Metrobus Service Evaluation Study
Pershing Drive-Arlington Boulevard Line
Routes 4A, 4B, 4E, 4H

Technical Memorandum #2
Traffic Operations Assessment

June 2013

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1.0 Introduction

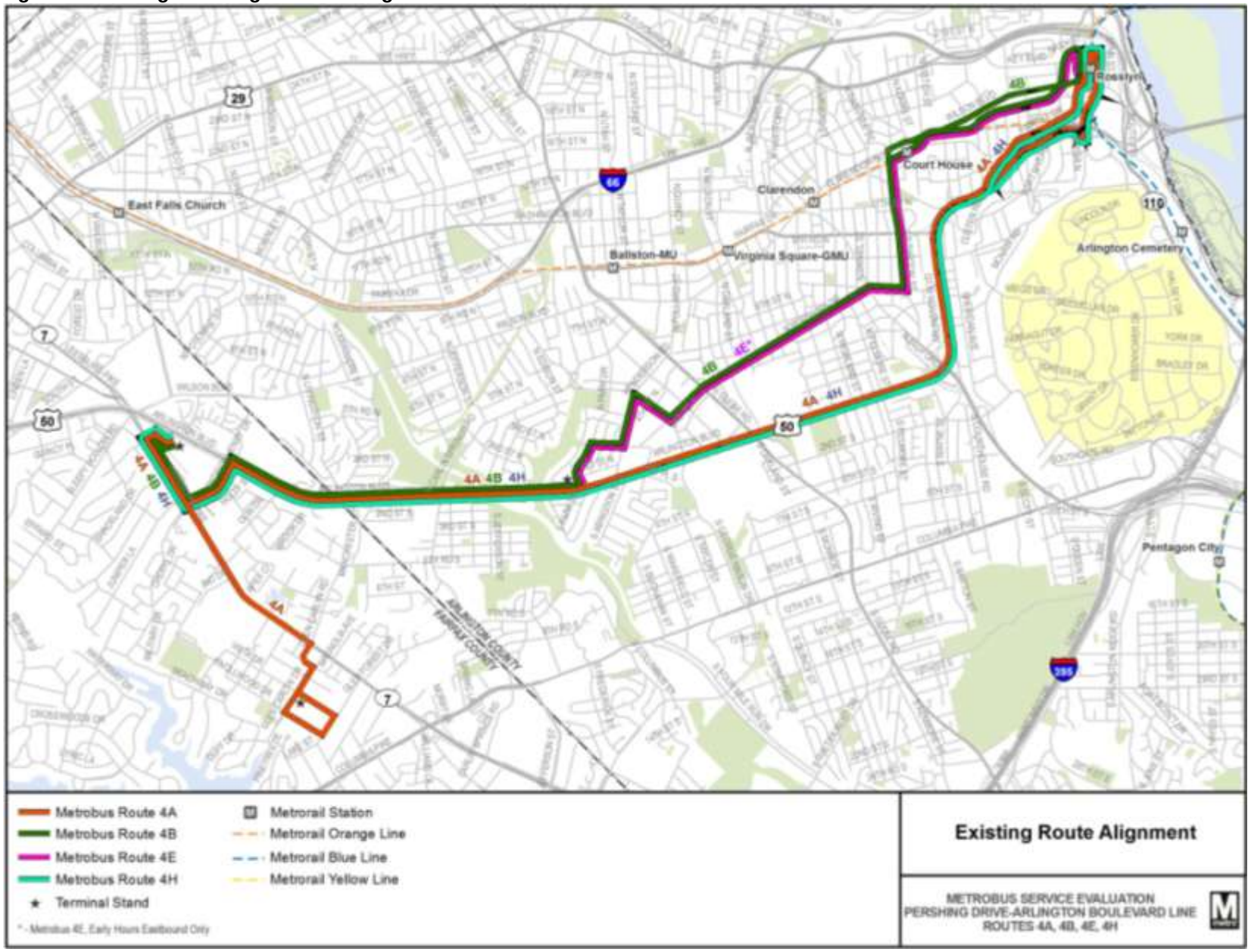
The Washington Metropolitan Area Transit Authority (WMATA) is studying ways to improve transit service along the Metrobus Pershing Drive - Arlington Boulevard Line (Routes 4A, 4B, 4E, 4H). One element of the study is to assess the traffic conditions along the line, with an emphasis on identifying traffic operational issues that negatively impact run times and service reliability of the line. This traffic assessment is the subject of this technical memorandum. The inventory of existing conditions will help identify problem areas as well as opportunities for improving traffic operations along the Pershing Drive – Arlington Boulevard Line.

This study focuses on peak period operations and traffic conditions for the line. **Error! Reference source not found.** shows the existing Pershing Drive – Arlington Boulevard Line.

The organization of the remainder of the technical memorandum is as follows:

- Section 2: Existing Traffic Conditions Review
- Section 3: Review of Existing Studies
- Section 4: Conclusion

Figure 1: Existing Pershing Drive - Arlington Boulevard Line Route



2.0 Existing Traffic Conditions Review

The Pershing Drive – Arlington Boulevard Line consists of the following route patterns:

- The 4A route is 8.2 miles long and operates on weekdays between Rosslyn Metro Station and Culmore (Vista Drive & Glen Carlyn Drive) via Arlington Boulevard
- The 4B route is 6.3 miles long and operates on weekdays, Saturdays, and Sundays between Rosslyn Metro Station and Seven Corners Transit Center via Pershing Drive.
- The 4E route is 3.9 miles long and operates on weekdays traveling eastbound in the AM peak period only between Arlington Forest (Arlington Boulevard & Park Dr.) and Rosslyn Metro Station via Pershing Drive.
- The 4H route is 6 miles long and operates on weekdays and Saturdays between Rosslyn Metro Station and Seven Corners Transit Center via Arlington Boulevard

2.1 Right-of-Way Conditions: Lane Configurations and Parking

The current alignment and lane configuration of the 4A and 4H routes from east to west between Rosslyn Metro Station and Seven Corners Transit Center are as follows:

- Moore Street between 19th Street and Wilson Boulevard has two (2) travel lanes in the southbound direction.
- Wilson Boulevard between Moore Street and Fort Myer Drive has two (2) travel lanes in each direction.
- Fort Myer Drive between Wilson Boulevard and Fairfax Drive three (3) travel lanes in the southbound direction.
- Fairfax Drive between Fort Myer Drive and Arlington Boulevard has one (1) travel lane in each direction.
- Arlington Boulevard (service road) between Rolfe Street and Meade Street has one (1) travel lane in each direction.
- Meade Street between Arlington Boulevard (service road) and Fairfax Drive has two (2) travel lanes in each direction.
- Lynn Street between Fairfax Drive and Wilson Boulevard has four (4) travel lanes in the northbound direction.
- Lynn Street between Wilson Boulevard and 19th Street has four (4) travel lanes in the northbound direction with on-street parking along both curbsides.
- 19th Street between Lynn Street and Moore Street has one (1) travel lane in each direction.
- Arlington Boulevard between Fairfax Drive and Patrick Henry Drive has three (3) travel lanes in each direction.
- Patrick Henry Drive between Arlington Boulevard and Leesburg Pike has one (1) travel lane in each direction with on-street parking in both directions.
- Leesburg Pike between Patrick Henry Drive and Castle Road has three (3) travel lanes in each direction.

