

## Memorandum

To	Amy Inman – DRPT, Lorna Parkins – Michael Baker	Page	1
CC	Jeffrey Roux		
Subject	Richmond Broad Street BRT Calculation of Linked Trips on Project, Methodology and Results		
From	Daniel Evans		
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This technical memorandum describes the methodology used to compute the “linked trips on project” statistic for the Richmond Broad Street Bus Rapid Transit (BRT) project. The linked trips on project statistic will be used to support the Federal Transit Administration (FTA) Small Starts project justification evaluation metrics including mobility benefits and cost-effectiveness.

### **Average Weekday Linked Trips on Project Statistic**

FTA’s migration to using the linked trips on project statistic created a challenge for the forecasting team to extract the evaluation statistics. This challenge was due to the different categories of riders who will benefit from the Broad Street BRT project as well as the complexity of the accounting required to assemble the statistics consistent with FTA expectations. The Broad Street project is intended to benefit Greater Richmond Transit Company (GRTC) customers in the following fashion:

1. Improve mobility for longer-haul Broad Street transit customers by introducing dedicated BRT service on Broad Street. The BRT will utilize dedicated bus lanes (curb running in Downtown along with a median approaching downtown from the west), will use differentiated BRT branding, and will provide formal stations with:
  - a. Passenger information systems
  - b. Off-board fare collection
  - c. Enhanced shelters
2. Improve the customer experience for local GRTC bus customers riding into downtown Richmond. Many GRTC routes perform downtown distribution on Broad Street. The project will introduce a dedicated bus lane through downtown Richmond, which will 1) offer improved travel times, 2) consolidate station stops (BRT route and all locals at three stops in the bus lane), 3) reduce bus bunching, and 4) improve operational reliability.

After consulting with the FTA, AECOM and FTA defined a “project boarding” as any boarding that meets one of the following criteria:

- All customers boarding the BRT trunk line.
- A boarding in which the customer boards or alights from a local bus at a BRT station outside the dedicated bus lane.
- A boarding by a local bus customer who either is on-board as the bus enters the dedicated bus lane or boards the local bus which operates within the dedicated bus lane.

Based on the criteria above, project boardings could be classified in two ways: boardings by customers who either (1) board or alight at a BRT station, or (2) completely “run through” the downtown dedicated bus lane.

### **Linked Trips on Project Boarding or Alighting at a BRT Station**

A customer who boarded or alighted at a BRT station was counted as a project boarding, regardless of whether the customer used BRT, local bus, or express bus. For each transit mode (local bus, express bus, and BRT), skims were generated to indicate the beginning node and ending node of linked transit trips between zones. If either the first or last node of a linked trip was one of the 14 BRT stations, the transit trips in the input trip table for a given zonal pair were counted as project boardings for a particular mode.

### **Linked Trips on Project “Running Through” Downtown Dedicated Bus Lane**

AECOM estimated the number of local bus linked trips that “run through” the dedicated bus lane along Broad Street in downtown Richmond (from 3<sup>rd</sup> St. to 12<sup>th</sup> St.). These linked trips are local bus linked trips that run through the downtown bus lane, but do not use a BRT station. To estimate the number of these linked trips, AECOM used the 2009 GRTC on-board origin-destination survey to compute the number of linked trips that began to the east/west of the bus lane, passed through the downtown bus lane, and ended to the west/east of the bus lane. Three steps were taken to extract relevant records from the survey.

- Survey records without a transfer were selected.
- Local bus routes were selected which traversed the dedicated bus lane. These routes include the #1 & 2, 3 & 4, 6, 10, 19, 22, 24, 37, and 74.
- The trip origin had to be east/west of the downtown bus lane, and the trip destination had to be beyond the opposite limits of the bus lane. Survey data included longitudinal coordinates for origins and destinations, so the team was able to isolate trips that began east/west of the bus lane and ended west/east of the bus lane.

Together, the three criteria essentially would require a trip to run through the downtown bus lane using a route that traverses the bus lane. The zonal pairs of the survey records that met the three criteria were used to create a “dummy” trip table. The dummy trip table simply indicated with a “1” every zonal pair meeting the three criteria (all other zonal pairs had a value of 0 in the dummy trip table). The 2015 and 2035 Build 3 scenario trip tables were then multiplied by the dummy trip table to estimate the number of linked trips “running through” the downtown dedicated bus lane on Broad Street. In order to avoid double-counting “run-through” trips that began or ended at a BRT station (these trips would have been counted already because of a stop at a BRT station), “run-through” trips were not counted for any zonal pair interchange in which a BRT station was a beginning or ending node in the transit skims (local bus, express bus, and BRT skims).

### Linked Trips on Project Results

Table 1 below shows the forecasted average weekday linked trips on project by transit mode for both the current and horizon years. Also, the table includes the number of linked trips on the project made by households with a vehicle and by zero-car households, a proxy for transit-dependent customers. A few observations can be made based on the results:

- The overall total project boardings increase approximately 20 percent between today and 2035.
- Transit-dependent customers account for roughly half of total average weekday linked trips on project.

**Table 1 – Average Weekday Linked Trips on Project**

Linked Trips	Current (2015)			Horizon (2035)		
	All	0-Car	1+ Car	All	0-Car	1+ Car
BRT	3,300	1,800	1,500	4,000	2,100	1,900
Local Bus	7,600	4,000	3,600	9,200	4,800	4,400
Express Bus	700	100	600	900	100	800
Local Run-Through	300	200	100	300	200	100
<b>Total</b>	<b>11,900</b>	<b>6,100</b>	<b>5,800</b>	<b>14,400</b>	<b>7,200</b>	<b>7,200</b>

Table 2 below shows the annual linked trips on project and is based on the data in Table 1. An annualization factor was derived using GRTC’s reported average weekday and annual unlinked trips in the 2011 National Transit Database (NTD). The resulting factor was 289, which was used to convert the average weekday figures in Table 1 to annual figures in Table 2. The FTA evaluation measure for mobility benefits is calculated as:

$$\text{FTA Evaluation Measure} = 1.0 * \text{Annual Trips Made by Non-Dependents (1+ car HHs)} + 2.0 * \text{Annual Trips Made by Transit-Dependents (0 car HHs)}$$

Table 2 shows that the FTA evaluation measure for linked trips on the project is calculated as 5.2M in the current year and 6.2M in the horizon year (2035). FTA allows project sponsors to submit either the current year forecasts or the average of the current year forecast and the 20-year horizon forecast. In either case, our forecasts show that the Broad Street BRT project would earn a “medium” rating on mobility benefits (annual boardings of between 5 and 15 million).

**Table 2 – Annual Linked Trips on Project**

Linked Trips	Current (2015)			Horizon (2035)		
	All	0-Car	1+ Car	All	0-Car	1+ Car
BRT	953,700	520,200	433,500	1,156,000	606,900	549,100
Local Bus	2,196,400	1,156,000	1,040,400	2,658,800	1,387,200	1,271,600
Express Bus	202,300	28,900	173,400	260,100	28,900	231,200
Local Run-Through	86,700	57,800	28,900	86,700	57,800	28,900
<b>Total</b>	<b>3,439,100</b>	<b>1,762,900</b>	<b>1,676,200</b>	<b>4,161,600</b>	<b>2,080,800</b>	<b>2,080,800</b>
<b>FTA Evaluation Measure</b>		<b>5,202,000</b>			<b>6,242,400</b>	