Station Access & Capacity Study

Final Report
April 2008

METRORAIL STATION ACCESS & CAPACITY STUDY

Washington Metropolitan Area Transit Authority

metro

Final Report
April 2008

a joint venture of:
- Parsons Transportation Group Inc.
- PB Americas, Inc.
- Delon Hampton & Associates, Chartered

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EXECUTIVE SUMMARY

Thirty years after service first began on the Washington Metrorail, the system has become an integral and important part of the region's transportation network. Metrorail ridership has increased over the years as the system expanded and the region developed. Ridership continues to increase as development occurs throughout the region, particularly near stations. Continued growth in ridership requires expansion of station facilities to handle passenger flow within the station, as well as expansion of facilities to support auto, bus, and pedestrian access to stations.

In order to meet growing demand and maximize capacity of the system, the Washington Metropolitan Area Transit Authority (Metro) initiated the Station Access and Capacity Study, a systemwide look at future passenger demand and available capacity. The purpose of the study was to identify and prioritize the needs of the existing 86 stations and identify stations where more detailed analysis is needed. The study addressed three basic questions:

- How will ridership grow over the next 25 years?
- Is there sufficient capacity to handle the growth?
- How will customers access the system?

Background

The Station Access and Capacity Study built upon the efforts of two previous studies. The Transit Service Expansion Plan in 1999 called for maintaining transit shares in existing markets, creating new markets through focused development near stations, and expanding the reach of rail throughout the region, the combination of which would result in doubling transit ridership—bus and rail—by 2025. The 2002 Core Capacity Study focused on capacity deficiencies at the core stations in the Metrorail system based on the ridership growth and full system expansion envisioned in the 1999 plan.

Instead of assuming major system expansion like the studies above, this study focused on the planned Metrorail system improvements contained in the region's fiscally Constrained Long Range Plan (CLRP) and addressed the needed improvements to system capacity and station access throughout the entire Metrorail system to support the ridership growth. It also identified stations where further detailed studies are needed.

Findings

The Washington, DC region is growing. Between 2000 and 2030, regional employment and households are each expected to increase by nearly 50 percent. The study found that ridership growth will continue into the future, placing demands on system and station capacity. Ridership increases are expected to be primarily driven by system expansion—the Dulles Corridor Metrorail extension—and regional growth.

Figure 1. Assumed 2020 and 2030 Metrorail System Map

Ridership Trends

The study forecasted that the system ridership will reach 970,000 daily by 2030, representing a 42 percent increase between 2005 and 2030, or an average annual growth rate of 1.7 percent. This growth trend will be influenced by a number of unknown factors and events such as modifications to the existing Metrorail network, continued increase in gasoline prices, increased parking costs near Metrorail stations, and population and job growth beyond what is already forecasted.

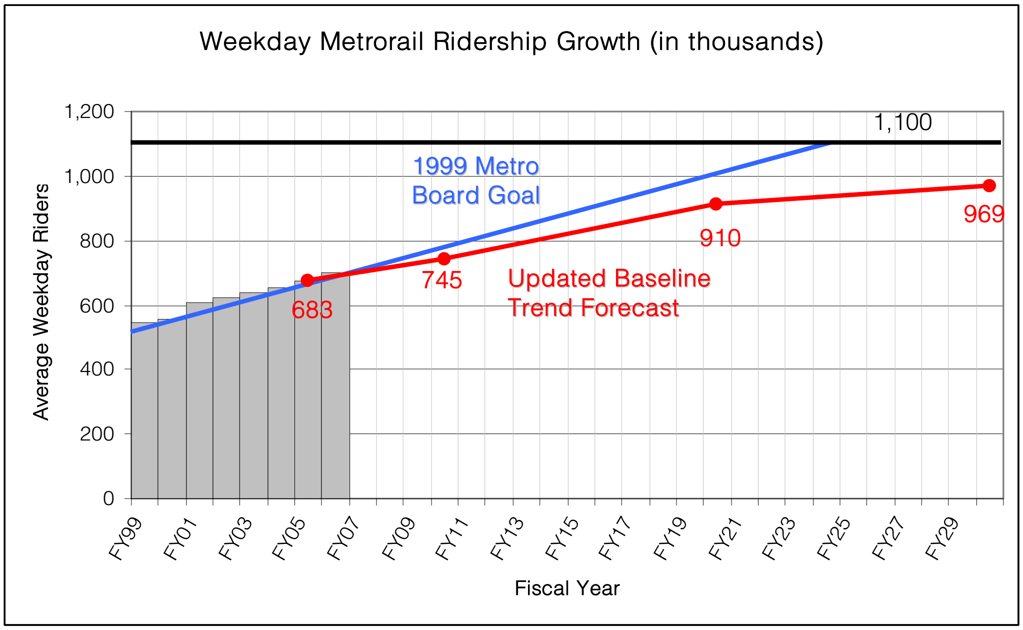

Figure 2. Past and Forecasted Metrorail Ridership

High-ridership stations. The current top ridership stations will remain high-ridership stations. The top ridership stations in 2030 are forecasted to include Metro Center, Gallery Place-Chinatown, Union Station, Farragut West, Dupont Circle, L'Enfant Plaza, Foggy Bottom-GWU, Farragut North, Rosslyn, and McPherson Square. Among the 86 stations, Court House and Gallery Place-Chinatown are expected to have high ridership growth as both neighborhoods will have substantial increases in households.

Growth inside and outside the core. Of the 2030 average daily ridership, 50 percent will be within the core, 12 percent in non-core areas of the District, 19 percent in non-core areas of Maryland, and 19 percent in non-core areas of Virginia. Within the system core, Metrorail ridership on all the lines will remain strong, reaching 365,000 trips daily by 2030. Outside the system core, ridership will experience faster growth than the growth inside the core, indicating a continuing trend of job and population growth in suburbs and an increasing demand for transit service outside the system core.

Peaking. The systemwide peaking pattern in 2030 is expected to be similar to that of 2005. Approximately 60 percent of daily ridership will occur during the AM and PM peak periods. The AM peak-hour Metrorail trips to non-core areas will grow faster than the core, suggesting an increasing demand for reverse commuting on Metrorail during the peak period. Stations located within the system core will remain top destinations of rush-hour trips totaling 75,100, the majority of which are work trips.

Transfers. This study found that significant increases will occur at the major transfer stations. Metro Center will remain the highest-volume transfer station, with large morning volume increases between the westbound Blue/Orange and eastbound Red Line. Rosslyn will see large increases in both transfer directions due in part to Silver Line volumes. Gallery Place-Chinatown will remain a major station handling passengers transferring between the Green, Red, and Yellow Lines. L'Enfant Plaza's peak-hour transfers would almost double, largely due to the future Blue Line split and forecasted ridership increases at Blue Line stations.

Line Capacity. This analysis showed that eight-car trains are needed on most Metrorail lines by 2020, confirming findings in the Core Capacity Study. If Metro operates all eight-car trains, the maximum load locations along each line would, in most cases, be the same in 2030 as in 2005. The most significant increase in the maximum passenger load between 2005 and 2030 will occur on the Orange and Yellow-Blue Lines. The opening of the Silver Line will result in a significant increase in the total load on the Orange and Silver Lines in Arlington. The increase of maximum load on Yellow-Blue Lines is mainly caused by the Blue Line split at Pentagon. However, further sensitivity tests in the demand-forecasting model are necessary to obtain an accurate assessment of ridership shift from the existing Blue Line to the Yellow-Blue Lines.

Station Trends

This study analyzed station-level access and capacity issues. To maximize ridership, pedestrian and bicyclist improvements should be made at fast-developing stations and mature stations with existing deficiencies. Station capacity improvements should be made at several key core and transfer stations.

Station Access

Based on data from the 2002 Survey, 62 percent of passengers walked or biked to stations, 16 percent drove and parked, 16 percent arrived by bus or commuter rail, and 6 percent arrived by Kiss & Ride, carpool, or taxi. At the core stations, an even greater percentage walk and bike, whereas at the stations outside the core, more drive and park.

Park & Ride. Metro presently owns and operates 58,186 parking spaces. On an average weekday, almost all of those spaces are occupied. Demand for parking will likely continue to outpace Metro's ability to provide it. If the access mode split were to remain constant, and station-area land were to develop according to MWCOG forecasts, as many as 44,000 new parking spaces could be needed by 2030. There are presently 8,100 spaces planned at four Silver Line stations, Glenmont, and Vienna. This falls quite short of what future demand could be, and Metro does not own enough land to make up the difference. A combination of transit-oriented development, satellite parking and feeder bus service, and private-sector and/or shared parking facilities can provide passenger access to stations.

Walking and biking access. The study prioritized pedestrian and bicyclist improvements based on an inventory of existing conditions and forecasted development rates. Stations in developing areas will have new needs, and some built-out and low-density stations need better pedestrian and bicycle facilities.

Station Capacity

Almost all needed capacity improvements will be at key transfer stations in the region's core. These are the highest-priority stations for capital investment, shown in Table 1.

Table 1. Existing and Future Station Capacity Issues

Station	Mezz	Vertical		Faregate	
		2005	*2030*	*2005*	*2030*
Archives-Navy Memorial-Penn Quarter		⊙	⊙		
Bethesda			⊙		
Branch Ave		⊙	⊙		
Cleveland Park					⊙
Court House			⊙		⊙
Farragut North	SE	◎	◎		
Farragut West	W	⊙	⊙		
Foggy Bottom-GWU		⊙	⊙		
Franconia-Springfield			⊙		
Gallery Pl-Chinatown	N	⊙	◎	⊙	◎
	W				⊙
Judiciary Square	E		⊙		
L'Enfant Plaza	E	⊙	◎		
	W		◎		
Metro Center	N	⊙	◎		⊙
	S	◎	◎		
	W		⊙		
Navy Yard*	E				⊙
Shady Grove		⊙	◎		
Takoma				⊙	⊙
Twinbrook					⊙
White Flint					⊙
Union Station	S	⊙	⊙		
	W	⊙	⊙		

Legend

⊙ Needs study ($0.5 \leq v/c < 0.75$)
◎ Needs improvement ($v/c \geq 0.75$)

**Note: Both Navy Yard mezzanines will have unique future needs, which may not be reflected in this analysis, due to the opening of the Washington Nationals Ballpark in 2008.*

Based on an order-of-magnitude analysis, the study identified a list of highest-priority capital improvements, including:

- Farragut North-Farragut West Tunnel: Construct pedestrian tunnel between two stations.
- Farragut North: Add southeast mezzanine-to-platform vertical capacity.
- Metro Center: Add platform-to-platform vertical capacity, possibly by building the Farragut North-Farragut West pedestrian tunnel. Building this tunnel could reduce Orange or Blue Line transfers to the Red Line.
- Gallery Place-Metro Center Tunnel: Construct pedestrian tunnel between two stations.
- Gallery Pl-Chinatown: Add platform-to-platform vertical capacity and faregates at the north mezzanine and extend mezzanine between 7th and 9th Street entrances.
- L'Enfant Plaza: Add platform-to-platform vertical capacity, possibly by building the Gallery Place-Metro Center pedestrian tunnel. Building this tunnel could decrease L'Enfant Plaza transfers.
- Shady Grove: Add mezzanine-to-platform vertical capacity.

Conclusion

Strong residential and employment growth in the Washington, DC region and the extension to the Dulles Corridor will generate additional Metrorail riders. Additionally, a proposed split of the Blue Line to accommodate the Dulles Corridor Metrorail extension would increase pressure on key transfer stations. As a result, by 2030, eight-car trains will be needed on several Metrorail Lines. To efficiently handle passenger volumes, Metro will need to enhance the capacity of several stations. One way to do so is to build the two previously proposed pedestrian tunnels between Farragut North and Farragut West, and Metro Center and Gallery Place. Finally, to ensure that passengers can access Metrorail stations, Metro and the local jurisdictions will need to work together to provide and/or improve pedestrian and bicycle facilities, satellite parking and feeder bus service, and shared parking facilities, while continuing to promote transit oriented development.

SECTION 1 STUDY PURPOSE AND APPROACH

Thirty years after service first began on the Washington Metrorail, the system has become an integral part of the region's transportation network. Metrorail ridership has increased over the years as the system expanded and the region developed. Ridership continues to increase as development occurs throughout the region, particularly near stations. There is widespread recognition that land use development around Metrorail stations has many benefits to the region and will support the Metro goal of doubling ridership between 2000 and 2025. However, station-area development requires tradeoffs among land needed for parking, bus bays, and adjacent development. Continued growth in ridership may require expansion of station facilities to handle passenger flow within the station, as well as expansion of facilities to support auto, bus, and pedestrian access to stations.

In order to meet growing demand and maximize capacity of the system, the Washington Metropolitan Area Transit Authority (Metro) initiated the Station Access and Capacity Study, a systemwide look at future passenger demand and available capacity. The purpose of the study was to identify and prioritize the needs of the existing 86 stations and identify stations where more-detailed analysis is needed.

Figure 3. Metrorail Station

1.1 Background

In 1999, the Metro Board set a goal in the Transit Service Expansion Plan of doubling transit—bus and rail—ridership by 2025. This would mean an annual growth rate of about three percent per year and weekday Metrorail ridership of approximately 1.1 million by 2025. In general, growth was expected to occur by maintaining transit shares in existing markets, creating new markets by focusing development near stations, and expanding the reach of rail throughout the region. The plan called for station enhancements, additional parking, additional feeder bus service, and new lines including the Dulles corridor and the Purple Line. Overall, the plan called for an approximate 50 percent increase in fixed-guideway miles.

Figure 4. 2007 Metrorail System Map

In 2002, Metro initiated the Core Capacity Study to analyze what would happen to the inner, or core, stations and rail network if the Board's ridership and system expansion goals were met. The 29 core stations, show in Figure 5, handle the majority of riders and transfers between lines.

