Operations Guidelines for Metrobus in

Bus Rapid Transit/Light Rail Transit/Streetcar Corridors

# Final Report

December 2013

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# 1 Forward

This report is the outcome of Metro's efforts over the last year to work with local jurisdictions to identify how new modes of transit can be best integrated into the region's existing bus network. As new modes of transit take shape around the region, it is Metro's goal to ensure that customers can easily and seamlessly incorporate these new modes into their travel plans. This report identifies a wide range of operational scenarios, and guides the reader in considering how various operational decisions can help new transit modes better integrate into the regional bus network. It is designed to serve as a toolbox for planners, guiding them through the decision making process as they plot the service profiles for new projects.

We selected three pilot corridors, each a different mode, and each already in the planning and implementation phases, to demonstrate how these guidelines can be applied to real life projects.

These guidelines are designed to give planners the tools they need to identify operational choices and coordination opportunities at each stage of project development, spanning from envisioning a new service, to designing the best cross section, to selecting station locations and fare payment strategies.

As transit professionals, the ability for our customers to navigate seamlessly though the region via transit, regardless of the mode or operator, is our ultimate goal. Incorporating operational considerations into the beginning stages of a new project gives us the best prospects for achieving system integration and improving connectivity and mobility for all.

The following table gives a brief overview of the mode types and opportunities for coordination discussed in this report.

| Coordination Category | Streetcar | Light Rail | Bus Rapid Transit |
|---|---|---|---|
| Metrobus coordination | Local Metrobus | MetroExtra | Local Metrobus and MetroExtra |
| Running way coordination | All vehicles can use if streetcar operates in mixed traffic. Local buses should not use center running streetcar right of way. | Ballasted track right of way cannot be used by buses. In locations that paved right of way exist, bus services that have the same stopping pattern as Light Rail may use running way. | Curb bus lanes and transitways can be used by all buses. Median running ways cannot be used by local bus services. |
| Schedule coordination | Coordinated headway management; can be schedule or headway based. | Corridor services are not coordinated with local buses. May be coordinated with express buses. | Schedule coordination along BRT running ways will be based on individual running way characteristics. |
| Fare collection coordination | Feasible – requires coordination. | Feasible – requires coordination. | Feasible – requires coordination. |
| Customer Information | Should be coordinated. | Should be coordinated. | Should be coordinated. |

We hope you will find these guidelines both useful and thought provoking. Happy Planning!

# 2 Executive Summary

In the Washington region, bus rapid transit (BRT), light rail transit (LRT) and streetcar (SC) systems are currently under study or construction on major transit corridors within the Washington Metropolitan Area Transit Authority (WMATA) Compact jurisdictions. All of these corridors currently have heavy bus ridership. Some existing riders will be fully served by the new service; however, many others will require a combination of existing bus service and the new fixed route transit to reach their final destinations.

This *Operations Guidelines for Metrobus in BRT, LRT and Streetcar Corridors* study addresses the best way to coordinate new service modes with WMATA's existing bus transit system (i.e., Metrobus) to optimize rider mobility and system efficiency.

**Chapter 2**, Document and Data Collection Summary, summarizes the data collected and methodology to determine the three corridors that would be analyzed to form a template for future Metrobus operating concepts. All of the light rail, streetcar, and bus rapid transit projects in the region were identified. Three rounds of screening were used to select the final three corridors that were analyzed. The final three corridors, Phase 1 of the One City Line (H Street/Benning Road Streetcar), the Purple Line, and the Beauregard/Van Dorn Street corridors are described in this chapter.

**Chapter 3** presents potential operating strategies for Metrobus services in the three pilot corridors. Complete definitions of each mode that operates within each corridor are presented in this chapter. Different types of running way that may be used in each corridor are also described. Different types of schedule coordination strategies are also presented. Preliminary recommendations regarding which operating strategies can be applied to each corridor are described in this chapter.

The impact to Metrobus operations in each corridor are presented in **Chapter 4**. This chapter sets the priority of reinvesting any Metrobus cost savings from implementation of streetcar/LRT/BRT in a corridor within the same corridor, which can be done either by enhancing Metrobus services within the corridor or enhancing services on intersecting corridors that would feed passengers to the enhanced corridor service. Operational and schedule strategies for each corridor are presented in this chapter which include route changes and eliminations, service frequency recommendations, and service coordination strategies. Impacts to Metrobus operating costs and the number of vehicles housed at Metrobus Operating Divisions are also presented in this chapter.

Fare collection technology use, media, and its applicability to each project corridor is presented in **Chapter 5**. This includes a description of the proposed fare collection methodology for each corridor when this information was available, fare technology and equipment, and recommendations regarding fare coordination and technology are made.

The main body of this report is followed by four Appendices, which present the four original technical memoranda as prepared for this study. It is important to note that these versions of the technical memoranda include data and information that was subsequently revised as part of the Final Report, thus they do not exactly reflect the findings as presented in the Final Report. However, the study team has included them herein so as to present as complete a record as possible of the entire study process.

Since the purpose of this study is to have a template for WMATA to use throughout the region as new streetcar/LRT/BRT services are implemented, many of the recommendations are phrased both specifically to a corridor and generic to be applied to the new mode service. **Table 1** presents a summary of coordination methods for operations and fares which can be applied to Metrobus when streetcar, BRT, or LRT services are implemented.

**Table 1 – Metrobus Operations and Fare Coordination Method for Each Mode/Corridor**

| Coordination Category | Streetcar – One City Line (H Street/Benning Road NE) | Light Rail – Purple Line | Bus Rapid Transit – Beauregard/Van Dorn Street |
|---|---|---|---|
| Applicable template mode | Streetcar | Light Rail/Rapid Transit | Bus Rapid Transit/Transitway |
| Jurisdiction of template | District of Columbia | Maryland | Virginia |
| Metrobus coordination | Local Metrobus | MetroExtra | Local Metrobus and MetroExtra |
| Running way use | All vehicles can use – streetcar operates in mixed traffic. Local buses should not use center running streetcar right of way. | Ballasted track right of way cannot be used by buses. In locations that paved right of way exist, Metrobus/MetroExtra services that have the same stopping pattern as Light Rail can use Light Rail running way. | Beauregard/Van Dorn Street BRT will be an open system, with all buses allowed to use running way. Curb bus lanes and transitways can be used by all buses. Median running ways cannot be used by local bus services. |
| Schedule coordination method | Headway based schedules. Coordinated headway management will be needed to ensure proper headway separation between X2 buses and streetcars. | Corridor services are not coordinated. Schedule coordination is limited to Metrobus schedules coordinated at key stations to facilitate transfers. | Schedule coordination along BRT running ways will be based on characteristics of the individual running way and services operated. For Beauregard/Van Dorn Street, schedules will be timetable based. |
| Fare media | Use and provide incentives for SmarTrip usage and future next generation contactless fare technology | Use and provide incentives for SmarTrip usage and future next generation contactless fare technology | Use and provide incentives for SmarTrip usage and future next generation contactless fare technology |
| Fare collection coordination | Hybrid on-board/off-board fare collection with off-board fare collection at select streetcar stops and on-board fare collection at local only bus stops. Would apply to MetroExtra as well. | Off-board fare collection at stations/closed fare system for both Metrobus and LRT. Station may have fare gates. | Hybrid on-board/off-board fare collection with off-board fare collection at BRT stations that Metrobus and BRT services share and on-board fare collection at local only stops. |

# 3 Document and Data Collection Summary

The purpose of this chapter is to present the three "Pilot Corridors" that were analyzed for the *Operations Guideline for Metrobus in BRT, LRT and Streetcar Corridors* study. Three corridors were selected so that one would be located in each of the three major jurisdictions that comprise the WMATA service area. Besides the identification of the corridors to be analyzed, this chapter also presents the methodology for screening out and selecting the three final Pilot Corridors. The final sections of this chapter present some of the more detailed data collected for the final three Pilot Corridors and some of the preliminary known impacts to Metrobus services from the streetcar, light rail, and bus rapid transit investments.

## 3.1 Identification of Corridors and Projects

A region-wide inventory of potential projects for analysis was created. This inventory was based on an internet search of public documents from planning and transportation agencies within the WMATA service area, as well as conversations with members of the project management team (PMT).

## 3.2 Screening Process

Selection of the three corridors/projects for analysis and development of an operating plan required three rounds of screening. The first round consisted of screening out projects and corridors that do not affect Metrobus service or would not be implemented prior to 2020. The information and list from the first round was presented to the PMT for confirmation regarding the status of the various studies.

For the second round of screening, the list created for the first round was presented to the PMT for confirmation and discussion. The key criteria for the second round of screening was based on each jurisdiction selecting up to three corridors that they would like to see implemented and analyzed further for a complementary Metrobus operating concept. This discussion represented the second round of screening.

The third round and final round of screening selected the final three Pilot Corridors for the development of operating concepts. Public information regarding the remaining candidate projects was evaluated to determine mode, level of service, and level of financial commitment. The goal for selecting each corridor was to be as inclusive as possible. Corridors that serve multiple jurisdictions were preferred versus corridors that serve only one jurisdiction. The other goal was to provide different Metrobus operating concepts for different modes, thus the selected corridors include one streetcar corridor, one light rail corridor, and one bus rapid transit corridor. The selected corridors include the Purple Line in Maryland, the One City Line (H Street/Benning Road NE) in the District of Columbia, and the Beauregard/Van Dorn Street corridor in Virginia.