The remaining 4A route continues beyond the Seven Corners Transit Center to Culmore and has the following alignment from east to west:

- Leesburg Pike between Patrick Henry Drive and Glen Carlyn Drive has two (2) travel lanes in each direction.

- Glen Carlyn Drive between Leesburg Pike and Argyle Drive has one (1) travel lane in each direction.
- Glen Carlyn Drive between Argyle Drive and Knollwood Drive has one (1) travel lane in each direction with on-street parking in both directions.
- Vista Drive between Glen Carlyn Drive and Lake Street has one (1) travel lane in each direction with on-street parking in both directions.
- Lake Street between Vista Drive and Knollwood Drive has one (1) travel lane in each direction with on-street parking in both directions.
- Knollwood Drive between Lake Street and Glen Carlyn Drive has one (1) travel lane in each direction with on-street parking in both directions.

The current alignment and lane configuration of the 4B and 4E routes from east to west between Rosslyn Metro Station and Arlington Forest (Arlington Boulevard & Park Dr.) are as follows:

- Moore Street between 19th Street and Wilson Boulevard has two (2) travel lanes in the southbound direction.
- Wilson Boulevard between Moore Street and Oak Street has two (2) travel lanes in each direction.
- Wilson Boulevard between Oak Street and Courthouse Road has two (2) travel lanes in the westbound direction with on-street parking along both curbsides.
- Wilson Boulevard between Courthouse Road and Veitch Street has two (2) travel lanes in the westbound direction with on-street parking along the right curb line.
- Wilson Boulevard between Veitch Street and Barton Street has two (2) travel lanes in the westbound direction with on-street parking along both curbsides.
- Clarendon Boulevard between Barton Street and Wayne Street has two (2) travel lanes in the eastbound direction with on-street parking along both curbsides.
- Clarendon Boulevard between Wayne Street and Courthouse Road has two (2) travel lanes in the eastbound direction with on-street parking along the right curb line.
- Clarendon Boulevard between Courthouse Road and Ode Street has two (2) travel lanes in the eastbound direction with on-street parking along both curbsides.
- Clarendon Boulevard between Ode Street and Oak Street has three (3) travel lanes in the eastbound direction.
- Nash Street between Wilson Boulevard and Fort Myer Drive has one (1) travel lane in each direction with on-street parking in both directions.
- 19th Street between Nash Street and Moore Street has two (2) travel lanes in each direction.
- Barton Street between Wilson Boulevard and Pershing Drive has one (1) travel lane in each direction with on-street parking in both directions.
- Pershing Drive between Barton Street and Washington Boulevard has one (1) travel lane in each direction with on-street parking in both directions.
- Pershing Drive between Washington Boulevard and Garfield Street has two (2) travel lanes in each direction.
- Pershing Drive between Garfield Street and George Mason Drive has one (1) travel lane in each direction with on-street parking in both directions.
- George Mason Drive between Pershing Drive and Henderson Road has two (2) travel lanes in each direction.
- Henderson Road between George Mason Drive and 2nd Street has one (1) travel lane in each direction with on-street parking in both directions.

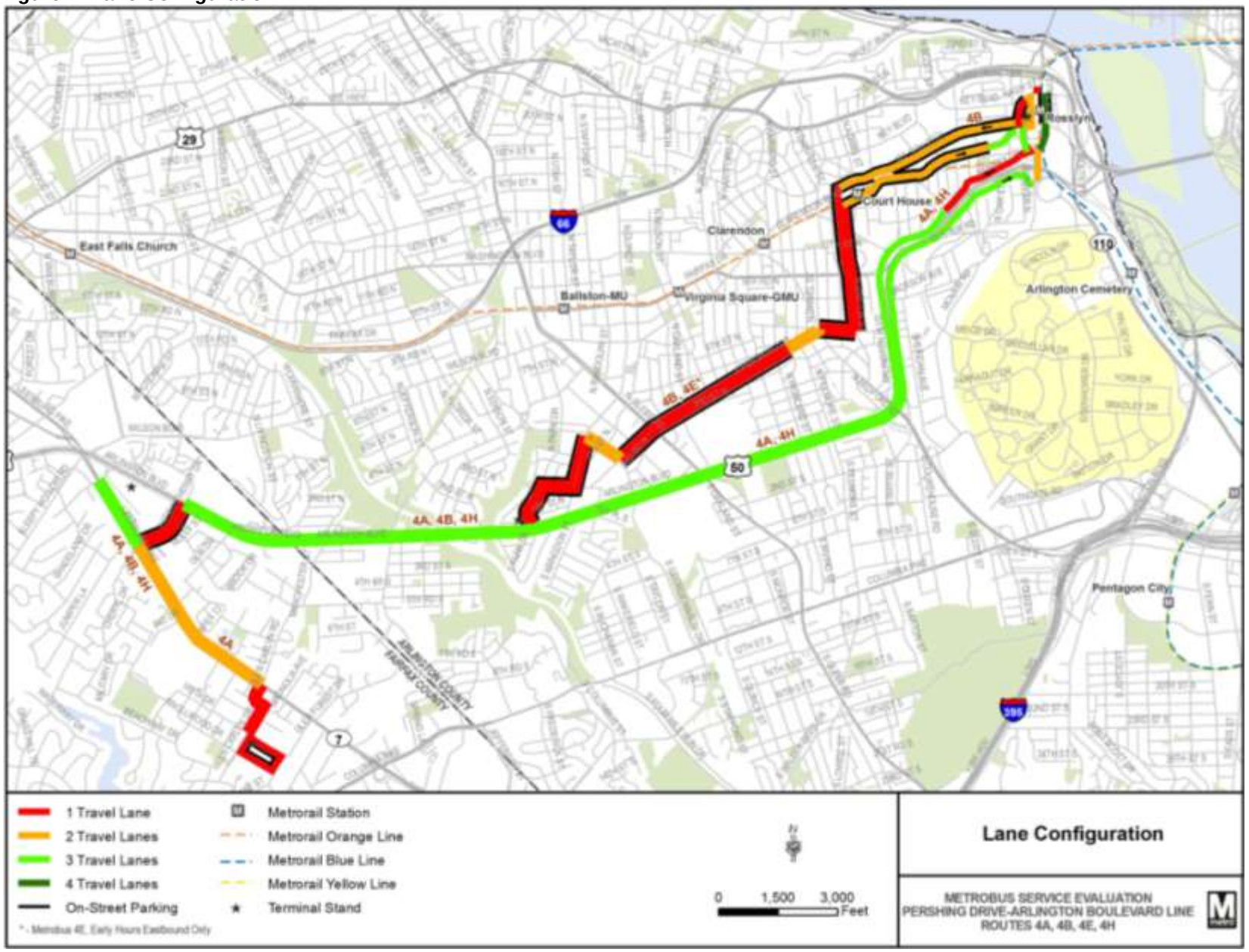
- 2nd Street between Henderson Street and Park Drive has one (1) travel lane in each direction with on-street parking in both directions.
- Park Drive between 2nd Street and Arlington Drive has one (1) travel lane in each direction with on-street parking in both directions.

