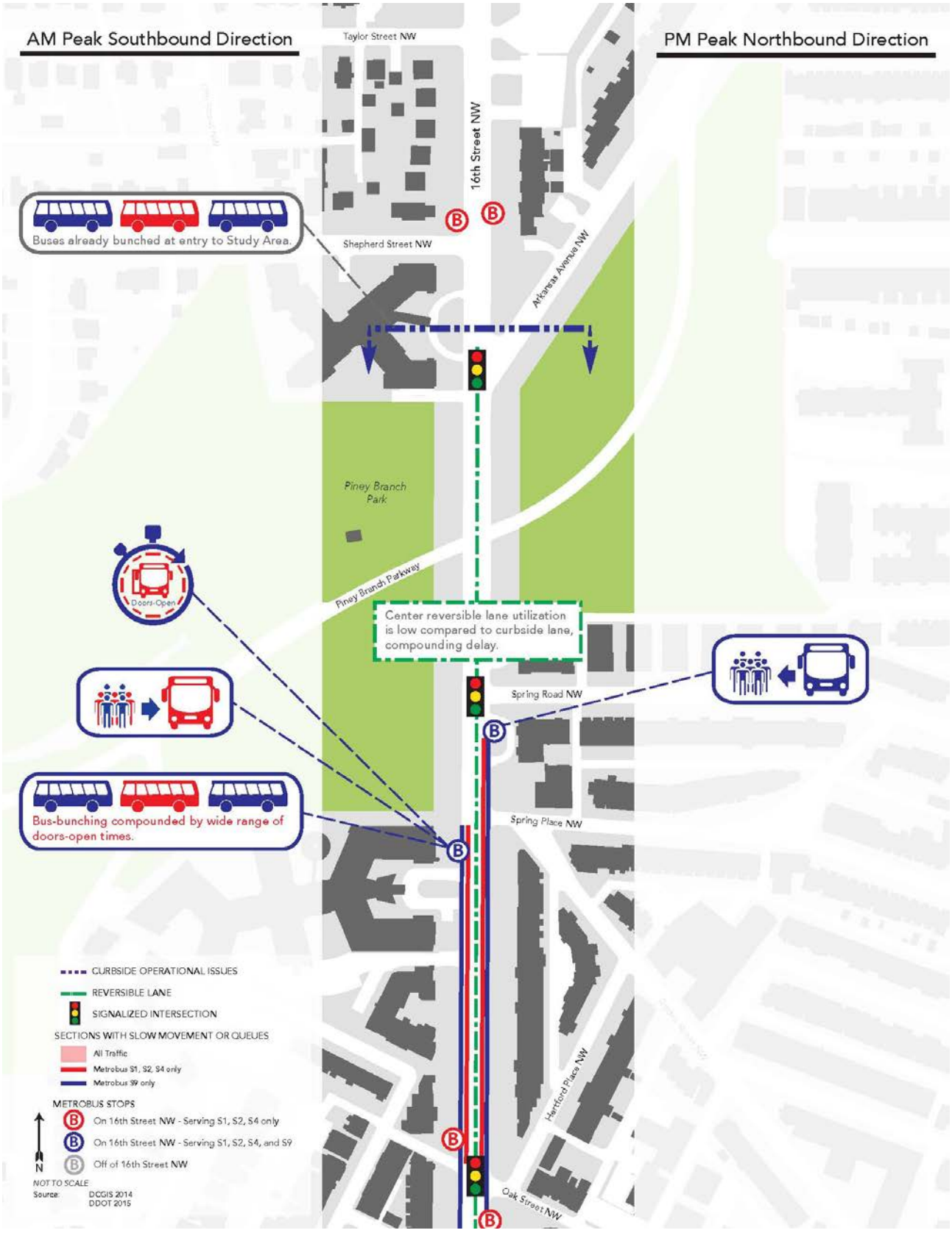


Figure 43 – Transit Operations Findings - Peak Periods – Oak Street NW to Irving Street NW

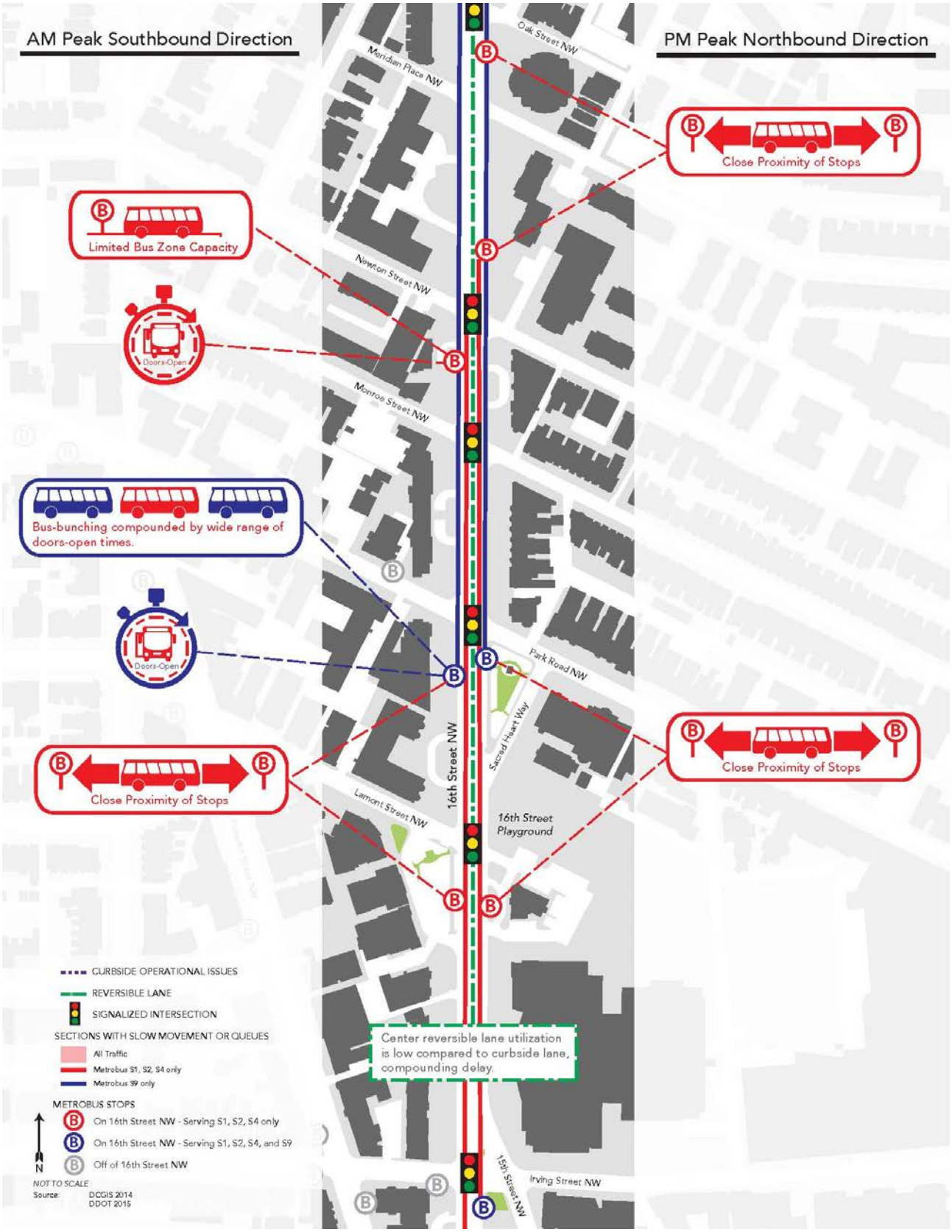


Figure 44 – Transit Operations Findings - Peak Periods – Irving Street NW to Kalorama Road NW

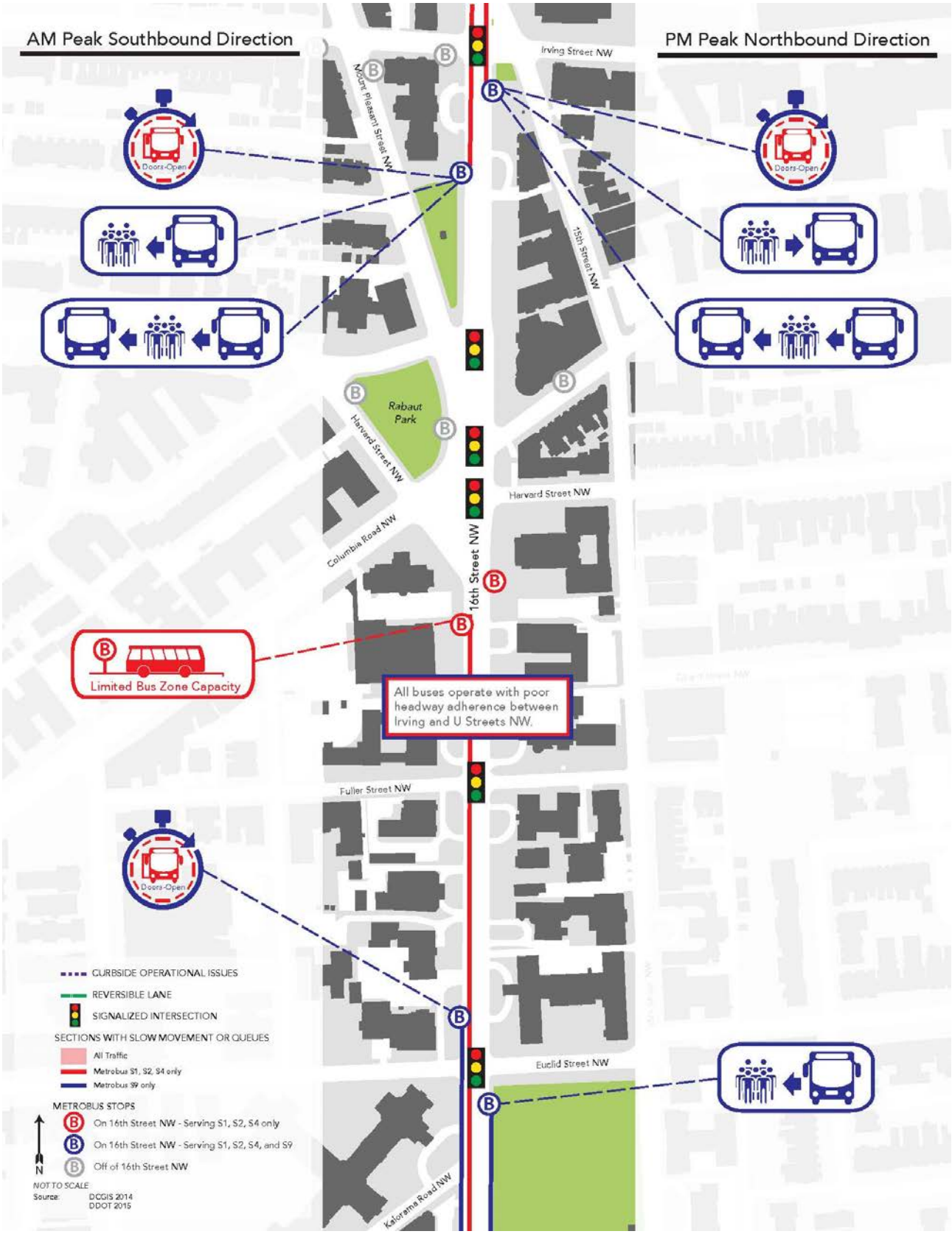


Figure 45 – Transit Operations Findings - Peak Periods – Kalorama Road NW to U Street NW