## 3.3 Additional Data Collection

To obtain additional information regarding each of the final Pilot Corridors, study team staff met with the individual jurisdictions and project sponsors. Information requested included details regarding service levels, station locations and layouts, ridership projections for new services and Metrobus services, Intelligent Transportation Systems (ITS) and other physical strategies and treatments that will be a part of the project, and coordination with other services. Fare policy for any new service was also discussed including fare levels, transfer policies, fare media that would be used, and whether fares would be collected onboard or off-board transit vehicles. The phasing of the transit

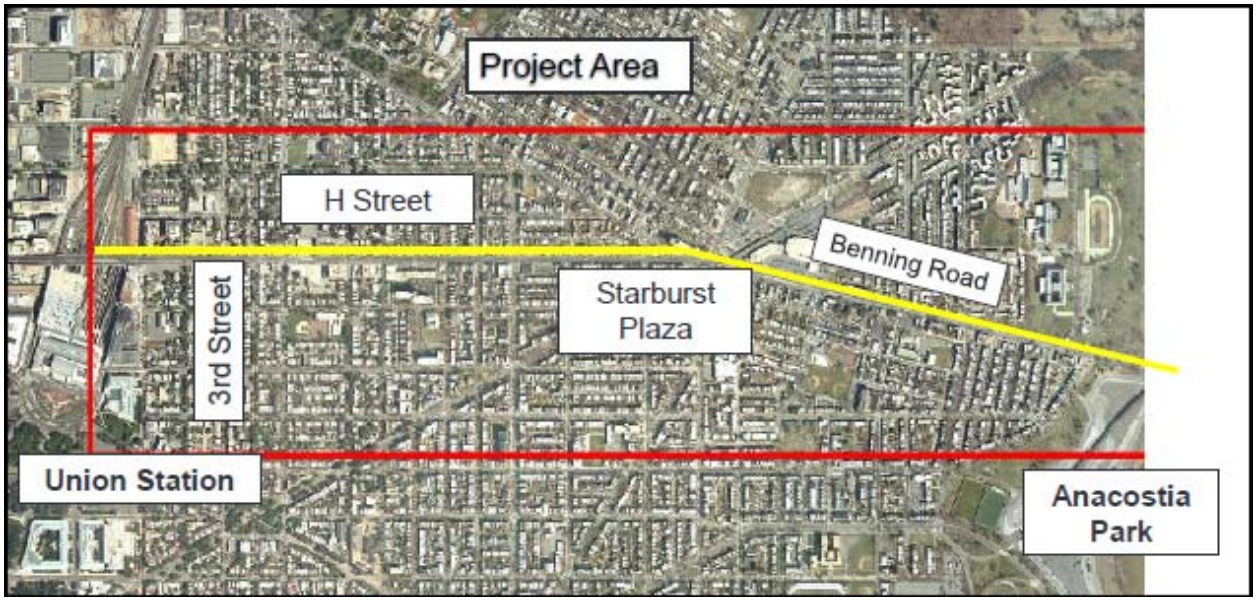
improvement was also discussed as was the ability for other transit operators to take advantage of the new infrastructure. Below is a description of information obtained for each corridor.

**One City Line**

The One City Line is an east/west streetcar corridor within the District of Columbia. The project sponsor of the One City Line is the District of Columbia Department of Transportation (DDOT).

As shown in **Figure 1**, the H Street/Benning Road NE corridor is the initial service segment for this corridor. There are 8 stations on this operating segment of this streetcar service between Union Station and Oklahoma Avenue NE. The running way is in mixed traffic with portions running in a median lane and other portions on a curb lane. Streetcars and buses will not be using the same boarding locations due to streetcar stops having a raised platform that is not compatible with WMATA buses.

**Figure 1 – One City Line Initial Operating Segment – H Street NE & Benning Road NE**




Based on a ridership forecast completed for the Urban Circulator grant, the initial operating segment is anticipated to have a ridership of 1,500 per day.

As shown in **Figure 2**, the streetcars themselves are 66-foot long vehicles with a capacity of 157 people. Their stops will feature raised platforms for level boarding onto the vehicles and overhead catenary wires will be insulated.

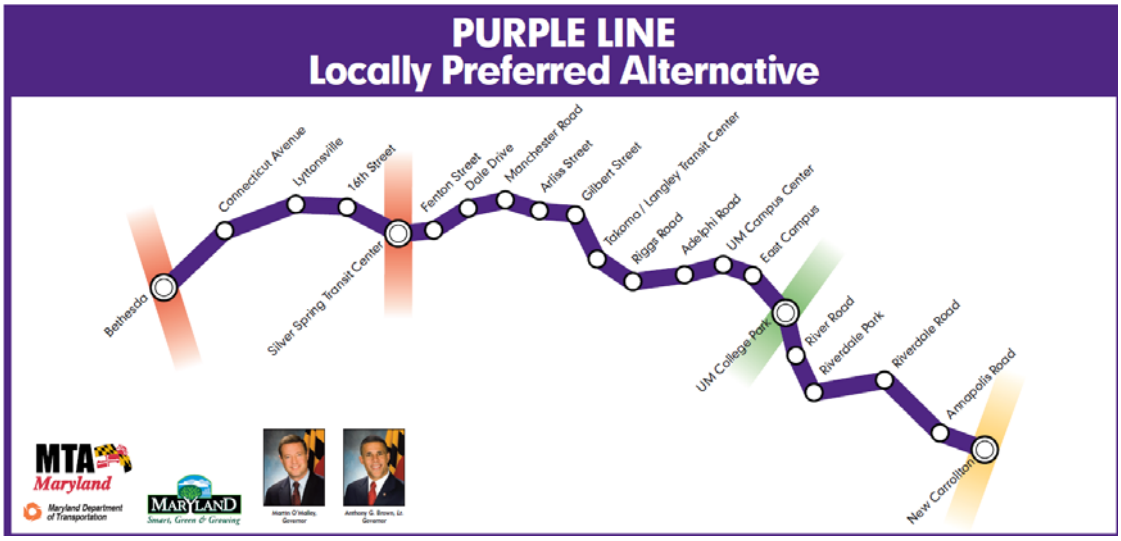
**Figure 2– One City Line**

Streetcars would potentially have traffic signal priority (TSP) at some selected intersections along this corridor. The fare and transfer policy is under development by DDOT. It has not been decided whether fare will be collected onboard the vehicles or off, although a hybrid on-board/off-board approach is being considered. The initial operating segment will be similar to the current Metrobus Route X2 service east of Union Station.

### Purple Line

As shown in **Figure 3**, the Purple Line is a light rail transit service planned to operate in the corridor between Bethesda and New Carrollton in Maryland.

**Figure 3 – Proposed Purple Line**



The Purple Line closely parallels East-West Highway west of Silver Spring. The Purple Line will operate along University Boulevard between Langley Park and the University of Maryland campus. On the eastern end, the Purple Line will operate along Veterans Parkway

As shown in **Figure 4** (for the segment along the Capital Crescent Trail), the Purple Line will operate primarily in an exclusive right-of-way, with segments of mixed traffic operation along Wayne Avenue in Silver Spring and Paint Branch Parkway in College Park. Ridership is expected to be approximately 68,000 passengers per day.

**Figure 4 – Purple Line Right-of-Way Along Capital Crescent Trail**

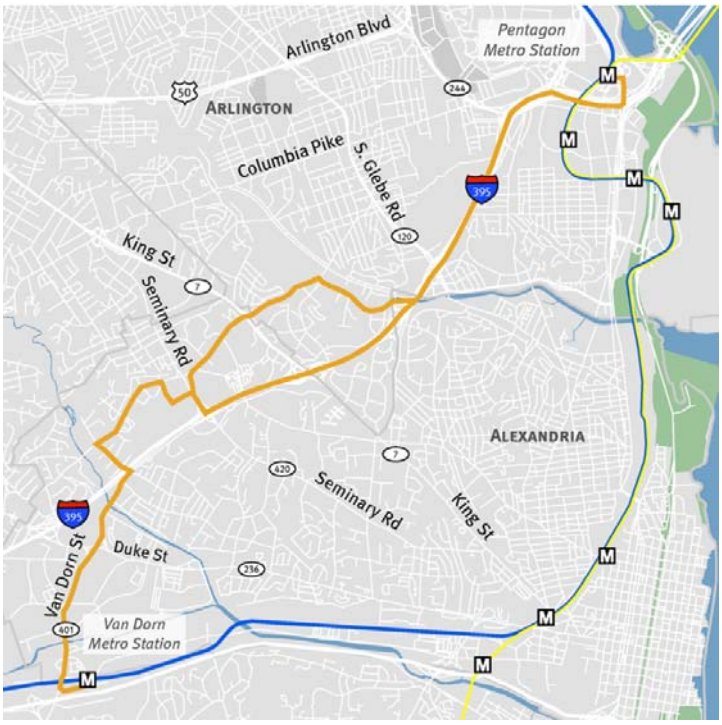
There are a number of current bus routes that are likely to be modified or eliminated since they operate along the same corridor as the Purple Line; these include Metrobus Routes C2, J2, J3, and J4, Ride-On Route 15, and the University of Maryland Shuttle Bus route to Silver Spring. Other intersecting bus routes may be modified to serve Light Rail stations. There will be a total of 21 stations along the Purple Line; these will have platforms that are 200 feet long. There will be a mix of side and center island platforms throughout the corridor. Light Rail vehicles will individually be 95 feet long articulated units that will be able to accommodate 140 people. The fare policy will be a flat fare structure, similar to Metrobus; however, fares will likely be higher than Metrobus. Off board fare collection will likely be used.

### 3.4 Beauregard/Van Dorn Streets

As shown in

**Figure** 5, the Beauregard/Van Dorn Streets service is a proposed bus rapid transit (BRT) corridor operating between the Van Dorn Street Metrorail station and the Pentagon Metrorail station. The corridor will operate through Alexandria, and connect to points in Fairfax County and Arlington County. The City of Alexandria is leading this project.

**Figure 5 – Beauregard/Van Dorn Streets Bus Rapid Transit Corridor**




Infrastructure improvements will occur primarily along Van Dorn Street and Beauregard Street. Access to the Pentagon will be via Interstate 395. Ten stations are proposed within Alexandria. This service will primarily affect the Metrobus 7-series bus routes as well as a number of Alexandria DASH bus routes. The Beauregard/Van Dorn Streets BRT service will consist of low-floor BRT vehicles that will be branded for the service. Fare collection will be off-board at stations, and stations will have numerous passenger amenities. There will be dedicated BRT lanes for about 80 percent of the corridor, while in other locations BRT buses will run in mixed traffic. Besides dedicated right-of-way there will be real-time arrival information at bus stops and transit signal priority at intersections. Other local buses that operate along the corridor but are not branded will be able to take advantage of the dedicated transit lanes along the corridor and other ITS improvements that will improve bus travel speeds. By 2035, ridership along this corridor is expected to be between 12,500 and 17,500 passengers per day.

### 3.5 Impacts of Projects

The potential impacts that each of these projects will have on Metrobus services in the corridor are described in this section. This includes identifying the Metrobus routes that are affected by each project and the impact that these projects may have to the routes. The H Street/Benning Road Streetcar should allow for service changes on some of the Metrobus services in this corridor primarily along the X2. The Purple Line LRT service will affect a number of Metrobus services operating out of Montgomery Division which include Metrobus Routes C2, C4, J1, J2, J3, and J4. The proposed Beauregard/Van Dorn Streets BRT service primarily follows Alexandria DASH routes; however, the Metrobus 7-series bus routes also utilize various portions of the Beauregard and Van Dorn Streets corridor.

