RIDERSHIP AND COST ESTIMATION METHODOLOGY

This document summarizes the methodologies used to project ridership and to estimate operating and capital costs.

RIDERSHIP

Ridership projections were developed using a variety of industry and planning best practice methods. This section documents the planning assumptions used in estimating the ridership projections. The estimates are order of magnitude estimates based on the general service delivery parameters. The estimates were not modeled based upon a regional mode choice nor a trip assignment model. The actual ridership levels may vary as the service design becomes more precise, actual land use patterns evolve, and recent externalities (e.g., the increasing price of gasoline) are encountered.

Population Data

Population data projections for the GWR were provided by the GWRC and were developed for 2015 and 2035 and by individual Transportation Analysis Zone. Since data for 2017 was not projected, the change in population was linearly interpolated from 2015 to 2017 so that consistency with the service plan scenarios can be maintained.

Bus Service Day Assumptions

The following service day assumptions were used in the ridership projections. This calendar was developed based on average calendar day allocation of peer systems in peer regions, as documented by the 2006 FTA NTD. This calendar allocation incorporates service that may or may not be offered during minor and major public and local holidays. The actual days of service for any given year will fluctuate based on calendar and leap years, and by service policy of the agency.
- 253 Service Days per Year
- 52 days of Saturday and Minor Holiday Service per Year
- 60 days of Sunday Service and Major Holiday per Year

The following assumptions for Saturday and Sunday services were used in the ridership projections. This was based on peer service average, as reported in the 2006 FTA NTD.

- Saturday ridership: 50% of average weekday ridership
- Sunday ridership: 30% of average weekday ridership

**Bus Service Span and Frequency Assumptions**

The following service span and frequency assumptions and information were used in the ridership projections:

- Weekday service, Saturday, and Sunday service vary based on attributes of the scenario
- Service frequency for Saturday and Sunday service are the same as offpeak weekday service

**Baseline Ridership Assumptions**

According to the TCRP 61, pp.13, service elasticity may be defined as the percentage change in the quantity of a commodity or service demanded by the public in response to a 1 percent change in price or service. Many factors affect consumer choice include demographic factors, geographic factors (e.g., population density, employment density and pedestrian accessibility). For example, if transit service is measured by the number of bus miles operated, the transit service elasticity indicates the percentage change in patronage observed or expected in response to a 1 percent change in the number of bus miles. A service elasticity of 1.0 indicates that customers are very responsive to change, whereas an elasticity of 0.1 indicates that they are not responsive to change.

For each individual service and route, the 2008 baseline ridership was projected up to the 2017 ridership based on a linear population growth rate of the community or TAZ it serves, as determined by the current GWR model. Then, elasticities based on those presented in TCRP Report 95, “Traveler Response to
Transportation System Changes\textsuperscript{1},” were applied to reflect changes in service parameters. For local services, that report found that “Increased bus frequency normally attracts increased patronage, and vice versa but with wide variation in results” but that “elasticities calculated for the more recently reported frequency changes group either around an elasticity of +0.3 or around +1.0.” Systems with lower responses (closer to +0.3) tended to be larger systems, and those that had the higher responses (elasticities around +1.0) tended to be smaller systems. Based on these findings, or this evaluation, we used an elasticity of +1.0 for level of service changes, and lower elasticities for express bus and VRE service.

In more detail:

**Local Bus Routes**

The following assumptions were used to determine the ridership projections for the local bus routes:

- Baseline ridership growth is proportional to TAZ and land use population growth.
- Service elasticity of 1.0 for all local bus service based on TCRP 100 guidelines for exurban/rural service change impacts.
- VRE feeder service meets every VRE train.

**Regional Routes**

The following information and assumptions were used in determining the baseline 2017 and 2035 ridership for the new regional routes that replace and consolidate existing FRED local routes with higher density transit service:

- R1 replaces local bus route F2; use F2 ridership as baseline for R1.
- R2 replaces local routes S1, D5; use S1 and D5 ridership as baseline.
- R3 replaces local bus route F3; use F3 ridership as baseline for R3.

**Flex Routes**

The following assumptions were used in determining the baseline ridership projections for the Flex routes:

- 4 passengers per trip (based on experience elsewhere).
- Baseline daily ridership is 4 passengers per trip multiplied by number of trips per service day.