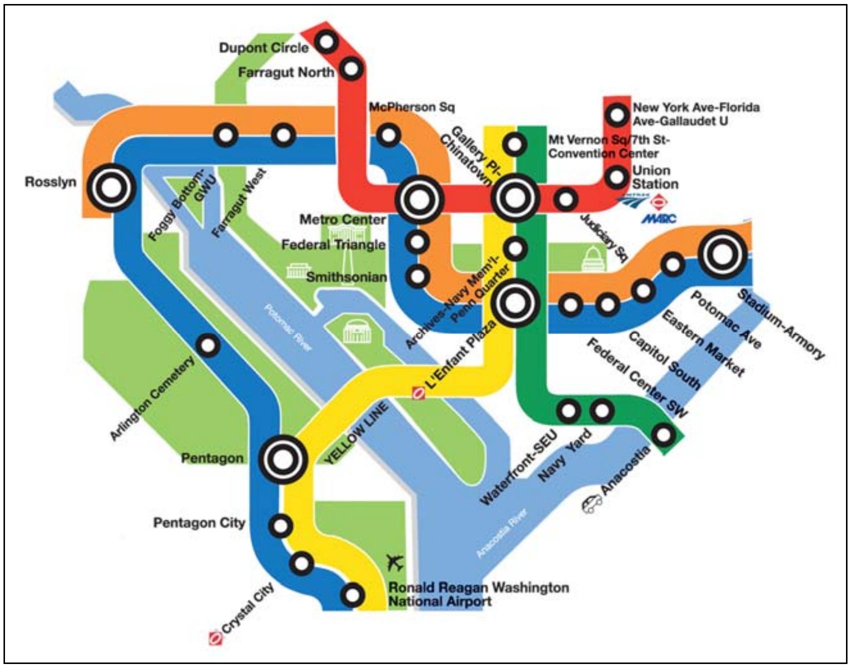

Figure 5. Metrorail Core

The Core Capacity Study found that daily Metrorail ridership could reach 1.4 million by 2025, given a certain amount of system expansion including the Purple Line. The study also found that AM peak half-hour transfers could more than double by 2025, increasing pressure especially on the Metro Center, L'Enfant Plaza, and Gallery Place-Chinatown stations. The recommended actions were to:

- Operate some eight-car trains beginning in 2006, and operate 100 percent eight-car trains by 2014.
- Construct station improvements at Metro Center, Gallery Place-Chinatown, Union Station, Farragut North, Farragut West, and L'Enfant Plaza.
- Construct passenger walkways between Farragut North and Farragut West, and between Metro Center and Gallery Place-Chinatown.
- Increase access to stations by providing feeder bus service, an improved bus fleet and pedestrian and bicycle enhancements.
- Construct new inter-line connections between Courthouse and Arlington Cemetery stations and between Pentagon and L'Enfant Plaza stations, and construct a pocket track on the Orange/Blue Line between Eastern Market and Potomac Avenue.

Since that time, the Metro Matters campaign called for $1.5 billion in capital funding for a number of bus and rail projects including repair and maintenance of station facilities, capacity and safety enhancements to stations, and operating eight-car trains on Metrorail lines.

Several previous systemwide studies and plans have focused on the future of the Metrorail system; the Station Access and Capacity Study built on these efforts.

1.2 Regional Growth and Development

Metrorail is an integral part of the region's transportation network. In 2006, 43 percent of all inbound AM peak period trips to the central employment core were made by transit, 32 percent by Metrorail.[1] On an average weekday in 2006, over 700,000 passengers rode the Metrorail system. Major sources of ridership growth include new stations on the Blue and Red Lines, tourism, Washington Nationals baseball games, and other special events.

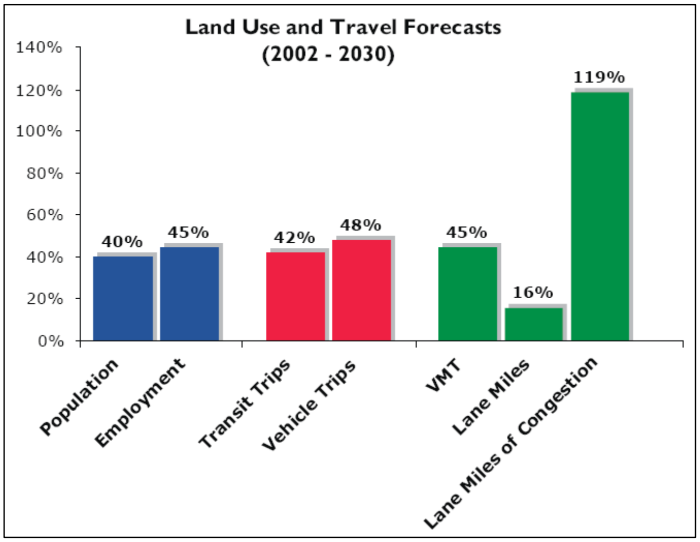

Figure 6. Travel Growth and Congestion (source: MWCOG)

The Metropolitan Washington Council of Governments (MWCOG) predicts that the Washington, DC region will add approximately 1.9 million new people and 1.3 million new jobs between 2002 and 2030. This growth would result in increased vehicle miles traveled (VMT) and congestion, as shown in Figure 6. Increasing transit trips helps to manage congestion, improve air quality, and make efficient use of existing infrastructure.

1.3 Study Goals

Metro initiated the Station Access and Capacity Study to meet growing ridership demand and to maximize capacity of the existing system. The study addressed three basic questions:

- How will ridership grow over the next 25 years?
- Is there sufficient capacity to handle the growth?
- How will customers access the system?

While the Core Capacity Study had focused on the first two questions, the Station Access and Capacity Study also considered the capacity for stations outside of the core. Perhaps more important, this study attempted to include the future access needs as a potential capacity constraint. In other words, even if there is sufficient capacity in the core of the system to double ridership, will customers be able to get to the system? What are the constraints on parking, Kiss & Ride, bus connections, and walking that might limit ridership growth?

[1] MWCOG, Draft 2006 Central Employment Core Cordon Count, March 2007.

The study accomplishes the following objectives:

- Developed model-based ridership forecasts to determine how ridership will grow over the next 25 years
- Determined whether there is sufficient line and station capacity to handle the growth
- Assessed the capacity and access needs of all 86 existing Metrorail stations and identified deficiencies
- Identified stations where further detailed studies are needed
- Defined conceptual priority projects and order-of-magnitude cost estimates for the next Capital Improvement Plan (CIP) update
- Built on the efforts of the 2002 Core Capacity Study, with the major differences being:
    - This study included a network-based ridership forecast. The Core Capacity Study, however, used the Fratar method, which applies growth factors to existing ridership based on land use forecasts, congestion, and parking fees, among other elements.
    - This study included all existing and planned Metrorail stations, not only the core.
    - Instead of assuming major system expansion like the Core Capacity Study, this study focused on station capacity and access improvements for the planned Metrorail system contained in the region's fiscally-constrained long-range plan.

1.4 Project Approach

The first task of this study was to inventory the access and capacity characteristics of all 86 Metrorail stations. The results of this inventory can be found electronically in Appendix A-E. Many station-specific characteristics were collected including station layout and access facilities. Due to the number of existing Metrorail stations and the variety of configurations among them, this study made many systemwide assumptions about dimensions, passenger travel patterns, and station operations. These systemwide assumptions enabled a general screening of station issues. A more-detailed assessment of station capacity would have required that these assumptions be supplemented with specific information on station characteristics.

This study included model-based ridership forecasts for the 86 existing stations as well as planned stations for 2010, 2020, and 2030. These are summarized in Appendix B-E. These forecasts included peak-half-hour and peak-hour volumes at each station and each Metrorail line link. Because typical weekday, peak-period trips were the basis of the modeling, special events such as the Cherry Blossom Festival and baseball games cannot be captured in the analysis.

Next, a systemwide capacity analysis was performed for faregate arrays, farecard vendors, escalators, and elevators. The stations with high volume-to-capacity (v/c) ratios were identified as stations that need either enhancement or more-detailed study. Similarly, stations with existing or future access needs were identified. Finally, order-of-magnitude costs were estimated for the station capacity and access projects identified.

This project was carried out by Metro's Office of Long-Range Planning (PLAN). During the study, PLAN also consulted with the Metro Jurisdictional Coordinating Committee and the Operations and Engineering staff.

SECTION 2 METHODS

This study included network model-based ridership forecasts out to 2030, a capacity analysis of the Metrorail lines and all 86 stations, and an assessment of present and future station access. This information was used to develop a prioritized list of needed station enhancements and recommended station studies.

2.1 Future Network and Operations

This study assumed that the only modifications to be made to the Metrorail network by 2030 are the ones included in the MWCOG Transportation Planning Board (TPB) Constrained Long Range Plan (CLRP). The TPB approved the latest CLRP in October 2006. This document includes a list of funded transportation projects that are planned to be built by 2030. The ones relevant to the Metrorail system and this study include:

- Dulles Corridor Metrorail Extension to Wiehle Avenue (2011) and to Dulles Greenway (2015)
- Potomac Yard Metrorail Station between Braddock Road and National Airport (2015)

This report refers to the Dulles Corridor Metrorail Extension as the Silver Line, though this line does not yet have an official name. As shown in Figures 7 and 8, it is planned to extend from Route 772 and the Dulles Greenway to just west of East Falls Church, with a total of 11 stations. It will then share tracks with the Orange Line as it travels east towards the District.

In addition to the CLRP projects, this study used Metro's proposed rail operating plan developed for the Dulles Final Environmental Impact Statement. According to this plan, beginning in 2010, the Blue Line would be split such that half of the trains would follow the Yellow Line and then the Green Line alignment to Greenbelt, while the other half would follow the Blue Line's current route. Similarly, a portion of the Orange Line trains would follow the present Blue Line route to Largo Town Center instead of New Carrollton. These changes are shown in the map in Appendix C. By 2010, approximately half of the trains in operation would be six-car and half would be eight-car, and by 2020, all trains would be eight-car. The study also assumed the future headways in Metro's operating plan; these are listed in Appendix C. The Metro Board of Directors has not yet approved this plan.

Figure 7. Assumed 2020 and 2030 Metrorail System Map

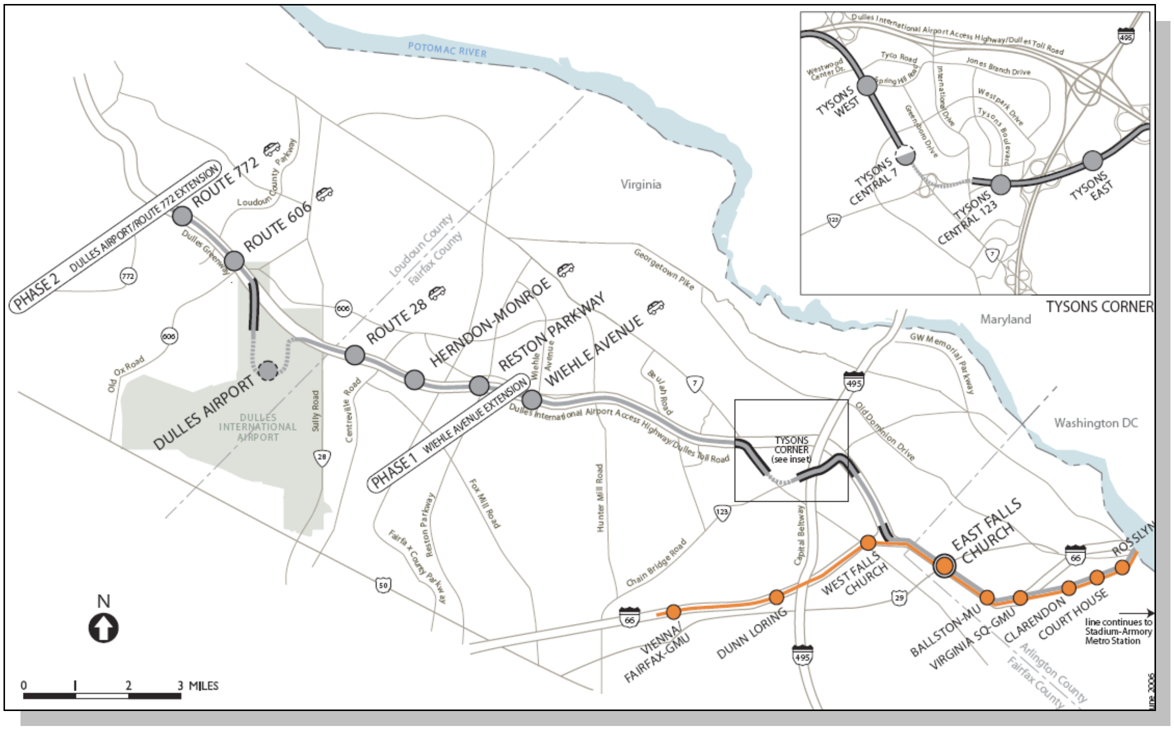

Figure 8. INSET: Dulles Corridor Metrorail Extension (source: www.dullesmetro.com)

2.2 Ridership Forecasts

This study included model-based Metrorail ridership forecasts for 2010, 2020, and 2030. The ridership forecasting was performed using the MWCOG/TPB Travel Forecasting Model Version 2.1D #50 and Round 7.0 Cooperative Land Use Forecasts. This model is an advanced four-step planning tool consisting of trip generation, trip distribution, mode choice, and traffic assignment procedures. At the end of the model application, total motorized person trips are apportioned among three different modes: auto driver, auto passenger, and transit. Transit person trips, however, are not further divided among their different sub modes (Metrobus, Metrorail, and commuter rail). Consequently, it is not possible to forecast rail ridership by using the MWCOG/TPB model alone.

To that end, the Washington Regional Demand Forecasting Model was then used to develop future-year ridership forecasts by transit sub mode and access mode (walk, Park & Ride, and Kiss & Ride). This model, developed for Metro as part of the District of Columbia Alternatives Analysis Study, retains the highway networks, trip generation, trip distribution, and highway assignment results from the MWCOG/TPB Travel Forecasting Model. However, new transit paths by sub mode are built and a more elaborate mode choice model—which apportions the total motorized person trips among the different auto and transit paths—is utilized.

2.2.1 Model Calibration

The base year for this study's analysis was 2005. The Washington Regional Demand Forecasting Model used to develop the rail forecasts relied on the 2002 On-Board Metrorail Passenger Survey to calibrate the number of rail trips. This model calibration was based on Round 6.3 Cooperative Land Use Forecasts, the most up-to-date land use forecasts available when that model was developed. Model performance was validated for groupings of stations, rather than at the individual station level. Table 18 in Appendix A summarizes the observed and estimated trip productions in the year 2002 at all Metrorail stations for the home-based-work (HBW) trip purpose during the peak periods (PK)—typical weekday, rush hour trips—and for all daily trips. For HBW PK, the model captures 87 percent of the observed productions; this figure goes up to about 96 percent for all daily trip productions.

A similar analysis was prepared for 2005 using the Round 7.0 Land Use Forecasts. Observed productions at all Metrorail stations for an average weekday in May 2005 totaled 683,277. The model captured only 91 percent of these.

To verify that the model's ridership estimates were consistent with projected land use growth, summaries were prepared comparing the growth in person trips and transit trips for seven different groups of the study area corresponding to the core, urban, and suburban regions. These summaries showed reasonable growth in both person and transit trips considering the underlying land use growth.

2.2.2 Approach

Although the Washington Regional Demand Forecasting Model was not calibrated to estimate ridership at a sufficient level of accuracy at the station level, the model did perform well in projecting reasonable growth in transit trips between years. As a result, the model was used throughout the analysis by applying the percentage change in Metrorail ridership to actual 2005 base ridership, rather than using the raw forecasts produced by the model.