# 4 Operating Strategies

This chapter describes the operational strategies that the Washington Metropolitan Area Transit Authority (WMATA) might apply to streetcar, light rail, and bus rapid transit corridors that also accommodate Metrobus operations. This includes the identification of operational scheduling strategies and how to coordinate differing operational paradigms. Also included in this chapter are guidelines on the utilization of transit facilities, including what modes could utilize specific types of facilities.

## 4.1 Identification of Transit Modes

This section identifies the different modes and service types that could take advantage of the various types of running ways. The descriptions below mention the ability for each mode to take advantage of any transitway or priority treatment that may be implemented with a bus, streetcar, or light rail corridor.

**Light Rail or Streetcar** – Streetcars and light rail vehicles are rail vehicles that run on fixed track guideways. This trackage can be on its own exclusive right-of-way or it can be embedded in the street pavement so that the rail service can operate in mixed traffic. These rail vehicles have an inherent alignment limitation in that they can on only operate along alignments that have tracks; however, this feature is also viewed as a positive one in that it represents a longer-term commitment to the transit service along that alignment. A modern streetcar is illustrated in **Figure 6**.

**Figure 6– Modern Streetcar**


**Metrobus** – Metrobus is the local bus service operated by the Washington Metropolitan Area Transit Authority (WMATA) throughout the Washington metropolitan area. Metrobus local routes typically have short stop spacing and provide service along major corridors as well as local neighborhood streets. Metrobus services connect neighborhoods to Metrorail stations as well as provide regional

transit connectivity. Local buses may only be able to use certain types of dedicated lanes or transitways due to their frequent stopping patterns. A Metrobus is illustrated in **Figure 7**.

**Figure 7 – Metrobus**


**MetroExtra** – MetroExtra refers to branded limited stop bus routes operated by WMATA. MetroExtra routes have wider stop spacing, with stops located at bus stops with high ridership, transfer locations with other transit services, or near major generators. These routes primarily operate along major surface transit corridors, providing a quicker trip and enhancing transit capacity along these corridors. MetroExtra vehicles would be able to take advantage of most dedicated lanes or transitways, and one is illustrated in **Figure 8**.

**Figure 8 – MetroExtra**


**Local Jurisdiction Local Bus** – Local jurisdiction local buses are simply local bus services that are operated by local jurisdictions and not by WMATA, thus they are not branded as “Metrobus”. Most local jurisdiction buses are local buses; however, the local jurisdictions do operate some commuter and express bus routes as well. The local jurisdiction local bus operations have similar characteristics to local Metrobus operations. Local jurisdiction local buses can use the same transitways or dedicated lanes that Metrobus would be able to use, but – similar to Metrobus – they

may only be able to use certain types of dedicated lanes or transitways due to their frequent stopping patterns. A local jurisdiction local bus is illustrated in **Figure 9**.

**Figure 9 – ART – Arlington Transit**


**Commuter/Express Bus** – Commuter and express buses are longer distance bus services that connect park-and-ride or residential locations to major employment areas. These services could be operated by either WMATA or a local jurisdiction operator. Commuter and express buses can take advantage of many of the transitway or dedicated lanes; a commuter express bus is illustrated in **Figure 10**.

**Figure 10 – Commuter/Express Bus**


**Taxicab** – A taxicab is a private for-hire vehicle that provides point-to-point transportation, typically usually utilizing a sedan vehicle. In many locations local policy dictates that any for-hire vehicle should have access to any dedicated transit lane or transitway.

**Bicycle** – Bicycle usage in the Washington metropolitan area is growing. Like taxis and for-hire vehicles, the policy regarding letting bicycles utilize a dedicated lane or transitway depends on local policy.

## 4.2 Identification of Dedicated Lanes and Transitways/Guidelines for Use

In this section, a description of dedicated lane and transitway types that may be implemented in the Washington metropolitan area is presented, along with guidelines for their use. **Table 2** provides a summary of the dedicated lane and transitway guidelines for use.

**Exclusive Rail Right-of-Way (Ballast or Other)** – An exclusive right-of-way with ballast or another type of surfacing (other than pavement) is a dedicated rail right-of-way for streetcar and light rail vehicles. This type of right-of-way is similar to Metrorail's "heavy rail" right-of-way; however, it may include grade crossings. **Figure 11** provides an illustration of such a right-of-way, in Boston along the Green Line's B Branch on Commonwealth Avenue.

**Figure 11 – Exclusive Rail Right-of-Way (Ballast or Other) – Boston**

**Exclusive Rail Right-of-Way (Paved)** – An exclusive paved rail right-of-way is similar to the exclusive rail right-of-way described previously; however, it has pavement that allows for other vehicles to use the right-of-way. An example of such an exclusive paved rail right-of-way would be the Seattle Transit Tunnel, as shown in **Figure 12**.

**Figure 12 – Seattle Transit Tunnel (Utilized by Light Rail and Bus Modes)**

The paved exclusive right-of-way does not necessarily need to have decorative paving; it can utilize the same pavement type as a street. This would allow for bus modes to utilize the right-of-way and allows for a joint bus and rail right-of-way.

**Dedicated Paved Rail (Median Lane)** – A dedicated paved rail lane involves either constructing a paved rail lane in the median/center of the roadway or converting a general use vehicle lane in the median by placing rails in the pavement and restricting use to rail vehicles (or other transit vehicles). An example of such a dedicated paved rail right-of-way in the roadway median is North Howard Street in central Baltimore, as shown in **Figure 13**.

**Figure 13 – Dedicated Paved Rail (Median Lane) – North Howard Street, Baltimore**

**Table 2 – Transit Mode User Guidelines for Dedicated Lanes and Transitways**

| | Light Rail Vehicle or Streetcar | Metrobus | MetroExtra | Commuter Bus | Local Jurisdiction Bus | Taxicab | Bicycle |
|---|---|---|---|---|---|---|---|
| *Rail rights-of-way/Transitways* | | | | | | | |
| Exclusive rail right-of-way (Ballast/Other) | Exclusive use | Can't use due to right-of-way limitations | Can't use due to right-of-way limitations | Can't use due to right-of-way limitations | Can't use due to right-of-way limitations | Can't use due to right-of-way limitations | Can't use due to right-of-way limitations |
| Exclusive rail right-of-way (Paved) | Primary user | Low priority depending on stop needs | Secondary user depending on ability for rail and buses to pass each other | Secondary user depending on ability for rail and buses to pass each other | Low priority depending on stop needs | Use based on jurisdictional policy | Use based on jurisdictional policy |
| Dedicated paved rail (Median Lane) | Primary user | Shouldn't use due to bus stop spacing needs | Secondary user depending on stop needs | Secondary user depending on stop needs | Shouldn't use due to bus stop spacing needs | Use based on jurisdictional policy | Use based on jurisdictional policy |
| Dedicated paved rail (Curb Lane) | Primary user | Secondary user depending on ability for rail and buses to pass each other | Secondary user depending on ability for rail and buses to pass each other | Secondary user depending on ability for rail and buses to pass each other | Secondary user depending on ability for rail and buses to pass each other | Use based on jurisdictional policy | Use based on jurisdictional policy |
| Mixed traffic center running streetcar | Primary user | Shouldn't use due to bus stop spacing needs | Secondary user depending on stop needs | Secondary user depending on stop needs | Shouldn't use due to bus stop spacing needs | Can Use | Can use |
| Mixed traffic curb running streetcar | Primary user | Secondary user depending on ability for rail and buses to pass each other | Secondary user depending on ability for rail and buses to pass each other | Secondary user depending on ability for rail and buses to pass each other | Secondary user depending on ability for rail and buses to pass each other | Primary user | Can use |
| *Bus rights-of-way/Busways* | | | | | | | |
| Exclusive separated busway | Can't use | Secondary user depending on provision for stops | Primary user | Secondary user depending on stop needs | Secondary user depending on provision for stops | Use based on jurisdictional policy | Use based on jurisdictional policy |
| Median bus only lane | Can't use | Shouldn't use due to bus stop spacing needs | Primary user | Secondary user depending on stop needs | Shouldn't use due to bus stop spacing needs | Use based on jurisdictional policy | Use based on jurisdictional policy |
| Curb bus only lane | Can't use | Secondary user depending on provision for stops | Primary user | Secondary user depending on stop needs | Secondary user depending on provision for stops | Use based on jurisdictional policy | Use based on jurisdictional policy |
| Mixed traffic | Can't use | Primary user | Primary user | Primary user | Primary user | Primary user | Can use |

**Dedicated Paved Rail (Curb Lane)** – A dedicated paved curb rail lane involves either converting or constructing a paved rail lane on the curb of the roadway. An example of a dedicated paved rail median lane includes portions of the rail right-of-way in central Portland, Oregon, as shown in **Figure 14**.

**Figure 14 – Dedicated Paved Rail (Curb Lane) – Portland**

**Mixed Traffic Center Running Streetcar** – A mixed traffic center running streetcar has a streetcar or light rail vehicle operating with mixed traffic in the center of the roadway. An example of this includes portions of the proposed One City Line streetcar along H Street/Benning Road NE or the Green Line's E Branch along Huntington Avenue in Boston, which is shown in **Figure 15**.

**Figure 15 – Mixed Traffic Center Running Streetcar – Boston**

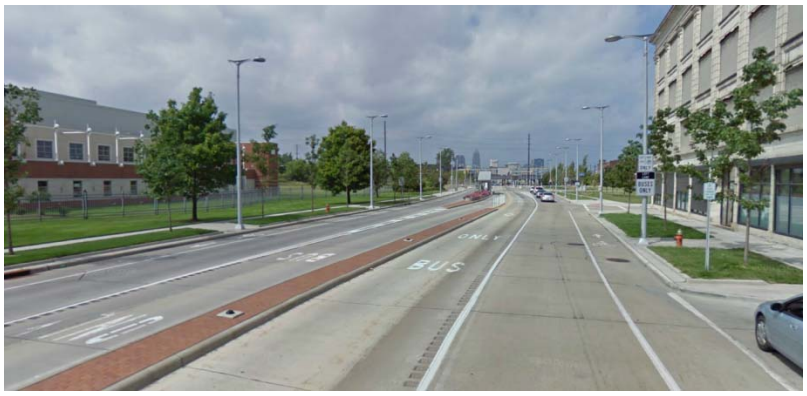
**Mixed Traffic Curb Running Streetcar** – A mixed traffic curb running streetcar consists of a streetcar or light rail vehicle operating in mixed traffic on the curb lane. Examples of this are the planned Columbia Pike streetcar line in Arlington and the DC Streetcar on H Street/Benning Road NE.