\textsuperscript{1} Transit Cooperative Research Program, 2004.
Express Bus
The following assumptions were used in determining the baseline ridership projections for the express bus routes:

- Baseline of 30 passengers per trip for all existing services
- Baseline of 40 passengers per trip for all new services
- 2017 & 2035
  - Growth in ridership on established routes used an elasticity of 0.3.
  - Growth in ridership on new services used an elasticity of 0.5; except 2017 Medium Scenario, which used an elasticity of 1.0 for new services.
- There were several situations where 2035 High Scenario projections result in more passengers projected to ride the service than the corridor has practical service capacity. If the projected express bus ridership is greater then the total number of trips multiplied by the standard capacity of a coach (57 seats), the ridership projections were capped to the practical service capacity for the route.

VRE Service
The following assumptions were used in determining the ridership projections for the GWR share of VRE service on the Fredericksburg line:

- VRE Ridership at new stations was developed as a function of VRE station parking supply and utilization.
  - Crossroads station would have 500 parking spaces
  - Stonewall Jackson, Bowling Green, and Carmel Church would have 200 spaces
- All AM Peak boardings for Washington, D.C. would return in the PM peak (1:1 directional bias).
- New Stations
  - Initial ridership was based on current average VRE parking utilization and the current 112% average automobile occupancy at VRE lots.
- 2017 Transit Scenarios:
  - Service elasticity of 0.3 was used.
- 2035 Transit Scenarios
  - Ridership at new stations was based upon new stations is based upon parking utilization.
• Crossroads would have a 90% parking utilization due to existing passengers using that station instead of Fredericksburg.
• Rt. 606 & Bowling Green would have parking utilization of 70%.
• Carmel Church would have parking utilization of 85%.
  – An elasticity of 0.3 was used for existing stations in 2035 Low Scenario.
  – An elasticity of 0.1 used for existing stations in 2035 Medium Scenario except for Brooke, was used an elasticity of 0.3.
  – An elasticity of 0.3 was used for existing stations in 2035 High Scenario except for Fredericksburg, which was based on an elasticity of 0.1.

**Volunteer Driver Service**

The following assumptions were used in determining the ridership carried by volunteer drivers:

- The number of trips provided by volunteer drivers was calculated by an average number of trips per capita multiplied by the size of the 2017 or 2035 eligible populations.
- Based on experience at Addison County, VT’s volunteer driver program, ridership per capita was assumed to be six trips per capita.

**OPERATING COSTS, FARE REVENUE, AND CAPITAL COSTS**

Estimates of capital costs and annual operating cost estimates for the George Washington Region (GWR) are important in determining which transit scenario the GWR best meets regional transportation infrastructure and service investment. The following establishes sources and capital and annual operating costs that used. Unit capital and operating costs were developed for the following services:

- VRE service
- Express Bus Service
- Flex Bus Service
- Regional Bus Service
- Local bus service
- Transit Centers
- Fredericksburg Streetcar service
Operating Costs

A unit cost approach was used to estimate the operation and maintenance costs for each scenario were derived from variety of sources, including the planning team’s survey efforts and previous studies. The unit cost estimates and their sources are listed in Table 1.

### Table 2. Unit Costs for Operating Expenditures

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost Item</th>
<th>Unit</th>
<th>Unit Cost</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus</td>
<td>Express Bus</td>
<td>Hour of Operation</td>
<td>$86.77</td>
<td>PRTC Hourly Cost figure used in HOT Lane Study</td>
</tr>
<tr>
<td></td>
<td>Regional Bus</td>
<td>Hour of Operation</td>
<td>$65.00</td>
<td>FRED Operating Costs</td>
</tr>
<tr>
<td></td>
<td>Local Bus</td>
<td>Hour of Operation</td>
<td>$65.00</td>
<td>FRED Operating Costs</td>
</tr>
<tr>
<td></td>
<td>Flex Bus</td>
<td>Hour of Operation</td>
<td>$65.00</td>
<td>FRED Operating Costs</td>
</tr>
<tr>
<td>VRE</td>
<td>VRE Service</td>
<td>Hour of Operation</td>
<td>$4,886</td>
<td>VRE Strategic Plan</td>
</tr>
<tr>
<td>Streetcar</td>
<td>Streetcar</td>
<td>Service Year</td>
<td>$2,000,000</td>
<td>FTA NTD</td>
</tr>
<tr>
<td>Volunteer</td>
<td>Mileage Reimbursement</td>
<td>Cost per Mile</td>
<td>$0.505</td>
<td>US Gov't Mileage Reimbursement Rate</td>
</tr>
</tbody>
</table>

**Express Bus**

The unit cost of operation of express bus service was estimated using the hourly rate of $86.77 used for PRTC services in the 2008 HOT Lane Report. Annual costs were then estimated by multiplying the fully loaded hourly cost of operation by the daily vehicle revenue hours per day and the number of service days per year for each scenario.