The first step involved modifying the latest-release MWCOG networks for 2005, 2010, 2020, and 2030 to become compatible with the Washington Regional Demand Forecasting Model. This meant adding access links at Metrorail stations, adjusting the Metrorail service operating plans to agree with the Constrained Long Range Plans (CLRP), and, finally, adjusting the bus service operating plans especially in 2020 and 2030 with the introduction of the Silver Line.

The result of applying the forecasting model to each network is a station-to-station trip summary in production/attraction (P/A) format. Ultimately, this was converted to a mezzanine-to-mezzanine trip summary in origin/destination (O/D) format for assignment to the micro-coded Metrorail network. The final outputs from the assignment procedure are average peak and daily entries (exits) at each Metrorail station mezzanine by mode of access (egress), passenger loads on each link in the Metrorail system, and number of transferring passengers between Metrorail lines within stations (where applicable).

Mezzanine-Level Analysis

Metro provided mezzanine-level passenger entries and exits for the average weekday in May 2005 in 30-minute increments. The passenger load profile at each station mezzanine was studied separately to determine: 1) when the peak-hour and peak-half-hour entries and exits occurred, and 2) what percentage of the daily load each comprised. Tables 19 and 20 in Appendix A summarize these findings for the peak-half-hour and peak-one-hour periods, respectively.

Figure 23 in Appendix A shows a plot of the peak half-hour occurrences for all Metrorail stations. As expected, the peak half-hour entries mainly occur between 7:00–9:00 AM for stations outside the DC core and 4:00–6:00 PM for core stations. This trend is reversed for peak half-hour exits, which spread between 7:30–9:00 AM for core stations and 5:00–6:30 PM for other stations.

Figure 24 in Appendix A displays the frequency distribution of the ratio of peak half-hour load to daily load for all Metrorail stations. This ratio ranges from 0.18 at Branch Avenue for entries to 0.05 at Farragut West's west mezzanine for exits. The majority of the stations exhibit a ratio between 0.07 and 0.14 for both entries and exits.

Metro also provided a mezzanine-level O/D trip table for the average weekday in May 2005 by 30-minute increments. Using this trip table and the peak-half-hour and peak-hour definitions shown in Tables 19 and 20, the peak-half-hour and peak-hour factors for mezzanine-to-mezzanine flow were calculated at both the entry and exit levels. These factors basically represent the percent of daily flow between each mezzanine pair for that particular peak period, either half hour or one hour.

Systemwide Analysis

One of the parts of this study was to evaluate passenger loads between each station pair in the Metrorail system, the maximum load point on each Metrorail line, and the inter-platform passenger flows at transfer stations. These measures can only be evaluated using a systemwide approach where mezzanine-to-mezzanine flows are assigned for the same peak time periods (half hour and one hour).

To determine the system AM and PM peak half-hour and one-hour time periods, the passenger entries and exits at the Metrorail core stations were plotted and are shown in Figure 22 in Appendix A. The half-hour system peaks are 8:30–9:00 and 5:00–5:30 for the AM and PM periods, respectively. The one-hour peaks are 8:00–9:00 and 5:00–6:00 for the AM and PM periods, respectively. Similar to the mezzanine-level analysis, AM and PM peak-half-hour and peak-hour factors for mezzanine-to-mezzanine flow were then calculated using these system peak-period definitions and the mezzanine-level O/D trip table for a typical weekday in May 2005.

Flow Summary Preparation and Assignment

The result of running the Washington Regional Demand Forecasting Model is a daily station-to-station trip summary in P/A format. This was changed to a mezzanine-to-mezzanine trip summary in O/D format for assignment in the Metrorail network. The process for this conversion is discussed in Appendix A.

2.3 Capacity Analysis

Metro's station designs give primary consideration to peak passenger flows, efficiency to maximize passenger movements under normal operating conditions, and safety to facilitate evacuation of passengers during an emergency. This study did not include a station safety analysis, as that would have involved a detailed assessment of each station's performance on the measures defined in NFPA 130, the national emergency evacuation standard for transit. Instead, this study focused on the efficiency of passenger flow through existing stations, or station capacity. The capacity of proposed stations, such as Potomac Yard or the Silver Line stations, was not assessed.

2.3.1 Data Collection

This study included a systemwide, broad screening of station capacity. The first step in assessing each station's capacity and access was the creation of an electronic inventory that included existing ridership, access mode split, station layout and configuration, and an inventory of facilities for buses, pedestrians, and bicyclists. Appendix A-E contains this inventory.

Table 2. Summary of Data Collection Inventory

Element	Source
Station layout, entrances, and access points	WMATA drawings, www.wmata.com
Number and location of escalators, elevators, stairs, faregate arrays, and farecard vendors	WMATA drawings, Emergency Egress drawings, WMATA database
Parking spaces, access points, and Kiss & Ride facilities	WMATA inventory, Google Earth, field visits
Bus bays and service levels	WMATA drawings, Google Earth, MWCOG 2002 shapefile of regional bus routes
Bike routes, bike lockers and racks	Local jurisdiction bike maps, WMATA inventory of bike facilities
Sidewalks, major roadways	Google Earth
Existing and future land use	MWCOG Round 7.0 land use forecasts

Not all data was readily available, however. Because gathering detailed station characteristics would have involved extensive data collection and field visits, many systemwide assumptions on dimensions, station configurations, and passenger travel patterns were made.

2.3.2 Station Analysis

The passenger flow between each station level and element was analyzed and compared with standard or assumed capacity flow rates, as shown in Table 3. The vertical flows between the surface and mezzanine, mezzanine and platform, and platforms at transfer stations were estimated. In addition, this study determined the passenger flow through horizontal elements such as faregate arrays and farecard vendors. Each flow was calculated using the peak 15-minute entry (boarding) or exit (alighting) volume.

Table 3. Station Capacity Criteria

Item	Value	Units	Source
15-minute peaking factor for entries (applied to peak half-hour volume)	67	%	WMATA, 2006 ridership data
15-minute peaking factors for exits (applied to peak half-hour volume)	50	%	WMATA, 2006 ridership data
Percent passengers using farecard vendor	25	%	WMATA, Farecard transaction data
Farecard vendor transaction rate	1.67	p/min	WMATA, Core Capacity Study
Faregate aisle flow rate	35	p/min	WMATA, Field measurements
Escalator flow rate	90	p/min	WMATA, Station Access and Capacity Study (see Appendix B)
Stairway flow rate (for a 5.5-foot wide stair)	30	p/min	Transit Capacity and Quality of Service Manual
Platform occupancy	7	ft^2/p	Transit Capacity and Quality of Service Manual
Metrorail car load standard for maximum load point in the peak direction and hour	120	ppc	WMATA Metrorail Revenue Vehicle Fleet Management Plan

The analysis included the following assumptions concerning escalators, stairways, elevators, platforms, faregates, farecard vendors, and entrances:

General:

- For mezzanines with more than one entrance, the same future growth rate was applied to all of the entrances. Thus, this analysis may not account for changing station-area land use geographic distribution.
- No alighting or boarding factors were applied to the peak 15-minute volumes.
- The mezzanine-level ridership forecast analysis included peak entry and exit volumes for each station, and not necessarily AM and PM peak volumes. For example, in 2005 the Bethesda station served its highest half-hour entry and exit volumes in the morning. Therefore, the model did not produce an evening peak volume for the Bethesda station.

Vertical facilities:

- All escalators would be in operation, i.e. none would be out of service.
- The majority of escalators would operate in the peak direction. Where only one escalator connects two levels, it would operate in the peak direction.
- Stairways were assumed to be 5.5 feet wide in each direction.
- The analysis did not include elevators because, on average, a small percentage of passengers use elevators.

Horizontal facilities:

- Center platforms were assumed to be 30 feet wide and side platforms were assumed to be 13 feet wide.
- A station manager can change the direction of the faregate arrays in Metrorail stations. This study assumed that the entry/exit split of the faregates was proportional to the peak entry/exit volumes split. Because only 2005 bidirectional (entry and exit) volumes were available for the same time period, the 2030 analysis assumed that the faregates would operate the same as in 2005.
- A minimum of two faregates were assumed to operate in the off-peak direction.

Using these assumptions, the study determined the peak 15-minute entry and exit volumes traveling on or through each station element. That volume was expressed in passengers per minute and compared to the standard criteria in Table 3. A volume-to-capacity (v/c) ratio was developed for each station element.

The stations with an element for which the v/c ratio was equal to or greater than 0.75 were identified as needing enhancement. If the v/c ratio was between 0.5 and 0.75, a station was identified as needing more detailed study. Order-of-magnitude cost estimates were developed for stations needing enhancement.

2.3.3 Metrorail Line Load Analysis

Equally as important as mobility within stations is mobility along Metrorail lines. One of the ways that Metro measures line capacity is by comparing these volumes to passenger load standards. The application of these standards ensures high quality of service through passenger comfort and operating efficiency. This study analyzed 2005 and 2030 Metrorail line volumes for the AM peak hour by applying Metro's peak primary passenger load standard for system planning purposes. This standard states that no more than an average of 120 passengers per car (ppc) shall pass the maximum load point in the peak direction in the peak one hour on each line.

Figure 9. Crowded Metrorail car during peak period

The passenger loads were calculated using the results of the systemwide ridership analysis described in Section 2.2, which determined mezzanine-to-mezzanine flows between 8:00 and 9:00 AM. Metro's proposed future Metrorail operating plan, described in Appendix C, determined the average number of cars per line during the peak hour. Using these two values, the ppc for each line's maximum load was compared to the standard. This method assumes an even distribution of passengers within the peak hour as well as an even distribution of passengers among train cars.

2.4 Access Considerations

In 2006, Metro issued Station Access Guidelines for station area planning. These guidelines establish the general hierarchy of access to Metrorail stations and offer specific criteria for the placement and design of parking, Kiss & Ride lots, bus bays, bike racks and lockers, and sidewalks. Any new station or station modification should follow these guidelines.

Metrorail passengers get to and from stations by walking, cycling, bus, commuter rail, or automobile. Though Metro gives the highest priority to pedestrians when considering access, as shown in Figure 10, each station has its own unique set of access needs. While outer stations typically need to devote land to parking, bus transfer facilities, and Kiss & Ride facilities, core stations typically do not have the same need or space for off-street facilities.

This study collected mode-of-access data from the various sources noted in Table 2 and from the 2002 On-Board Metrorail Passenger Survey. The 2002 access mode split was applied to the 2005 ridership volumes to approximate present mode of access. Access comparisons were made between existing use and supply for parking, pedestrian, and bicycle facilities. Based on this information, stations with possible access issues were identified.

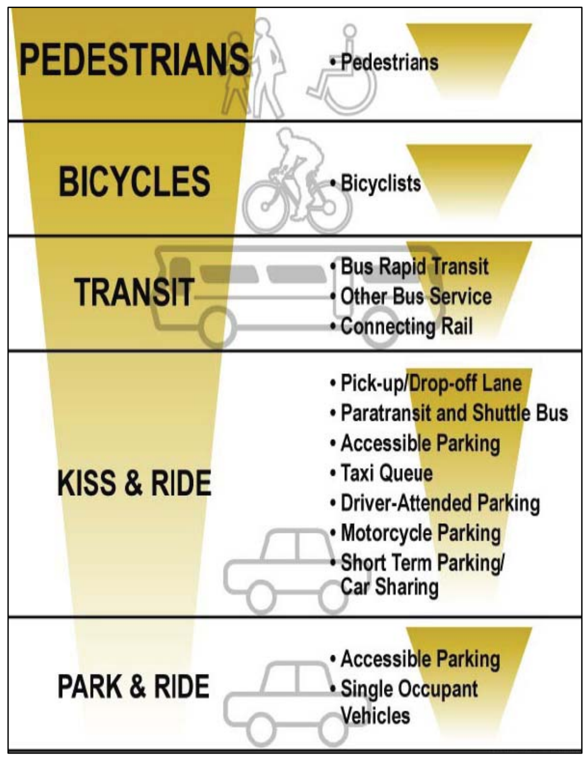

Figure 10. Mode of Access Hierarchy

The identification of future station access needs focused on pedestrians and bicyclists. Because this study did not include extracting future mode of access data from the model, future access modes for each station were not available. Instead, this study identified the stations with the highest rate of development forecasted for 2030. The development numbers were estimated in ESRI ArcGIS by capturing the MWCOG Round 7.0 land use forecasts for the transportation analysis zones within a one-half-mile buffer around each station. This data was used to identify stations with future pedestrian and bicyclist needs such as sidewalks, improved street crossings, bicycle paths, and bicycle racks/lockers.

Additionally, this study included a systemwide look at existing and future access mode shares based on projected land use growth. By summarizing existing walking, biking, and parking shares, and factoring these based on future land use forecasts, an estimate of future parking needs was developed.

SECTION 3 FINDINGS: SYSTEMWIDE TRENDS

Ridership growth will continue into the future, placing demands on system and station capacity. Ridership increases are expected to be primarily driven by system expansion—the Dulles Corridor Metrorail extension—and regional growth. This section describes the findings from the systemwide analysis, which include Metrorail line volumes and capacity, transfer volumes, and access considerations.

3.1 Ridership Trends

3.1.1 Existing Ridership

Current ridership growth rates are exceeding the Board's service expansion plan target of three percent annual growth that would double ridership in 25 years. From 1996 to 2006, Metrorail ridership grew by 41 percent, with an average annual growth rate of 3.5 percent per year. During this time, Metro expanded its system to include new stations and line segments:

- Blue Line extension to Franconia-Springfield (one new station): June 1997
- Red Line extension to Glenmont (one new station): July 1998
- Green Line extension from Columbia Heights to Fort Totten (two new stations): September 1999
- Green Line extension to Branch Ave (five new stations): January 2001
- New station at New York Ave-Florida Ave-Gallaudet U (one new station): November 2004
- Blue Line extension to Largo Town Center (two new stations): December 2004

This ridership growth was also due to a healthy regional economy; during these years, the Washington, DC region grew in both population and employment by 26 percent and 22 percent, respectively. The start of Washington Nationals baseball games near the Stadium-Armory station in 2005 contributed to ridership increases during both evening peak-period and off-peak times. Another possible reason for some ridership growth could be increasing gasoline prices; between 1996 and 2006, the average U.S. price for gasoline increased 110 percent in constant dollars.[2]

3.1.2 Future Ridership

The updated baseline trend forecast is for approximately 970,000 daily riders by 2030, shown in Figure 11. This represents a 42 percent increase in ridership between 2005 and 2030, or an average annual growth rate of 1.7 percent. This study found that while ridership is expected to significantly increase in the future, it might not reach the Transit Service Expansion Plan's target of 1.1 million riders per day by 2025, without the significant new fixed-guideway miles envisioned in the Expansion Plan. Though the forecast is lower than the Board's goal, it is consistent with the recent and similar modeling in the Dulles Corridor Metrorail Extension Project. The growth trend could be influenced by a number of unknown future events such as modifications to the Metrorail network, continued increase in gasoline prices, increased parking costs near Metrorail stations, and population and job growth beyond what is already forecasted.