**Exclusive Separated Bus Lane** – An exclusive separated bus lane is a physically separated bus transitway. Examples of an exclusive separated bus transitway include the MLK East Busway in Pittsburgh and the Orange Line in Los Angeles (shown in **Figure 16**).

**Figure 16 – Exclusive Separated Bus Lane – Los Angeles**


**Median Bus Only Lane** – A median bus only lane is a dedicated transit lane that operates in the median of a roadway. An example of a dedicated median bus only lane would be portions of the "Health Line" Bus Rapid Transit (BRT) in Cleveland, as shown in **Figure 17**. Frequently this type of lane will have stations built in the median to support BRT services.

**Figure 17 – Median Bus Only Lane – Cleveland**




**Curb Bus Only Lane** – A curb bus only lane is one of the more common examples of transit priority in the United States. This reserves the curb travel lane on a roadway for transit vehicles and can be in

effect all day or only part of the day. An example of a dedicated curb bus only lane is along 7th Street NW in the District of Columbia.

**Mixed Traffic Bus Operation** – Mixed traffic bus operations is the normal operating condition for bus routes. Under this operation there are no physical bus priorities provided for transit vehicles.

### 4.3 Identification of Operational Strategies and Preliminary Recommendations

There are two primary types of operational strategies that would need to be coordinated among the various transit modes operating along the three pilot corridors selected for this study. The strategies are based on scheduling and include timetable-based schedules and headway-based schedules. In addition, the "time-slot scheduling" method of scheduling coordination among the various modes – which was utilized during the development of the Crystal City-Potomac Yards (CCPY) Transitway operating plan – is also described.

#### Multiple Operators

In addition to the two scheduling strategies, consideration must be given to the factors impacting multiple transit providers operating (in some cases) differing modes of transit along the same corridor, as well as to the bus services that intersect each other and which need to be considered in a light rail transit (LRT), streetcar, or bus rapid transit (BRT) corridor. Operational strategies that facilitate transfers need to be considered as well.

Overall, all transit operators and routes in any corridor – including the three pilot corridors selected for this study – should coordinate schedules as much as possible to facilitate transfers and/or provide increased frequency and even spacing between vehicles along a corridor.

This means multiple operators will need to agree on the "key points" along the corridor in terms of where transfers are to occur and at what times, and that Metrobus and local operators should agree to a common set of running times in the corridor for services operating the same modes and stopping patterns.

#### Time-Slot Scheduling

In 2011, WMATA, Arlington County, and the City of Alexandria developed a detailed transit service operations and transitway access policy plan in order to prepare for the opening of the Crystal City-Potomac Yards Transitway and the beginning of the region's first BRT service, scheduled to begin operating in 2013.

To realistically assess the functionality of the dedicated bus lane, the planned headways of the new premium WMATA bus services and the scheduled arrival times of existing WMATA, DASH, ART and long-haul commuter bus routes were fit into "time-slots" of 2 minutes (i.e., 30 vehicles per hour). Each 2 minute time slot would accommodate one bus along the dedicated lane with appropriate leeway to account for variations in running time and dwell time across different transit services, even those with differing fare collection methods. This approach was designed to manage vehicle arrival patterns and the capacity of the dedicated bus lane.

#### Timetable Based Schedules

Timetable based schedules are the most common operating strategy in the transit industry. This strategy consists of fixed time points where buses are assigned specific times to serve each time point. Timetable based schedules are set up to provide consistent spacing between buses. There are a few guiding principles that should be followed to allow for coordination of services based on timetable scheduling; these include:

- Similar routes and services along a corridor should be scheduled to maintain an even headway along the corridor where possible. Different service types (for example local buses and limited stop buses) should have common running times within the service type. It is important to note that mode does not necessarily determine service type; for example, local bus services combined with streetcars could make up the local service operating plan for a number of planned streetcar corridors in the Washington metropolitan area.
- Utilize a common set of scheduled running times along the corridor – the running times need to be the same amongst routes, lines, and even operators during each time period that service is operating for similar modes and service types. This will allow for schedules to be coordinated along the corridor and allow for optimization of timetable based schedules to provide frequent service.
- Intersecting routes and local services should be timed to meet longer distance/higher capacity corridor services where possible. This will facilitate transfers among services and will allow passengers to choose services based on how far along a corridor they are traveling.

**Headway Based Schedules**

Headway based scheduling is based on maintaining an even spacing between buses and not having buses arrive at timepoints at assigned times. Headway based scheduling requires active management of a bus line to ensure that buses are properly spaced along the line. Headway based scheduling does require coordination of services along a corridor when multiple routes and operators are all providing service. An issue with headway based scheduling is that on routes or corridors with less frequent bus service (or on branches of such a corridor, where less frequent service is more likely), customers do not know what time the transit vehicle would arrive at a bus stop, resulting in long customer wait times for transit vehicles. Headway based scheduling works best on corridors with very frequent service and minimal branching. There are a few guiding principles that should be followed to allow for coordination of services based on headway based scheduling; these include:

- Utilize a common set of scheduled running times along the corridor – the running times need to be the same amongst routes, lines, and even operators during each time period that service is operating for similar modes and service types.
- Headway based schedules require a set of corridor supervisors to manage and dispatch all services in a corridor regardless of operator, line, or route. These supervisors allow for even spacing of buses within the corridor to take full advantage of headway based scheduling. This means that in corridors where multiple operators provide headway based schedules, a degree of control over an individual bus route may need to be sacrificed by some operators in order to provide evenly spaced service along the corridor.
- It is more difficult to facilitate transfers when operating a headway based schedule. This is because the guiding principle is maintaining even spacing along the corridor. It is typically hoped that corridors which utilize headway based scheduling are providing such frequent service that waiting times for passengers transferring *to* a service along the corridor are minimized.

**Mixed Schedule/Headway Operations**

In some corridors there may be services that operate with a headway based schedule and others that operate with a timetable based schedule. This could potentially be problematic on the trunk portion of a corridor where both types of services are being operated, since it could lead to a lack of consistent headways on the corridor if not all services are being managed or if there are on-time performance issues on the individual routes that are timetable based. There are three potential strategies for addressing a mixed schedule/headway operation corridor: manage for a timetable based schedule, manage for a headway based schedule, or do not manage headway operations and timetable operations together.

The alternative to not manage headway and timetable based operations together would result in headway based services being managed based on headway operations principles and timetable based services to be managed based on timetable principles. The advantage is that on the trunk corridor the individual operating strategies of one group of routes will not conflict with the operating strategies of services utilizing the other operating strategy. The negative is that not having a unified strategy along the corridor may result in passengers experiencing inconsistent headways along the corridor, at least in terms of differing service types or modes.

Regardless of how services with different operating strategies are managed, there still are a number of guiding principles that should be followed along a corridor:

- Even headways should be maintained amongst services whenever possible. This will provide the most frequent service along the corridor.
- Utilize a common set of scheduled running times along the corridor.
- Intersecting routes and local services should be timed to meet longer distance/higher capacity corridor services where possible.

### 4.4 Pilot Corridor Potential Strategies

**Table 3** presents which strategies will be analyzed and evaluated for each corridor. The table indicates that the only strategy that will not be evaluated for each corridor is the mixed schedule/headway operations strategy. This strategy is not appropriate for the proposed Purple Line as there are no bus routes that parallel the Purple Line for any significant distance.

**Table 3 – Potential Strategies for Each Corridor to be Analyzed/Evaluated**

| Corridor | Time-Slot Scheduling | Timetable Based Scheduling | Headway Based Scheduling | Mixed Schedule Headway Operations |
|---|---|---|---|---|
| One City Line (H/B) | X | X | X | X |
| Purple Line | X | X | X | |
| Beauregard/Van Dorn Street | X | X | X | X |

# 5 Metro Operations Impacts

This chapter describes the application of operational strategies that the Washington Metropolitan Area Transit Authority (WMATA) could apply to streetcar, light rail transit (LRT), and bus rapid transit (BRT) corridors. This chapter also includes information on the application of operational strategies, methods of schedule coordination, and overall impacts to Metrobus services in each of the corridors. The purpose of the operating concepts presented in this technical memorandum is to serve as a template for Metrobus operations as new transit running ways and treatments are constructed and implemented throughout the Washington metropolitan region.

## 5.1 Methodology and Overall Approach to Reinvestment of Savings

As part of developing these operating concepts and strategies, AECOM staff met with WMATA's bus operations and service planners to discuss anticipated impacts to Metrobus service as a result of the implementation of the fore mentioned transit lines. The Metrobus service planners indicated that – beyond those Metrobus services that would be directly replaced by any new light rail, streetcar or bus rapid transit – other Metrobus service frequencies would only be modified when and if there were a demonstrated change in ridership on those services.

After consultation with WMATA bus operations planners, it is recommended that any operating cost savings due to implementation of new light rail, streetcar or bus rapid transit services should be reinvested directly in the impacted transit corridor. This can be accomplished by adding service to intersecting routes in order to feed the new LRT, streetcar or BRT services or by enhancing Metrobus services (i.e., improving the frequency of service or lengthening the span of service) that operate along the same corridor.

## 5.2 One City Line Streetcar Corridor (H Street/Benning Road)

Currently, the H Street/Benning Road NE corridor has Metrobus local service as well as limited-stop MetroExtra service. The DC Streetcar service along H Street/Benning Road NE is proposed to have fewer stops than the current local bus service but more stops than the limited-stop MetroExtra service. The WMATA bus service planners indicated that the current local bus service is in need of bus stop consolidation as it presently has more bus stops per mile than what is recommended in WMATA's bus stop spacing guidelines. Such a bus stop consolidation program would result in a similar stop spacing pattern for both the local Metrobus service and the new streetcar service, although it is recognized that streetcar and local bus boarding locations will be on separate sides of the same intersections.

It should be noted that streetcar operating concepts in other parts of the Washington metropolitan region rely on bus service – both Metrobus service and services operated by the local jurisdictions – to provide complementary service along the transit corridor. An example of this mixed mode operating concept is the Columbia Pike corridor in Virginia. Typically, streetcars and buses utilize the same general boarding locations, and sometimes even the same platforms, along these corridors to allow passengers to use whichever vehicle is most useful for their trip.

### Analysis and Recommendations for Operating Strategies

The H Street/Benning Road NE portion of the One City Line streetcar service provides an opportunity for intermodal schedule coordination between the streetcar service and Metrobus services. Streetcars will be operating in mixed traffic in this corridor, with a mixture of curb lane and median lane operation. Current guidelines call for streetcar stop spacing to be wider than local bus stop spacing but not as wide as limited-stop bus stop spacing.

