

# **BROAD STREET RAPID TRANSIT STUDY**

## **OPERATIONS AND MAINTENANCE COST ESTIMATES**

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The GRTC Transit System and Virginia Department of Rail and Public Transportation (GRTC/DRPT) are conducting a study consistent with the requirements of the Federal Transit Administration’s (FTA) Small Starts program to evaluate transit improvements along the Broad Street corridor. This memo provides a summary of the Operations and Maintenance (O&M) costs estimated for the No Build, and Build Alternatives. Based on the results of the O&M cost model, the study team reached the following conclusions:

- **In 2015 dollars, the O&M costs for the Build Alternative are 2.4% higher than the 2012 O&M costs for the existing system.** Small Starts projects can receive a “Medium” rating for Local Financial Commitment if their costs are less than 5% of existing O&M costs. Even taking into account inflation between 2012 and 2015, the Build Alternative is anticipated to be only slightly more expensive to operate than the existing system due to:
  - The conversion of the existing fleet to compressed natural gas (CNG) vehicles, which is expected to lower unit fuel costs by 16% for the total fleet by 2015;
  - The use of CNG vehicles on the BRT service, which is expected to result in fuel costs 56% lower than if the BRT service were operated using diesel vehicles;
  - The reduction of headways on the Route 6 to account for the transfer of ridership to the BRT service on the Broad Street corridor.
  
- **In 2015 dollars, the total O&M costs for the Build Alternative are 1% higher than operations under the No Build Alternative.** The No Build Alternative anticipates that GRTC will have 47 CNG vehicles available for fixed-route service by 2015; therefore, it is more comparable to the Build Alternative than the existing, all-diesel service provided by GRTC. The difference in costs between the Build and No Build can be largely attributed to the costs of providing off-board fare collection as part of the BRT service. The additional costs of providing 10 minute peak and 15 minute off-peak BRT service have been offset by reductions in service on Route 6.

### **1.0 OVERVIEW OF METHODOLOGY AND ASSUMPTIONS**

As described in the October 2013 update of the *O&M Cost Methodology Report*, these cost estimates were developed in a manner consistent with FTA guidance published in two documents:

- Part II (Conduct of the Analysis), Chapter 4 (Operating and Maintenance Costs) of *Procedures and Technical Methods for Transit Project Planning*; and,

- *Final Guidance on New Starts/Small Starts Policies and Procedures.*

O&M costs were developed using a fully allocated cost model, where costs were estimated based on changes in three, key driving supply variables:

- Revenue hours of service
- Revenue miles of service
- Peak vehicle requirements

Each category of operations and maintenance expense associated with non-specialized service was assigned to one of these variables. The incremental cost associated with each key driving supply variable was then calculated by summing the line item costs associated with the variable by the total for the year 2012 (e.g. dividing total costs associated with revenue hours by the total revenue hours in 2012).

Where the introduction of BRT services was anticipated to change the costs of specific cost categories, the study team introduced an adjustment factor that would be applied to incremental costs of BRT operations. A similar approach was used to account for GRTC’s planned transition from diesel buses to CNG buses, of which 47 will be available for fixed-route service by 2015. The categorization of line item costs and adjustments for BRT service and CNG vehicles may be found in the *O&M Cost Methodology Report*. Table 1 summarizes the incremental costs of the key driving supply variables used in the fully allocated cost model. Appendix A provides a detailed accounting of the line item costs used to develop the incremental costs.

**Table 1: Incremental Costs of Key Driving Supply Vehicles**

	2012\$			2015\$		
	Existing	No Build/ Non-BRT Build*	BRT	Existing	No Build/ Non-BRT Build*	BRT
Incremental cost per revenue hour	\$43.82	\$43.82	\$43.82	\$46.58	\$46.58	\$46.58
Incremental cost per revenue mile	\$1.74	\$1.59	\$1.30	\$1.85	\$1.69	\$1.38
Incremental cost per vehicle	\$86,500	\$86,500	\$92,600	\$92,000	\$92,000	\$98,400
Incremental cost, off-board fare collection			\$626,100			\$665,600

\*Refers to the fixed-route services operated under the No Build Alternative and the non-BRT, fixed-route services operated under the Build Alternative.