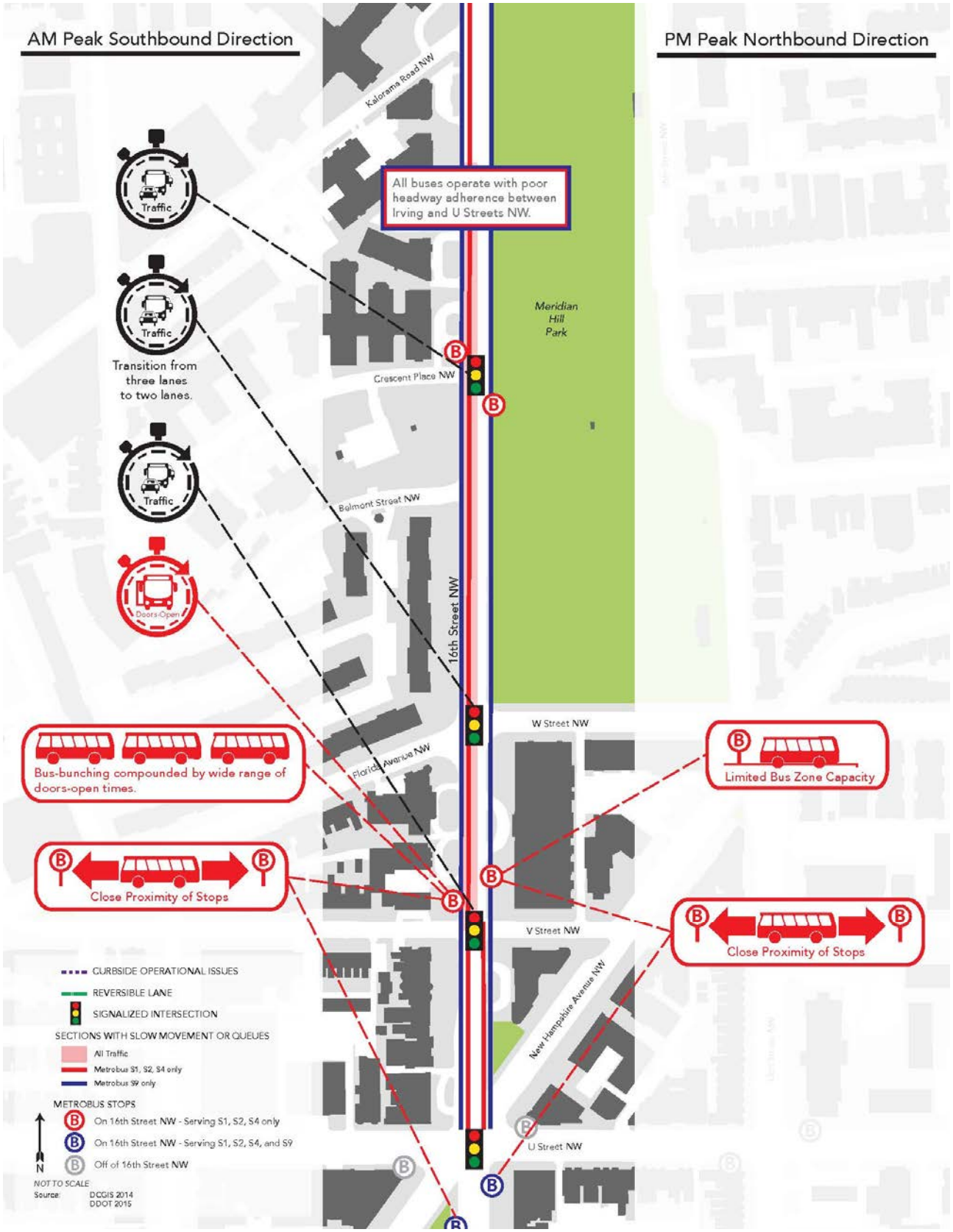


Figure 46 – Transit Operations Findings - Peak Periods – U Street NW to Q Street NW

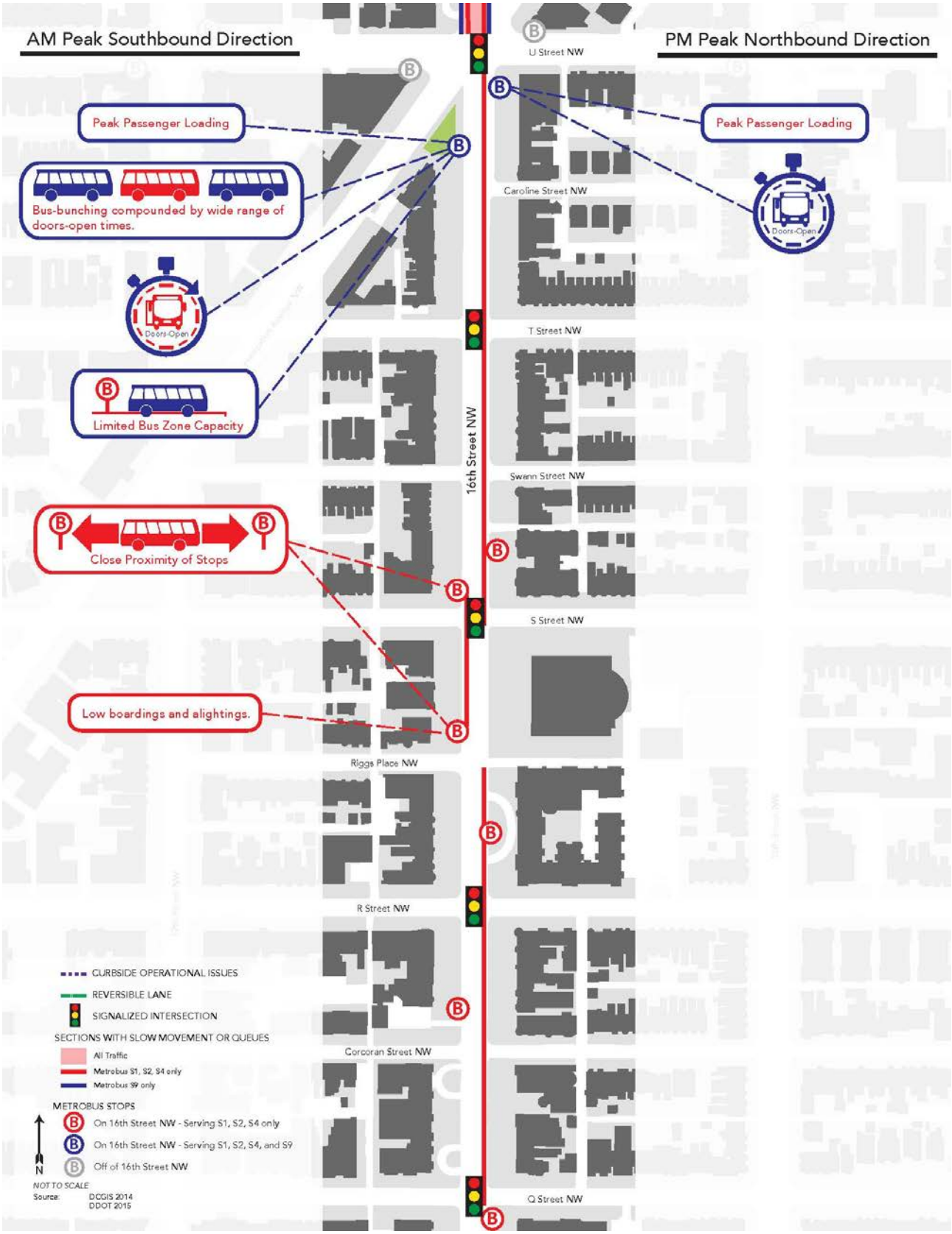


Figure 47 – Transit Operations Findings - Peak Periods – Q Street NW to M Street NW

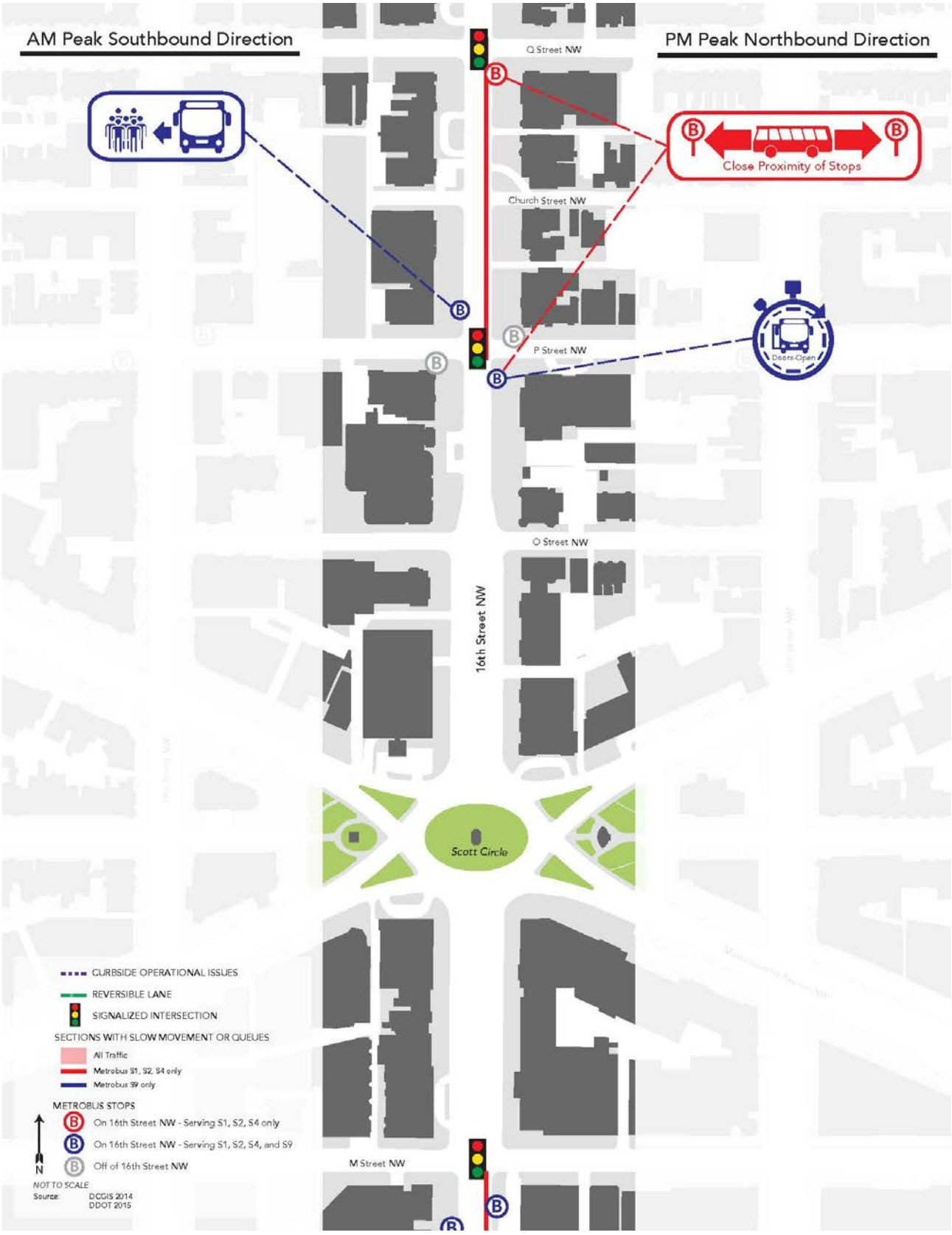
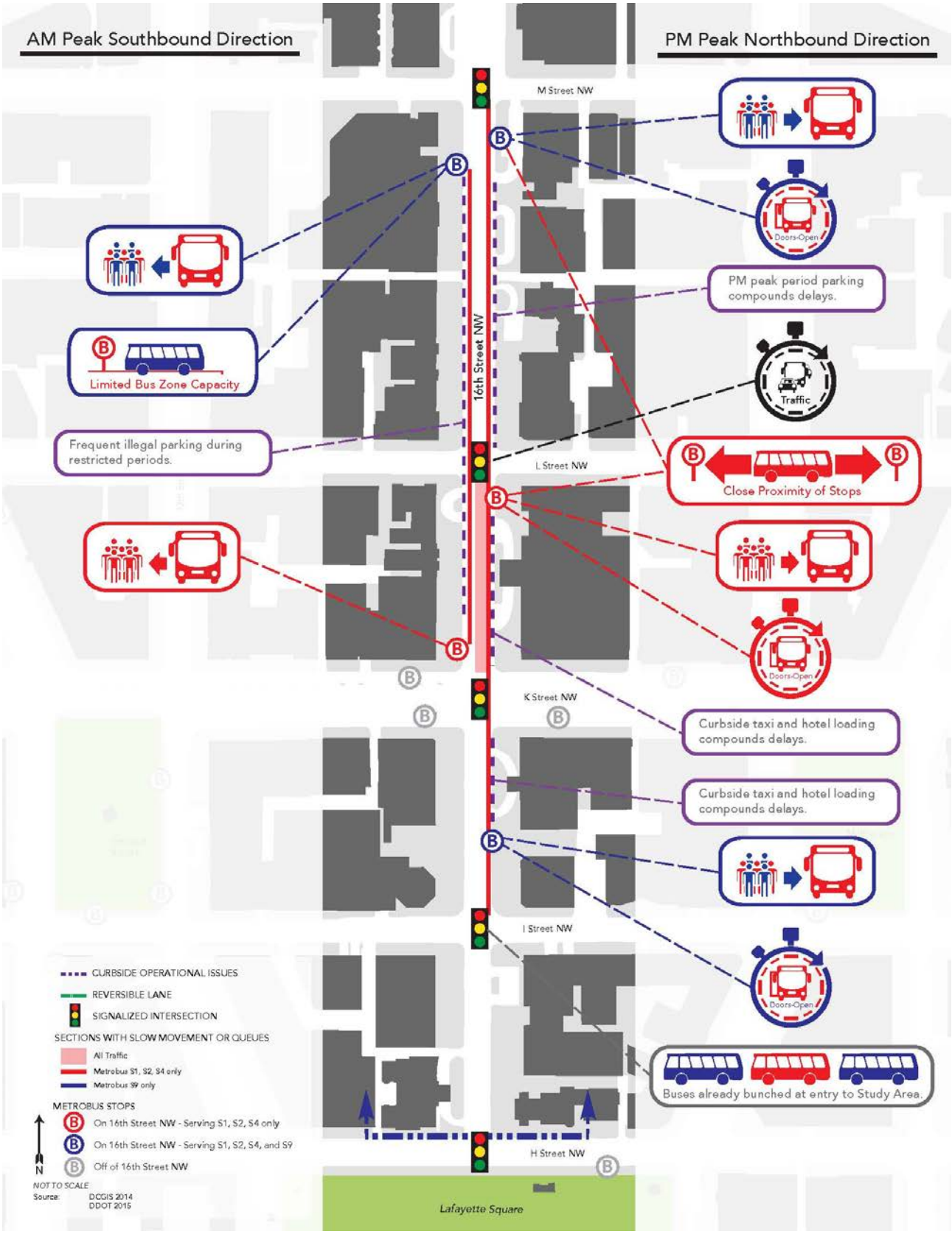


Figure 48 – Transit Operations Findings - Peak Periods – M Street NW to H Street NW



16TH STREET NW
TRANSIT PRIORITY
Planning Study

APPENDICES

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A. FREQUENCY BY LINE BY HOUR

The following tables summarize the number of buses scheduled for operation along each S route by time of day and direction.