[2] Gasoline and Diesel Fuel Update, http://tonto.eia.doe.gov/oog/info/gdu/gasdiesel.asp (June 2007). There is no proven correlation between ridership growth and gasoline prices.

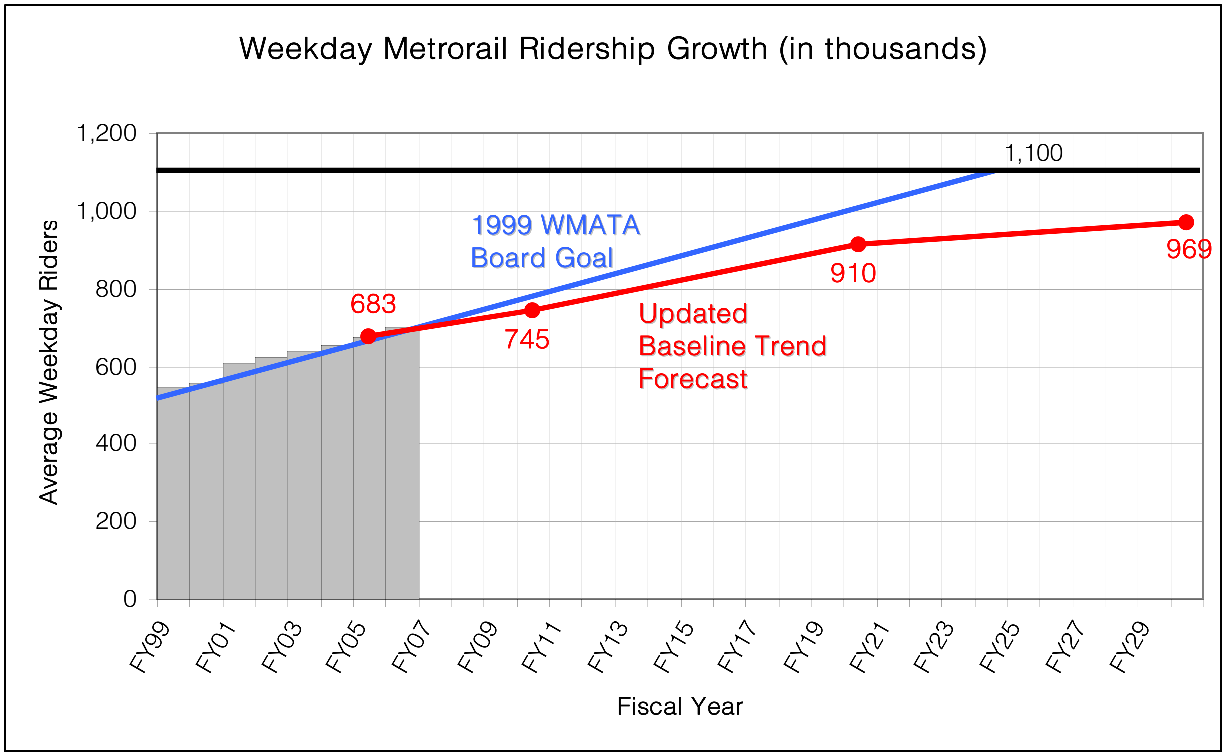

Figure 11. Past and Forecasted Metrorail Ridership

The forecasted ridership growth rates are comparable to forecasted regional land use growth. Between 2005 and 2030, the MWCOG expects regional employment to increase by nearly 39 percent, population by 33 percent, and households by 35 percent.[3] The general pattern of growth, however, will continue to expand outward from the District: 28 percent of the employment growth and 45 percent of population growth is expected to occur in the outer suburbs, beyond the current extent of the Metrorail network. In other words, Metrorail may not serve some of the region's growth.

Table 4 summarizes the MWCOG cooperative land use forecasts for the Metro service area. Employment in the central jurisdictions of the District, Arlington, and Alexandria will not grow as fast as the inner suburbs. Central jurisdiction jobs and population are expected to grow by 23 and 26 percent, respectively, between 2005 and 2030. The District is projected to remain the largest employment center in the region with 860,000 jobs in 2030. Fairfax County would remain a close second with 844,600 jobs, and Montgomery County third with 670,000. While peak-period Metrorail trips to the core will remain high, they will lose some share to the suburbs. In 2030, 50 percent of daily ridership will be at the core stations, compared to 54 percent in 2005.

[3] MWCOG, "Growth Trends to 2030: Cooperative Forecasting in the Washington Region," Fall 2006.

Table 4. Employment and Population Forecasts for Metro Service Area

JURISDICTION	2005 (thousands)	2010 (thousands)	2020 (thousands)	2030 (thousands)	Change 2005 to 2030
EMPLOYMENT					
District of Columbia	745.0	783.6	830.0	860.0	15.4%
Arlington	195.2	217.8	254.4	275.8	41.3%
Alexandria	105.6	113.3	132.5	148.0	40.2%
Central Jurisdictions	1,045.8	1,114.7	1,216.9	1,283.8	22.8%
Montgomery	500.0	545.0	615.0	670.0	34.0%
Prince George's	358.7	390.0	460.9	544.7	51.9%
Fairfax	600.5	683.9	774.5	844.6	40.6%
City Fairfax	29.2	31.3	35.3	39.3	34.6%
Falls Church	9.5	11.8	17.8	20.3	113.7%
Inner Suburbs	1,497.9	1,662.0	1,903.5	2,118.9	41.5%
Total Service Area	2,543.7	2,776.7	3,120.4	3,402.7	33.8%
POPULATION					
District of Columbia	577.5	608.7	672.6	732.5	26.8%
Arlington	198.3	212.2	233.1	249.5	25.8%
Alexandria	135.9	143.9	152.6	166.3	22.4%
Central Jurisdictions	911.7	964.8	1,058.3	1,148.3	26.0%
Montgomery	942.0	1,000.0	1,077.7	1,155.8	22.7%
Prince George's	852.9	872.6	914.9	993.1	16.4%
Fairfax	1,041.2	1,133.0	1,276.3	1,331.2	27.9%
City Fairfax	22.5	23.9	26.0	26.6	18.2%
Falls Church	10.6	12.3	14.7	15.4	45.3%
Inner Suburbs	2,869.2	3,041.8	3,309.6	3,522.1	22.8%
Total Metro Service Area	3,780.9	4,006.6	4,367.9	4,670.4	23.5%

Sources: MWCOG Round 7 Cooperative Forecasts

Fairfax County is expected to remain the region's most populous jurisdiction, with 1,331,200 residents by 2030. Montgomery County would remain second with 1,155,800 residents, and Prince George's County third with 993,100. Increased population and employment in the suburbs may result in more suburb-to-suburb commuting. Primarily a hub-and-spoke system, the existing and planned Metrorail network does not conveniently serve these types of trips.

Ridership is forecasted to increase by approximately 2.2 percent per year between 2005 and 2020. The Dulles Corridor extension (Silver Line), planned to be in operation by 2015, contributes to the relatively high growth rate. After 2020, ridership growth is forecasted to slow to 0.65 percent per year; this is largely due to the lack of planned system expansion between 2020 and 2030 and the lower growth expected within the region's core.

3.1.3 Ridership Growth Trends

Growth inside and outside the core

Figure 14 shows the relative magnitude of systemwide average daily boardings in 2030. Of the 2030 average daily ridership, 50 percent will be within the core, 12 percent in non-core areas of the District, 19 percent in non-core areas of Maryland, and 19 percent in non-core areas of Virginia.

The current and projected ridership levels present different growth trends inside and outside the Metrorail system core, as shown in Table 5. Ridership generated outside the core area will grow by 53 percent, faster than the growth generated inside the core at 27 percent. Metrorail trips traveling between non-core areas will grow by 80 percent, indicating a continuing trend of job and population growth in suburbs and an increasing demand for transit service outside the system core.

Table 5. Daily Ridership Growth Inside and Outside the System Core (2005-2030)

	2030 Daily Trips			% Change: 2005 2030		
Destination (To) / Origin (From)	Entire System	Inside Core	Outside Core	Entire System	Inside Core	Outside Core
Entire Metrorail System	969,300	366,600	602,700	42%	26%	54%
Outside System Core	604,200	262,500	341,700	53%	28%	80%
Inside System Core[4]	365,100	104,100	261,000	27%	20%	29%
Red (core)	175,200	51,800	123,500	26%	16%	31%
Green/Yellow (core)	46,700	13,700	33,000	26%	44%	19%
Blue/Orange (core)	143,200	38,700	104,500	27%	20%	30%

Sources: WMATA, AECOM Consult

Within the system core, Metrorail ridership on all the lines will remain strong, reaching 365,100 daily trips by 2030. Most core stations will have ridership growth trends similar to that of the system, except for the Green and Yellow Lines stations, between L'Enfant Plaza and Shaw-Howard University, which could attain a considerable 44 percent increase in trips to the system core.

[4] The system core includes:

- Red core stations: Dupont Circle, Farragut North, Metro Center, Gallery Place, Judiciary Square, and Union Station
- Green/Yellow core stations: Shaw-Howard Univ, Mt. Vernon Square, Archives-Navy Memorial, L'Enfant Plaza
- Blue/Orange core stations: Rosslyn, Foggy Bottom-GWU, Farragut West, McPherson Square, Federal Triangle, Smithsonian, Federal Center SW and Capital South

Figures 12 and 13 show the change in AM ridership in parts of the core and Arlington between 2005 and 2010, and 2010 and 2030, respectively. The effect of the proposed operating plan's Blue Line split, proposed for 2010, is evident in Figure 14. Between 2005 and 2010, ridership in the morning would significantly grow in the northbound direction via the 14th Street Bridge between Pentagon and Farragut West, while ridership would significantly decrease in the northbound direction via the Rosslyn tunnel between Pentagon and Rosslyn and between Rosslyn and Farragut West. In other words, many passengers that are presently riding the Blue Line north to Downtown would instead take the Blue-Yellow Line to L'Enfant Plaza and transfer to the Orange or Blue Line headed westbound. Between 2010 and 2030, however, the major growth area would be the Orange, Silver, and Blue Lines in inner Arlington and Downtown, particularly from East Falls Church to Metro Center due to the addition of the Silver Line.

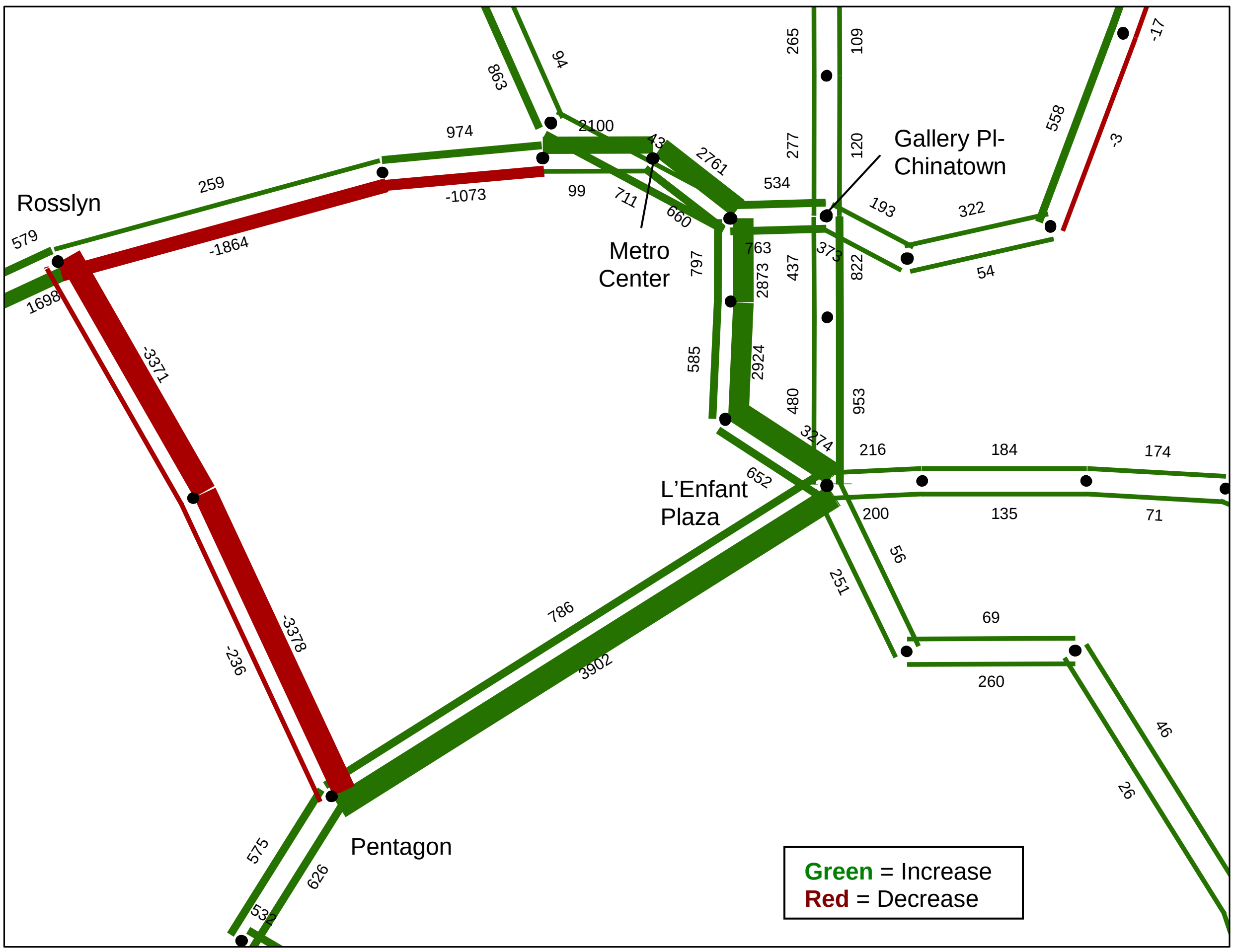

Figure 12. Forecasted Change in AM Peak Hour Ridership (2005-2010) (Source: AECOM Consult)