The remaining 4B route continues beyond Arlington Forest to Seven Corners Transit Center and has the following alignment from east to west:

- Arlington Boulevard between Park Drive and Patrick Henry Drive has three (3) travel lanes in each direction.
- Patrick Henry Drive between Arlington Boulevard and Leesburg Pike has one (1) travel lane in each direction with on-street parking in both directions.
- Leesburg Pike between Patrick Henry Drive and Castle Road has three (3) travel lanes in each direction.

Figure 2 shows the alignment, lane configurations, and locations of on-street parking along the Pershing Drive – Arlington Boulevard Line.

Figure 2: Lane Configuration



2.2 Traffic Controls

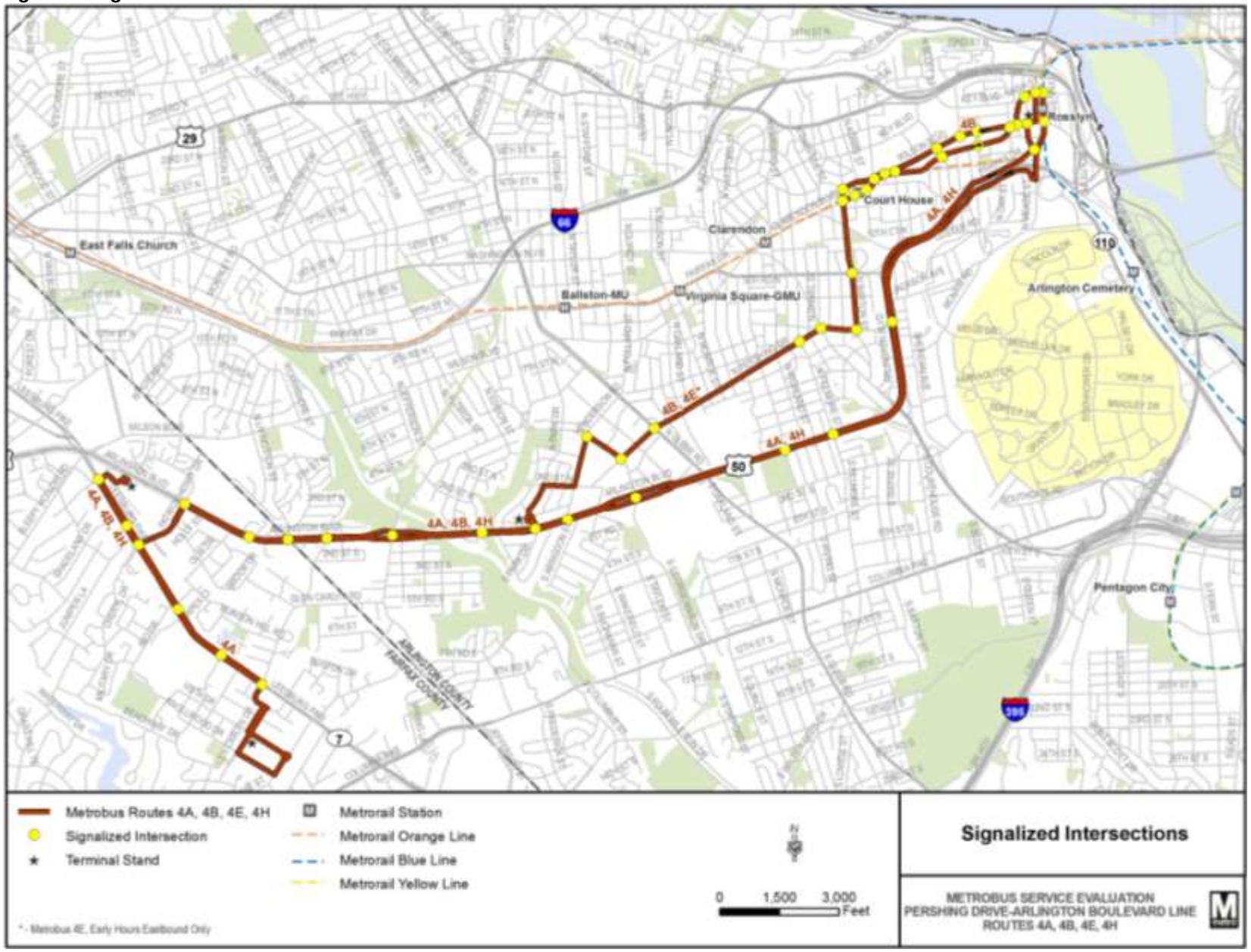
Signalized Intersections

Figure 3 shows a map of the Pershing Drive – Arlington Blvd Line alignment and all the signalized intersections along the lines. Overall, there are a total of 45 signalized intersections along the line.

Most of the signals operate with 4 to 8 phases depending on traffic demand and intersection geometry. Some of the prominent intersections along the Pershing Drive – Arlington Blvd Line include:

- Fort Myer Drive and Wilson Boulevard
- Arlington Boulevard and Pershing Drive
- Arlington Boulevard and Glebe Road
- Arlington Boulevard and George Mason Drive
- Arlington Boulevard and Carlin Springs Road
- Arlington Boulevard and Patrick Henry Drive
- Patrick Henry Drive and Leesburg Pike
- Leesburg Pike and Glen Carlyn Drive
- Wilson Boulevard and Veitch Street
- Barton Street and Clarendon Boulevard
- Barton Street and 10th Street
- Pershing Drive and Washington Boulevard
- Pershing Drive and Glebe Road
- Pershing Drive and George Mason Drive
- George Mason Drive and Henderson Road

Figure 3: Signalized Intersections



2.3 Travel Speeds

Traffic travel speeds were measured during the weekday AM and PM peak periods. These measurements depict factors affecting peak hour traffic conditions with which buses contend with along the Pershing Drive – Arlington Boulevard Line. Furthermore, these travel speeds include delays due to traffic congestion and the wait time at traffic signals.