WEEKDAY: BUS TRIPS PER HOUR																										
ROUTE	DIRECTION	HOUR:																								GRAND TOTAL
		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
S1	NORTH																1	6	3	3	1					14
	SOUTH						1	5	11	11	2															30
S2	NORTH	1	2	2	1	1	3	4	3	3	4	4	3	4	4	6	7	10	11	7	4	3	6	6	4	103
	SOUTH	2	2	1		3	5	6	14	14	7	4	3	4	4	4	3	6	6	4	3	3	2	2	2	104
S4	NORTH	2				1	3	3	3	4	3	4	4	4	4	2	3	7	6	6	4	3	3	2	2	73
	SOUTH					2	4	5	3	4	3	4	4	3	4	4	4	4	5	4	3	2	3	2	2	69
S9	NORTH							3	6	6	2						6	6	6	6	1					42
	SOUTH							3	6	6	6	1					6	6	6	2						42
TOTAL	NORTH	3	2	2	1	2	6	10	12	13	9	8	7	8	8	8	17	29	26	22	10	6	9	8	6	232
TOTAL	SOUTH	2	2	1	0	5	10	19	34	35	18	9	7	7	8	8	13	16	17	10	6	5	5	4	4	245

Source: WMATA

SATURDAY: BUS TRIPS PER HOUR																									
ROUTE	DIRECTION	HOUR:																							GRAND TOTAL
		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
S2	NORTH	1	1	1	1		2	4	3	4	4	4	4	4	4	4	4	4	4	3	2	2	2	1	2	65
	SOUTH	1	1	1		2	3	4	4	4	4	4	4	4	4	4	4	4	3	2	2	2	1	2	1	65
S4	NORTH	2	1				2	3	4	4	4	4	4	4	4	4	4	4	3	3	2	2	2	2	1	63
	SOUTH	1				1	3	4	4	4	4	4	4	4	4	4	4	4	3	2	2	2	2	1	2	63
TOTAL	NORTH	3	2	1	1	0	4	7	7	8	8	8	8	8	8	8	8	8	7	6	4	4	4	3	3	128
TOTAL	SOUTH	2	1	1	0	3	6	8	8	8	8	8	8	8	8	8	8	8	6	4	4	4	3	3	3	128

Source: WMATA

SUNDAY: BUS TRIPS PER HOUR																									
ROUTE	DIRECTION	HOUR:																							GRAND TOTAL
		00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	
S2	NORTH	2	1				2	2	2	3	3	3	3	3	3	3	3	3	3	3	1	2	1	2	1	49
	SOUTH	1	1			1	2	3	3	3	3	3	3	3	3	3	3	3	2	2	2	1	2	1	1	49
S4	NORTH	1	1				1	2	3	3	3	3	3	3	2	3	3	3	3	3	2	1	2	1	2	48
	SOUTH	1				1	2	2	3	4	2	4	2	3	3	3	3	3	3	2	1	2	1	1	2	48
TOTAL	NORTH	3	2	0	0	0	3	4	5	6	6	6	6	6	5	6	6	6	6	6	3	3	3	3	3	97
TOTAL	SOUTH	2	1	0	0	2	4	5	6	7	5	7	5	6	6	6	6	6	5	4	3	3	3	2	3	97

Source: WMATA

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B. HEADWAY VARIATION - RELIABILITY

The following three tables present the average scheduled headways (i.e., time between bus arrivals at a single location) and the variation of headways for the four individual S Line routes. WMATA operates a schedule-based, rather than headway-based, service on the 16th Street Line. However, headway variation is an indicator of schedule reliability and bus bunching. The analysis examines two WMATA time-check points within the Primary Study Area: at the intersection of 16th Street NW and Irving Street NW and at the intersection of 16th Street NW and U Street NW.

The methodology is drawn from the *Transit Capacity and Quality of Service Manual – Third Edition* (Transit Cooperative Research Project Report 165, 2013). The coefficient of variation of headways is the ratio of the standard deviation of the headway deviations to the mean of the scheduled headways.

LEVEL OF SERVICE	COEFFICIENT OF VARIATION OF HEADWAYS	COMMENTS
A	0.00 - 0.21	Service provided like clockwork
B	0.22 - 0.30	Vehicles slightly off headway
C	0.31 - 0.39	Vehicles often off headway
D	0.40 - 0.52	Irregular headways, with some bunching
E	0.53 - 0.74	Frequent bunching
F	>= 0.75	Most vehicles bunched

Source: WMATA 2014 S Line Data

		SOUTHBOUND – WEEKDAY – BY ROUTE					
		16th and Irving Streets NW			16th and U Streets NW		
		Mean Scheduled Headway	Standard Deviation of Headway Deviations	Coefficient of Variation of Headways	Mean Scheduled Headway	Standard Deviation of Headway Deviations	Coefficient of Variation of Headways
S1	All Day	7.9 min	6.4 min	0.81	8.0 min	6.8 min	0.85
	Early AM	---	---	---	---	---	---
	AM Peak	7.3 min	6.1 min	0.84	7.3 min	6.4 min	0.88
	Midday	13.3 min	8.1 min	0.61	11.8 min	7.0 min	0.59
	PM Peak	---	---	---	---	---	---
	Early Night	---	---	---	---	---	---
	Late Night	---	---	---	---	---	---
S2	All Day	13.7 min	6.5 min	0.47	12.5 min	6.6 min	0.52
	Early AM	16.8 min	3.8 min	0.23	18.0 min	3.9 min	0.22
	AM Peak	6.2 min	6.0 min	0.97	5.4 min	5.2 min	0.97
	Midday	13.2 min	5.6 min	0.42	11.5 min	5.9 min	0.52
	PM Peak	11.4 min	6.7 min	0.59	11.4 min	7.7 min	0.68
	Early Night	30.0 min	9.4 min	0.31	28.2 min	9.4 min	0.33
	Late Night	32.3 min	7.2 min	0.22	32.3 min	7.3 min	0.23
S4	All Day	18.1 min	6.0 min	0.33	18.1 min	6.2 min	0.34
	Early AM	15.8 min	3.2 min	0.20	15.8 min	3.3 min	0.21
	AM Peak	15.8 min	5.3 min	0.34	16.1 min	5.8 min	0.36
	Midday	16.4 min	5.5 min	0.34	16.3 min	5.7 min	0.35
	PM Peak	14.9 min	5.7 min	0.38	14.9 min	5.5 min	0.37
	Early Night	29.3 min	8.9 min	0.31	29.0 min	9.1 min	0.31
	Late Night	30.3 min	6.4 min	0.21	30.3 min	6.7 min	0.22
S9	All Day	10.1 min	5.1 min	0.50	10.1 min	5.0 min	0.50
	Early AM	---	---	---	---	---	---
	AM Peak	8.1 min	4.2 min	0.51	8.3 min	4.4 min	0.53
	Midday	9.0 min	4.1 min	0.46	8.7 min	4.2 min	0.48
	PM Peak	10.2 min	5.6 min	0.55	10.0 min	5.1 min	0.51
	Early Night	15.3 min	5.6 min	0.37	15.2 min	6.2 min	0.40
	Late Night	---	---	---	---	---	---

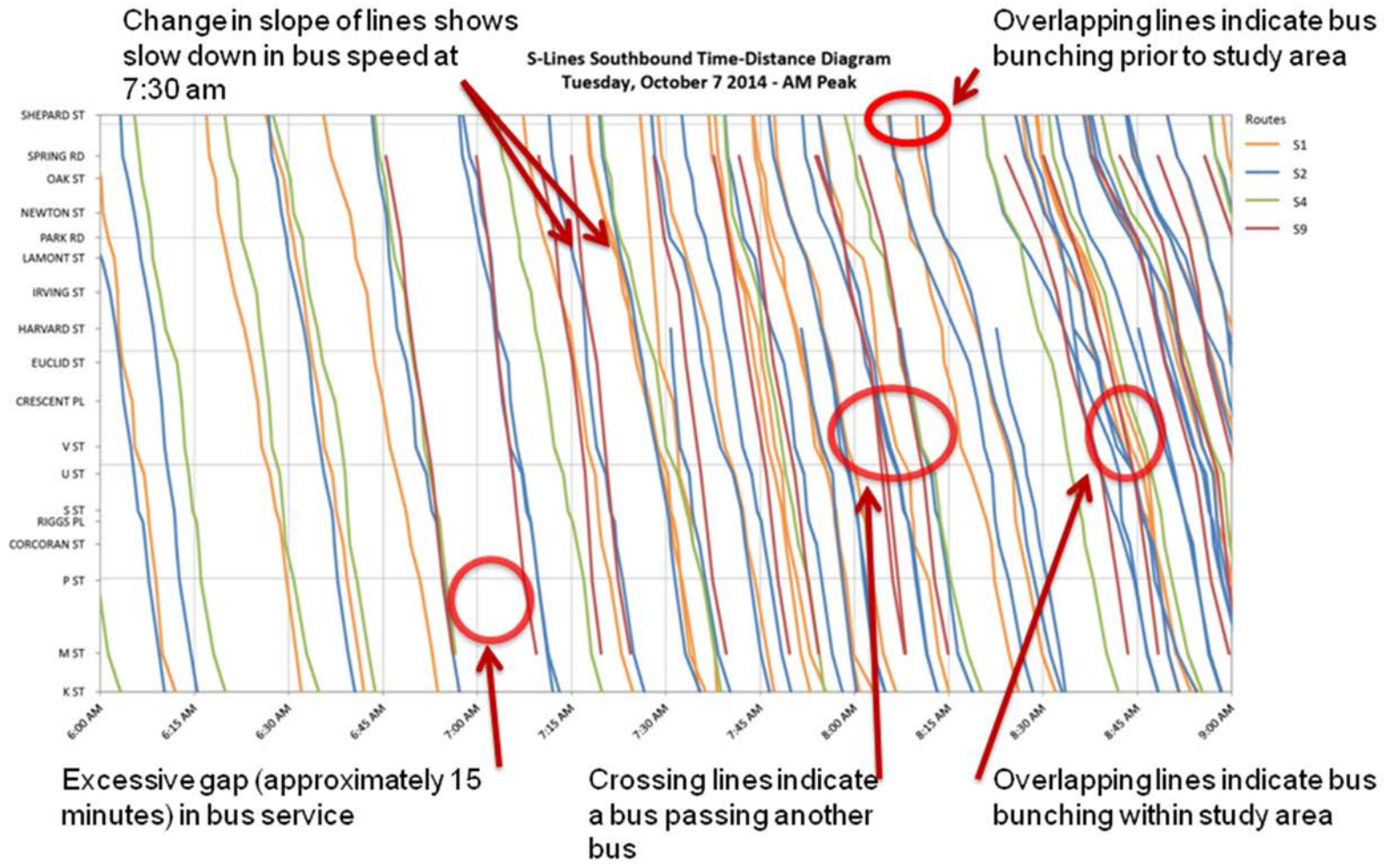
Source: WMATA 2014 S Line Data

		NORTHBOUND – WEEKDAY – BY ROUTE					
		16th and U STREETS NW			16th and IRVING STREETS NW		
		Mean Scheduled Headway	Standard Deviation of Headway Deviations	Coefficient of Variation of Headways	Mean Scheduled Headway	Standard Deviation of Headway Deviations	Coefficient of Variation of Headways
S1	All Day	16.7 min	9.4 min	0.56	16.7 min	9.8 min	0.59
	Early AM	---	---	---	---	---	---
	AM Peak	---	---	---	---	---	---
	Midday	---	---	---	---	---	---
	PM Peak	15.8 min	8.4 min	0.53	15.8 min	8.8 min	0.56
	Early Night	21.0 min	9.5 min	0.45	21.0 min	9.7 min	0.46
	Late Night	---	---	---	---	---	---
S2	All Day	13.1 min	6.2 min	0.47	13.1 min	6.6 min	0.50
	Early AM	26.5 min	1.9 min	0.07	26.5 min	1.8 min	0.07
	AM Peak	18.1 min	4.4 min	0.24	18.2 min	4.7 min	0.26
	Midday	15.2 min	5.7 min	0.37	15.5 min	6.2 min	0.40
	PM Peak	6.6 min	6.8 min	1.04	6.6 min	7.0 min	1.06
	Early Night	12.6 min	6.1 min	0.49	12.8 min	6.4 min	0.50
	Late Night	23.6 min	7.0 min	0.30	22.3 min	7.5 min	0.34
S4	All Day	16.8 min	6.1 min	0.36	16.8 min	6.5 min	0.39
	Early AM	26.0 min	2.9 min	0.11	26.0 min	3.0 min	0.11
	AM Peak	18.2 min	4.2 min	0.23	18.3 min	4.5 min	0.25
	Midday	16.3 min	5.3 min	0.32	16.4 min	5.6 min	0.34
	PM Peak	13.3 min	6.4 min	0.48	13.2 min	6.8 min	0.52
	Early Night	17.9 min	6.9 min	0.38	17.9 min	7.3 min	0.41
	Late Night	24.8 min	10.3 min	0.41	24.6 min	10.5 min	0.43
S9	All Day	10.0 min	5.4 min	0.54	10.0 min	4.7 min	0.47
	Early AM	---	---	---	---	---	---
	AM Peak	9.1 min	3.1 min	0.34	9.4 min	5.0 min	0.53
	Midday	10.0 min	3.8 min	0.38	9.5 min	4.3 min	0.46
	PM Peak	8.5 min	6.5 min	0.77	8.5 min	4.6 min	0.55
	Early Night	14.2 min	3.9 min	0.27	14.2 min	4.0 min	0.28
	Late Night	---	---	---	---	---	---