There are two concerns in terms of coordinating services along this corridor: the first concern is the variation in stop spacing between the modes and service types, and the second concern relates to the different stop locations for the H Street/Benning Road NE streetcar service and the Metrobus services on separate sides of the same intersections. Bus stop spacing will be addressed as WMATA reevaluates bus stops along this corridor in an effort to bring bus stop spacing on H Street NE in accordance with Metrobus guidelines.

Although these issues make coordination more complex, the nature of streetcar passenger trips and local bus passenger trips (as well as their similar stop spacing and other surface transit characteristics) indicates that schedule coordination between streetcars and the local Metrobus service should occur in this corridor. It is believed that coordination between the MetroExtra limited-stop service along this corridor and the streetcar is less of a priority. An analysis of the implications of each schedule coordination strategy and a recommendation follow. With future expansion of the One City Line, many issues will be addressed during coordination.

**A time slot schedule** is not recommended for the H Street/Benning Road Streetcar due to the lack of an exclusive transitway for the majority of the route and the high likelihood that late buses or streetcars would regularly miss their allotted two-minute service window.

**Timetable-based scheduling** strategy is feasible for the H Street/Benning Road Streetcar and Metrobus since the timetables for both streetcars and buses can be relatively easily coordinated between agencies.

**Headway-based scheduling** could be utilized to coordinate streetcar and local Metrobus schedules along this corridor.

**A mixed schedule/headway-based** strategy along this corridor is feasible. For the H Street/Benning Road NE Streetcar corridor, this strategy would have Metrobus services operating on a timetable-based schedule, while the streetcar would operate on a headway-based schedule. Along the common sections of the corridor, this will allow for the active supervision of the service to manage both the streetcar's and *local* Metrobus headways so that they maintain an even spacing between themselves; this also would allow for the provision of a regularly scheduled service on portions of the corridor where there would be less frequent service (i.e., those locations away from the corridor's "trunk" portion where the streetcar would not operate).

Staff from DDOT mentioned that it might be challenging to coordinate streetcar and bus service during H Street/Benning Road NE of the One City Line. Streetcars will be operating such a short distance and very few stops will be shared amongst the modes, that schedule coordination may not be worthwhile until the streetcar is traveling a longer distance.

In other streetcar corridors in the Washington metropolitan region, bus service is planned to supplement the other transit services within a corridor. As with the H Street/Benning Road Streetcar, local bus services and streetcar services can be complementary to each other, but will require an operational strategy to coordinate service. The local service buses and the streetcars should combine to provide frequent trunk transit service along a corridor, assuming they have similar stop spacing patterns. For corridors that have frequent service along a trunk portion, maintaining an even spacing/headway between buses and streetcars is believed to be more important than the published schedule. There are two possible scheduling options proposed for H Street/Benning Road NE

corridor; operating both local Metrobus services with headway based schedule or operating both services with a timetable based schedule. Each option is described below.

The first option is to operate streetcars and Metrobus X2 with a headway based schedule along the segments of H Street and Benning Road NE that services are operating together. Under this scheduling option, there is no set timetable for local transit services (either local Metrobus or streetcar) and service levels are based on even separation amongst transit vehicles. This scheduling option will require either joint streetcar/Metrobus supervision or close coordination of supervisors in order to maintain proper headway separation amongst the two services. The following bullet points describe how each service would operate:

- Streetcar service – Streetcars would operate on headway based schedules and would be coordinated with local Metrobus X2 services. This will entail either joint DDOT/WMATA supervision or coordinated supervision.
- Metrobus Local X2 – X2 service would operate on headway based schedules and coordinated with streetcar services. This will entail either joint DDOT/WMATA supervision or coordinated supervision.
- Metrobus Local X1/X3 – The X1 and X3 provide peak period only service in a single direction and branch off of the H Street/Benning Road NE corridor. These services would operate on a timetable based schedule as they do today and would not be coordinated with other services.
- MetroExtra X9 – The X9 provides limited stop service along the H Street/Benning Road NE corridor. This service would continue to operate on a timetable based schedule as limited stop service along the corridor and should not be coordinated with local services.

The second option is to operate both services with a timetable based schedule. A timetable based schedule requires less resources for supervision since operators are assigned specific times to begin each trip, including arrival times at mid-route timepoints and terminals. This option would require coordination between Metrobus X2 services and streetcar in schedule development to ensure even scheduled headways between the two services. The following bullet points summarize schedule coordination amongst the various services:

- Streetcar service – Schedule coordination would occur with Metrobus local Route X2 to ensure even scheduled headways amongst the services.
- Metrobus Local X2 – X2 service would be scheduled to coordinate with streetcar services along the corridor to ensure that services have a scheduled even headway separation.
- Metrobus Local X1/X3 – The X1 and X3 schedules would not be coordinated with other services.
- MetroExtra X9 – MetroExtra X9 schedules would not be coordinated with other services.

This corridor was considered for a mixed operating schedule, with streetcars operating a headway based schedule and buses operating a timetable based schedules. It was decided that this scheduling paradigm would be very difficult to coordinate and manage in the early phases of streetcar service implementation for because scheduled based services are required to be at specific locations at specific times, there is very little opportunity to coordinate services to ensure proper headway separation amongst the X2 and the H Street/Benning Road NE Streetcar. Maintaining proper headway separation would require streetcar service to yield to longer distance timetable based schedule X2 service.

The preferred scheduling option is to operate a headway based schedule for the H Street/Benning Road NE Streetcar and Metrobus local Route X2 since these two local services would combine to provide high frequency local service along the corridor on all days and throughout the service day. This will allow streetcar and Metrobus X2 to coordinate services within the corridor. Metrobus local X1 and X3, as well as MetroExtra X9 would continue to operate as timetable based services.

**Evaluation of Existing Bus Routes**

The H Street NE/Benning Road NE corridor is part of the Priority Corridor Network and is served by three Metrobus lines: the Benning Road-H Street Line (Metrobus Route X2) is the primary local bus service, the Benning Road Line (Metrobus Routes X1 and X3) provides additional peak period local bus service and connects the H Street NE corridor to the State Department and Tenleytown, and the Benning Road/H Street Limited Line (MetroExtra Route X9) provides limited-stop service along the corridor.

It has been indicated that the proposed streetcar service would not alter the operations of MetroExtra Route X9 because the X9 provides limited-stop service along the corridor, and it operates well beyond the termini of the first phase of the proposed streetcar service. Metrobus Routes X1 and X3 would also not be modified based on the introduction of streetcar service in H Street/Benning Road NE because they serve distinct areas apart from the corridor that would not be served by the streetcar. Metrobus Route X2 is the busiest of the current H Street NE/Benning Road NE services and the portion of the route between North Capitol Street and 15th Street NE is the most consistently crowded segment[1]. The possibility exists, logically, that there may be opportunities to reduce Metrobus Route X2 service based on the future expansion of the streetcar services along the One City Line given the similarities in their stopping patterns and the fact that they share at least some portion of the route along the same corridor.

However, the WMATA bus service planners indicated that the frequency of service would not be modified on Metrobus Route X2 unless ridership and crowding along the bus route were to be reduced by the streetcar. At this point, it is the opinion of the WMATA service planners and the study team that DC Streetcar services between Union Station and Oklahoma Avenue NE along H Street/Benning Road NE would not have much of an impact on Metrobus Route X2 ridership, as the streetcar will not operate west of Union Station and thus will not enter Downtown Washington. DDOT planners mentioned that the real impact will occur once the streetcar enters Downtown Washington. Passengers who currently use Metrobus for shorter trips entirely within the initial operating segment may start using the streetcar; however, passengers who are traveling a longer distance into Downtown Washington will continue to use either Metrobus Route X2 or MetroExtra Route X9. Therefore, the service plan for the X-Line Metrobus services when streetcars begin operation in H Street/Benning Road NE assumes that the current service levels are maintained.

It should be recognized that in the long term (i.e., during Phase 2 and beyond), the One City Line may have a more dramatic impact on local Metrobus services.

**Changes to Bus Capacity at WMATA Garages**

Although the current service plan will be maintained when the H Street/Benning Road Streetcar opens, any future reduction in service to Metrobus Route X2 will result in fewer peak period vehicles operating from the Bladensburg Division. Metrobus Route X2 operates with articulated buses, thus

[1] Metrobus Benning Road/H Street Priority Corridor Study Technical Memorandum 1

these vehicles would be re-deployed to other articulated bus routes within the Metrobus system. The first priority for any savings in financial resources is that they will be reinvested within this same corridor. Therefore, with the One City Line corridor, any future long term savings accrued as the result of requiring fewer articulated buses for Route X2 would be utilized to provide for additional MetroExtra buses that would be used on Route X9 service. The current policy is to use standard buses for MetroExtra services, so the articulated buses would be redeployed to other routes possibly operating from other divisions.

**Identification of Potential Cost Savings**

There is no cost savings anticipated for Metrobus services associated with the first segment of the One City Line (H Street/Benning Road Streetcar). There are no expected intelligent transportation system (ITS) improvements or physical treatments that will reduce travel time for Metrobus Route X2 or MetroExtra Route X9 in this first segment of the One City Line. However, future long term streetcar operations along the One City Line corridor will add passenger capacity, and may allow for reductions in Metrobus service along the corridor.

Metrobus Route X2 is a regional route. This means that the cost burden for this route is shared amongst all jurisdictions that are a part of the WMATA Compact. It would be in the District of Columbia's interest to reinvest any potential future cost savings from Route X2 into another regional route. Any reduction in service on Metrobus Route X2 would have the saved resources reinvested into the corridor by providing additional MetroExtra Route X9 service or perhaps Metrobus Routes X1 and X3 service.

## 5.3 Purple Line Light Rail Transit Corridor

The Purple Line does not parallel a single Metrobus corridor, it does serve portions of three Metrobus Priority Corridors: the East-West Highway Line (Metrobus Routes J1, J2, J3 and J4), the Greenbelt-Twinbrook Line (Metrobus Routes C2 and C4), and the New Carrollton-Fort Totten Line (Metrobus Route F6). The Purple Line will offer the opportunity for reduced service on some Metrobus lines that serve the corridor as well as the elimination of other services.