Figure 4 and **Figure 5** depict the measured vehicle travel speeds along the Pershing Drive – Arlington Boulevard Line during the AM and PM peak periods, respectively. Several roadway sections were found to have slow travel speeds (less than 10 mph). **Table 1** lists the segments with travel speeds less than 10 mph.

Table 1: Pershing Drive – Arlington Boulevard Line Slow Travel Segments (<10mph)

From	To	Direction	Peak Period	Segment Length (miles)	Travel Speed (MPH)*
Rosslyn (19th & Moore)	Fort Myer Dr & Fairfax Dr	Westbound	PM	0.3	7.7
Arlington Dr & Carlin Springs Rd	Arlington Dr & Patrick Henry Dr	Westbound	PM	1.0	8.2
Glen Carlyn Dr & Knollwood Dr	Leesburg Pike & Glen Carlyn Dr	Eastbound	AM/PM	0.40	8.2/6.1
Arlington Dr & Fillmore St	Arlington Dr & Pershing Dr	Eastbound	PM	0.7	5.7
Fort Myer Dr & Fairfax Dr	Rosslyn (19th & Moore)	Eastbound	AM/PM	0.7	6.4/5.9
Pershing Dr & George Mason Dr	Pershing Dr & Glebe Dr	Eastbound	AM/PM	0.2	6.0/7.5

*Segments with two speeds refer to AM/PM

Figure 4: Travel Speeds (AM Peak)

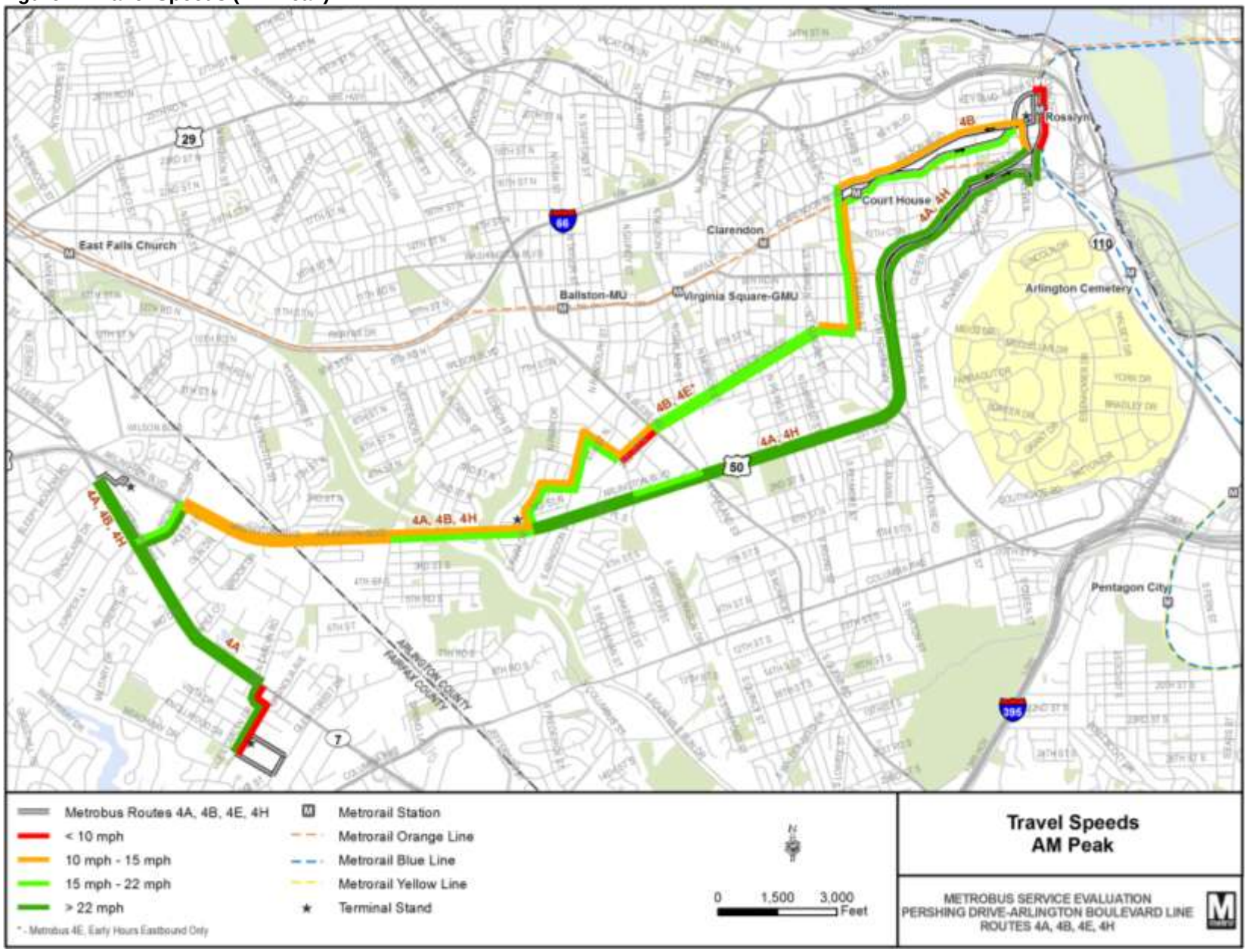
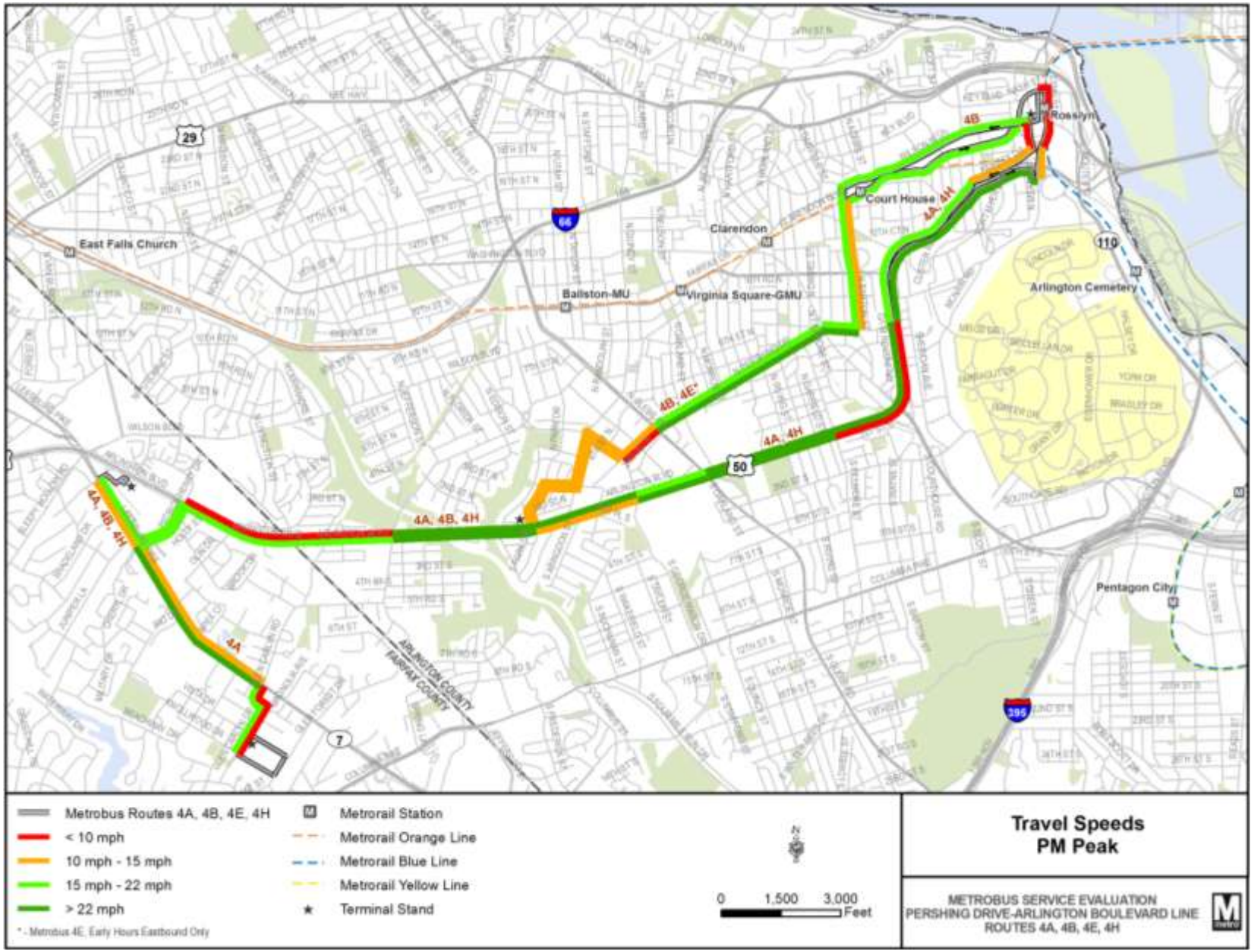