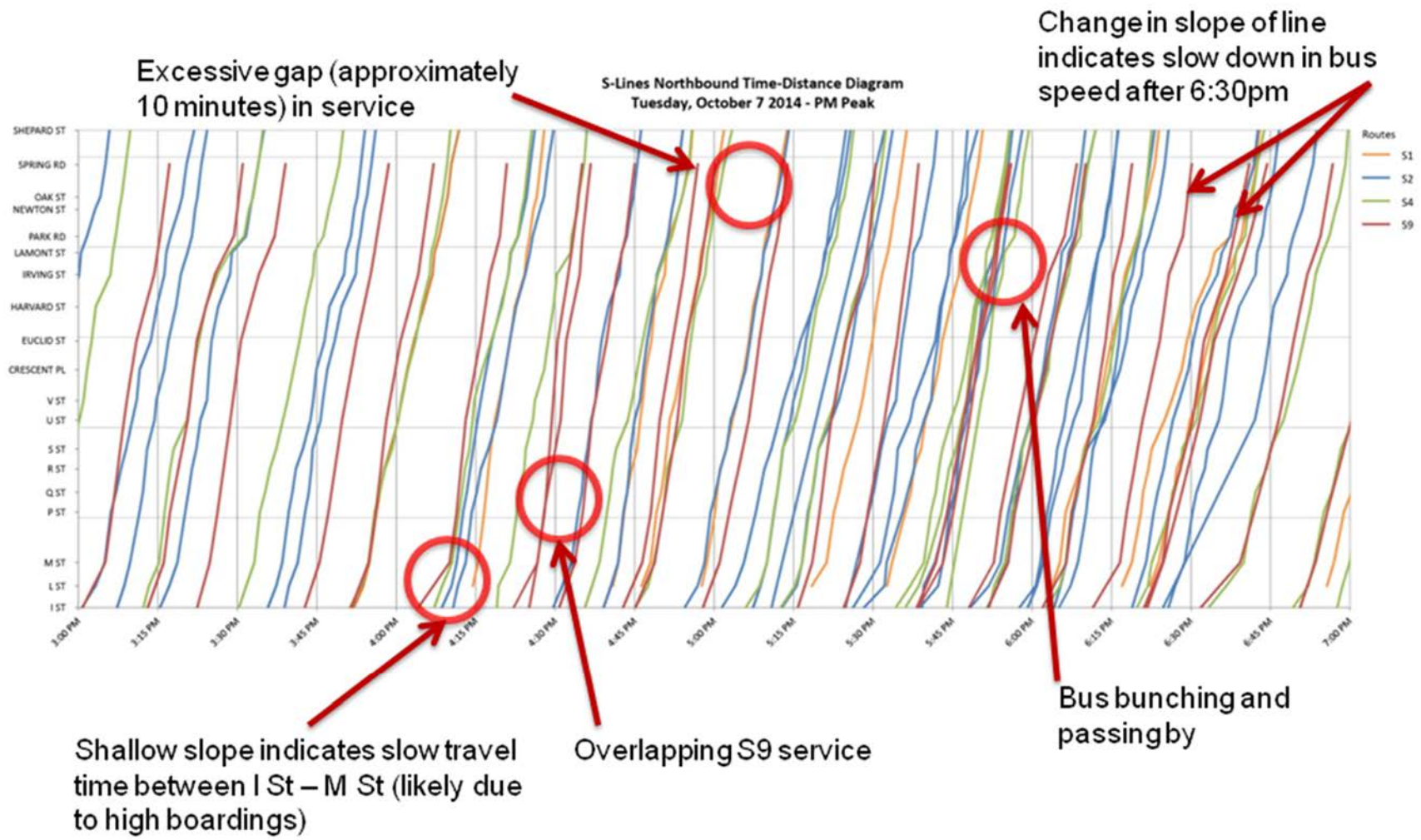
Source: WMATA 2014 S Line Data

C. TRANSIT PROGRESSION DIAGRAMS

The following diagrams plot the location and time point of each bus during the AM Peak and PM Peak periods on a representative day (Tuesday, October 7, 2014). Each line represents a bus trip and shows how the bus progressed along the corridor during the time period. A faster bus trip is represented by a steeper line, while a more shallow line indicates delay. Where lines overlap, that indicates bus bunching or buses passing.



Source: WMATA S Line AVL Data



Source: WMATA S Line AVL Data

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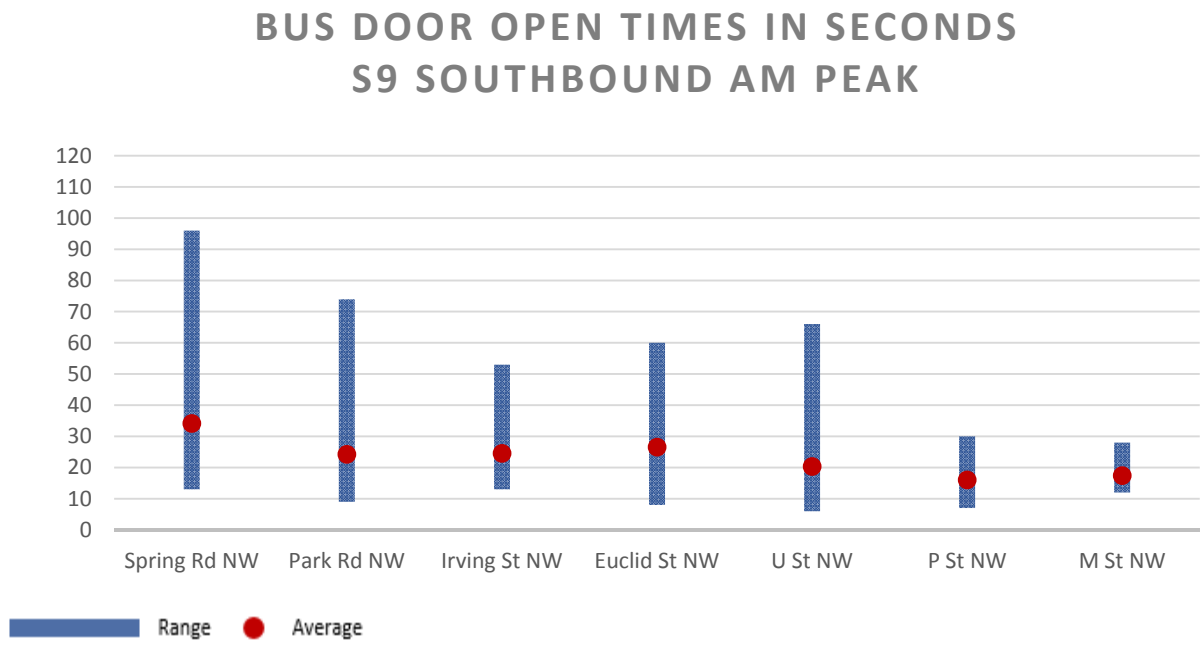
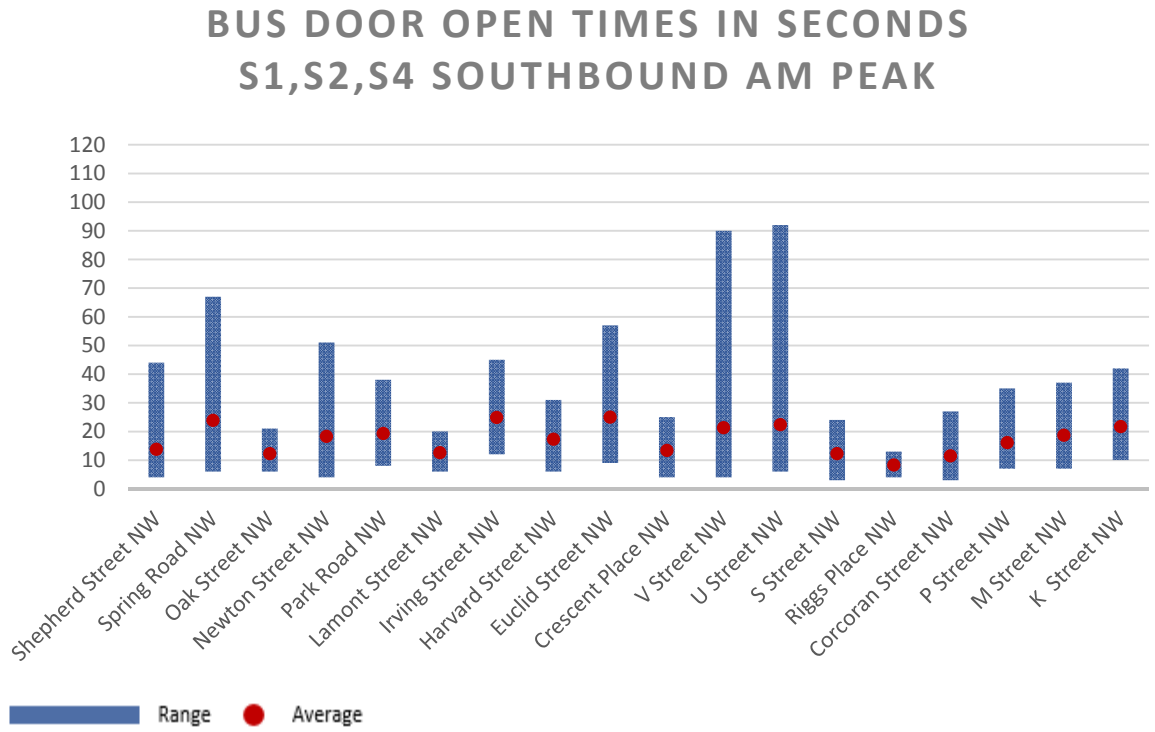
D. BUS DOOR OPEN TIMES

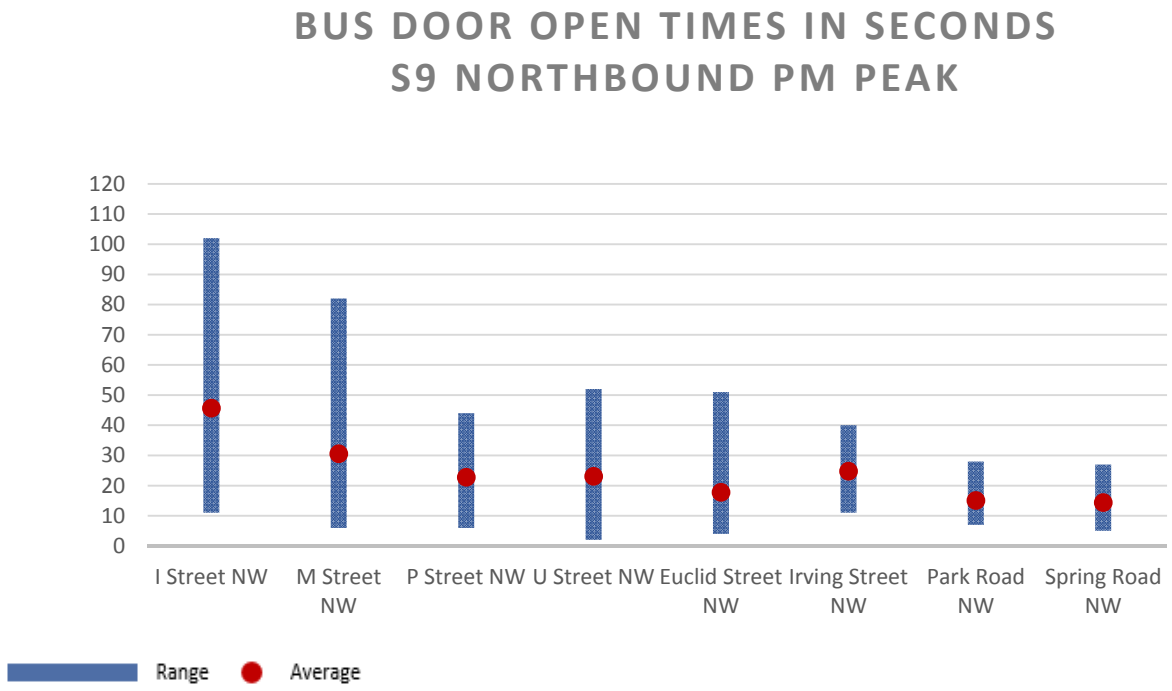
The following graphs present the average and range of doors open time, or time spent boarding and alighting, recorded at each stop for the S9 and S1, S2, and S4 routes.