**Analysis and Recommendations for Operating Strategies**

Based on the running way limitations and operating characteristics of both the Purple Line and local Metrobus services, a joint Metrobus and Purple Line operating strategy is highly unlikely, nor does it appear to be feasible. The Purple Line will operate in a separate running way from Metrobus, and the Purple Line will have much wider station spacing than Metrobus. These two factors will allow the Purple Line to operate at higher speeds than Metrobus, making a joint operating strategy very difficult. Even if MetroExtra and other BRT services were to use the Purple Line, a joint operating strategy would not be employed due to the likely short distances where the running way is shared and different markets served.

While a joint operating strategy may not be practical, coordination of schedules to allow for transfers is recommended. Part of the coordination recommendation is that Intersecting bus route schedules should be developed to allow for transfers to Purple Line trains to the greatest extent possible. Parallel bus routes need to be scheduled to facilitate transfers at major transfer stations such as Bethesda, Silver Spring Transit Center, Takoma/Langley Park Transit Center, College Park Metrorail Station, and New Carrollton.

Operating strategies for the Purple Line are analogous to other potential LRT lines in the Washington area as well as to Metrorail lines. The Purple Line has longer station spacing than local and even limited-stop bus service. This train service, operating in its own right of way, provides higher speed but (especially in this case) also has an infrastructure that buses cannot utilize. Metrorail and LRT do not allow for a coordinated operating strategy for parallel bus routes, but they can nonetheless replace the use of the buses for longer distance trips. The result would be reduced demand for local bus services that operate in the same corridor as either LRT or Metrorail. Cost savings from reducing bus service on routes that parallel the Purple Line, or any rapid transit line, would be reinvested in the same corridor by enhancing certain underlying services and/or adding service to lines that feed the rapid transit line.

**Evaluation of Existing Bus Routes**

No bus route parallels the Purple Line for its entire length. The route that most closely parallels the Purple Line is Metrobus Route J4, which operates between Bethesda and College Park and provides limited-stop bus service. The current concepts for the Purple Line do have a number of bus route modifications affecting both Metrobus and locally operated bus lines. These concepts include the potential elimination of four Shuttle UM routes (i.e., Routes 109, 109, 111, and the River Road Shuttle), one Ride On route (i.e., Route 15), and one Metrobus route (i.e., Route J4). The potential also exists to reduce the frequency of service along Metrobus Routes J2 and J3. Metrobus Route C2 could be modified to operate solely between the Langley Park Transit Center and Greenbelt, with Metrobus Route C4 continuing to operate along its current route alignment. This would allow Metrobus Routes C2 and C4 to each operate at the appropriate frequency for each service that they provide.

Due to the relatively wide station spacing of the proposed Purple Line, it will be necessary to maintain underlying local bus service along the corridor. Metrobus Route F6 service should not be eliminated, as this service is the primary local bus service along the east end of the corridor between the University of Maryland and New Carrollton. Metrobus Route C2 service will be maintained to provide local bus service between the University of Maryland and Langley Park. Between Langley Park and Silver Spring, local bus service is provided by a myriad of Ride On bus routes.

It is the opinion of Montgomery County that the Purple Line may afford the opportunity to increase service on Metrobus Route J1 which connects Silver Spring and the East-West Highway corridor to the Medical Center area. This change would provide Purple Line riders with a more direct connection to jobs at Medical Center versus transferring in Downtown Bethesda.

**Changes to Bus Capacity at WMATA Garages**

The only Metrobus route elimination that can be quantified at this point is the proposed elimination of Metrobus Route J4. Metrobus Route J4 currently has a peak vehicle requirement of seven MetroExtra branded buses – operating out of the Montgomery Division – that would no longer be needed. These buses would be redeployed to support other MetroExtra services.

The reduction in Metrobus Route J2 or J3 services will also lower the number of buses required at Montgomery Division.

**Identification of Potential Cost Savings**

As stated previously, the policy for all cost savings based on the introduction of new streetcar, LRT, or BRT services should be to redirect savings to services that complement the corridor. This can be accomplished by using any cost savings for other bus services within the corridor or by redirecting the resources to bus services that intersect the corridor.

Traffic Signal Priority (TSP) will be implemented within Montgomery County and along the Purple Line. At this time the type of priority, which can range from giving buses absolute priority at an intersection to only providing priority to buses when they are later than the on-time performance guideline, has yet to be determined. For this reason, no cost savings are assumed based on TSP or any other technology application.

The Metrobus services within this corridor are primarily regional services, funded by all WMATA Compact members. The only Metrobus change that can be quantified prior to the opening of the Purple Line is the elimination of the Metrobus Route J4 service, which is classified as a regional route. Metrobus Route J4 currently operates 11,890 annual platform hours (i.e., approximately $1,324,189 per year, based on $111.37 per platform hour) that could be distributed amongst other regional routes that serve the Purple Line corridor. Service would not be reduced on other local routes unless there is a demonstrated reduction in ridership along those routes.

The fare policy for the Purple Line has not been determined at this point. The fare policy will have an impact on local bus ridership since many studies have shown that Metrobus riders tend to be more price sensitive than Metrorail riders. The fare policy for the Purple Line may be similar to either the Metrobus policy with a flat fare, the Metrorail policy that varies depending on the boarding and alighting station as well as by time of day, or something in between.

Any reductions in Metrobus service based on the Purple Line should be reinvested in the corridor. This could include potential service increases for Metrobus Route F6 or any of the other local bus services that may need to be increased. There are a number of regional Metrobus lines that intersect the Purple Line corridor that would be candidate services for any resources made available by the future elimination/reduction or other type of modification to the Metrobus routes associated with the Purple Line. These include the Priority Corridor Network lines such as the 70 Lines, K6/K9 Line, Q Line, R Lines, S Lines, Y Lines, and the Z Lines. Other regional lines that intersect the corridor include the Metrobus Routes C8 and T18. Montgomery County would be interested in using cost savings associated with the Purple Line to fund MetroExtra or BRT services along Georgia Avenue (Y9), New Hampshire Avenue (K9), or Veirs Mill Road (Q9).

### 5.4 Beauregard/Van Dorn Street Bus Rapid Transit Corridor

There is no current bus route operated either by WMATA or Alexandria's DASH service that serves the entire Beauregard/Van Dorn Street corridor. Portions of the Van Dorn Street corridor are served by Metrobus Route 25B. The Beauregard Street portion of the corridor is served by two Metrobus lines: the Lincolnia-North Fairlington Line (Metrobus Routes 7A, 7E, 7F and 7Y) and the Lincolnia-Park Center-Pentagon Line (Metrobus Routes 7B, 7C, 7H, 7P, 7W and 7X). DASH also provides local bus service along portions of the corridor. DASH Routes AT1, AT5 and AT8 operate along the Van Dorn Street portion of the corridor. DASH Routes AT1 and AT2 serve portions of the Beauregard Street corridor.

There are very few opportunities for significant route modifications based on BRT along this corridor since many of the current routes that serve parts of this corridor serve different markets that compliment BRT in the corridor. The same can be said about the City of Alexandria's DASH service.

Cost saving opportunities may exist through reductions in Metrobus service and/or faster running times along the Metrobus lines that operate along this corridor. The eventual operator of BRT service along the Beauregard/Van Dorn Street corridor is still to be determined.

**Analysis and Recommendations for Operating Strategies**

The Beauregard/Van Dorn Street corridor provides an opportunity for interagency schedule coordination between DASH and local Metrobus services. All of the Metrobus services operating in the Beauregard/Van Dorn Street corridor are local bus services. The planned Beauregard/Van Dorn Street transit corridor utilizes median bus running ways for a significant portion of the corridor, which are difficult for local buses to utilize because of their more frequent stopping patterns.

There are four schedule coordination strategies that could be used for the Beauregard/Van Dorn Street corridor. These include time slot schedules, timetable-based scheduling, headway-based scheduling, and mixed schedule operations. An important item to note when selecting an operating strategy is that Metrobus provides local bus service along this corridor which cannot take advantage of median running ways due to bus stop spacing needs. It may be possible to convert one Metrobus route – Route 7Y – to a limited-stop service along Beauregard Street that could then utilize the median running way with its wider stop spacing. An analysis of the implications of each schedule coordination strategy and a recommendation follow.

**A time slot schedule** strategy could be utilized along this corridor.

**Timetable-based scheduling** operating strategy is feasible for this corridor.

**Headway-based scheduling** may be difficult. Coordinating headways would need to occur at the locations where each of the services join the “trunk” BRT right-of-way, which northbound is at the intersection of Beauregard Street and Sanger Avenue, and southbound it is at the Pentagon.

**A mixed schedule/headway-based schedule** along this corridor is feasible and realistic. As Metrobus only operates along limited portions of the Beauregard/Van Dorn Street corridor, this strategy would have Metrobus services operating on a timetable-based schedule, while the proposed new BRT service and DASH services would operate on a headway-based schedule. Along the common sections of the corridor, this will allow for the active supervision of the service managing both the BRT services and the local DASH headways so that they maintain an even spacing between themselves.

There are opportunities for Metrobus to operate a limited-stop bus service along this corridor that could take advantage of the BRT preferential treatment facilities would serve relatively short portions the Beauregard Street segment. “Spot coordination” of bus services may be needed at Southern Towers Apartments for the utilization of the transitway through the complex.

After speaking with WMATA’s bus service planners, the study team recommends that timetable-based scheduling be utilized in this corridor, as it should be sufficient to maintain even spacing between buses. BRT services should be scheduled to fill in the gaps between 7 Line buses along the Beauregard Street portion of the corridor, with the “control point” for the 7 Line and BRT service being at Beauregard Street and Sanger Avenue, the location where all services join together.

**Evaluation of Existing Bus Routes**

The existing bus service along the proposed BRT corridor is complex, with service differing not only by day of the week, but also by direction of service. As was previously mentioned, the Beauregard/Van Dorn Street corridor will primarily utilize exclusive median busways. While these busways would be available for all buses to utilize, local Metrobus services would not be able to utilize these busways due to their differing stop spacing patterns. The major exception is the exclusive transitway through Southern Towers Apartments that is served by most 7-Lines buses.

Local Metrobus services will be able to take advantage of short segments of curb bus lanes – primarily along Eisenhower Avenue and Van Dorn Street north of Landmark Mall – which will benefit Metrobus Route 25B. Since Route 25B is not a frequent service, there are no opportunities to reduce service along this route or reduce vehicle requirements. In fact, there are concepts to increase service on Metrobus Route 25B in the near future. DASH may also modify or reduce service on local bus routes that serve the corridor; however, this will have very little impact on Metrobus.