Figure 5: Travel Speeds (PM Peak)



2.4 Roadway Capacity

Figure 6 and **Figure 7** identify the volume-to-capacity ratios (v/c) along the Pershing Drive – Arlington Boulevard Line in each direction for the AM and PM peak periods, by alignment section. This data was extracted from the MWCOG regional model v2.3 2007 network. A high v/c is an indication of congestion, and demand is approaching or exceeding the capacity of the roadway while lower ratios indicate that existing roadway provides adequate capacity.

A summary of v/c ratios and associated roadway operations is included below:

- v/c ratio of less than .6 – free flowing operations
- v/c ratio - .6 to .8 – generally free flow operations – some intermittent slowing
- v/c ratio - .8 to 0.9 – significant traffic slowing – approaching capacity
- v/c ratio greater than 0.9 – consistently slow traffic – system operating poorly

Volume-to-capacity ratios were not available for the following segments along the Pershing Drive – Arlington Blvd Line:

- On Barton Street between Clarendon Boulevard and Pershing Drive
- Segment along Henderson Road, 2nd Street, and Park Drive
- Segment between Vista Drive, Lake Street and Knollwood Drive

Major roadway sections where traffic volumes are at or over capacity (v/c > 0.9) in the AM peak period include:

- Westbound Wilson Boulevard between Quinn Street and Rhodes Street
- Southbound Leesburg Pike between Patrick Henry Drive and Glen Carlyn Road
- Northbound Leesburg Pike between Row Street and Patrick Henry Drive
- Eastbound Arlington Boulevard between Patrick Henry Drive and Nottingham Street
- Eastbound Arlington Boulevard between George Mason Drive and entrance to National Foreign Affairs Training Center
- Eastbound Arlington Boulevard between Jackson Street and Highland Street
- Eastbound Arlington Boulevard between Fillmore Street and Washington Boulevard
- Eastbound Arlington Boulevard between 2nd Street and Pershing Drive
- Eastbound Arlington Boulevard between Courthouse Road and Meade Street
- Eastbound Pershing Drive between Jackson Street and Washington Boulevard
- Eastbound Clarendon Boulevard between Barton Street and Pierce Street

Major roadway sections where traffic volumes are at or over capacity (v/c > 0.9) in the PM peak period are:

- Southbound Moore Street between 19th Street and Wilson Boulevard
- Westbound Wilson Boulevard between Pierce Street and Veitch Street
- Westbound Pershing Drive between Washington Boulevard and Glebe Road
- Westbound Arlington Boulevard between Meade Street and Fairfax Drive
- Westbound Arlington Boulevard between Washington Boulevard and Fillmore Street
- Westbound Arlington Boulevard between Highland Street and Jackson Street
- Westbound Arlington Boulevard between Thomas Street and George Mason Drive
- Westbound Arlington Boulevard between Nottingham Street and Patrick Henry Drive

- Southbound Leesburg Pike between Patrick Henry Drive and Nevius Street
- Northbound Leesburg Pike between Nevius Street and Patrick Henry Drive
- Eastbound Arlington Boulevard between Patrick Henry Drive and Fallswood Glen Court
- Eastbound Wilson Boulevard between Rhodes Street and Pierce Street

Figure 6: Volume-to-Capacity Ratio (AM Peak)