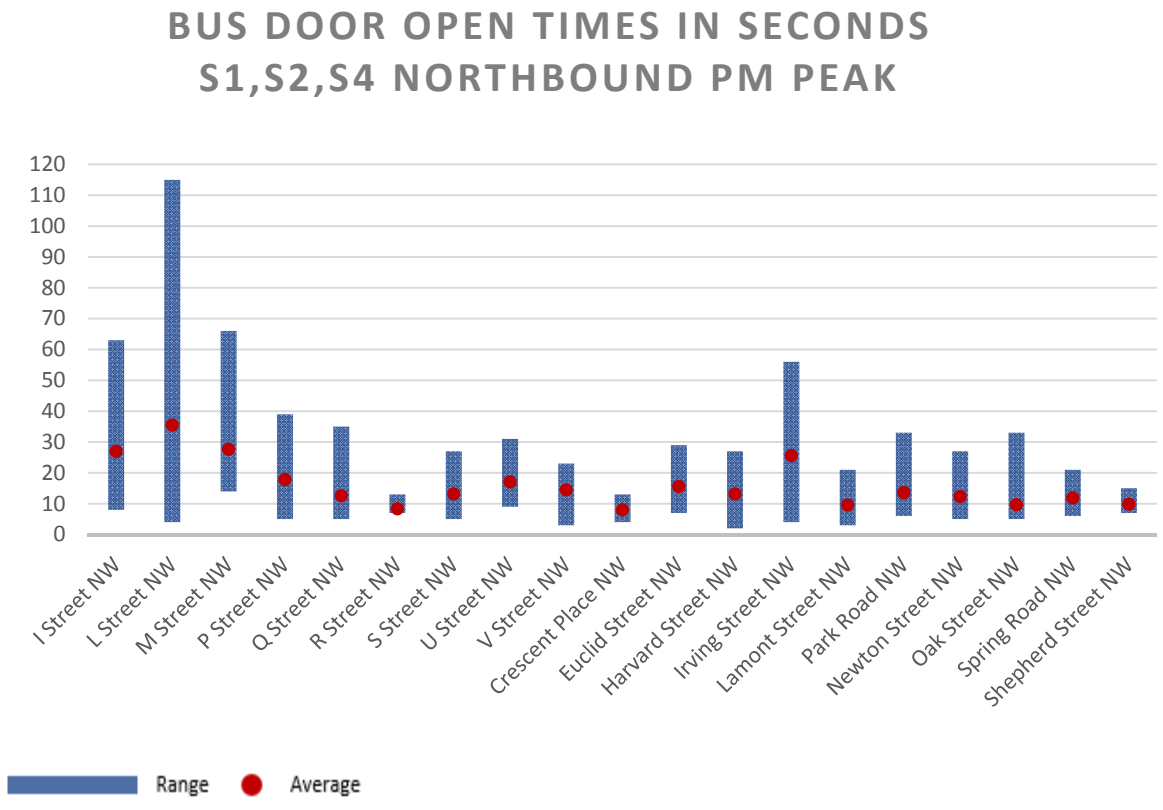
Source: DDOT On-Board Data Collection March 12-26 and June 1-18, 2015



Source: DDOT On-Board Data Collection March 12-26 and June 1-18, 2015



Source: DDOT On-Board Data Collection March 12-26 and June 1-18, 2015



Source: DDOT On-Board Data Collection March 12-26 and June 1-18, 2015

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E. ON-TIME PERFORMANCE

The following table identifies scheduled run times for the entire length of each bus route compared to average actual run times for the fall quarter 2014. This data indicates that the S1, S2, and S4 typically travel behind the scheduled trip run time throughout the entire day (i.e., all service periods). The S9 operates at or near the scheduled run time.

WMATA also uses time-point observations to monitor on-time route performance. A bus is considered on-time if it arrives no more than 2 minutes before or 5 minutes after its scheduled arrival time.

ROUTE & TIME PERIOD	TRIP RUNTIME (MIN)		TIME-POINT OBSERVATIONS			ON-TIME
	SCHEDULES	ACTUAL	ON	EARLY	LATE	
S2 Route						
AM Early	40.9	43.9	94	5	5	90.5%
AM Peak	39.5	44.1	234	19	64	74.0%
Midday	49.1	52.1	341	29	72	77.2%
PM Peak	47.5	51.7	281	30	115	66.0%
Early Night	42.2	46.1	143	9	61	67.2%
Late Night	37.3	39.1	118	6	22	81.0%
Route Total	--	--	*1,211*	*97*	*338*	*73.5%*
S4 Route						
AM Early	40.2	43.3	71	5	4	88.6%
AM Peak	49.0	52.0	133	17	24	76.4%
Midday	43.1	44.9	271	19	33	83.8%
PM Peak	46.1	49.1	195	19	61	70.9%
Early Night	41.8	46.8	109	9	39	69.1%
Late Night	38.5	43.0	36	2	10	76.1%
Route Total	--	--	*815*	*71*	*171*	*77.1%*
S1 Route						
AM Early	30.0	37.5	5	1	1	68.1%
AM Peak	36.4	45.8	95	8	57	59.3%
Midday	36.0	42.0	5	1	5	47.1%
PM Peak	37.2	39.4	50	4	23	65.1%
Early Night	36.0	38.7	3	--	2	56.6%
Route Total	--	--	*158*	*15*	*88*	*60.7%*
S9 Route						
AM Peak	38.3	39.7	207	4	27	86.8%
Midday	35.2	38.4	50	3	6	84.3%
PM Peak	40.8	41.8	304	20	58	79.5%
Early Night	38.6	38.5	116	2	20	83.7%
Route Total	--	--	*677*	*29*	*112*	*82.7%*
All 4 Routes	--	--	*2,861*	*213*	*710*	*75.6%*

Source: WMATA

F. TRAVEL SPEED BY TIME OF DAY

The following graphics illustrate the average travel speed of buses between bus stops. The average speed includes time that buses spend at bus stops with doors open. The data is presented by route, direction, and time of day.

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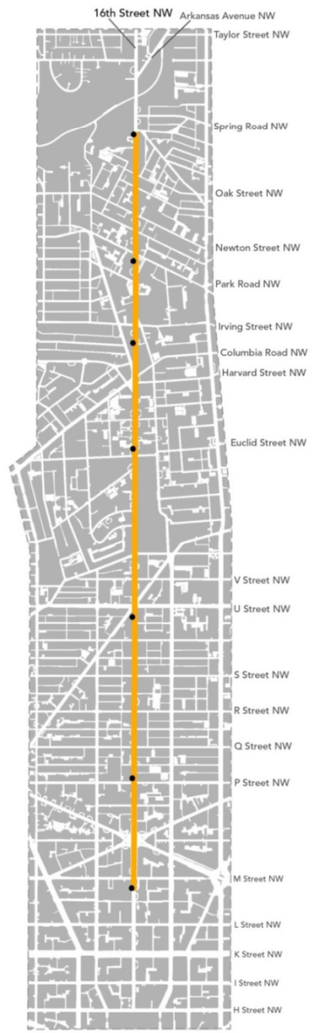
S9 AVERAGE TRAVEL SPEED WEEKDAY AM PEAK - SOUTHBOUND

S9 AVERAGE TRAVEL SPEED WEEKDAY MIDDAY - SOUTHBOUND

S9 AVERAGE TRAVEL SPEED WEEKDAY PM PEAK - SOUTHBOUND



S9 AVERAGE TRAVEL SPEED WEEKDAY EARLY NIGHT - SOUTHBOUND

Source: WMATA S Line Raw Bus State Data from October 2014

S1, S2, S4 AVERAGE TRAVEL SPEED
EARLY AM - SOUTHBOUND

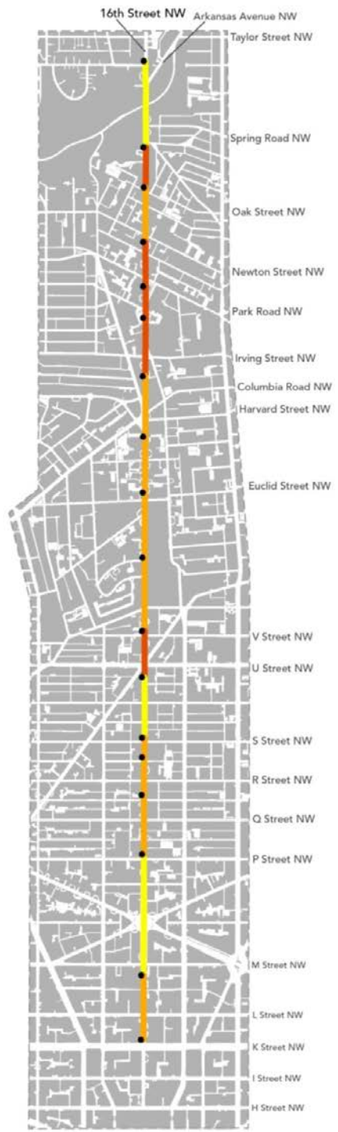
S1, S2, S4 AVERAGE TRAVEL SPEED
WEEKDAY AM PEAK - SOUTHBOUND

S1, S2, S4 AVERAGE TRAVEL SPEED
WEEKDAY MIDDAY - SOUTHBOUND

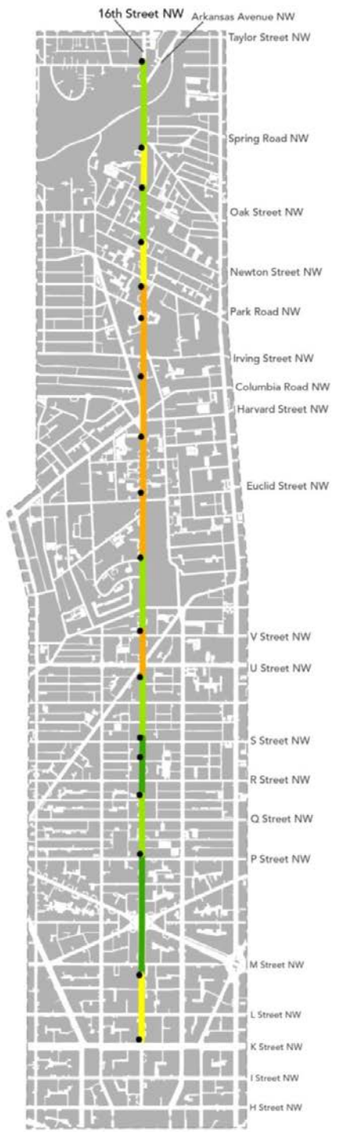
Source: WMATA S Line Raw Bus State Data from October 2014