The Metrobus 7-Lines all connect various portions of the Beauregard Street corridor to the Pentagon, with Metrobus Route 7Y crossing the Potomac River and continuing to Federal Triangle in Washington. There may be minor time savings on these routes when they are able to take advantage of priority treatments, although the time savings would not be significant enough to reduce vehicle requirements for the 7-Lines.

Traffic Signal Priority (TSP) will be implemented along this corridor. This may save some time for transit services that use the corridor regardless of the operator. The time savings for Metrobus would be minor as Metrobus services serve only small segments of the corridor.

There may be some opportunity to reduce service along the 7-Line based on the implementation of BRT during peak periods. One variation – Metrobus Route 7C – could be eliminated, as this variation duplicates the proposed BRT service and there is underlying local DASH service. Service could also be reduced on Metrobus Routes 7W and 7X because the northern portion of these routes somewhat duplicate the proposed BRT service as well as other 7-Line variations. During the peak hour, Metrobus Routes 7W and 7X operate nine trips per hour, with six trips operating on the “W” variation and 3 trips operating on the “X” variation. WMATA bus service planning staff feels that the southern end of Metrobus Routes 7W and 7X require six trips per hour, three on each variation.

During the off-peak periods there are no opportunities to reduce service on the 7-Lines. The 7-Line buses should be able to save up to 2 minutes per trip by utilizing bus lanes along Beauregard Street; however, this will not reduce overall vehicle requirements.

Metrobus Route 7M, which operates as a shuttle between the Pentagon and the Mark Center, would only be modified if WMATA and the Department of Defense were to deem that BRT improvements were sufficient to meet the needs of people traveling between the Mark Center and the Pentagon.

**Changes to Bus Capacity at WMATA Garages**

Metrobus lines that serve the Beauregard/Van Dorn Street corridor operate primarily out of Four Mile Run Division, with some buses operating from Royal Street Division. Any service changes related to improvements to the Beauregard/Van Dorn Street corridor will not have an impact on the Royal Street Division, as this division primarily houses Metrobus Routes 25B and 7M.

The incremental running time improvements to the 7-Lines are not likely going to be enough to reduce vehicle requirements; however, there could be some impacts from the elimination of Metrobus Route

7C and reduction of service on Metrobus Routes 7X and 7W. These three bus routes are all part of Metrobus "Line 76", which has a peak vehicle requirement of 8 buses during the AM peak period and 9 buses during the PM peak period. It is estimated that these service modifications would result in a reduction of 1 to 2 peak buses on this line.

**Identification of Potential Cost Savings**

Any operating cost savings for Metrobus associated with the introduction of BRT service on the Beauregard/Van Dorn Street corridor will primarily be based on the elimination of Metrobus Route 7C, the reduction in the frequency of service on Metrobus Route 7W, and incremental reductions in running time by about 2 minutes for services that can utilize the BRT preferential treatment improvements. As previously mentioned, it is WMATA priority is to reinvest any operating cost savings to support Metrobus services within the same corridor. Therefore, the priority for this corridor would be to use any operating cost savings to increase service on Metrobus Route 25B.

Beyond Metrobus Route 25B, intersecting routes that would feed the Beauregard/Van Dorn Street BRT corridor are potential candidates to receive resources that would not be used by the 7-Lines. Since the 7-Lines are regional routes – which means that the cost for these services are shared amongst all WMATA Compact members – resources made available from reductions in 7-Line services should be used only on other regional routes in Virginia. In addition to Metrobus Route 25B, WMATA planning staff has identified Metrobus Route 28A as a service that would benefit from additional resources. Other possible regional routes that would be candidates for additional resources that would be made available from the introduction of BRT service in the Beauregard/Van Dorn Street corridor include the 8-Line, Route 16L, Routes 22A/B, Routes 23A/C, Routes 25A/C/D, Routes 28F/G/X, and Routes 29K/N. **Table 5** presents the estimated Metrobus cost savings based on implementing BRT along the Van Dorn/Beauregard corridor.

**Table 4 – Estimated Metrobus Cost Savings based on Van Dorn/Beauregard BRT Service**

| | Service Elimination | Running Time Savings from BRT Treatments | | | |
|---|---|---|---|---|---|
| | | Weekday | Saturday | Sunday | Annual |
| 7A | 0.00 | 1.73 | 1.30 | 1.60 | 602 |
| 7B | 0.00 | 0.33 | 0.00 | 0.00 | 84 |
| 7C | 8.86 | 0.00 | 0.00 | 0.00 | 2,224 |
| 7F | 0.00 | 1.27 | 1.00 | 0.00 | 376 |
| 7W | 4.41 | 0.00 | 0.00 | 0.00 | 1,107 |
| 7Y | 0.00 | 0.87 | 0.00 | 0.00 | 218 |
| Hours Saved | 13.27 | 4.20 | 2.30 | 1.60 | 4,610 |
| Cost Savings | $1,478 | $468 | $256 | $178 | $513,368 |
| Annual Savings | $370,948 | $117,406 | $14,857 | $10,157 | $513,368 |

## 5.5 Summary

The operating concepts presented in this chapter are meant to serve as templates for how Metrobus service should respond to various transit service investments and improvements. There are a few guiding principles for Metrobus service in response to new multi-modal transit investments. These include:

- Service reductions on Metrobus routes will primarily be based on observed ridership patterns after new services are implemented.
- Metrobus routes may be modified and restructured in response to new transit capital investments.
- Any Metrobus operating cost savings realized by investments in new BRT, LRT or streetcar services should be reinvested in the same corridor. This could be done either by improving other local bus services in the corridor or by redirecting resources to routes that intersect/feed into the corridor.
- Funding for regional routes is shared amongst all jurisdictions; therefore it is in the best interest of the affected jurisdiction to allocate cost savings resulting from any reductions in regional route service based on capital projects (i.e., new modes) to other regional routes that serve the corridor.

Below is a summary of the preferred coordination strategy by mode.

**Streetcar**

In most corridors, streetcar operations are very similar to Metrobus in terms of operating speed and stopping pattern. Some corridors, such as Columbia Pike, rely on Metrobus as part of the operating plan for transit services within the corridor. In the case of the pilot corridor – H Street/Benning Road Streetcar – the streetcar will be operating a shorter segment than the Metrobus lines that serve the corridor. Where streetcars operate, transit service is usually very frequent; this is conducive to headway based schedules, where transit vehicles are evenly spaced along the corridor.

Schedule coordination between bus and streetcar needs to therefore be based on the mode that is traveling a longer distance outside of the corridor; in many cases that mode is Metrobus. The longer distance mode needs to have priority to maintain the reliability of its service, as it is traveling farther. The shorter distance mode, which sometimes only serves a portion of the corridor, should be “slotted” in to fill in the gaps in frequency using a headway based scenario.

### Light Rail

Light rail transit (LRT) service is primarily a higher speed/longer distance service. Metrobus and Light Rail would not be sharing a running way for long distances very often. For the most part, schedule coordination between Metrobus and LRT services will be limited to coordinating schedules to facilitate transfers at key station locations. On short segments where buses and the LRT service do operate together, schedules do not need to coordinate since the LRT service and buses are typically serving different markets with buses entering and exiting the corridor at varying locations.

### Bus Rapid Transit

Metrobus and Bus Rapid Transit (BRT) vehicles are physically able to run on the same right-of-way. Coordination of schedules and use of running way will need to be based on the individual characteristics of the running way and service. For example, the Van Dorn/Beauregard BRT has median running ways along some portions of the corridor which cannot be used by local Metrobus services because of the varying stopping patterns between the local Metrobus routes and the BRT service. On the other hand, along Beauregard Street, all bus routes can take advantage of the dedicated curbside running way, with limited stop Metrobus services likely an important part of the BRT operating guidelines.

BRT also offers many options for schedule coordination. Schedule coordination will need to depend on the service running way and operating rules (including which buses are allowed on the running way), station layout, and service design (vehicle type and frequency of service).

# 6 Fare Collection

As new fixed route transit services – including bus rapid transit (BRT), light rail transit (LRT), and streetcar modes – come online in corridors with existing heavy bus ridership, coordination of fare collection systems is needed in order to optimize passenger convenience and system efficiency across all transit modes and services.

This chapter presents the range of fare collection strategies and operational considerations for Metrobus in terms of coordinating with the proposed services along the three pilot corridors".

## 6.1 Planned Pilot Corridors Fare Collection Strategies

The three "Pilot Corridors" selected for review as part of this study effort are in various stages of planning and engineering; however, some decisions have been made with regards to the fare collection strategies envisioned for each project. Details of the fare collection systems under review for each project are discussed below.

**One City Corridor** – The fare collection strategy for the District of Columbia's One City Corridor has not been finalized. Yet to be decided is whether the fare will be collected on-board the vehicles or off-board.

**Purple Line** – The Purple Line will likely use an off-board fare collection strategy.

**Beauregard/Van Dorn Corridor** – The Beauregard/Van Dorn Corridor will feature off-board fare collection infrastructure as well as other passenger amenities.

## 6.2 Fare Collection Strategies

Fares are currently collected on-board Metrobus vehicles via exact change (cash) or SmarTrip cards. SmarTrip cards can be reloaded at a variety of sales locations including on-board Metrobuses and other jurisdictional bus systems' vehicles at the farebox, at a fare vending machine at a Metrorail station, at WMATA sales offices or commuter stores, at select retail outlets, and online. The current practice of on-vehicle fare collection and fare loading causes delays as passengers line up to pay fare or load fare media. Outreach to WMATA bus operators has also indicated that the current practice of allowing SmarTrip cards to retain a negative balance can also lead to delays, as the boarding passengers must first replenish their SmarTrip cards in addition to paying the newly incurred fare.

Overall, there are two general approaches to fare collection for surface transit: on-board payment and off-board payment. **Table 5** describes these two approaches as well as the advantages and disadvantages of each approach.

Additionally, a hybrid fare collection strategy which utilizes both on- and off-board strategies is sometimes used on BRT, LRT and streetcar systems. Ticket vending machines for proof-of-payment are made available at major stops/stations to speed boarding and traditional on-board payment is used at stops/stations with low boarding totals.