**Local Bus**

The unit cost of operation of regional bus service was estimated at $65 per hour. This is higher than FRED’s current hourly cost of approximately $51.50 and reflects that as the system grows, cost will also likely grow as a higher percentage of full-time employees with benefits will be required, and other reasons. Annual costs were then estimated by multiplying the fully loaded hourly cost of operation by the daily vehicle revenue hours per day and the number of service days per year for each scenario.
Regional Bus

It was assumed that hourly costs for regional bus would be the same as for local bus service. Annual costs were estimated by multiplying the hourly cost of operation by the daily vehicle revenue hours per day and the number of service days per year for each scenario.

Flex Bus

It was assumed that hourly costs for Flex-Bus service would also be the same as for local bus service. Annual costs were estimated by multiplying the hourly cost of operation by the daily vehicle revenue hours per day and the number of service days per year for each scenario.

VRE Service

Unit costs for operation of VRE service were estimated on a train hour basis. This cost was estimated by dividing VRE’s annual operating cost by the number of annual train miles. Annual costs were estimated by multiplying the hourly cost of operation by the daily train revenue hours per day and the number of service days per year for each scenario.

Fredericksburg Streetcar Service

The unit operating cost is based on peer cities currently running similar trolley service using 2006 NTD database. The peer systems used were Memphis, Tennessee, Galveston, Texas, and Tampa, Florida.

Volunteer Driver Service

The annual cost for operation for the volunteer driver program was found by multiplying the federal reimbursement rate for mileage ($0.505) by the average trip length, average number of trips per capita, and the eligible population.

Fare Revenue

Estimates of revenue recovery of the proposed services for the George Washington Region (GWR) are important in determining which transit scenario best meets regional transportation needs. The following information documents the rationale for the estimated revenue recovery ratios.
VRE

It is assumed that the VRE service will have a farebox recovery of 47%, as documented in the 2008 HOT Lane Report on page 9–2. This ratio assumes that additional operating costs will be partially covered by fares – both when adding cars per train and new trains.

Express Bus

Farebox recovery for express bus service is an order of magnitude estimate based on the VRE recovery ratio listed in the 2008 HOT Lane Report on page 9–2.

Local Service

Based on FRED’s current recovery ratio, it is assumed that with the increases in service, local buses will continue to operate at their current recovery ratio of 3%.

Flex Service

Flex service will be a local service in the GWR. It is assumed to have the same recovery ratio as local service at 3%.

Regional Service

Regional bus service will be a better performing service than local service since it replaces several routes and operates on a more regional level. From this information, it is assumed regional buses will operate marginally better than local bus service, and a 5% recovery ratio is estimated.

Capital Costs

A unit cost approach was used to estimate the capital construction, infrastructure upgrades, and equipment acquisition costs for each scenario, with unit costs derived from variety of industry sources, prior planning and financial documents and general order of magnitude estimates based on existing cost structures and future escalations. The unit cost estimates and their sources are listed in Table 1.
### Table 1. Unit Costs for Capital Expenditures ($2008)