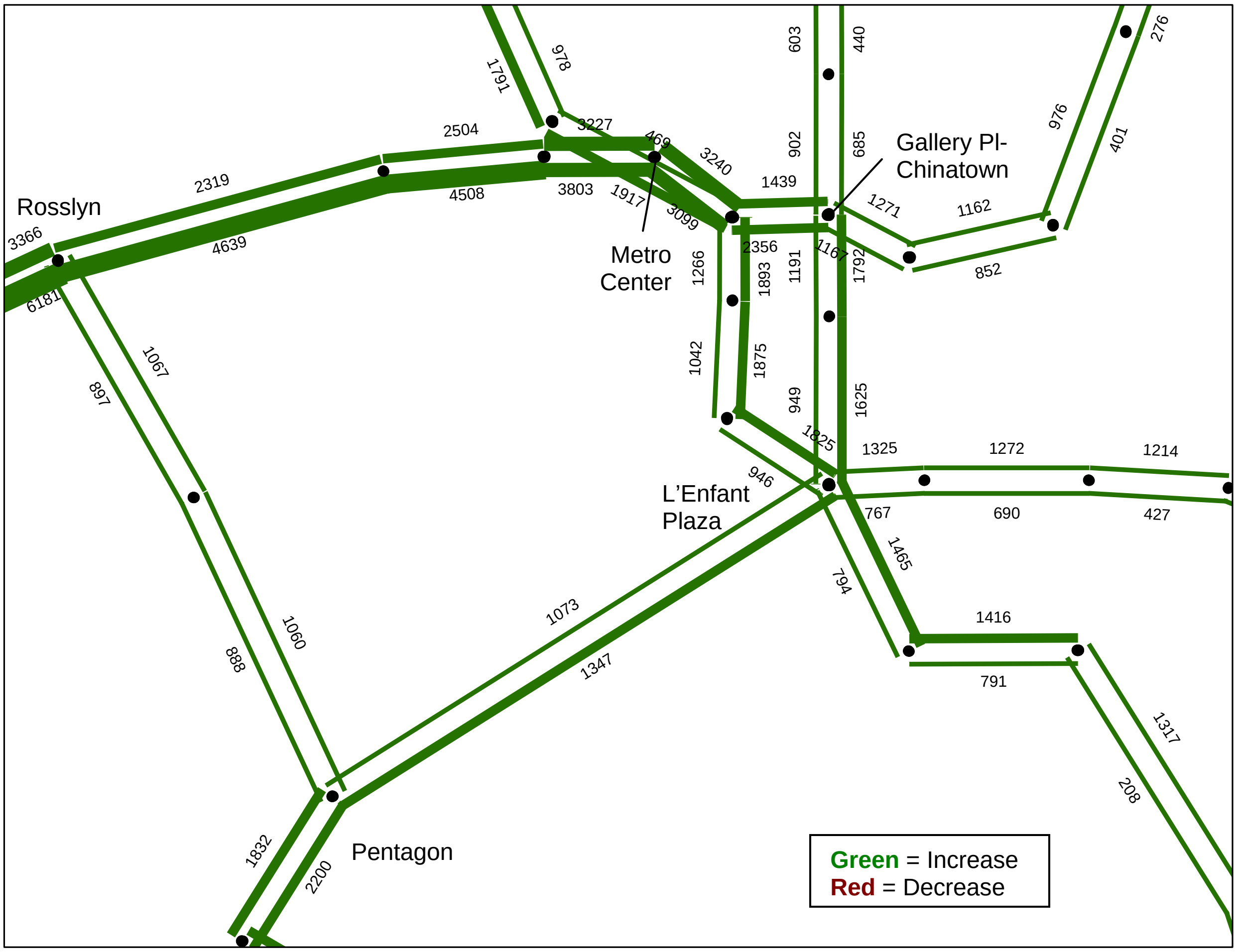

Figure 13. Forecasted Change in AM Peak Hour Ridership (2010-2030) (Source: AECOM Consult)

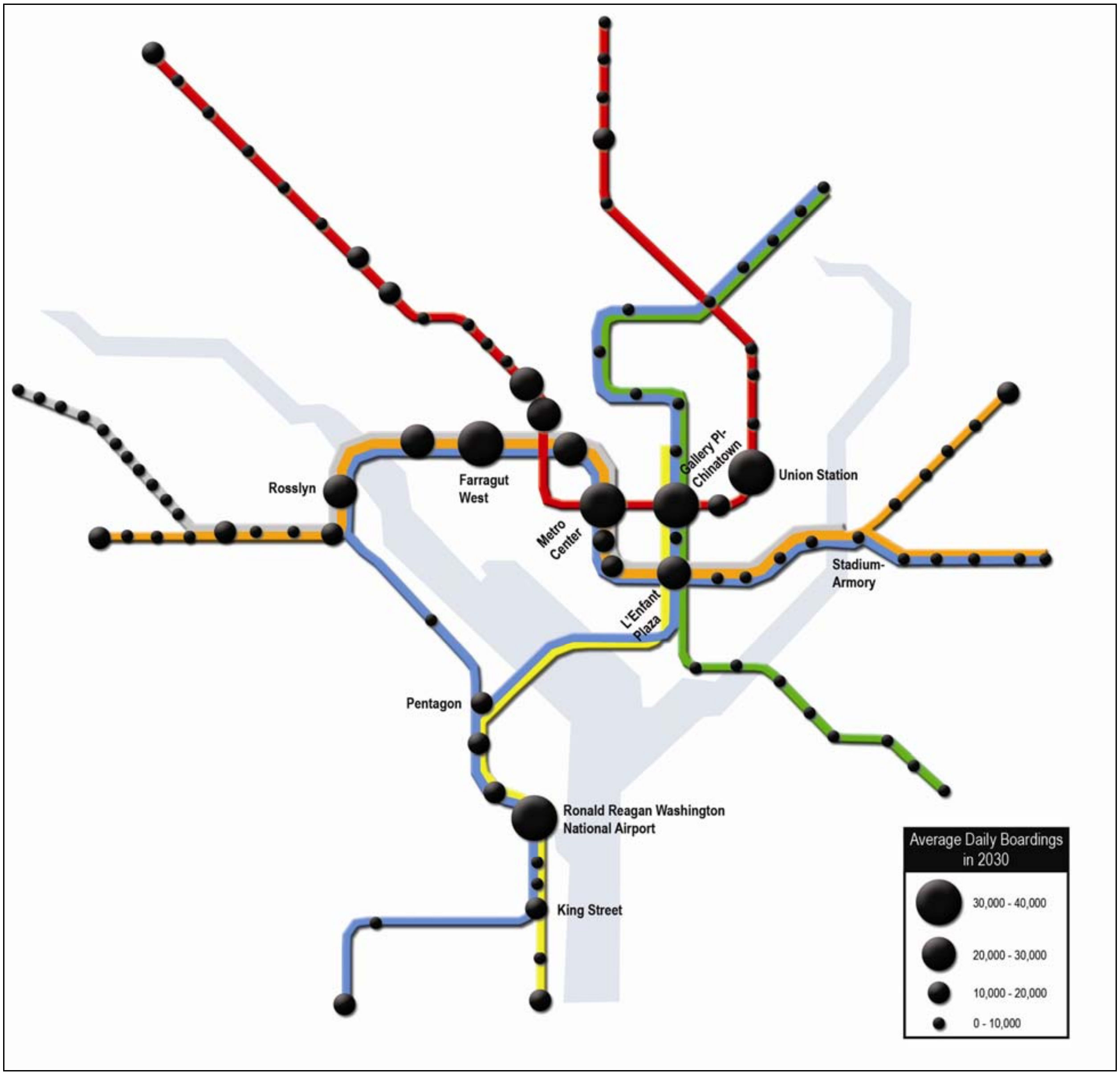

Figure 14. Average Daily Boardings in 2030

Outside the system core, existing high-ridership stations will experience significant growth. The Red Line stations north of Grosvenor could reach 53 percent in ridership growth between 2005 and 2030 and the stations on Orange, Blue and Yellow Lines in Arlington are likely to have ridership doubled. The Green Line stations in Northeast DC and the stations on Green, Blue, and Orange Lines in Southeast DC are also anticipated to have approximately 50 percent increase in ridership.

The introduction of the Silver Line by 2020 will have a significant effect on ridership. The new Silver Line stations would comprise approximately 44,000 daily boardings, or five percent of the total system boardings in 2020. In addition, most likely because of the new Silver Line and the decrease in bus service along that same corridor, ridership at West Falls Church is forecasted to decrease by approximately 50 percent. The West Falls Church station currently serves a large portion of bus-to-rail transfers.

High ridership stations

Figure 15 shows the 2005 and 2030 average daily ridership of selected top Metrorail stations. Many of the 2030 high-ridership stations are also among the top 20 stations in 2005. By 2030, Court House will become one of the high-ridership stations, with a 136 percent ridership increase between 2005 and 2030. Gallery Place-Chinatown will see a 92 percent ridership increase during this time. The MWCOG land use forecast shows that both neighborhoods will have substantial increases in households.

Forecasts also show that the Ronald Reagan National Airport station's ridership would substantially increase; this could be due to the nearby development at Potomac Yard, most of which is located closer to this station than the proposed Potomac Yard station.

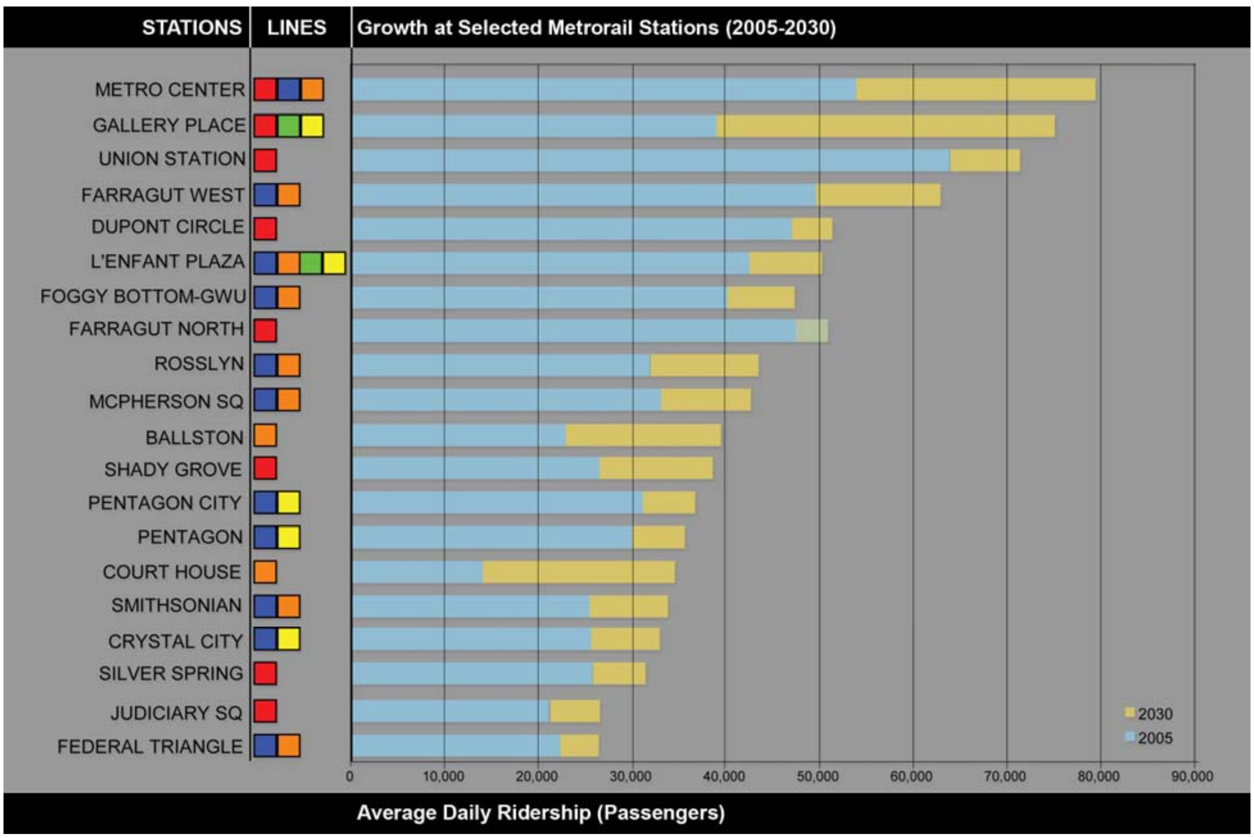

Figure 15. Daily Passenger Volume* Growth at Top Stations (2005-2030)

**Note: Volumes shown represent the sum of daily entries and exits.*

Peaking

Table 6 shows the growth in AM peak hour ridership. Overall, peak-hour growth is forecasted to be 35 percent between 2005 and 2030. This is less than the 42 percent growth projected for daily trips, indicating higher growth in the off-peak period.

The systemwide peaking pattern in 2030 is expected to be similar to that of 2005. Approximately 60 percent of daily ridership will occur during the AM and PM peak periods. The AM peak-hour Metrorail trips to non-core areas will grow faster than the core, suggesting an increasing demand for reverse commuting on Metrorail during the peak period.

Table 6. AM Peak Hour Ridership Growth (2005-2030)

	2030			% Change: 2005-2030		
Destination (To) / Origin (From)	Entire System	Inside Core	Outside Core	Entire System	Inside Core	Outside Core
Entire Metrorail System	117,800	75,100	42,700	35%	33%	39%
Inside System Core	17,200	10,600	6,600	12%	12%	13%
Outside System Core	100,600	64,600	36,000	40%	37%	46%

Sources: WMATA, AECOM Consult

Stations located within the system core will remain top destinations of rush-hour trips totaling 75,100, the majority of which will be work trips. Outside the system core, three areas are on the way to becoming major employment centers: between Waterfront and Congress Heights on the Green Line, between the Pentagon and Potomac Yard on the Blue and Yellow Lines, and on the Orange Line inside Arlington. These areas are likely to receive almost doubled increase in AM peak-hour trips: 108 percent on the Green Line segment, 85 percent on the Blue-Yellow Line segment, and 108 percent on the Orange Line segment.

The Orange and Blue-Yellow corridors in Arlington, with high concentrations of residential development, are expected to become the top origins of AM peak-hour Metrorail trips. Each corridor could generate more than 10,000 trips during the peak hour, outpacing the current top origin segments on the Red Line inside the core and in the Interstate 270 corridor between Grosvenor and Shady Grove. Such substantial growth in both origin and destination trips in the Arlington Metrorail corridors is a reflection of the intensity and mix of the planned land use development, according to the MWCOG land use forecasts. The MWCOG forecasts show that the Rosslyn-Ballston corridor would grow by 46 percent in households and 36 percent in jobs between 2005 and 2030; similarly, the Blue Line in Arlington would grow by 50 percent in households and 42 percent in jobs. By 2030, the Court House station area would remain the densest concentration of households in the Arlington Metrorail corridors, with approximately 21 households per acre, and Crystal City would become Arlington's densest concentration of employment with 42 jobs per acre (with Court House, Virginia Square-GMU, and Ronald Reagan Washington National Airport close behind).

Among the stations, some exhibit more peaking than others do—that is, the peak ridership at these stations makes up a large portion of the daily ridership. Figure 16 shows that the most peaked stations would be Route 772/Dulles Greenway, which is planned to be the terminus of the Silver Line; Morgan

Boulevard; Cheverly; and Branch Avenue. Stations with more distributed daily use would include Stadium-Armory, Pentagon City, Mt. Vernon Square-UDC, and Tysons Central.