Source: GRTC’s *Statement of Operating Expenses and Taxes for the Year Ending June 30, 2012*. Vehicle and off-board fare collection costs rounded to nearest \$100. 2015 costs assume 2% annual inflation.

The total O&M cost of non-specialized services under each alternative was then calculated using the formula:

$$C(h, m, v) = h \times C_h + m \times C_m + v \times C_v + l \times C_l$$

Where:

- $C(h, m, v)$  is the estimated annual operations and maintenance cost of an alternative that includes  $h$  hours of service,  $m$  revenue miles of service, and  $v$  peak vehicles.
- $C_h$  is incremental operating cost of adding an additional revenue hour of service
- $C_m$  is incremental operating cost of adding an additional revenue mile of service
- $C_v$  is incremental operating cost of adding an additional peak hour vehicle to the transit system

- $C_l$  is incremental operating cost of adding an additional route-mile of bus lane to the transit system

Per the request of the Federal Transit Administration, the Build Alternative was modified to consider the impacts of off-board fare collection. As this cost is anticipated not to vary by hours or frequency of operation, it was considered a fixed cost to be added to the O&M costs of the Build Alternative.

For purposes of this study, it is assumed that specialized services (including paratransit, chartered buses, and long-distance service to Petersburg) would remain constant across all alternatives. Therefore, the O&M cost of specialized services was added to the estimated O&M cost of each alternative to arrive at the total operating expense for each alternative. The revenue hours, revenue miles, and vehicle requirements for specialized services were not calculated as part of each alternative.

## 2.0 ESTIMATION OF KEY DRIVING SUPPLY VARIABLES

As the travel demand model being used as part of this study does not provide estimates of revenue hours, revenue miles, or vehicle requirements for each alternative, these variables were estimated using the route lengths, two-way travel times, and frequencies of service input into the travel demand model for local and express bus services. To ensure the validity of this approach, the study team first tested it on the existing system, comparing calculated values for the key driving supply variables against the real data available from the GRTC *Statement of Operating Expenses and Taxes for the Year Ending June 30, 2012*. The results of this test are summarized in Table 2; the route-by-route calculation of these variables is provided in Appendix B.

**Table 2: Summary of O&M Costs and Statistics, Local and Express Services**

Unit	Existing Service		
	Actual*	Modeled	Model vs. Actual
Annual Revenue Hours Operated	397,288	386,427	-3%
Annual Revenue Miles Operated	4,766,011	4,242,864	-11%
Fleet Size	136	131	-4%

\*Sources: GRTC's *Statement of Operating Expenses and Taxes for the Year Ending June 30, 2012*. Fleet size represents maximum vehicles in service, as reporting in the *2009 National Transit Database*.

The estimated values for revenue hours were 3% lower than actual values and the estimated values for revenue miles were 11% lower than actual. Estimated fleet requirements were 4% lower than actual due to the need to round vehicle requirements on a route-by-route basis. These variations may be attributed to two issues:

1. The travel times used to estimate revenue miles and hours were derived from the travel times used in the travel demand forecast, and may vary from actual operating conditions in 2012.
2. The method used to estimate revenue miles and revenue hours may not completely reflect actual revenue miles and hours associated with pull-ins and pull-outs of vehicles in revenue service.

That being said, this level of accuracy still makes it possible to make meaningful comparisons between the No Build and the Build Alternatives. These estimates will be refined and revised as the project moves forward and more detailed information is available to the study team.