**Table 5 – Fare Collection Strategies**

| Fare Collection Strategies | Characteristics | Advantages | Disadvantages |
|---|---|---|---|
| **On-Board Payment** | | | |
| **Pay-on-Entry (Farebox)** | Passengers enter a transit vehicle and deposit cash into a farebox, activate fare media, or show the operator a pass/ticket for entrance onto the vehicle. | Least expensive.<br><br>Does not require additional ticketing infrastructure. | Increases dwell time associated with passengers' boarding, paying, and on-vehicle fare media loading.<br><br>Typically does not allow for multi-door boarding. |
| **Proof-of-Payment (On-board Fare Validation)** | Passengers pay with smart media at payment targets at all doors on-board or fill card at on-board vending machines. | Low capital and maintenance costs.<br><br>Allows for multi-door boarding. | Greatest likelihood of fare evasion.<br><br>Fare payment machines may be difficult to access on crowded transit vehicle.<br><br>Requires enforcement personnel. |
| **Off-Board Payment** | | | |
| **Proof-of-Payment** | Passengers pre-purchase tickets at ticket vending machines prior to boarding the transit vehicle; ticket inspectors check riders and fine those without valid tickets or passes. | Minimizes dwell time associated with passenger boardings and on-vehicle fare media loading.<br><br>Allows for multi-door boarding. | Can be costly; requires ticketing machines at all stops/stations as well as enforcement personnel. |
| **Closed Fare System** | Passengers purchase fare and pass through faregates or turnstiles at all stops/stations to control access to boarding areas. See **Figure 1.** | Minimizes dwell time associated with passenger boarding.<br><br>Allows for multi-door boarding.<br><br>Enhances visibility of transit services.<br><br>Allows for faster, easier transfers between services. | Can be costly; requires ticketing machines as well as significant infrastructure at each stop/station.<br><br>Stop/station area must be large enough to control access to boarding areas.<br><br>Personnel staffed at loading platforms may be required for enforcement. |

Fare enforcement is critical for the Proof-of-Payment (PoP) fare collection strategy as every passenger is expected to pay the fare on their honor. Fare inspection is typically performed by personnel assigned to be fare inspectors. Fines must be high enough and enforcement frequent enough to produce a fare evasion level that is acceptable to the transit provider.

The operating efficiencies associated with PoP fare collection provide the opportunity for operating costs savings. Decreased dwell times, thus faster travel times, has the potential for the agency to reduce the required number of vehicles needed to provide the given level of service, or at a minimum, improve service reliability. Additionally, improvements in reliability and customer convenience may also increase ridership, increasing farebox revenue.

Although PoP may offer operating costs savings, there are other cost implications of employing such a strategy. These costs include the capital costs of buying new enforcement equipment as well as the hiring of fare inspection personnel. These costs vary in terms of the precise strategy the agency plans to enforce fare collection. The following policy considerations must be determined to implement an effective fare inspection strategy:

- What is the legal authority to inspect and enforce?
- What is an acceptable fare evasion rate and what will be the level of the agency's inspection effort?
- How many inspection personnel are required and how will inspection personnel be deployed?
- What type of inspection personnel will be used (agency police, contract police, agency staff, or contract security)?
- What will the level of punishment be for fare evaders?
- What equipment will be used to collect and validate fare and inspect for violators?

### 6.3 Fare Collection Technology and Equipment

Fares are currently collected via exact change (cash) and SmarTrip cards on-board Metrobus vehicles. SmarTrip is a contact-less stored-value smart card used for payment in all Metrorail stations (including at Metrorail station parking lots), Metrobus vehicles, and most other jurisdictional public transit systems.

Since the NextFare technology, which is the backbone of SmarTrip, is near its end of life cycle and is obsoleting, WMATA is currently working with all local and regional transit operators to plan a next generation fare payment system – NEPP (New Electronic Payment Program), which is not based on any costly exclusive proprietary system. The planned NEPP system will be an "open payment" fare system, which will be based on using contactless media to pay for transit fare, usually in the form of contactless credit or debit cards, or smart phones (using near-field communication technology), or any micro-chip embedded identification cards. The contactless media will provide a direct connection to an individual's bank account and/or Commuter Benefit account and would not necessitate the reloading of fare media. WMATA's goal of using the new open payment system and contactless media is to reduce the costs associated with the obsoleting NextFare technology that supports the SmarTrip, to minimize cash collection and to improve customer convenience with acceptance of contactless credit and debit cards and smart phones for transit payments. In addition to accepting near-field communication technology payments, WMATA is also expecting to still maintain a unique smart card technology for payment. WMATA expects to implement the new NEPP system starting in 2013 with a 5 year overlap of the current SmarTrip system. It is believed that all three pilot corridors for this project will become NEPP ready too.

Fare collection can be broken down into three stages: vending, validation, and inspection.

*Fare vending* is the process of passengers paying for trips and the manner in which the transit system manages and receives those payments.

*Fare validation* is the process of "activating" fare media, whether the passenger has just purchased a ticket or is using a card with stored value.

*Fare inspection* involves checking a portion of riders for proper fare payment and validation.

### 6.4 Impacts on Schedule and Headway across Transit Modes

Dwell time comprises roughly ¼ of the time that passengers spend in surface transit. Fare collection is a major factor in the total time required per boarding passenger. Reducing or standardizing the time

required for fare collection can improve operating speeds and increase service reliability within a corridor regardless of the mode or modes being operated.

**Table 6** below shows the typical passenger boarding times by fare collection strategy. As can be expected, off-board pre-payment strategies have the lowest boarding time per passenger of all of the fare collection strategies. Additionally, the boarding time per passenger decreases as more doors are available for boarding. Off-board pre-payment is the only method where multiple door boarding is realistically an option.

**Table 6 – Typical Passenger Boarding Times by Fare Collection Strategy**

| Fare Collection Strategy | Typical Boarding Time/Passenger (seconds) |
|---|---|
| Off-board Pre-payment | 2.5 (1-door boarding); 1.5 (2); 1.1 (3) |
| Single Ticket/Token | 3.5 |
| Smart Card | 3.5 |
| Exact Fare | 4.0 |

Source: Transit Capacity and Quality of Service Manual 2nd Edition, 2003

As passenger boarding time for off-board payment is approximately twice as fast as passengers paying exact fare on-board, transit modes that exclusively use off-board fare collection will operate at a faster speed as those transit services using traditional on-board fare collection in the same corridor (and assuming roughly equal passenger loads). This may lead to uneven “gaps” in service as well as vehicle bunching.

### 6.5 Fare Collection Strategies to Maintain Vehicle Spacing

Normalizing dwell times through fare collection strategies can reduce the time it takes per passenger to board, allowing schedule planners to accurately plan for dwell times. These strategies have been utilized across the United States in order to manage operations.

#### Incentivize contactless smart card media

Exact change cash payments on-board transit vehicles causes increased dwell times, especially on transit corridors that have heavy volumes of cash paying passengers, as multiple coins in most cases are needed for the base fare. Many transit agencies offer prepaid fare media, such as a stored value smart card. Smart cards are able to have a stored value, which when waved next to a target sensor debits the fare from the stored value on the card.

WMATA has incentivized the use of SmarTrip cards with reduced fares throughout the system (20 cents lower on Metrobus and 25 cents lower on Metrorail). SmarTrip cards also allow for a more sophisticated fare policy including discounted transfers between modes. As of Fiscal Year 2011, WMATA reported that SmarTrip makes up 76% of all Metrobus transactions.

#### Hybrid on-board/off-board fare collection

A hybrid on-board/off-board fare collection strategy requires that passengers paying via “traditional” on-board fare collection must board through the front door to pay the farebox. However, passengers who have purchased through the off-board Proof-of-Payment may board through second (or third)

doors of the bus. Additionally, smart card media payment sensors can be installed near the rear doors for passengers to validate their smart cards, allowing for all-door boarding. This hybrid fare collection strategy requires fare inspection personnel to randomly inspect and ticket fare evaders.

**Pay-on-Exit Fare Payment**

Long-haul or commuter bus routes often experience long dwell times for passenger boarding. Reasons for the variability in dwell times may be due in part to heavy passenger boardings, vehicle design requiring passengers to climb stairs up into the vehicle, as well as fare payment. In the Washington metropolitan area, most commuter and long-haul bus routes utilize SmarTrip technology already; however, allowing pay-on-exit fare payment can increase the speed of passenger boardings in heavily trafficked urban roadways. Pay-on-exit fare payment strategy could also allow for multiple door boardings.

## 6.6 Recommendations

The recommendations for fare payment integration in each of the Pilot Corridors depends on the mode with which the Metrobus service must be integrated, the service type being operated by Metrobus, and the type of right-of-way.

**One City Line**

Given that the One City Corridor streetcar line has not yet determined its method of fare collection, the recommendations for this corridor may be subject to reconsideration and revision in the future.

However, if it is assumed that the One City Line uses an off-board fare collection method in order to minimize dwell time, then the Metrobus services along the same corridor should use a combination of strategies to maintain vehicle spacing. The strategies they utilize should consist of:

- For all services, continue to incentivize the use of the SmarTrip cards and the future next generation contactless system.
- For the MetroExtra services, the use of off-board fare collection should be implemented, so that the dwell times (and running times) more closely match the streetcar's.
- For the local Metrobus services, the use of hybrid on-board/off-board fare collection should be pursued, with the off-board method being used at those stops shared with the MetroExtra and/or streetcar services. It should be noted that fare inspectors would nonetheless be required for the MetroExtra service should it implement off-board fare collection, thus making the use of a hybrid strategy on the Metrobus local services more viable.

**Purple Line**

Given that the Purple Line will primarily operate along its own exclusive right-of-way, the fare collection systems integration is not as pertinent an issue as it is with the other two Pilot Corridors. However, transfers between the Purple Line and Metrobus would likely occur at major stations. To ease these transfers between modes, the following strategies should be utilized:

- Continue to incentivize the use of SmarTrip cards and the future next generation contactless system, as these technologies allow for "one-touch" transfers and a more sophisticated transfer and fare structure.
- Stations may be designed to allow Metrobus boarding and alighting within the closed fare system. A customer enters into the closed fare system either by paying fare on the bus or at a

Purple Line station and passing through the faregates or turnstiles. Once a customer is in the system, transfers are free and seamless, much like the Metrorail system.

**Beauregard/Van Dorn Corridor**

In this corridor, the proposed bus rapid transit (BRT) service will utilize off-board fare collection. The strategies that should be utilized along this corridor to maintain vehicle spacing include:

- For all services, continue to incentivize the use of the SmarTrip cards and the future next generation contactless system
- For the local Metrobus and DASH services, the use of hybrid on-board/off-board fare collection should be pursued, with the off-board method being used at those stops shared with the proposed BRT service. It should be noted that fare inspectors would nonetheless be required for the BRT service should it implement off-board fare collection, thus making the use of a hybrid strategy on the local Metrobus and DASH services more viable.