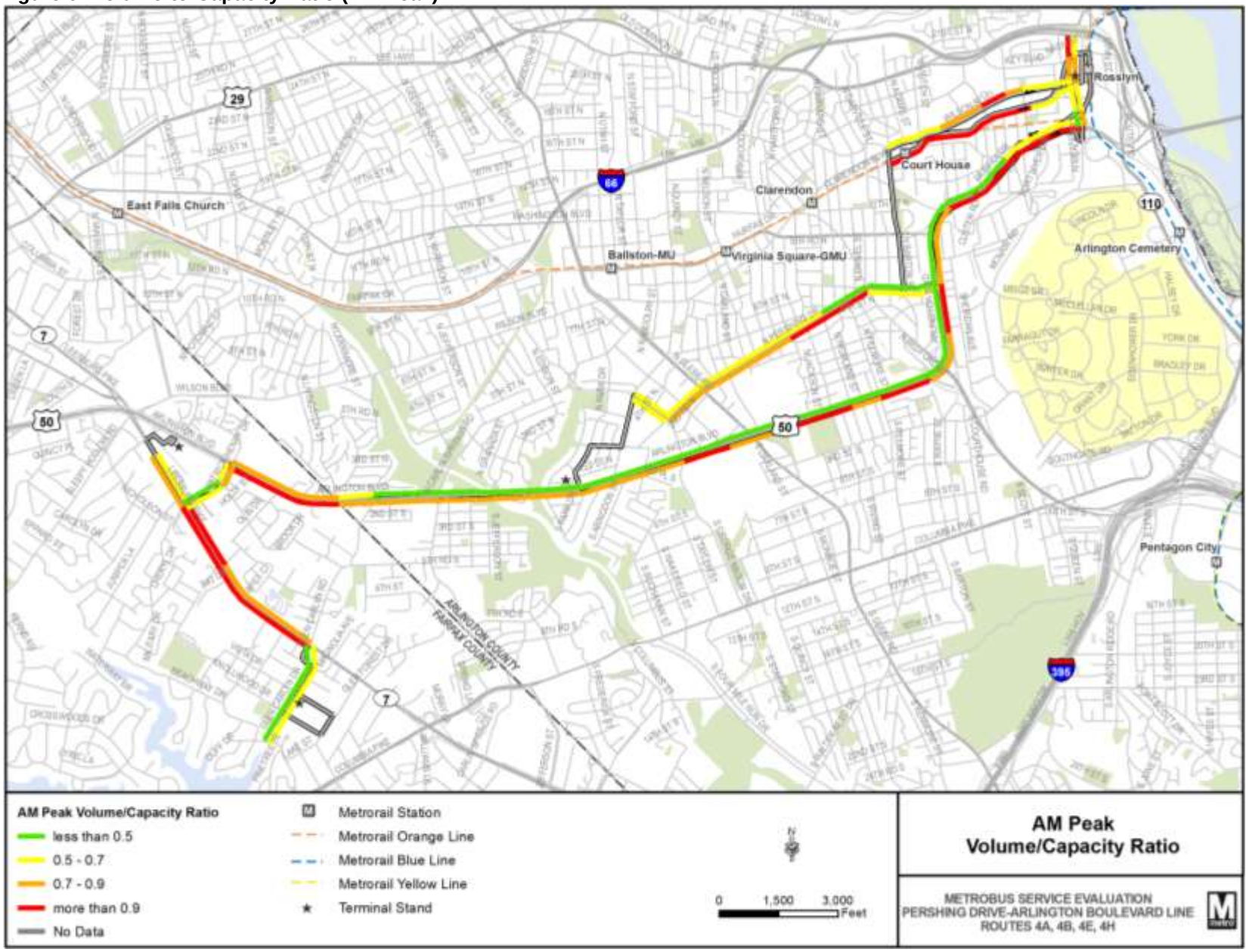
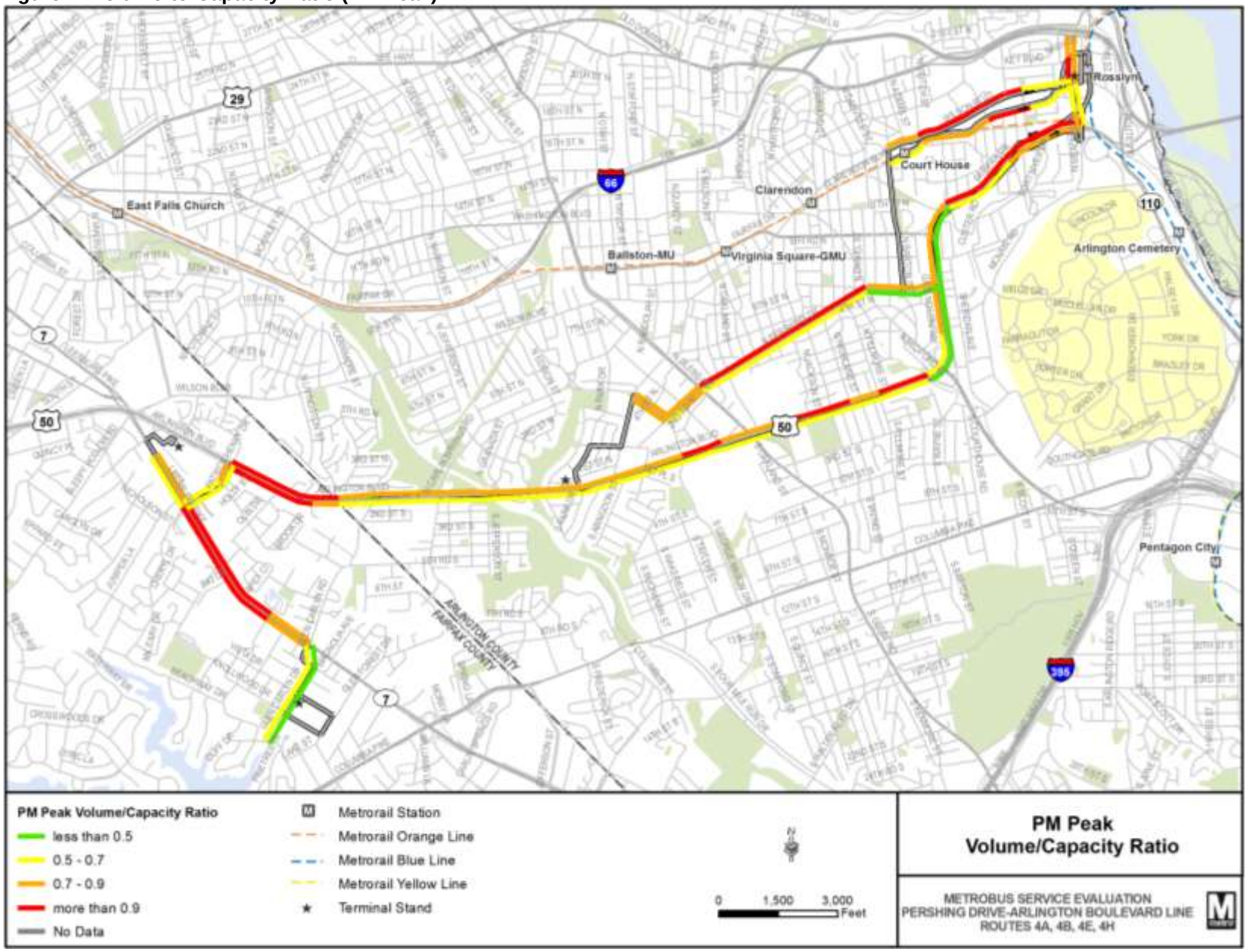


Figure 7: Volume-to-Capacity Ratio (PM Peak)



2.5 Traffic Operational Issues – Findings

Traffic operational issues for the 4 Line have been identified based on bus operator notes and consultant field observations/analysis during the AM and PM peak periods. Details on the traffic operational issues are outlined in this section. Traffic issues and recurring points of delay identified along the two lines corridors are shown in **Figure 8**. The findings from the traffic operational issues will be evaluated in the *Recommendations Technical Memorandum*.

a. Signal Timing and Phasing

Bus delays were observed at several locations along the Pershing Drive – Arlington Boulevard Line alignment, listed as follows.