The key driving supply variables for each alternative were calculated using the information input into the travel demand forecast for each alternative. The inputs to the travel demand forecasts, in turn, were derived from VISSIM microsimulations of each alternative, which were able to quantify the impacts of the service and facility improvements on travel times in the corridor. Both the travel demand forecasts and VISSIM microsimulations were developed from the description of alternatives provided in the November 17, 2010 *Detailed Definition of Alternatives* technical memorandum. Appendix C provides a route-by-route account of the inputs and calculations of each key supply variable.

### 3.0 MODEL RESULTS

Table 3 summarizes the key driving supply variables and estimated O&M costs for each alternative. The key findings from these estimates are as follows:

**No Build Alternative:** In 2015 dollars, No Build Alternative is estimated to cost 1.6% more to operate than the existing system. This reflects the impacts of inflation on operating the system, which are countered by both the increased use of CNG vehicles and potential of the model to underestimate revenue miles and hours. The No Build is anticipated to generate O&M costs 5% higher than the modeled existing service, due to estimated increases in miles and hours generated by the splitting of Route 6 into Routes 6 and 53.

**Build Alternative:** The Build Alternative is estimated to cost 2.4% more in 2015 dollars than the 2012 O&M costs for the existing system. The Build Alternative is also estimated to cost less than one percent more than the No Build Alternative to operate. In both cases, the addition of BRT service is offset by the decrease of service on Route 6 and the increased use of CNG vehicles, both on the BRT service and across the GRTC system.

Small Starts projects can receive a “Medium” rating for Local Financial Commitment if their costs are less than 5% of existing O&M costs. That being said, the model used to estimate O&M costs slightly underestimates revenue miles and revenue hours. Therefore, it is more appropriate to compare the Build Alternative with the No Build Alternative, as the costs for both alternatives were derived from the same model. Comparing the Build Alternative versus the No Build, it is likely that the Build Alternative will meet the 5% threshold that would allow for a “Medium” rating.

**Table 3: Summary of O&M Costs and Statistics**

		Existing Service (June 2012)	Modeled Service (June 2013)	No Build (2015)	Build (2015)			Build (2015\$) vs. Existing (2012\$)
					BRT Route	All Other Services	Total	
Operating Statistics	Peak Vehicle Requirement	136	131	133	7	127	134	-1.5%
	Annual Vehicle Hours	397,300	386,400	391,700	28,000	359,000	\$387,000	-2.6%
	Annual Vehicle Miles	4,766,000	4,242,900	4,288,900	79,700	4,113,800	\$4,193,500	-12.0%
Cost Breakdown by Category	Operating Costs (2012\$)			Operating Costs (2015\$)				
	Hourly Costs	\$17,409,000	\$16,933,000	\$18,246,000	\$1,308,000	\$16,724,000	\$18,032,000	3.6%
	Mileage Costs	\$8,305,000	\$7,393,000	\$7,245,000	\$110,000	\$6,949,000	\$7,059,000	-15.0%
	Vehicle Costs	\$11,769,000	\$11,336,000	\$12,235,000	\$689,000	\$11,683,000	\$12,372,000	5.1%
	Fixed Costs*				\$626,000		\$626,000	
	Subtotal: Non-specialized services	\$37,483,000	\$35,663,000	\$37,726,000	\$2,733,000	\$35,356,000	\$38,089,000	1.6%
	Specialized Services**	\$8,301,000	\$8,301,000	\$8,809,000			\$8,809,000	
	<b>Total: all O&amp;M costs</b>	<b>\$45,784,000</b>	<b>\$43,964,000</b>	<b>\$46,535,000</b>			<b>\$46,899,000</b>	<b>2.4%</b>
<b>% of total 2012GRTC expenses</b>	<b>100.0%</b>	<b>96.0%</b>	<b>101.6%</b>			<b>102.4%</b>		

All vehicle hours and vehicle miles rounded to the nearest 100. All costs rounded to the nearest \$1,000

\*Includes costs associated with off-board fare collection. \*\*Specialized services for 2015 inflated by 2% annually, assume same level of service.