Stations with a balance of job, housing, entertainment, and retail typically have a lower share in peak ridership of the daily total, as well as more of a balance between entries and exits during the same time period. Developing a mix of uses around the high-peaked stations would help increase ridership throughout the day, as well as in the nonpeak (reverse commuting) direction during peak hours.

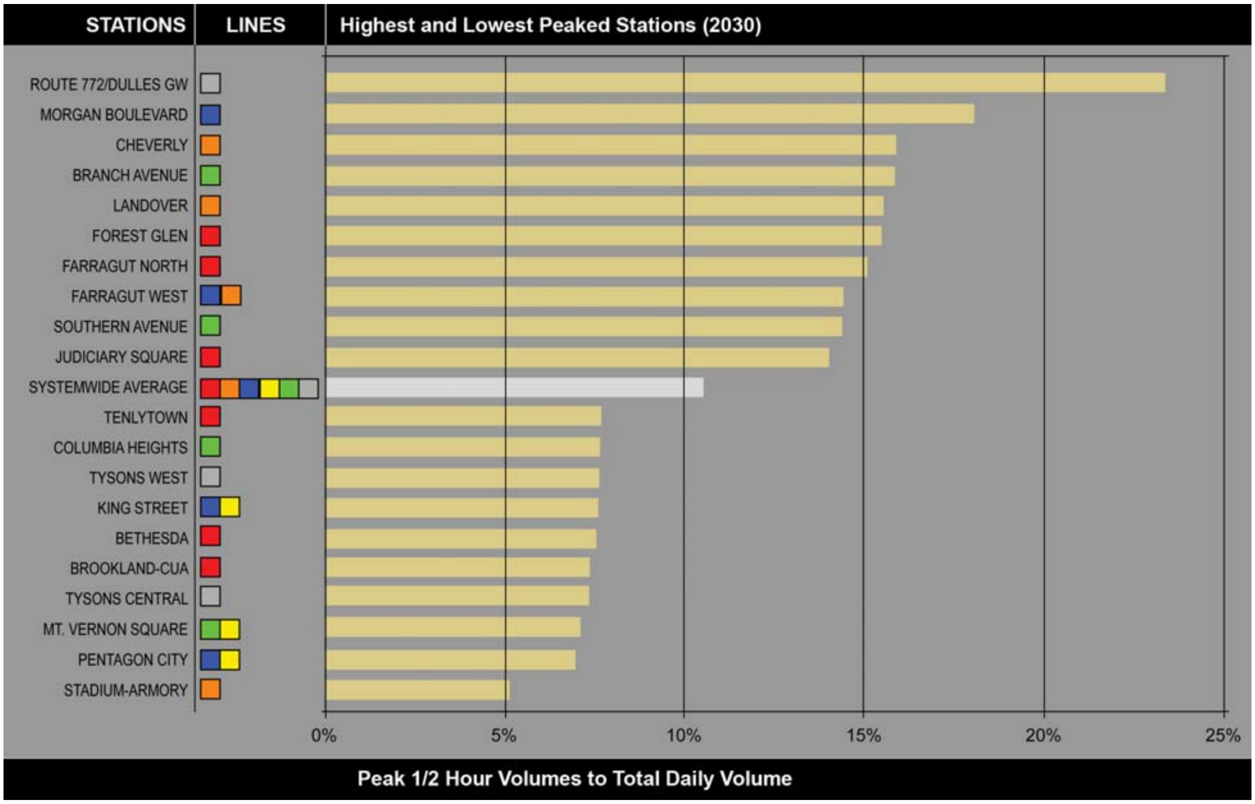

Figure 16. Most and Least Peaked Stations in 2030

Transfers

Transfer stations are those where two or more lines intersect. These stations offer passengers the opportunity to transfer between lines without leaving the station. The high-volume transfer stations—Metro Center, Gallery Place, L'Enfant Plaza—have multiple platform levels and sides between which passengers flow. These movements affect station capacity.

Future-year transfer activity would be heavily affected by Metro's proposed Blue Line split.

Existing Transfer Activity

Table 7 shows that Metro Center and Gallery Place are presently the stations with the highest number of peak-hour transfers, with L'Enfant Plaza ranked third. At Metro Center, the largest AM transfer occurs between the westbound Red and eastbound Blue/Orange Lines. At Gallery Place-Chinatown, the largest AM transfers occur between both directions of the Yellow/Green Line and the westbound Red Line. At L'Enfant Plaza, the largest AM transfer is between the northbound Yellow/Green and westbound Blue/Orange Lines, with passengers traveling to high-employment station areas such as Farragut West, Rosslyn, Foggy Bottom-GWU, and McPherson Square.

Figure 17. Transfer activity at L'Enfant Plaza

Table 7. Summary of 2005 and 2030 Peak-Hour Transfer Volumes

		2005		2030		
Station[5]	Between Lines	AM Hour	PM Hour	AM Hour	PM Hour	Peak Hour Growth (%)
Metro Center	Blue/Orange + Red	10,300	9,900	15,100	14,700	48
Gallery Pl-Chinatown	Yellow/Green + Red	9,700	9,500	12,600	12,900	33
L'Enfant Plaza	Blue/Orange + Yellow/Green	6,300	5,700	12,100	11,600	97
	Yellow + Green	700	800	1,100	1,200	57
Fort Totten	Red + Green	1,200	1,100	1,700	1,600	40
Rosslyn	Blue + Orange	1,049	1,100	2,800	2,900	168
King Street	Blue + Yellow	300	300	100	200	-50
Stadium-Armory	Blue + Orange	60	50	100	100	80
East Falls Church	Orange + Silver	NA	NA	765	824	NA
Total	All Transfer Volumes	29,609	28,450	46,365	46,024	59

Sources: AECOM Consult, PB

[5] Note that only major transfer stations are shown. Pentagon and Mt Vernon Sq/7th St-Convention Center are not included in this list.

Future Transfer Activity

The forecasts indicated that significant increases would occur at many of the transfer stations. Most notably, the L'Enfant Plaza peak-hour transfers would almost double. This is largely due to the future Blue Line split, as well as forecasted ridership increases at Blue Line stations. The Blue Line split will similarly affect Gallery Place-Chinatown, with large increases in northbound Yellow/Green to westbound Red Line volumes. However, the model was considered to over-predict the passenger volume going over the 14th Street Bridge for the future years. Further sensitivity tests in the demand forecasting model are necessary to obtain an accurate assessment of ridership shift from the existing Blue Line to the Yellow-Blue Lines as well as future transfers at L'Enfant and Gallery Place-Chinatown.

Metro Center will remain the highest-volume transfer station, with large morning volume increases between the westbound Blue/Orange and eastbound Red Line. Rosslyn will see large increases in both transfer directions due in part to Silver Line volumes. Gallery Place-Chinatown will remain a major station handing passengers transferring between the Green, Red and Yellow Lines; however, most of its growth is forecasted to come from stations entries and exits.

In 2004, Metro studied the feasibility of a free pedestrian tunnel connecting Farragut North and Farragut West. The study found that this tunnel could reduce transfer demand at Metro Center by 10 percent, as passengers traveling between Vienna and Shady Grove would no longer need to pass through Metro Center.

Metro did a similar study in 2005 of a pedestrian tunnel connecting Metro Center and Gallery Place-Chinatown. The tunnel would reduce the number of transfers at the L'Enfant Plaza station, as well as reduce overcrowding at the Gallery Place-Chinatown Red Line platforms. That study did not assume the Blue Line split and therefore did not account for the additional L'Enfant Plaza volumes this study forecasts. With the future Blue Line split, a pedestrian tunnel between the system's two largest transfer stations is even more warranted.

3.2 Line Capacity

Two types of capacity were analyzed in this study: station capacity and line capacity. Station capacity is the maximum allowance of passenger flows through various facilities within a station; line capacity is the maximum number of trains and passengers that can be carried on a single line. The combined evaluation of station and line capacities ensures safe and efficient movements of trains and passengers through the entire Metrorail system.

The line capacity analysis focused on the number of rail trains, cars, and passengers moving through the system during the AM peak hour and identified the load points along each line. Present and future transfer volumes were also summarized.

Existing Line Capacity

Metro primarily runs six-car trains along its lines during the peak hours.[6] Table 8 shows the peak load locations in the AM peak hour. The Yellow and Orange Lines carry the largest peak-direction passenger loads per car in the morning. The Red Line carries the largest passenger load, but its average passengers per car is smaller due to its frequent service.

[6] In 2005, a small number of four-car trains were also run on the Yellow and Blue Lines.

Table 8. 2005 and 2030 AM Peak Hour Line Loads

Line	Location		Passenger Load			Type of Train	
	From	To	2005	2030 Model[7]	2030 Adjusted[8]	2005	2030
Red	Gallery Pl-Chinatown	Metro Center	13,300	15,200	17,400	6 Car Train	8 Car Train
Yellow-Blue combined (via 14th St. Bridge)	Pentagon	L'Enfant Plaza	4,800 (Yellow)	11,300	11,300	4-6 Car Train (Yellow)	8 Car Train
Green	Waterfront-SEU	L'Enfant Plaza	7,400	8,900	9,700	6 Car Train	8 Car Train
Blue (via Rosslyn)	Pentagon	Rosslyn	4,700	5,600	3,100	4-6 Car Train (Blue)	8 Car Train
Orange-Silver combined	Court House	Rosslyn	11,700 (Orange)	19,600	21,100	6 Car Train (Orange)	8 Car Train

The projected passenger volumes from the 2030 forecasting model were adjusted to incorporate the recent growth trend of the system's maximum load segments and to correct the over-prediction on the Blue Line split. The adjusted 2030 passenger volumes were then applied to analyze the future peak-hour crowding condition on the maximum load segments of the system.

Future Line Capacity

Beginning in 2010, Metro has proposed to split portions of the Blue and Orange Lines, as described in Section 2.1. To meet the growing passenger demand, Metro has planned to implement 50% 8-car trains by 2010, 75% 8-car trains by 2015 and 100% 8-car trains by 2020. However, Metro is only funded for the 50% 8-car trains up to 2010.

Given the funding uncertainty for the additional railcars beyond 2010, two scenarios were developed to identify when and where the system would reach capacity during the am peak hour. The first scenario assumed that no additional railcars would be available after the funded 50% 8-car trains, and the second scenario assumed new funding sources would be available to support the proposed 75% 8-car trains by 2015 and 100% 8-car trains by 2020.

The analysis used the passenger load per car to measure levels of service quality and customer comfort. Metro defines an average peak hour load of 120 passengers per car as the railcar capacity. Since the system analysis focused on the average load during the am peak hour, passengers on individual trains during the peak of the peak hour could experience crowding beyond 120 passengers per car.

[7] The model's projections over-predicted the passenger volume on the Yellow and Blue Lines via the 14th Street Bridge.
[8] The adjusted 2030 passenger loads reflect corrections to the model's over-prediction and assume continuation of the recent growth rate on the max loads, where volumes were slightly higher than the projected rate from the model.

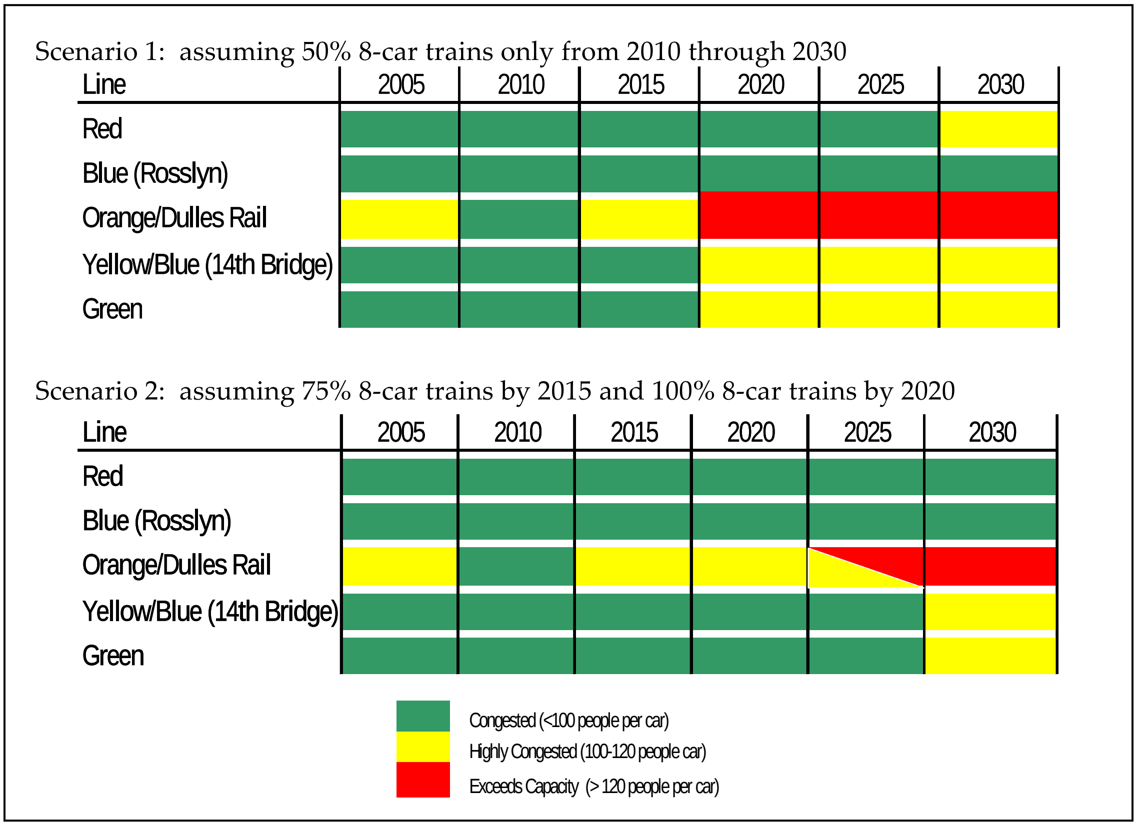

Figure 18. 2030 System Capacity at Maximum Load Segments (AM Peak Hour)

In terms of passenger load per car, without additional railcars beyond what is currently funded, the entire Metrorail system will approach capacity by 2030 (Refer to Scenario 1). Among those, the Orange and Silver (Dulles) Rail Lines between Courthouse and Rosslyn are expected to exceed capacity by 2020, exacerbating the already crowded condition during the peak hour. The growth on the Orange Line and the opening of the Silver (Dulles) Rail Line will result in a significant increase in the total load inside Arlington.

If Metro were able to fund and implement additional railcars as proposed as illustrated in Scenario 2, the system would be able to extend capacity out by more than 5 years. This analysis showed that eight-car trains are needed on most Metrorail lines by 2020, which confirms the findings in the Core Capacity Study.

In summary, full deployment of eight-car trains could handle the growing passenger demand around 2020 for several years. However, without major capacity expansions beyond the 8-car trains, the Metrorail system would reach capacity between 2025 and 2030, if actual growth proceeds according to the regional land use forecasts.