S1, S2, S4 AVERAGE TRAVEL SPEED
WEEKDAY PM PEAK - SOUTHBOUND

S1, S2, S4 AVERAGE TRAVEL SPEED
WEEKDAY EARLY NIGHT - SOUTHBOUND

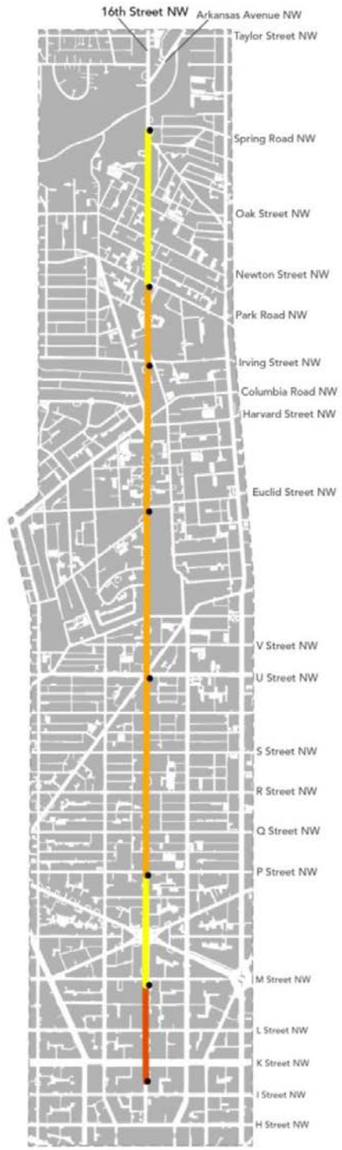


S1, S2, S4 AVERAGE TRAVEL SPEED
WEEKDAY LATE NIGHT - SOUTHBOUND



Source: WMATA S Line Raw Bus State Data from October 2014

S9 AVERAGE TRAVEL SPEED WEEKDAY AM PEAK - NORTHBOUND



S9 AVERAGE TRAVEL SPEED WEEKDAY MIDDAY - NORTHBOUND

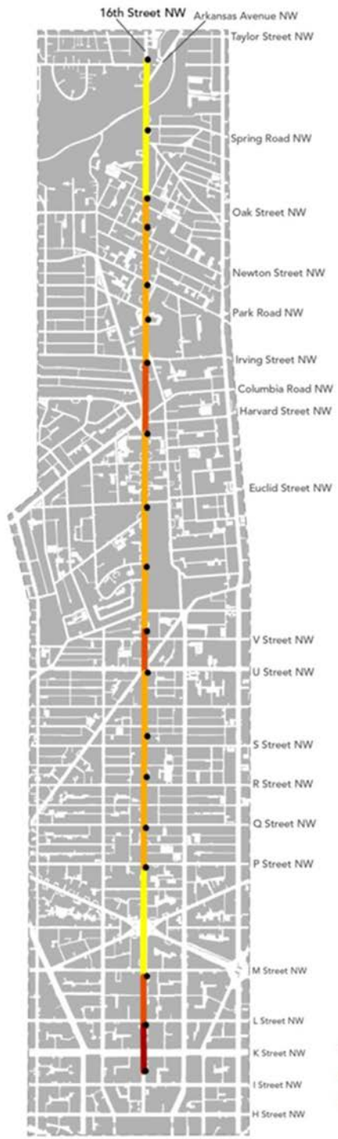
S9 AVERAGE TRAVEL SPEED WEEKDAY PM PEAK - NORTHBOUND

S9 AVERAGE TRAVEL SPEED WEEKDAY EARLY NIGHT - NORTHBOUND

Source: WMATA S Line Raw Bus State Data from October 2014

S1, S2, S4 AVERAGE TRAVEL SPEED
WEEKDAY EARLY AM - NORTHBOUND

S1, S2, S4 AVERAGE TRAVEL SPEED
WEEKDAY AM PEAK - NORTHBOUND

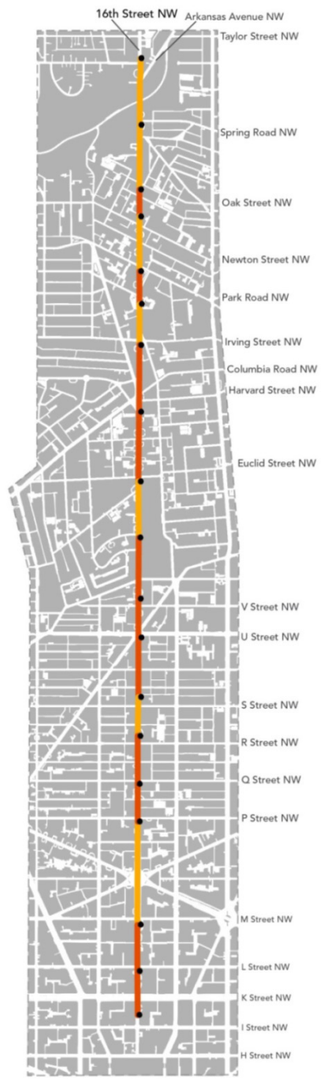


S1, S2, S4 AVERAGE TRAVEL SPEED
WEEKDAY MIDDAY - NORTHBOUND

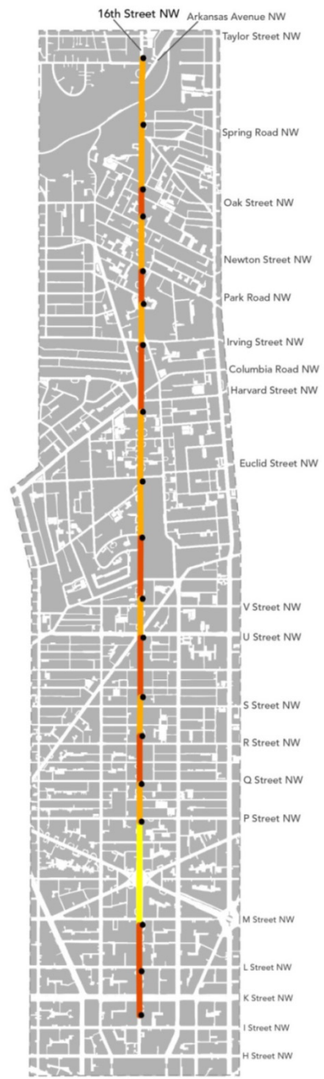
Source: WMATA S Line Raw Bus State Data from October 2014

S1, S2, S4 AVERAGE TRAVEL SPEED
WEEKDAY PM PEAK - NORTHBOUND

S1, S2, S4 AVERAGE TRAVEL SPEED
WEEKDAY EARLY NIGHT - NORTHBOUND



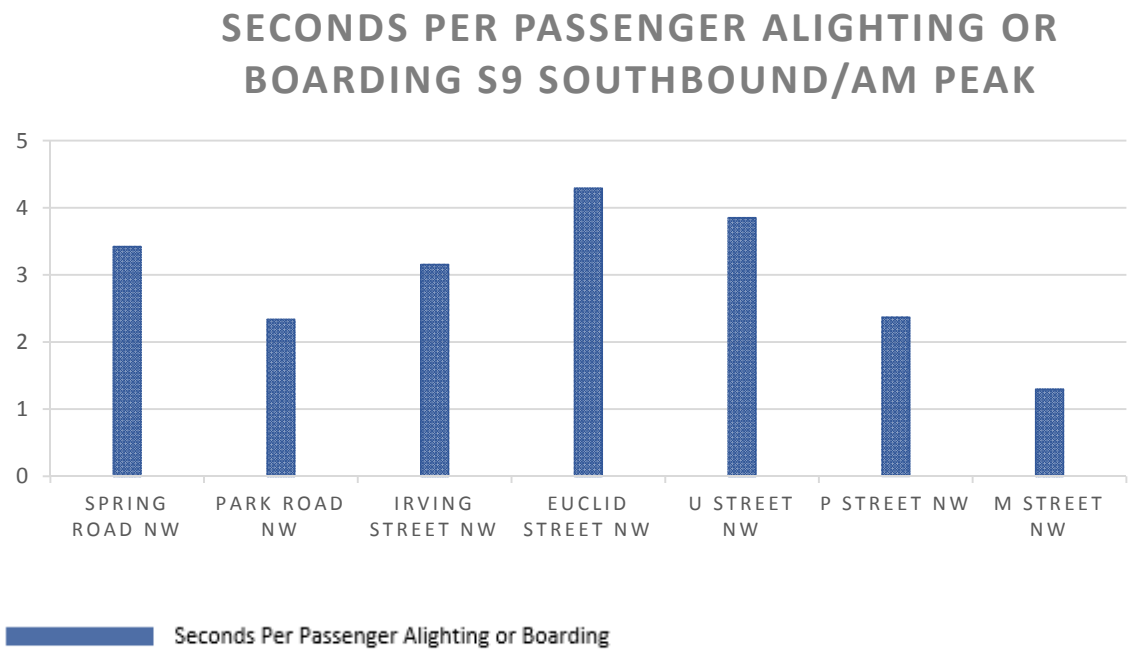
S1, S2, S4 AVERAGE TRAVEL SPEED
WEEKDAY LATE NIGHT - NORTHBOUND

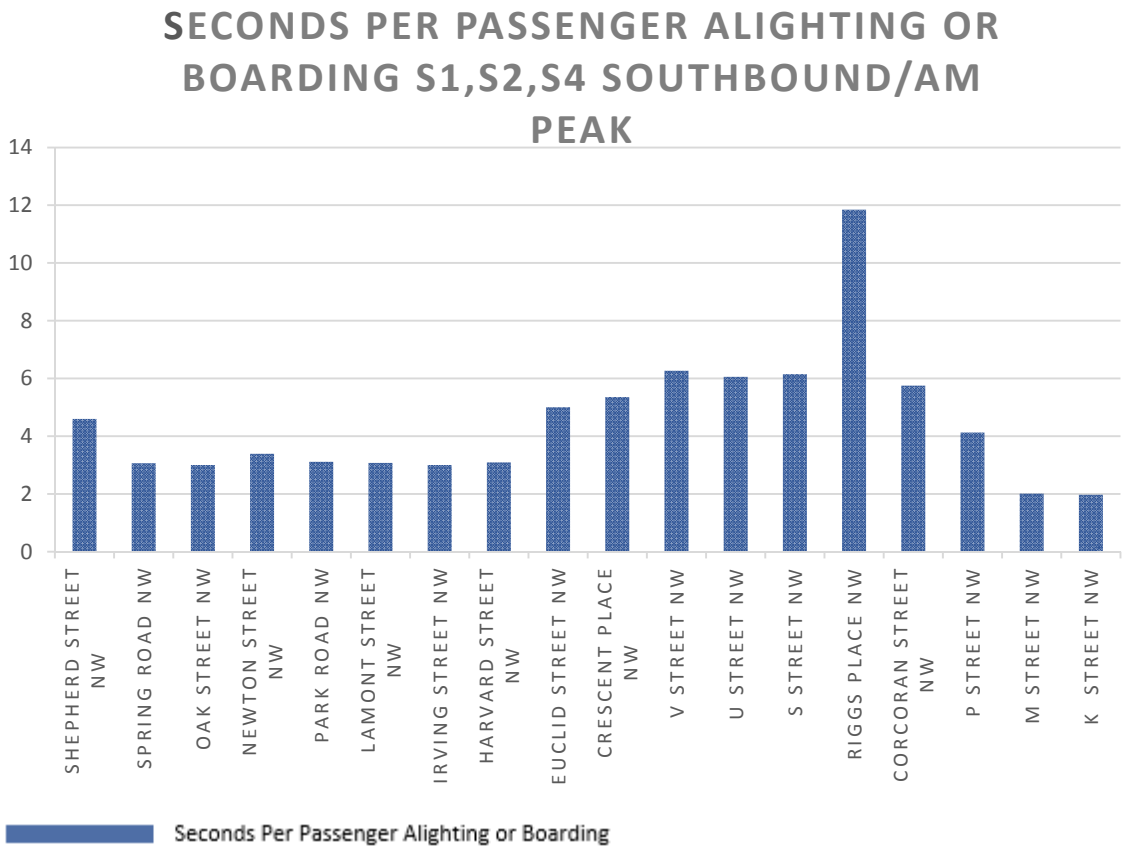


Source: WMATA S Line Raw Bus State Data from October 2014

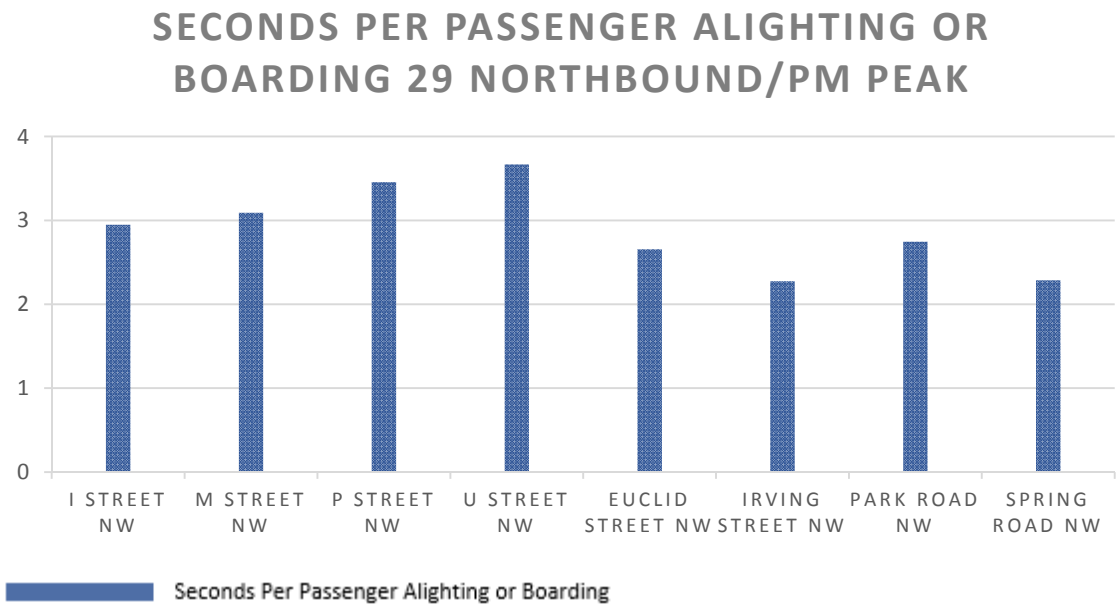
G. SECONDS PER PASSENGER BOARDING OR ALIGHTING

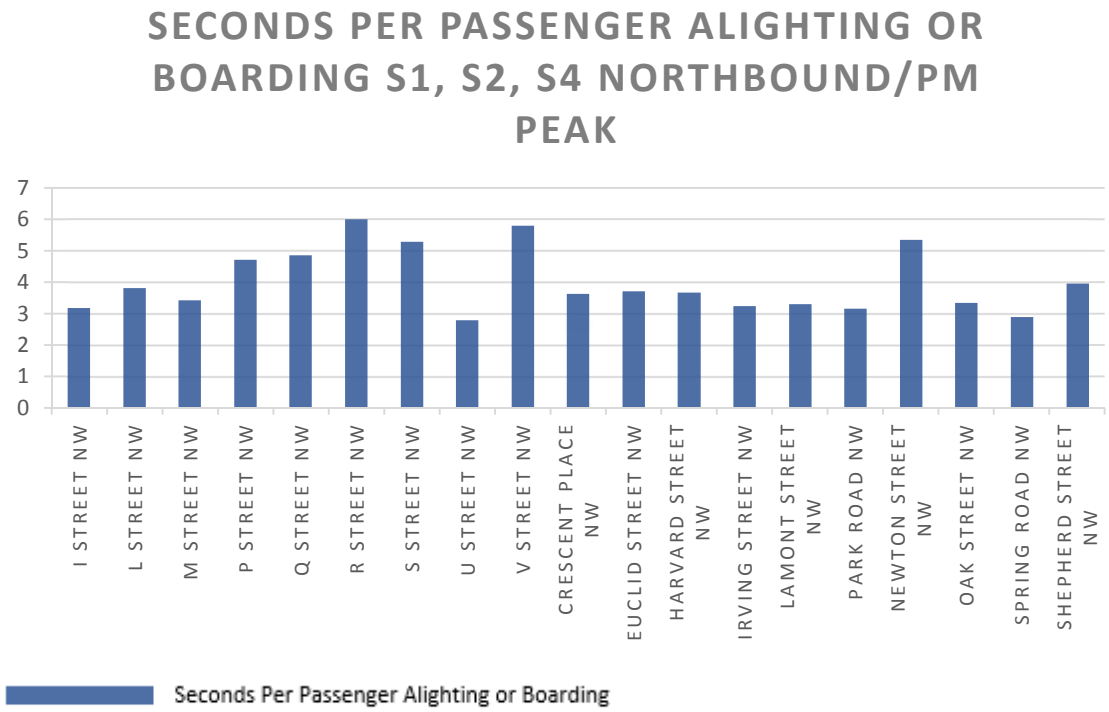
The following graphs present the seconds per boarding or alighting passenger at each stop. This value is a ratio of the doors open time to the total number of boardings and alightings for each stop.