While the model used to estimate O&M costs is of sufficient accuracy to compare the No Build versus the Build Alternative, it should be noted that there may be additional costs associated with operating both scenarios. Furthermore, should the costs of specialized services decrease, relative cost of the Build Alternative versus the No Build would increase. Therefore, it will be critical to refine these estimates as the project moves forward.

#### 4.0 NEXT STEPS

The travel demand forecasts for the study are being finalized, pending final input from FTA. Once these forecasts have been finalized, they will be used in conjunction with the annualized costs for the project to estimate the Cost-Effectiveness Index (CEI) for the project. The operating costs will also be utilized by the cost model for the project so that an appropriate financial plan for the project may be developed.

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**APPENDIX A:  
O&M UNIT COSTS**

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# APPENDIX A

## O&M Unit Costs

Source: GRTC, for 12 months ending June 30, 2012

Category	Actual	Budget	Unit	Unit Costs (2012\$)				Unit Costs (2015\$)			
				Base Unit Cost	No Build, non-BRT Build	Adjustment Factor: BRT	Adjusted Unit Costs, BRT only	Inflation Factor	Base Unit Cost	No Build, non-BRT Build	Adjusted Unit Costs, BRT only
<b>Operations</b>											
Operators Wages	\$11,058,718	\$11,590,386	Hours	\$27.84	\$27.84		\$27.84	2%	\$29.59	\$29.59	\$29.59
Transportation Supervisors	\$1,362,911	\$1,345,156	Hours	\$3.43	\$3.43		\$3.43	2%	\$3.65	\$3.65	\$3.65
Fuel and Lubricants (Ops)	\$4,605,738	\$4,848,971	Miles	\$0.97	\$0.81	-56%	\$0.43	2%	\$1.03	\$0.86	\$0.46
Tires and Tubes	\$327,946	\$332,734	Miles	\$0.07	\$0.07		\$0.07	2%	\$0.07	\$0.07	\$0.07
Other Materials and Supplies (Ops)	\$458,841	\$436,101	Peak Vehicles	\$3,373.83	\$3,373.83	20%	\$4,048.60	2%	\$3,586.66	\$3,586.66	\$4,303.99
Off-Board Fare Collection Operating Costs			Fixed	\$167,192.00	\$167,192.00		\$167,192.00	2%	\$177,738.78	\$177,738.78	\$177,738.78
<b>Maintenance</b>											
Mechanics Wages	\$1,776,927	\$1,620,111	Miles	\$0.37	\$0.37	20%	\$0.45	2%	\$0.40	\$0.40	\$0.48
Mechanics Supervisors	\$423,569	\$426,533	Miles	\$0.09	\$0.09	20%	\$0.11	2%	\$0.09	\$0.09	\$0.11
Contractor Support (Maint)	\$111,091	\$114,501	Miles	\$0.02	\$0.02		\$0.02	2%	\$0.02	\$0.02	\$0.02
Fuel and Lubricants (Maint)	\$71,222	\$53,400	Peak Vehicles	\$523.69	\$523.69		\$523.69	2%	\$556.73	\$556.73	\$556.73
Vehicle Parts	\$2,139,936	\$1,981,000	Peak Vehicles	\$15,734.82	\$15,734.82	20%	\$18,881.79	2%	\$16,727.40	\$16,727.40	\$20,072.89
Other Materials and Supplies (Maint)	\$225,225	\$198,090	Peak Vehicles	\$1,656.07	\$1,656.07	5%	\$1,738.87	2%	\$1,760.53	\$1,760.53	\$1,848.56