- ***Arlington Boulevard and Carlin Springs Road*** – Long signal cycles were observed along eastbound and westbound Arlington Boulevard Access Road at Carlin Springs Road during both AM and PM peak periods. Buses were observed waiting for over a minute at the signal with minimal cross-traffic passing through the intersection.

- ***Arlington Boulevard and Patrick Henry Drive*** – Long queues and signal cycles were observed at the intersection of Arlington Boulevard and Patrick Henry Drive during both AM and PM peak periods. Westbound buses were observed waiting for several minutes at the signal and through multiple signal cycles to make the left turn from Arlington Boulevard onto Patrick Henry Drive. This wait was due to a short left turn signal and long queues which were observed spilling over the queue lane and into the adjacent thru traffic lane. Eastbound buses were observed waiting for several minutes at the signal due to long queues to make the right turn from Patrick Henry Drive onto Arlington Boulevard.

- ***Leesburg Pike and Patrick Henry Drive*** – Long queues and signal cycles were observed along southbound Leesburg Pike and Patrick Henry Drive during both AM and PM peak periods. Buses were observed waiting for several minutes at the signal and through multiple signal cycles to make the left turn from Leesburg Pike onto Patrick Henry Drive.

- ***Pershing Drive and Washington Boulevard*** – Long signal cycles were observed along eastbound and westbound Pershing Drive at Washington Boulevard during both AM and PM peak periods. Buses were observed waiting for over a minute at the signal.

- ***Pershing Drive and Glebe Road*** – Long signal cycles were observed along eastbound Pershing Drive at Glebe Road during both the AM peak period. Buses were observed waiting for over a minute at the signal.

- ***Pershing Drive and George Mason Drive*** – Long signal cycles were observed along westbound Pershing Drive at George Mason Drive during both AM and PM peak periods. Buses were observed waiting for over a minute at the signal.

- ***Park Drive and Arlington Boulevard*** – Long signal cycles were observed along westbound Park Drive at Arlington Boulevard during both AM and PM peak periods. Buses were observed waiting for several minutes at the signal.

b. Transit Stop Location and Parking Restrictions

- ***Wilson Boulevard and Courthouse Road*** – The transit stop along westbound Wilson Boulevard at Courthouse is blocked by magazine stands. All riders have to exit out the front door, which causes the bus to miss the signal. The magazine stands also block ADA access to the bus. As a short term solution, Arlington County's bus stop maintenance staff will move the magazine stands down the sidewalk to not block the bus doors. Arlington County is currently planning a streetscape improvement project for this area and there is the potential to make permanent improvements to this stop in the future.

- ***Barton Street and Pershing Drive*** – The transit stop along southbound Barton Street at Pershing Drive is close to the intersection. The curb at the intersection bulbs out, and thus the bus is forced to make a difficult wide turn onto Pershing Drive from the stop. Arlington County Bus Stop Program Manager will review the intersection geometry with the Traffic Engineering Bureau and will look into making ADA improvements to the bus stop.

- ***Arlington Boulevard and Montague Street*** – 4A and 4B buses were observed bunching on eastbound Arlington Boulevard at the Montague Street bus stop. The stop features a bus pull off lane and vehicles were observed having a difficult time entering the right traffic lane. Arlington County Bus Stop Program Manager will look into extending the bus pull off lane or moving the shelter to the west. Improvements to the stop will be coordinated with Fairfax County, as the bus stop/bus pull-off lane is split by the boundary between Fairfax and Arlington Counties.

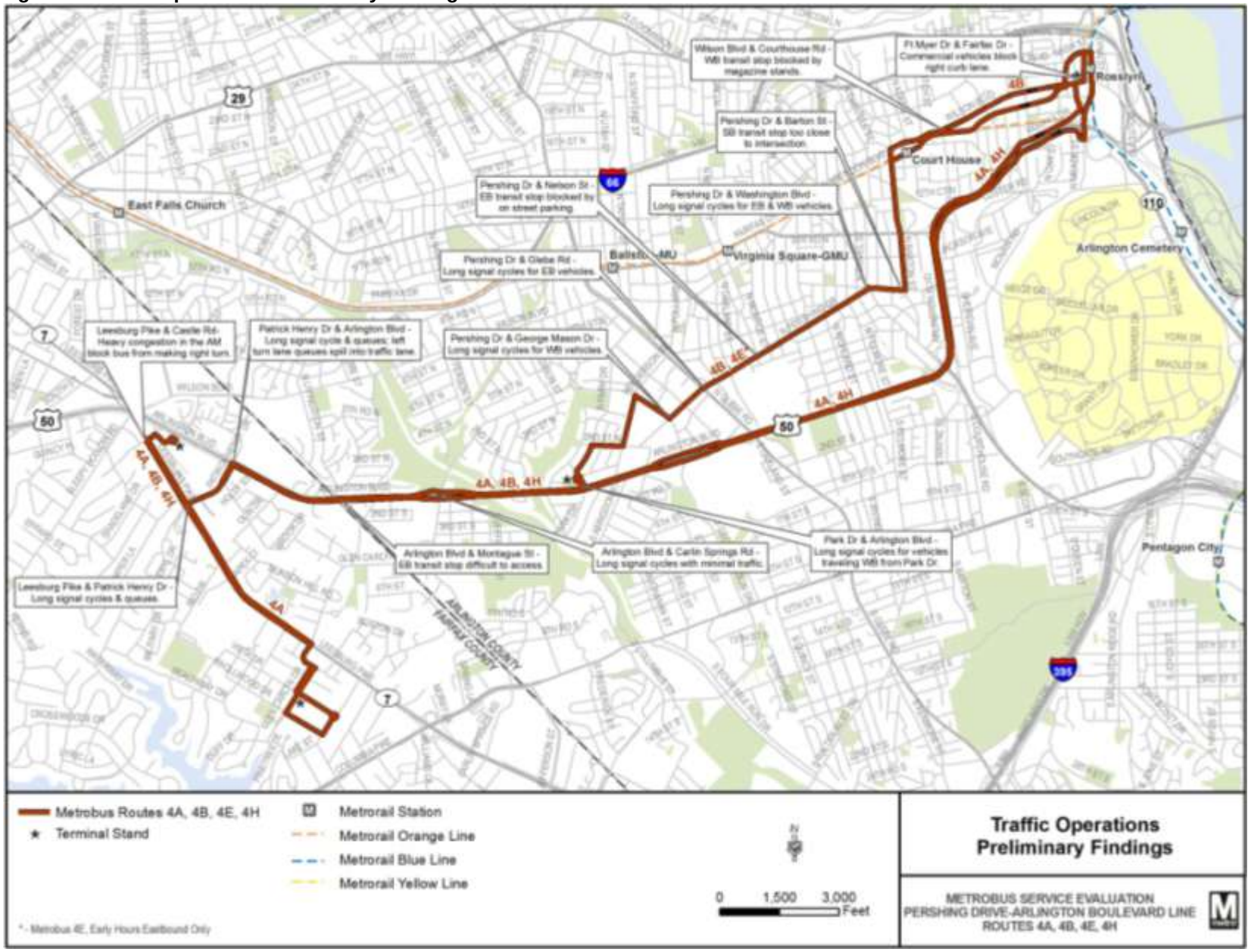
- ***Pershing Drive and Nelson Street*** – The transit stop along eastbound Pershing Drive at Nelson Street has on street parking available in front of the bus stop sign. Buses drive past the stop in order to access the curb lane. Buses are also forced to load/unload passenger in the road right of way. Arlington County Bus Stop Program Manager will look into relocating the bus stop.