SECTION 4 FINDINGS: STATION TRENDS

This study analyzed station-level access and capacity issues. To maximize ridership, pedestrian and bicyclist improvements should be made at fast-developing stations and mature stations with existing deficiencies. Station capacity improvements should be made at several key core and transfer stations.

4.1 Getting to the Station

4.1.1 Existing Access Modes

Systemwide Access

This study included a system-level analysis of existing and future access using the 2002 access mode splits (see Appendix E) and 2030 forecasted station-area development.

Based on data from the 2002 Passenger Survey, during an average weekday 62 percent of the system's passengers walked or biked to stations, 16 percent drove and parked, 16 percent arrived by bus or commuter rail, and 6 percent arrived by Kiss & Ride, carpool, or taxi. At the core stations, an even greater percentage walk and bike, whereas at the stations outside the core, more drive and park.

As of October 2006, Metro owned approximately 58,000 parking spaces at stations, 94 percent of which were occupied on an average weekday. Based on a comparison of these numbers and the 2002 access mode-split data, it is apparent that many riders also park in facilities or on-street spots not owned by Metro.

Station-Level Access

Figure 19 shows the predominant access mode at each existing station, based on the 2002 On-Board Metrorail Passenger Survey data. While access mode splits may have changed since 2002 due to station-area development or demographic changes, this data provides a suitable baseline.

Pedestrians

The stations with the highest portion of pedestrian access are generally the stations with the highest density. These stations are typically surrounded by destinations within reasonable walking distance. Table 9 shows that many of the core stations, along with some inner-suburban stations with concentrations of jobs and/or housing, fall into this category.

Figure 19. Predominant Access Modes by Station in 2002

Table 9. Stations with Highest Pedestrian Access (PM peak period)

		2005 Land Use		2002 Mode Share	
Rank	Station	HH per acre[9]	Jobs per acre	AM Ped	PM Ped
1	Federal Center SW	4.73	98.73	87.5%	98.5%
2	Capitol South	8.97	47.48	88.4%	97.3%
3	Judiciary Square	5.79	131.00	49.0%	97.0%
4	McPherson Square	13.82	246.86	73.1%	96.0%
5	Farragut North	17.86	224.70	55.2%	95.8%
6	Federal Triangle	1.58	157.05	69.8%	95.6%
7	Farragut West	15.04	250.38	44.4%	95.5%
8	Archives-Navy Memorial-Penn Quarter	3.51	168.99	68.0%	95.4%
9	Court House	14.41	32.86	92.6%	94.7%
10	Metro Center	11.09	159.82	37.0%	94.7%
11	Smithsonian	1.48	113.23	15.0%	93.8%
12	Gallery Pl-Chinatown	9.94	151.91	49.3%	93.0%
13	Van Ness-UDC	8.19	7.94	81.1%	92.1%
14	Navy Yard	5.97	36.43	48.5%	92.0%
15	Crystal City	5.77	25.35	65.2%	91.1%
16	U Street/African-Amer Civil War Memorial/Cardozo	23.89	26.40	83.3%	90.6%
17	Clarendon	10.79	26.76	66.1%	90.5%
18	L' Enfant Plaza	4.43	99.51	22.8%	89.7%
19	Bethesda	5.79	18.57	50.0%	89.2%
20	Shaw-Howard U	14.49	20.20	74.6%	89.2%

Source: WMATA, MWCOG

Table 10 shows the stations that, based on a preliminary aerial photograph scan, may have existing pedestrian access issues. For example, Van Ness-UDC was missing sidewalks along Windom Place NW and is located adjacent to six-lane Connecticut Avenue, which may be difficult to cross. This may be problematic because as many as 92 percent of its passengers access the station on foot.

Because this analysis was not based on field visits or extensive data collection, it should only be a starting point for further analysis and identification of suitable improvements.

[9] Households and jobs were summarized for a one-half mile area around the station.

Table 10. Stations with Possible Existing Pedestrian Access Issues

Station with missing sidewalks[10]	Setting	Adjacent to wide road?[11]
Anacostia	Core	Yes
Braddock Road	Outside Core	No
Branch Ave	Outside Core	No
Brookland-CUA	Outside Core	No
Cheverly	Outside Core	No
Dunn Loring-Merrifield	Outside Core	Yes
Eisenhower Avenue	Outside Core	Yes
Fort Totten	Outside Core	No
Franconia-Springfield	Outside Core	Yes
Greenbelt	Outside Core	Yes
Huntington	Outside Core	No
Landover	Outside Core	Yes
Largo Town Center	Outside Core	No
Morgan Boulevard	Outside Core	Yes
Naylor Road	Outside Core	Yes
Pentagon	Core	Yes
Prince George's Plaza	Outside Core	Yes
Rhode Island Ave-Brentwood	Outside Core	Yes
Shady Grove	Outside Core	No
Southern Avenue	Outside Core	No
Suitland	Outside Core	Yes
Van Dorn Street	Outside Core	Yes
Van Ness-UDC	Outside Core	Yes
Vienna/Fairfax-GMU	Outside Core	Yes
West Falls Church-VT/UVA	Outside Core	Yes
West Hyattsville	Outside Core	No

Sources: Google Earth (2006), PB

Bicyclists

Fewer passengers generally bike to and from Metrorail stations. The stations with the highest bike access shares are Medical Center (6.8 percent), Branch Avenue (4.3 percent), Columbia Heights (3.4 percent), East Falls Church (3.1 percent), and Vienna (3.1 percent). Once at the station, passengers have the option of leaving their bikes either on a bike rack or, at stations with off-street facilities, in a bike locker. Table 11 shows that many stations need more bike racks; that is, more cyclists are parking their bikes than there are bike racks.

Some areas do not have any dedicated bicycle facilities or bicycle routes leading to the station, which may limit the number of passengers arriving by bike. These stations are listed in Appendix E.

[10] An aerial photography scan was done to determine whether any of the roadways directly leading to a station entrance were missing sidewalks.

[11] An aerial photography scan was done to determine whether the station site was adjacent to a six or more lane roadway.

Table 11. Stations with Highest Bike Rack Utilization

Rank	Station	2002 Mode Share		Bike Locker Utilization Rate	Bike Rack Utilization Rate
		AM Bike	PM Bike		
1	McPherson Square	0.5%	0.1%	0.0%	500.0%
2	Farragut West	0.0%	0.0%	0.0%	225.0%
3	Woodley Park-Zoo/Adams Morgan	0.3%	0.0%	0.0%	200.0%
4	Union Station	0.0%	0.3%	0.0%	173.9%
5	Federal Center SW	1.3%	0.0%	0.0%	150.0%
6	Fort Totten	0.0%	0.0%	16.7%	150.0%
7	Silver Spring	1.0%	0.4%	86.7%	138.5%
8	Vienna/Fairfax-GMU	0.9%	3.1%	82.1%	135.2%
9	Takoma	1.2%	0.0%	80.0%	115.8%
10	Braddock Road	1.3%	1.3%	91.7%	110.9%
11	Van Dorn Street	0.4%	0.0%	0.0%	110.0%
12	Clarendon	1.5%	0.0%	83.3%	108.3%
13	King Street	0.4%	1.5%	55.0%	102.9%
14	Ballston-MU	0.7%	0.0%	0.0%	100.0%
15	Pentagon City	0.4%	0.0%	59.1%	100.0%
16	Foggy Bottom-GWU	0.0%	0.0%	55.0%	100.0%
17	West Hyattsville	1.4%	0.0%	58.3%	94.0%
18	Dupont Circle	0.6%	0.0%	58.3%	93.8%
19	Franconia-Springfield	0.2%	1.2%	80.0%	91.7%
20	East Falls Church	3.1%	2.0%	63.9%	88.4%

Source: WMATA, PB

Bus Access

Bus service at Metrorail stations varies substantially by type of station. Some stations are major bus transfer facilities, while other urban stations only have on-street bus stops. The stations with the highest number of bus arrivals in the AM peak hour are Silver Spring (210), Pentagon (205), Friendship Heights (132), and Anacostia (121).

Metro's Guidelines for Station Site and Access Planning include recommendations for bus facilities. The guidelines recommend one bus bay for every six buses per hour servicing the station. Based on these numbers, many stations may need more bus facilities. Appendix E includes a list of these stations. Though these guidelines are useful, many other factors influence bus facility needs, such as site circulation and bus passenger volumes.

Park & Ride

Metro presently owns and operates 58,186 parking spaces. On an average weekday, almost all of those spaces are occupied. Only a handful of stations—White Flint, Wheaton, College Park-U of MD, Prince George's Plaza, and Minnesota Ave—have a substantial amount of available capacity. Table 12 shows parking lot utilization as of October 2006.

Table 12. Metro Parking Lot Utilization, October 2006

Station and Region	Lot Capacity	Average Utilization[12] Mon-Thurs	Average Utilization Fri
MONTGOMERY COUNTY			
Grosvenor	1,894	103%	92%
White Flint	1,158	41%	31%
Twinbrook	1,097	84%	70%
Rockville	524	104%	101%
Shady Grove	5,467	83%	78%
Glenmont	1,781	103%	102%
Wheaton	977	63%	40%
Forest Glen	596	101%	96%
PRINCE GEORGE'S COUNTY			
New Carrollton	3,519	98%	88%
Landover	1,866	76%	49%
Cheverly	530	97%	84%
Addison Road-Seat Pleasant	1,268	91%	71%
Capitol Heights	372	88%	82%
Greenbelt	3,399	99%	85%
College Park-U of MD	1,870	68%	64%
Prince George's Plaza	1,068	67%	60%
West Hyattsville	453	101%	102%
Southern Ave	1,980	98%	89%
Naylor Road	368	110%	107%
Suitland	1,890	100%	91%
Branch Ave	3,072	108%	106%
Morgan Boulevard	635	95%	87%
Largo Town Center	2,200	97%	87%
DISTRICT OF COLUMBIA			
Deanwood	194	95%	82%
Minnesota Ave.	333	52%	44%
Rhode Island Ave.	340	95%	94%
Fort Totten	408	88%	86%
Anacostia	808	89%	71%
NORTHERN VIRGINIA			
Huntington	3,090	99%	93%
West Falls Church-VT/UVA	2,009	103%	89%
Dunn Loring-Merrifield	1,319	107%	105%
Vienna/Fairfax-GMU	5,849	100%	91%
Franconia-Springfield	5,069	96%	88%
Van Dorn Street	361	110%	118%
East Falls Church	422	117%	129%
System Total	58,186	94%	85%

Source: WMATA

[12] Parking rates can exceed 100 percent because of turnover of spaces.

4.1.2 Future Access Challenges

Systemwide Challenges

The trend toward local jurisdictions and the private sector providing station parking will need to continue. If the access mode split were to remain constant, and station-area land were to develop according to MWCOG forecasts, as many as 44,000 new parking spaces would be needed by 2030. There are presently 8,100 spaces planned: at four Silver Line stations, Glenmont, and Vienna. This falls quite short of what future demand could be, and Metro does not own enough land to make up the difference.

Table 13. Existing and Future Systemwide Mode of Access, Conservative Scenario

Mode of Access	2005 No. of Passengers	2002 Percent Share	2030 No. of Passengers	2030 Percent Share	Absolute Change, 2005 to 2030
# Metro Parking spaces occupied/ needed	54,424 (2005)		101,900 (2030)		
Existing parking spaces			58,186		
Planned parking spaces			8,100		
Possible parking shortfall in 2030			35,614		
Daily Totals:					
Walk/Bike	422,000	61.8%	549,800	56.7%	127,800
Park & Ride	107,700	15.8%	201,600	20.8%	93,900
Bus/Train	106,900	15.6%	151,600	15.6%	44,700
Kiss & Ride, Taxi, Carpool	46,700	6.8%	66,300	6.8%	19,600

Sources: WMATA Parking Utilization, 2002 On-Board Metrorail Passenger Survey, MWCOG, PB

Table 13 shows the existing and one possible variation on future systemwide mode of access. This assumes that the number of passengers walking and biking to Metrorail stations would increase proportional to the forecasted increase in jobs and housing surrounding the stations. According to this assumption, though the number of walk and bike trips would increase, their share of total access modes would slightly decrease. Table 13 also assumes that the bus/train and taxi, Kiss & Ride, carpool mode of access shares would remain the same as in 2005. The resulting scenario, though perhaps conservative, would result in a substantial increase—almost doubling—of those arriving to Metrorail stations by car.

Parking is capital- and land-intensive. Metro should conduct a systemwide parking study to develop a strategy for meeting future parking demand. Strategies that could be considered are shared parking with other nearby facilities, parking provided by the private sector, or meeting demand by shifting to other access modes.

As shown in Table 13, walking and biking are important modes of access to Metrorail stations. These modes are most attractive and prevalent when there are facilities to walk to and from, such as jobs, housing, and retail. Increased transit oriented development (TOD) at stations could be part of a future strategy to balance access modes and reduce the need for parking.

Figure 20. Metrobus destined for McPherson Square

Another increasingly important access mode is feeder bus service that travels from population centers to Metrorail stations. A current example is Metrobus Route 12 that connects several Park & Ride lots in Centreville to the Vienna/Fairfax-GMU station. Feeder bus service can help reduce parking demand at the station itself, while providing residents outside of the Metrorail network an alternative to driving. Metro should identify future population centers without present Metrorail access, and investigate the possibility of extending feeder bus service to those communities.

Station-Level Challenges

Because of limited information about future Park & Ride and bus demand at each station, this study focused on walking and biking trips. The stations with the highest rate of forecasted development within one-half mile were identified and their existing access characteristics were analyzed. The stations in Table 14 are sorted by household growth from 2005 to 2030, as residential density is one of the largest determinants of transit use. Stations with a greater-than-50 percent growth rate in either households or jobs are included in the table, along with their possible pedestrian and bike access needs. This determination was based on the existing bike rack and locker utilization, the presence of bike routes/facilities or sidewalks leading to the stations, and the presence of major roadways adjacent to the station.

Almost all of the fast-developing stations would need some type of pedestrian or bike access improvement, since those should be the primary access modes within one-half mile. Only five of the fast-developing stations, Shady Grove, Branch Avenue, Greenbelt, Largo Town Center, and New Carrollton, have land presently available for parking, and they are all terminal stations.

In addition to the fast-developing stations, many mature stations have existing bicycle and pedestrian access needs that should be addressed. Some of these possible issues are listed in Tables 25 and 26 and in Appendix E.

Most of the pedestrian and bike access improvements would be made on land not owned by Metro. Therefore, Metro should work with local jurisdictions to ensure that walking and cycling facilities at these Metrorail stations are adequate for the anticipated demand, and possibly ideal enough to increase demand. Improvements could include wayfinding, pedestrian-scale streetlights, street trees to provide shade, sidewalks, bicycle lanes or paths, bicycle lockers or racks, and/or improved pedestrian crossings at major roadways. In some cases, at auto-oriented stations, a grade-separated pedestrian crossing might solve an access issue.