Source: DDOT On-Board Data Collection March 12-26 and June 1-18, 2015





Source: DDOT On-Board Data Collection March 12-26 and June 1-18, 2015

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H. AVERAGE WEEKDAY BOARDINGS AND ALIGHTINGS

The following graphics illustrate the average daily number of passengers boarding and alighting at each stop by time of day and direction during October 2014.

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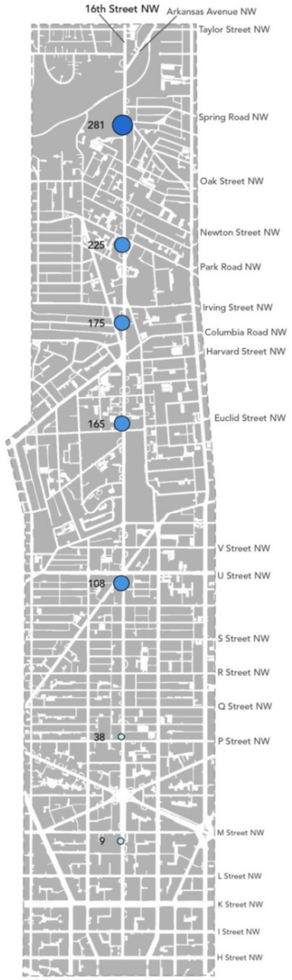
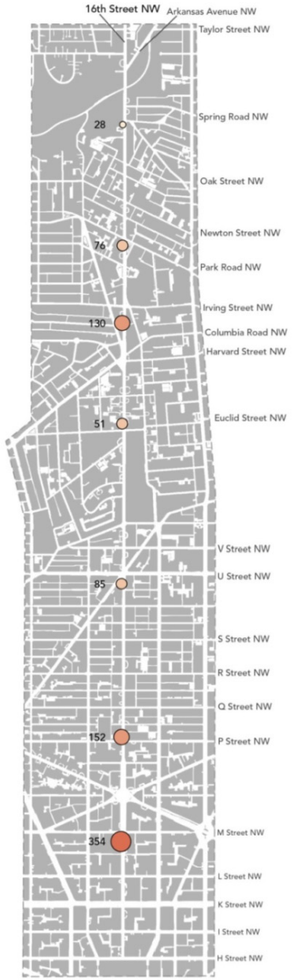
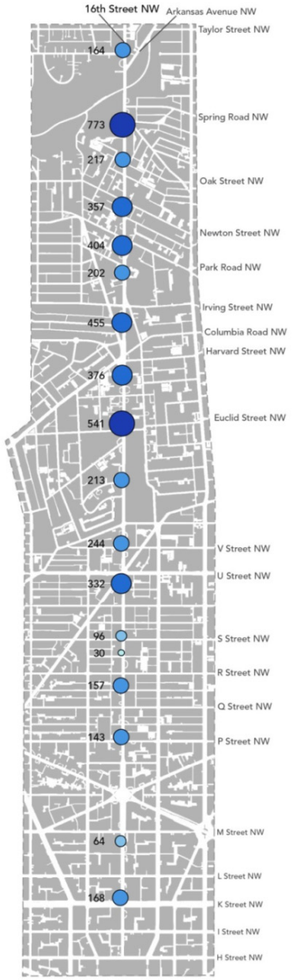
S9 AVERAGE DAILY BOARDINGS
WEEKDAY - SOUTHBOUND



S9 AVERAGE DAILY ALIGHTINGS
WEEKDAY - SOUTHBOUND



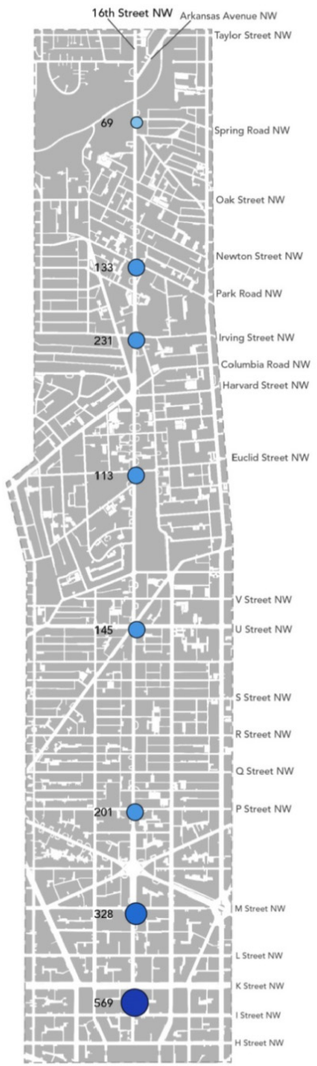
S1, S2, S4 AVERAGE DAILY BOARDINGS
WEEKDAY - SOUTHBOUND



S1, S2, S4 AVERAGE DAILY ALIGHTINGS
WEEKDAY - SOUTHBOUND

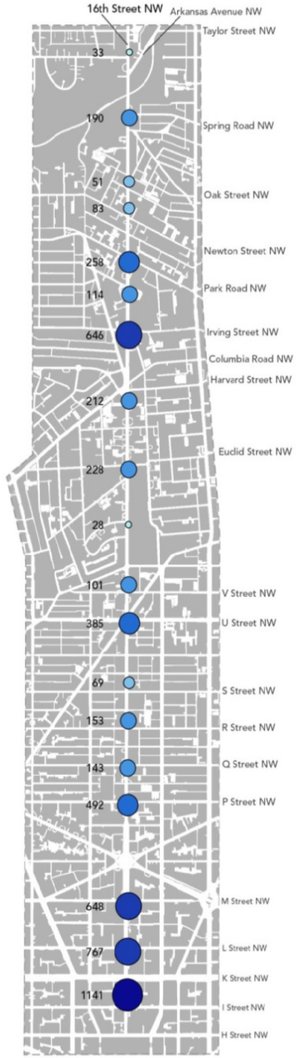
Source: WMATA S Line 2014 Q4 Ridership by Route and Stop – WMATA Ridecheck Plus Program

S9 AVERAGE DAILY BOARDINGS
WEEKDAY - NORTHBOUND



S9 AVERAGE DAILY ALIGHTINGS
WEEKDAY - NORTHBOUND

S1, S2, S4 AVERAGE DAILY BOARDINGS
WEEKDAY - NORTHBOUND

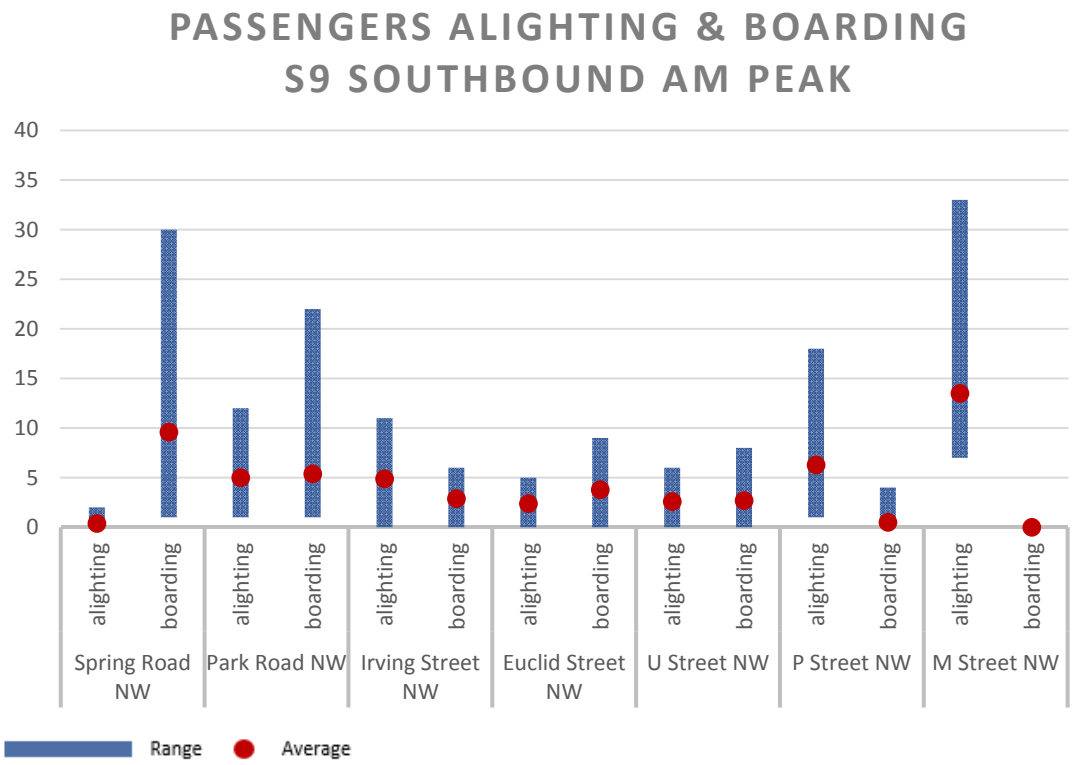


S1, S2, S4 AVERAGE DAILY ALIGHTINGS
WEEKDAY - NORTHBOUND

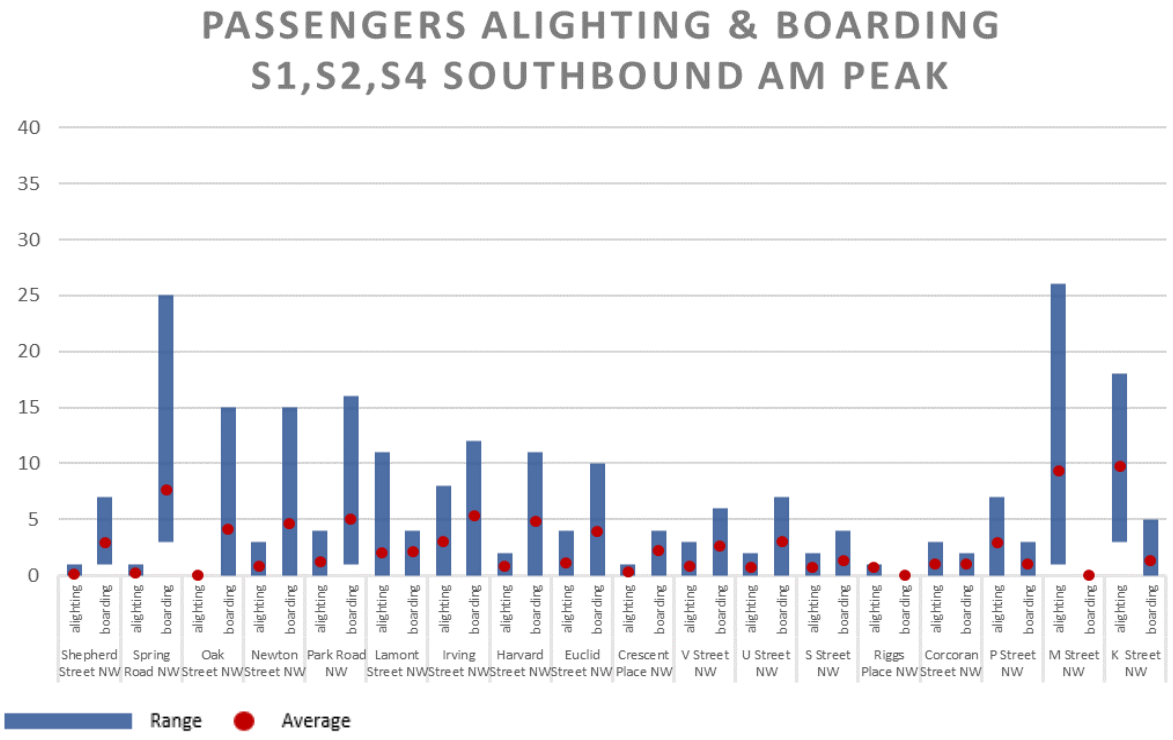
Source: WMATA S Line 2014 Q4 Ridership by Route and Stop – WMATA Ridecheck Plus Program