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost Item</th>
<th>Unit</th>
<th>Unit Cost</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parking</td>
<td>Surface Parking Space</td>
<td>Parking Space</td>
<td>$15,000</td>
<td>2008 HOT Lane Report, pp. 8 – 2</td>
</tr>
<tr>
<td></td>
<td>Garage Parking Space</td>
<td>Parking Space</td>
<td>$30,000</td>
<td>2008 HOT Lane Report, pp. 8 – 2</td>
</tr>
<tr>
<td>Transit Center</td>
<td>Rt. 610 Park &amp; Ride Facility</td>
<td>Each</td>
<td>$10,000,000</td>
<td>2008 HOT Lane Report, pp. 8 – 2</td>
</tr>
<tr>
<td></td>
<td>Massaponax Transit Center</td>
<td>Each</td>
<td>$7,500,000</td>
<td>2008 HOT Lane Report, pp. 8 – 2</td>
</tr>
<tr>
<td>VRE Stations</td>
<td>VRE Station in Spotsylvania Co.</td>
<td>Each</td>
<td>$7,000,000</td>
<td>VRE Strategic Plan, pp. 86</td>
</tr>
<tr>
<td></td>
<td>VRE Station in Caroline Co.</td>
<td>Each</td>
<td>$6,500,000</td>
<td>VRE Strategic Plan, pp. 46</td>
</tr>
<tr>
<td></td>
<td>Hybrid Transit Bus</td>
<td>Each</td>
<td>$500,000</td>
<td>Union of Concerned Scientists</td>
</tr>
<tr>
<td></td>
<td>Bus On Chassis</td>
<td>Each</td>
<td>$45,000</td>
<td>FRED 2008 Equipment Acquisition</td>
</tr>
<tr>
<td>VRE Fleet</td>
<td>VRE Locomotives</td>
<td>Each</td>
<td>$4,860,000</td>
<td>GO Transit Interim Report, pp. 138</td>
</tr>
<tr>
<td></td>
<td>VRE Coaches</td>
<td>Each</td>
<td>$2,200,000</td>
<td>VRE Strategic Plan, pp. 86</td>
</tr>
<tr>
<td></td>
<td>6 Car Trainset</td>
<td>Each</td>
<td>$15,000,000</td>
<td>VRE Strategic Plan, pp. 86</td>
</tr>
<tr>
<td>Maintenance &amp; Storage Facilities</td>
<td>Regional Bus Maintenance Facility</td>
<td>Each</td>
<td>$1,000,000</td>
<td>Planning Estimate</td>
</tr>
<tr>
<td></td>
<td>Transit Center Satellite</td>
<td>Transit Center</td>
<td>$1,000,000</td>
<td>Planning estimate</td>
</tr>
<tr>
<td></td>
<td>Crossroads Maintenance Yard Extension</td>
<td>Each</td>
<td>$1,350,000</td>
<td>2008 HOT Lane Report, pp. 8 – 2</td>
</tr>
<tr>
<td>Streetcar</td>
<td>Streetcar in Fredericksburg</td>
<td>Equip. + Infrastructure</td>
<td>$60,000,000</td>
<td>Based on per mile construction costs of Seattle Streetcar ²</td>
</tr>
</tbody>
</table>

#### Parking

**Surface Parking Spaces**

As previously listed, estimates of surface parking spot construction spot were listed in the provided by in the DRTC Hot Lane Report. The total cost of parking space construction was found by multiplying the designated number of spaces by the estimated cost per space, $15,000.

**Garage Structure Parking Spaces**

The cost per garage parking spot at the Fredericksburg VRE station was estimated to be double the construction cost of a surface space. The total cost of construction for the parking garage was found by multiplying the number of spaces to be built by the cost per space, $30,000.

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² [http://www.seattlestreetcar.org](http://www.seattlestreetcar.org)
Transit Centers

The cost for construction of the transit centers were estimated based upon the estimates provided in the DRTC Hot Lane Report. The total cost of each transit center is the sum of the cost of parking space construction and the facility construction cost.

VRE Stations

The cost for construction of VRE stations varies. According to the VRE Strategic Plan, it would cost VRE approximately $7.0 million to build Crossroads Station in Spotsylvania County with 500 parking spaces. To estimate the cost of construction of VRE stations in Caroline County, the low cost of construction of the proposed “Cherry Hill” station along the Fredericksburg route was used. It was conservatively estimated that this station would have 200 parking spaces, and would cost $6.5 million to build.

Bus Equipment and Fleet

The cost for new bus fleet acquisition was estimated from industry sources.

The cost of purchasing 57 passenger “over-the-road” (OTR) highway commuter buses was derived from the most recent New York City MTA Capital Program purchase.

The cost of purchasing 40’ standard low-floor hybrid diesel-electric powered transit coaches was derived from the Union of Concerned Scientists’ Clean Vehicles Program.

The cost of small “bus on chassis” (the existing fleet) was provided by FRED based on recent orders.

VRE Fleet

The cost for additional VRE coaches to serve the GWR is listed in the VRE Strategic Planning Report. According to the report, the purchase of 4 coaches would cost $8.8 million ($2.2 million each). The costs for purchasing additional locomotives to serve the GWR would be $4.8 based on previous planning work.
Maintenance and Storage Facilities

The cost for additional maintenance and storage facilities was derived from the VRE Strategic Plan based on the number of stations.

Streetcar

The capital cost for equipment acquisition and infrastructure was based on a general per mile equivalent from the City of Seattle’s Seattle Streetcar project.