Because this study did not include a detailed assessment of pedestrian and bicycle facilities and traffic patterns, future station-specific studies should determine specific needs and recommendations. In addition, Metro should work with local jurisdictions on an ongoing basis to ensure all station areas are walkable.

Table 14. Stations with Highest Forecasted Development

STATION NAME	HH Growth change 05-30	Job Growth change 05-30	Forecasted Ridership Growth	Land for More Parking?[13]	Bike Needs	Walk Needs
College Park-U of MD	153.9%	66.3%	47.1%	No	Bike racks	
Judiciary Square	131.9%	34.2%	27.2%	No		
Shady Grove	113.6%	59.0%	45.5%	Yes	Bike route	Sidewalks
Union Station	93.6%	33.7%	12.9%	No		
Navy Yard	87.2%	61.3%	80.2%	No	Bike route	
Federal Triangle	84.5%	20.7%	20.2%	No		
Brookland-CUA	84.4%	7.4%	14.4%	No		Sidewalks
Branch Ave	83.5%	233.9%	18.3%	Yes	Bike route	Sidewalks
Gallery Pl-Chinatown	80.1%	31.8%	92.0%	No	Bike racks	
New York Ave-Florida Ave-Gallaudet U	75.2%	45.5%	80.2%	No		
Arlington Cemetery	74.7%	28.3%	-15.9%	No		
Silver Spring	74.3%	15.1%	21.8%	No	Bike racks/lockers	
Anacostia	74.1%	11.1%	38.9%	No		Sidewalks, crossing
King Street	71.6%	58.0%	24.3%	No	Bike racks	
Greenbelt	69.0%	48.7%	-2.1%	Yes		Sidewalks, crossing
White Flint	64.8%	36.6%	157.7%	No		
Van Dorn Street	63.0%	50.7%	53.9%	No	Bike racks	Sidewalks, crossing
Crystal City	57.0%	65.2%	29.4%	No		
Waterfront-SEU	56.6%	36.9%	11.4%	No	Bike racks	
Clarendon	56.6%	39.1%	77.3%	No	Bike racks/lockers	
Largo Town Center	56.5%	221.5%	40.5%	Yes		Sidewalks
Mt Vernon Sq 7th St-Convention Center	56.2%	55.4%	121.0%	No	Bike racks	
Eisenhower Avenue	52.4%	68.0%	345.8%	No		Sidewalks, crossing
New Carrollton	47.8%	59.3%	15.5%	Yes	Bike route	
Ronald Reagan Washington National Airport	47.1%	58.9%	437.4%	No		
West Falls Church-VT/UVA	20.8%	76.9%	-50.5%	No		Sidewalks, crossing

Sources: WMATA, MWCOG, AECOM Consult, PB

[13] Based on a recent WMATA study.

4.2 Moving Through the Station

Using the ridership forecasts, peak 15-minute entry and exit volumes traveling through each station facility—escalators, stairs, faregates, and farecard vendors—were calculated. The capacity of these facilities was analyzed by calculating their present and projected future volume-to capacity (v/c) ratios. Some elements, such as platforms and farecard vendors, were not included in the screening because the analysis did not yield meaningful results.

Figure 21. Escalator to Woodley Park-Zoo/Adams Morgan

The stations having one or more facilities with a v/c ratio was equal to or greater than 0.75 were identified as needing enhancement. If the v/c ratio was between 0.5 and 0.75, a station was identified as needing more detailed study.

Due to the number of existing Metrorail stations and the variety of configurations among them, this study made many systemwide assumptions about dimensions, passenger travel patterns, and station operations. In order to determine specific capacity issues and solutions, a more detailed, station-specific assessment should be done with more information on individual characteristics.

4.2.1 Existing Capacity

This study found that present demand at Farragut North and Metro Center already exceeds their capacities. At Farragut North's southeast mezzanine (its K Street entrance), the escalators between the mezzanine and platform may be operating beyond their capacity. At Metro Center, the stairs and escalators between the eastbound Red Line platform and the Blue/Orange Line platform may operate beyond their capacity. Several other stations, shown in Table 15, need more detailed study to determine whether they operate beyond their capacity.

4.2.2 Future Capacity

As shown in Table 15, the stations needing enhancement by 2030 are almost all in the core, with Shady Grove being the exception. The Core Capacity study identified many of these same stations as needing improvement, and some are already in the existing CIP. The stations listed as needing study showed a possible existing or future capacity issue; a more detailed study should be done to verify the specific problems and solutions.

Appendix E includes a more detailed summary of the location and magnitude of the capacity issue for each mezzanine listed below.

Table 15. Existing and Future Station Capacity Issues

Station	Mezz	Vertical		Faregate	
		2005	*2030*	*2005*	*2030*
Archives-Navy Memorial-Penn Quarter		⊙	⊙		
Bethesda			⊙		
Branch Ave		⊙	⊙		
Cleveland Park					⊙
Court House			⊙		⊙
Farragut North	SE	◎	◎		
Farragut West	W	⊙	⊙		
Foggy Bottom-GWU		⊙	⊙		
Franconia-Springfield			⊙		
Gallery Pl-Chinatown	N	⊙	◎	⊙	◎
	W				⊙
Judiciary Square	E		⊙		
L'Enfant Plaza	E	⊙	◎		
	W		◎		
Metro Center	N	⊙	◎		⊙
	S	◎	◎		
	W		⊙		
Navy Yard*	E				⊙
Shady Grove		⊙	◎		
Takoma				⊙	⊙
Twinbrook					⊙
White Flint					⊙
Union Station	S	⊙	⊙		
	W	⊙	⊙		

<u>Legend</u>

⊙ Needs study (0.5≤v/c<0.75)
◎ Needs improvement (v/c≥0.75)

**Note: Both Navy Yard mezzanines will have unique future needs, which may not be reflected in this analysis, due to the opening of the Washington Nationals Ballpark in 2008.*

Source: PB

4.3 Related Station-Specific Studies

This study was not intended to be a detailed assessment of individual station capacity and access. Metro regularly conducts station-specific studies where field observations are conducted and capacity assumptions and criteria are modified based on site conditions. This study is not meant to override these studies; in fact, the results presented in this study should be supplemented with individual station study results. Table 16 summarizes the recent and ongoing station studies and their recommendations.

Table 16. Summary of Recent Station Studies

Station	Study Date	Primary Recommendations	Estimated Cost	Status
Bethesda	2005	In conjunction with Bi-County Transitway (BCT): ▪ New south entrance and mezzanine ▪ Platform connection to BCT level ▪ New elevators from platform to mezzanine and from mezzanine to street	$40 M	TBD
		Without BCT: ▪ New south entrance and mezzanine ▪ New elevators from platform to mezzanine and from mezzanine to street	TBD	TBD
Court House	2004	Recommended new elevator entrance and mezzanine with elevator, escalator, and stair from platform to a floating mezzanine and elevators from the mezzanine to a street level entrance mezzanine.	$30 M	TBD
Farragut North/ Farragut West	2004	▪ Pedestrian tunnel connection between two stations ▪ Farragut North: o New mezzanine o New mezzanine to platform stair and elevators ▪ Farragut West: o New street to mezzanine elevators o New mezzanine to platform elevators	$32 M	TBD
Foggy Bottom-GWU	2007	▪ New station entrance at the east end of the platform at 22nd & I Streets with new elevators, escalators, and stair from street to new mezz and new elevators from new mezz. to platform	$21 M	Would be built concurrent with new GWU building
Gallery Place/ Metro Center	2005	▪ Pedestrian tunnel connection between two stations ▪ New street to mezz. elevators and mezz. to platform elevators at both ends of the passageway ▪ New stair entrance to the passageway at mid-tunnel Gallery Place: New mezz. to mezz. bridge connection	$41 M	TBD
Minnesota Avenue	2006	▪ Realignment of bus facilities and Kiss & Ride facilities to improve access and incorporate streetcar facilities ▪ New pedestrian bridge to the Parkside development ▪ Additional elevators to the station mezzanine and platform.	$18 M	TBD

Station	Study Date	Primary Recommendations	Estimated Cost	Status
Navy Yard	Ongoing	▪ Relocation of kiosk, faregate, and farecard vendor to the surface ▪ Additional faregates and farecard vendors ▪ New stair between mezzanine and platform ▪ New elevators from surface to platform	TBD	Will be built by April 2008 to coincide with new Ballpark opening
Rockville	2005	▪ Relocation and expansion of bus facilities, relocation of Kiss & Ride facilities incorporated into Joint Development ▪ Enhanced mezzanine capacity	$28 M	TBD
Rosslyn	Ongoing	▪ New elevator entrance and mezzanine incorporated into adjacent Central Place development	$34 M	Will be built as part of Central Place
Shady Grove	Ongoing	Multiple alternatives analyzed, including: ▪ New elevators, escalators and stair connection to platform ▪ New entrance to south end of station via pedestrian bridge from east side of tracks with potential connection to Corridor Cities Transitway ▪ New entrance at south end of station via pedestrian bridge from Redland Road	TBD	TBD
Stadium-Armory	2006	▪ Improvements to bus facilities ▪ Add Kiss & Ride facilities at south entrance ▪ New streetcar facilities ▪ Additional elevators to the station mezz. and platform ▪ Station signage	$12 M	TBD
Vienna-GMU	Ongoing	▪ Additional stair and elevator to improve vertical circulation to respond to complaints of platform queues ▪ Other TBD	TBD	Will be built as part of Metro West

Sources: WMATA, PB

Other station studies that are in progress or about to start include Eisenhower Avenue, New York Avenue, Glenmont, Brookland-CUA, and White Flint.

SECTION 5 IMPLEMENTATION

Based on the systemwide and station findings, several actions should be taken to ensure adequate future Metrorail system capacity and access.

5.1 Priority Station Projects

Based on the station-level access and capacity findings, this study identified conceptual station projects for the stations needing enhancement listed in Table 15. These projects should be included in the 2007 CIP update. In the plan, the projects would fall under Metro's System Access and Capacity Program.

The projects identified have not been designed or thoroughly analyzed, so they are presented as conceptual solutions. There could be a variety of solutions to each station problem, which would depend on the station's physical, funding, and operational constraints.

The station enhancement and connection priority projects are:

- **Farragut North-Farragut West Tunnel**: Construct pedestrian tunnel between two stations.
- **Farragut North**: Add southeast mezzanine-to-platform vertical capacity.
- **Metro Center**: Add platform-to-platform vertical capacity, possibly by building the Farragut North-Farragut West pedestrian tunnel. Building this tunnel could reduce Orange or Blue Line transfers to the Red Line.
- **Gallery Place-Metro Center Tunnel**: Construct pedestrian tunnel between two stations.
- **Gallery Pl-Chinatown**: Add platform-to-platform vertical capacity and faregates at the north mezzanine and extend mezzanine between 7th and 9th Street entrances.
- **L'Enfant Plaza**: Add platform-to-platform vertical capacity, possibly by building the Gallery Place-Metro Center pedestrian tunnel. Building this tunnel could decrease L'Enfant Plaza transfers.
- **Shady Grove**: Add mezzanine-to-platform vertical capacity.

Similarly, Metro should include bicycle and pedestrian access enhancements in the CIP update at following high-forecasted-development stations:

- Anacostia
- Branch Ave
- Brookland-CUA
- College Park
- Eisenhower Avenue
- Largo Town Center
- Navy Yard
- New Carrollton
- New York Ave-Florida Ave-Gallaudet U
- Shady Grove
- Silver Spring
- Van Dorn Street
- White Flint

The specific bicycle and pedestrian improvements would vary at each station but could consist of items such as sidewalk improvement, crosswalks, bike racks or lockers, wayfinding, street trees, and streetlights.

As previously discussed, many mature stations also have existing bicycle and pedestrian access needs that should be addressed. Site visits should be done to determine which of these stations have the greatest needs, and what the specific needs are.

5.2 Recommended Studies

5.2.1 Station Studies

Before station modifications are designed at Gallery Pl-Chinatown, L'Enfant Plaza, and Metro Center, Metro should conduct detailed pedestrian circulation studies for these stations. Because these are all key transfer stations with complicated pedestrian flows, sophisticated simulation software could be used to model peak conditions and develop solutions.

Several other stations are recommended for individual station access and capacity studies. These stations were identified if they were found to have a possible capacity issue, shown in Table 15, and were not otherwise being studied. The stations are:

- Archives-Navy Memorial-Penn Quarter
- Branch Ave
- Cleveland Park
- Farragut West
- Judiciary Square
- Takoma
- Twinbrook
- Union Station[14]

5.2.2 Other Studies

Metro should consider conducting a systemwide parking study to develop a strategy for meeting future parking demand. This study could be combined with a systemwide assessment of station-area land use. The assessment could include a detailed look at future station land use to determine the most appropriate mix of access modes to each station, and identify where feeder bus service could help to reduce parking demand. This could help Metro maximize the value of the investment in Metrorail.

[14] Because it serves Amtrak, commuter rail, bus, and Metrorail, Union Station has unique pedestrian flow issues. Therefore, this station would also benefit from a detailed pedestrian simulation study.

5.3 Conceptual Cost Estimates

Conceptual costs were developed for each station enhancement project. These costs are order-of-magnitude in precision and include a significant contingency to account for further project definition.

The bicycle and pedestrian access-enhancement costs include new and enhanced sidewalks, crosswalks, street trees, bike racks, and wayfinding.

Table 17. Summary of Station Enhancement Project Costs

Station Enhancements by Mezzanine			Low	High
Farragut North	SE	vertical capacity, farecard vendors	$1.0	$1.3
Gallery Pl-Chinatown[15]	N	vertical capacity, farecard vendors, faregate	$1.2	$1.5
	E	vertical capacity, farecard vendor	$1.5	$1.8
	W	vertical capacity, farecard vendors	$0.7	$1.1
L'Enfant Plaza	total		$2.2	$2.9
	N	vertical capacity, farecard vendors	$1.0	$1.1
	S	vertical capacity, farecard vendors	$1.1	$1.8
Metro Center	total		$2.1	$2.9
Shady Grove		vertical capacity, farecard vendors	$0.6	$1.3
SUBTOTAL ($FY07m)			$7.1	$9.9
Pedestrian Connections			Low	High
Gallery Pl-Chinatown & Metro Center		pedestrian tunnel	$66.0	$66.0
Farragut North & Farragut West		pedestrian tunnel	$24.2	$26.7
SUBTOTAL ($FY07m)			$90.2	$92.7
Bicycle and Pedestrian Access Enhancements (Various stations)			Low	High
SUBTOTAL ($FY07m)			-	$5.2

Source: PB

[15] Cost estimate does not include mezzanine extension.

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