I. PASSENGER ALIGHTINGS AND BOARDINGS

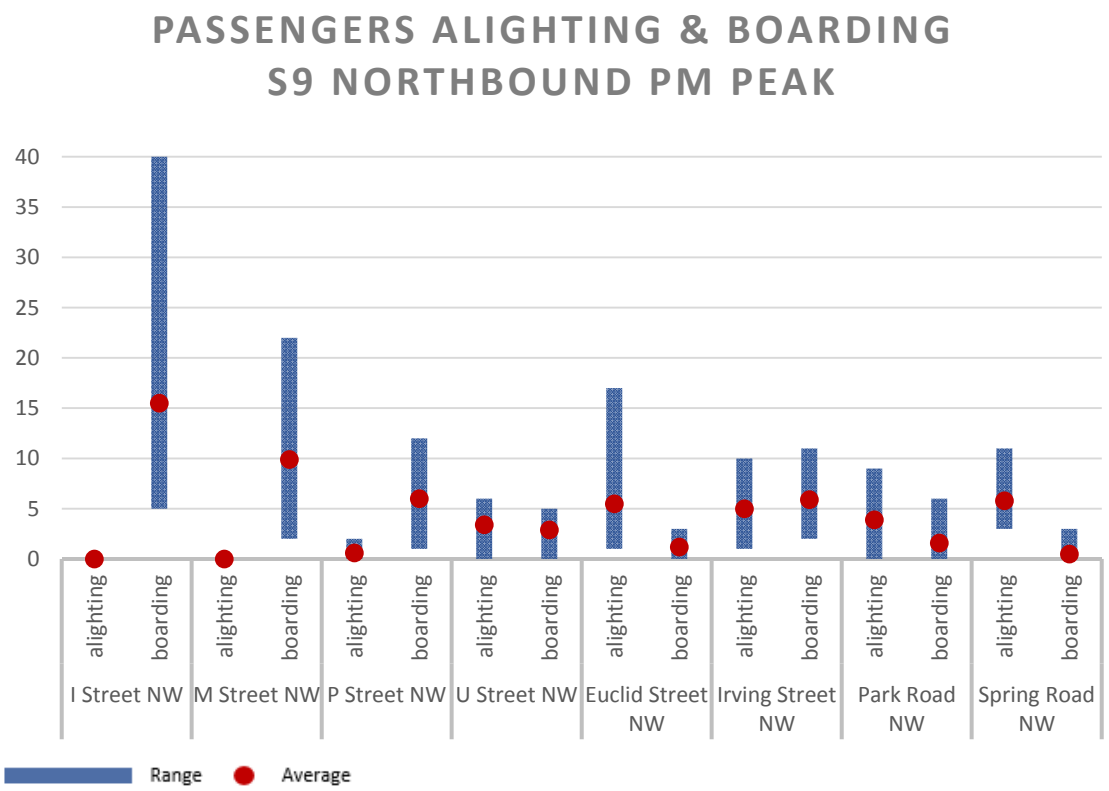
The following graphs present the average and range of boardings and alightings per bus at each bus stop by route. The data was collected to determine the variability of boarding and alightings at each stop.



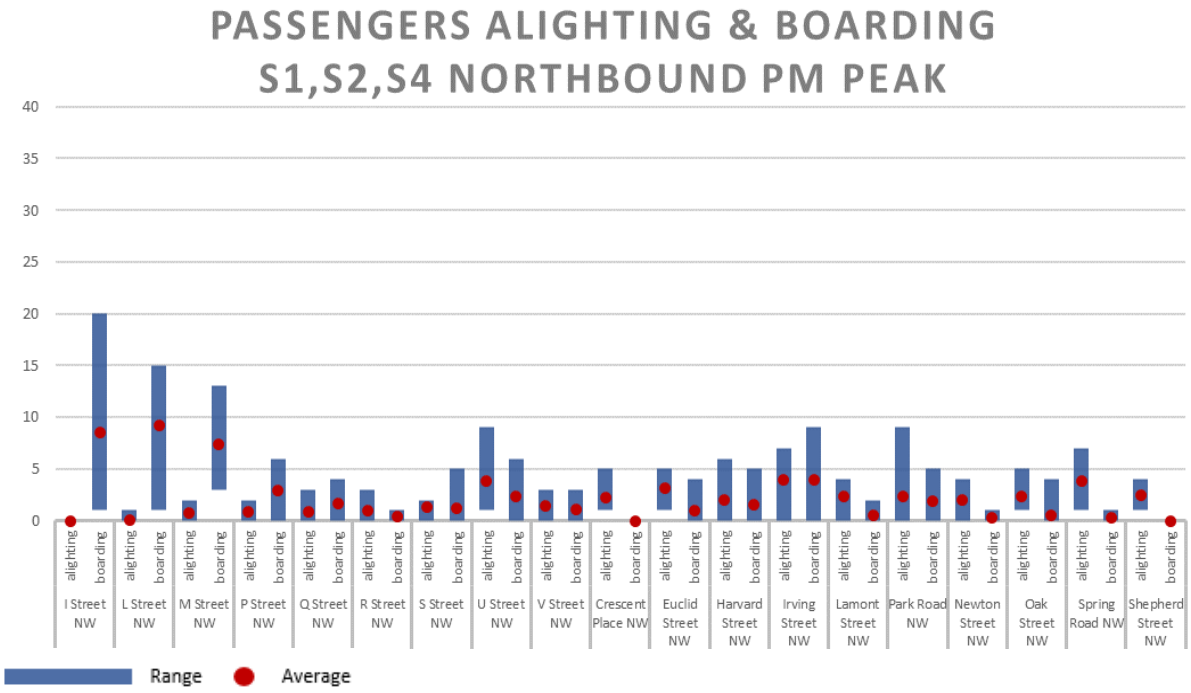
Source: DDOT On-Board Data Collection March 12-26 and June 1-18, 2015



Source: DDOT On-Board Data Collection March 12-26 and June 1-18, 2015



Source: DDOT On-Board Data Collection March 12-26 and June 1-18, 2015



Source: DDOT On-Board Data Collection March 12-26 and June 1-18, 2015

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J. MAX LOAD AND LOAD DURATION

This section summarizes average boardings and loadings on the S routes for fall quarter 2014. WMATA uses a peak hour load factor (see Max Load columns) to measure passenger demand and to determine when additional capacity is needed. The peak load is calculated by dividing the peak number of passengers by the seated bus capacity. A standard bus seats approximately 40 passengers and an articulated bus seats approximately 65 passengers. A load factor of 1.0 means that all seats are occupied and that no passenger is forced to stand. WMATA's threshold for radial services such as the 16th Street Line is 1.2 or 120 percent Max Load. The Max Load columns illustrate that the S2, S4, and S9 routes exceed this threshold for most of the day. The S1 route exceeds the threshold in the AM Peak period.

ROUTE & TIME PERIOD	BOARDINGS			MAX LOAD		LOAD DURATION	
	PER MILE	PER HOUR	PER TRIP	PATRON	SEATS	100%	120%
AM Early	4.91	47.8	40.0	56	140%	12.9%	6.6%
AM Peak	7.63	55.6	49.3	70	160%	11.1%	6.3%
Midday	6.02	49.1	47.1	57	143%	12.2%	5.8%
PM Peak	7.26	54.9	51.6	60	133%	15.0%	7.9%
Early Night	6.04	53.8	46.2	55	136%	11.5%	5.5%
Late Night	2.67	11.5	21.4	44	110%	2.6%	1.4%
S2 Route Total	*6.29*	*46.6*	*46.2*	--	--	--	--
AM Early	4.93	48.4	39.3	47	120%	10.6%	5.0%
AM Peak	6.77	55.1	53.8	61	156%	25.4%	15.6%
Midday	5.68	47.2	41.3	54	135%	9.3%	4.2%
PM Peak	7.62	61.8	56.0	62	156%	20.4%	11.8%
Early Night	5.65	55.9	44.8	62	129%	8.3%	3.8%
Late Night	4.31	48.1	34.6	59	92%	4.9%	1.9%
S4 Route Total	*6.23*	*53.8*	*47.2*	--	--	--	--
AM Early	4.72	27.5	31.2	23	35%	--	--
AM Peak	10.92	71.2	65.9	67	131%	9.8%	5.6%
Midday	8.44	79.8	47.9	39	83%	4.8%	2.9%
PM Peak	11.72	57.2	56.7	56	100%	5.2%	2.6%
Early Night	9.06	73.0	43.8	33	51%	0.1%	--
S1 Route Total	*10.81*	*65.7*	*61.0*	--	--	--	--
AM Peak	5.70	56.4	41.7	60	155%	16.2%	10.3%
Midday	5.02	59.3	36.1	52	132%	10.8%	6.1%
PM Peak	5.47	51.5	40.4	52	134%	13.3%	7.0%
Early Night	3.84	39.5	28.5	41	106%	5.0%	2.3%
S9 Route Total	***5.23***	***51.6***	***38.5***	--	--	--	--
All Four Routes	***6.34***	***51.1***	***46.1***	--	--	--	--

Source: WMATA

K. BUS LOADING

The following graphics illustrate the average number of passengers loaded on the bus by route for each stop after boarding and alighting is completed. The data identifies the locations where buses are likely to pass by stops due to lack of capacity.

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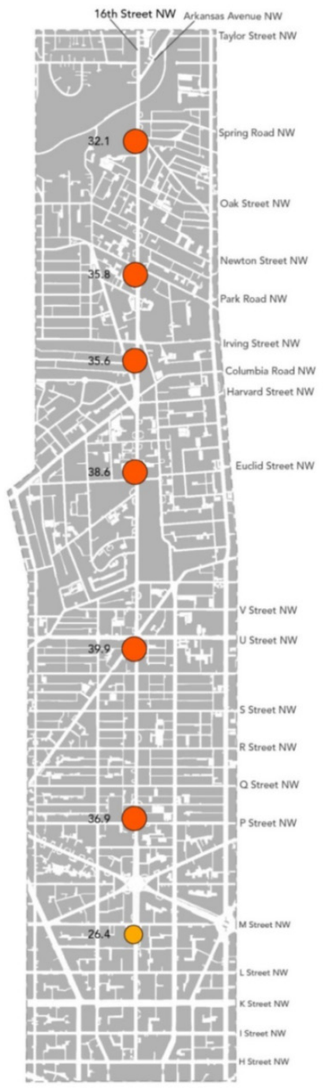
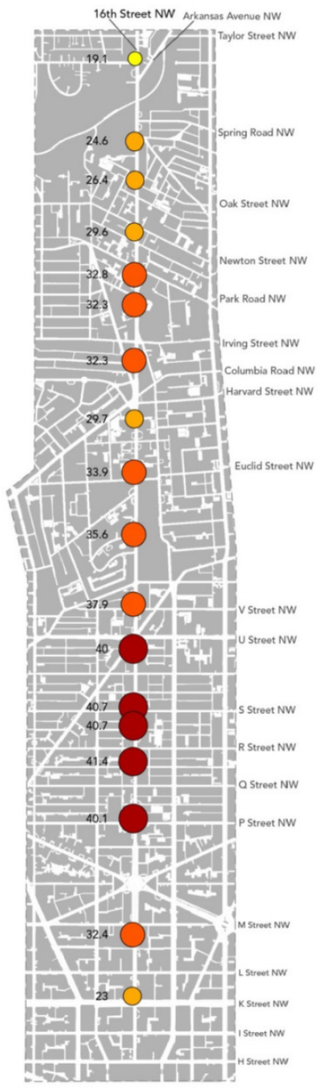
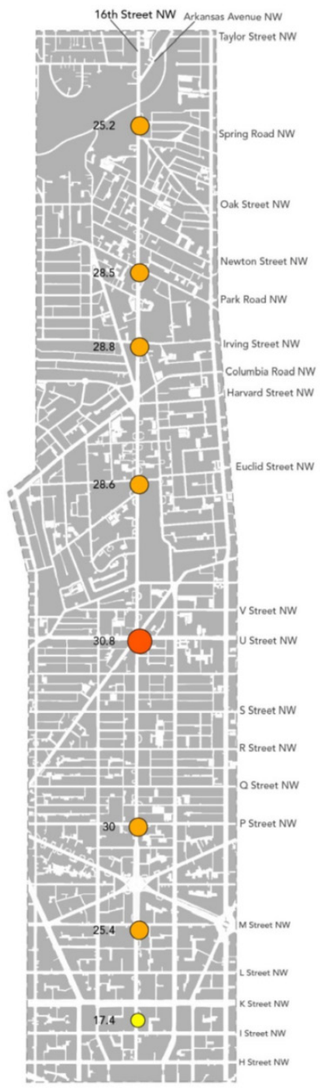
S9 AVERAGE LOAD WEEKDAY
AM PEAK-SOUTHBOUND



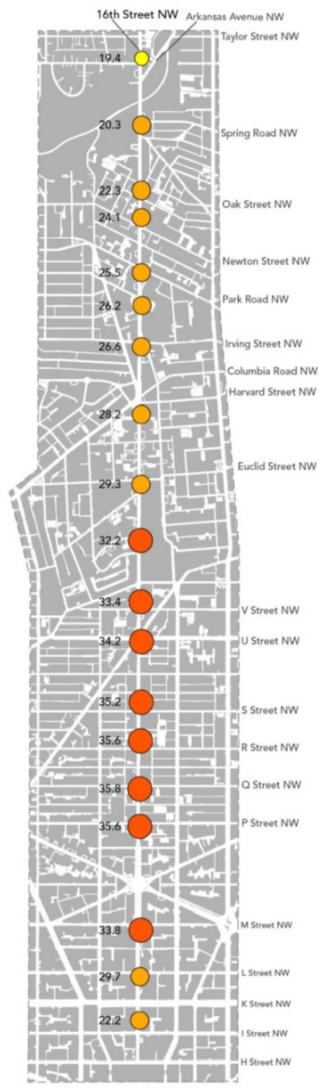
S1, S2, S4 AVERAGE LOAD WEEKDAY
AM PEAK-SOUTHBOUND



S9 AVERAGE LOAD WEEKDAY
PM PEAK-NORTHBOUND



S1, S2, S4 AVERAGE LOAD WEEKDAY
PM PEAK-NORTHBOUND



Source: WMATA S Line Raw Bus State Data from October 2014

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