c. Intersection Conflicts

- ***Fort Myer Drive and Fairfax Drive*** – Commercial vehicles accessing the loading dock at 1616 Fort Myer Drive were observed blocking the right curb lane. Buses were forced to move into the left lane and then make an immediate right onto Fairfax Drive.

- ***Leesburg Pike and Castle Road*** – Heavy congestion during the AM peak period blocked buses from making the right turn from Leesburg Pike onto Castle Road causing buses to sit through multiple signal cycles. The congestion is attributed to backup delays at the Seven Corners intersection.

Figure 8: Traffic Operations Preliminary Findings



3.0 Review of Existing Studies and Planned Improvements

The following projects are currently on-going or planned for areas in the proximity of the Pershing Drive – Arlington Blvd Line. Proposed improvements/recommendations from this study should be coordinated with these projects/studies as necessary.

VDOT PROJECTS

- **Route 50/10th Street and Route 50/Courthouse Road Improvements to two interchanges in Arlington County:** This project improves the interchanges on Arlington Boulevard at 10th Street and at Courthouse Road. The 10th Street and Courthouse Road bridges over westbound Arlington Boulevard will be replaced, and dedicated acceleration/deceleration lanes will be added on Arlington Boulevard, separated from the main roadway. These new lanes will improve traffic flow by managing the merge of entering and exiting vehicles. Additional improvements include:
  - Signalized intersections providing access from eastbound Arlington Boulevard to 10th Street and Courthouse Road;
  - Ramps providing access from westbound Arlington Boulevard to 10th Street and Courthouse Road; and
  - A signalized "T" intersection providing access from both directions of Fairfax Drive to the Courthouse Road ramp

  To allow crews to reconstruct the interchanges, four closures with signed detours are expected over the course of the project:

  - Westbound ramp to N. Courthouse Road (Detour 15th St. N) as well as westbound Arlington Boulevard to N. Fairfax Drive (Detour 10th St. N);
  - Fairfax Drive between N. Troy Street and N. Scott Street Detour N. Scott Street to 13th St. N. to N. Troy St. from spring 2012 to fall 2013;
  - Bridge from southbound 10th Street to eastbound Arlington Boulevard (Detour Washington Boulevard to N. Pershing to Arlington Boulevard) and the ramp from westbound Arlington Boulevard to N. Fairfax Drive from spring 2012 to fall 2013; and
  - Bridge for eastbound Rt. 50 to and from Courthouse Road from fall 2012 to spring 2013.

  As the trail along westbound Arlington Boulevard is also closed in the project area during construction, some detours for bicycles and pedestrians are also suggested. A bicycle trail will be added eastbound on Arlington Boulevard from Pershing Drive to Rolfe Street, and the existing westbound trail will be relocated and extended under the 10th Street Bridge. Two existing bus stops along westbound Arlington Boulevard will be consolidated into one stop.

ARLINGTON COUNTY PROJECTS

- **Ballston-Rosslyn Arterial Street Improvements:** Projects are located on Clarendon Blvd, Wilson Blvd, Clarendon Circle, Fairfax Drive and nearby intersecting streets. Projects include improved intersection geometry, updated traffic signals, left-turn lanes, accessible walking routes, bike lanes, new signage and striping, utility undergrounding, ADA compliant sidewalks and crosswalks, new streetlights, street trees, and modern bus facilities that are designed with consideration to incorporate artistic elements. This program will implement projects to upgrade physical conditions along sections of the Rosslyn-Ballston corridor in most critical need for improvement.

  The focus will be on areas where the oldest and most outdated pedestrian infrastructure and street conditions exist. Projects will rebuild streets as "Complete Streets" where all modes of transportation and street elements are accommodated typically from building face to building

face. The transportation benefit will be the ability of this corridor to handle a 45% increase in person trips by 2030 and improve conditions for the current +90,000 workers and +40,000 residents.

- **Rosslyn Station Access Improvements:** This project includes the design and construction of three new high-capacity elevators, a mezzanine with fare gates and kiosk, emergency stairs, and related infrastructure for the Rosslyn Metrorail station. Arlington County is leading this project and coordinating these improvements with WMATA and the adjacent redevelopment per the approved site plan for Central Place located across from the entrance to the Metro station. The project costs are estimated to total $50 million and are being covered by federal, state, local, and private funds. All new operating and maintenance costs that result from the opening and use of the new entrance will be covered by the Metrorail regionally allocated operating subsidy.

- **Court House Station Second Elevator:** This project will provide for engineering, design, and construction of a second elevator to the Court House Metrorail station from the street level to the station mezzanine. WMATA is currently studying location options for the second elevator and will provide a concept plan and cost estimate for the County's consideration. WMATA Board established an elevator redundancy plan stating that each Metrorail station should have a minimum of two elevators from the street level to the train platform for ADA access.

- **Improvements to Major Travel Corridors Outside Principal Business Districts:** Near-term projects include design and construction of pedestrian and bicycle facilities along Washington and Arlington Boulevards.

Other Ongoing and Proposed Studies include:

- Priority bus from Eastern Loudoun County to Arlington County on US 50.

4.0 Findings

Based on the data analysis and preliminary findings of the traffic assessment, the following are the summary of primary findings:

- Bus delays were observed at several locations including the signals at Leesburg Pike & Castle Road, Leesburg Pike & Patrick Henry Drive, Patrick Henry Drive & Arlington Boulevard, Park Drive & Arlington Boulevard (4B only), Pershing Drive & George Mason Drive, Pershing Drive & Glebe Road, and Pershing Drive & Washington Boulevard.
- The intersection at Arlington Boulevard & Carlin Springs Road was observed to have long signal phases with minimal traffic.
- It was noted that some transit stops were difficult for the bus to access including Arlington Boulevard & Montague Street, Pershing Drive & Nelson Street, Pershing Drive & Barton Street, and Wilson Boulevard & Courthouse Road.
- Vehicles were observed blocking traffic lanes at Fort Myer Drive & Fairfax Drive.