Utilities Cost (Maint)	\$254,689	\$350,796	Peak Vehicles	\$1,872.71	\$1,872.71	20%	\$2,247.26	2%	\$1,990.85	\$1,990.85	\$2,389.02
Off-Board Fare Collection Maintenance Costs			Fixed	\$458,940.90	\$458,940.90		\$458,940.90	2%	\$487,891.73	\$487,891.73	\$487,891.73
<b>Buildings, Grounds, Facilities</b>											
Maintenance Worker Wages	\$856,190	\$952,549	Peak Vehicles	\$6,295.51	\$6,295.51	20%	\$7,554.62	2%	\$6,692.65	\$6,692.65	\$8,031.18
Contractor Support (Bldg)	\$0	\$500	Peak Vehicles	\$0.00	\$0.00		\$0.00	2%	\$0.00	\$0.00	\$0.00
Administrative Building Materials	\$323,845	\$200,000	Peak Vehicles	\$2,381.21	\$2,381.21	20%	\$2,857.46	2%	\$2,531.42	\$2,531.42	\$3,037.71
<b>Administration</b>											
Administrative Wages/Salaries	\$2,687,052	\$2,622,002	Peak Vehicles	\$19,757.74	\$19,757.74		\$19,757.74	2%	\$21,004.09	\$21,004.09	\$21,004.09
Contractor Support (Admin)	\$583,422	\$279,000	Peak Vehicles	\$4,289.87	\$4,289.87		\$4,289.87	2%	\$4,560.48	\$4,560.48	\$4,560.48
Fuel and Lubricants (Admin)	\$3,961	\$4,750	Peak Vehicles	\$29.13	\$29.13		\$29.13	2%	\$30.96	\$30.96	\$30.96
Office Supplies (Admin)	\$1,728,078	\$1,755,544	Peak Vehicles	\$12,706.46	\$12,706.46		\$12,706.46	2%	\$13,508.00	\$13,508.00	\$13,508.00
Utilities Cost (Admin)	\$97,898	\$108,000	Peak Vehicles	\$719.84	\$719.84		\$719.84	2%	\$765.25	\$765.25	\$765.25
Pension	\$1,883,463	\$2,043,185	Hours	\$4.74	\$4.74		\$4.74	2%	\$5.04	\$5.04	\$5.04
Health Insurance	\$3,104,019	\$3,501,175	Hours	\$7.81	\$7.81		\$7.81	2%	\$8.31	\$8.31	\$8.31
Vehicle Liability Insurance	\$1,059,838	\$1,035,000	Miles	\$0.22	\$0.22		\$0.22	2%	\$0.24	\$0.24	\$0.24
Comprehensive Insurance	\$394,018	\$500,000	Peak Vehicles	\$2,897.19	\$2,897.19		\$2,897.19	2%	\$3,079.95	\$3,079.95	\$3,079.95
Other Insurance	\$1,944,608	\$1,931,008	Peak Vehicles	\$14,298.59	\$14,298.59		\$14,298.59	2%	\$15,200.57	\$15,200.57	\$15,200.57

<b>Subtotal: Non-specialized Services</b>	<b>\$37,483,205</b>
Gross cost per revenue hour	\$94.35
Gross cost per revenue mile	\$7.86
Gross cost per vehicle	\$275,611.80

	2012			2015		
	Existing	No Build	BRT	Existing	No Build	BRT
Incremental cost per revenue hour	\$43.82	\$43.82	\$43.82	\$46.58	\$46.58	\$46.58
Incremental cost per revenue mile	\$1.74	\$1.59	\$1.30	\$1.85	\$1.69	\$1.38
Incremental cost per vehicle	\$86,536.65	\$86,536.65	\$92,551.08	\$91,995.54	\$91,995.54	\$98,389.37
Incremental cost, off-board fare collection			\$626,132.90			\$665,630.50

**APPENDIX B:  
ESTIMATES OF KEY DRIVING  
SUPPLY VARIABLES  
FOR THE EXISTING SYSTEM**

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Name	Group	Direction	Type	Off-Peak Hours of Operation			Existing																	
				Distance	Weekday	Saturday	Sunday	PK Headway	Pk Vehicles/Hr	Combined Headway	OP Headway	End-to-End Travel PK Travel time	End-to-End Travel OP Travel time	Number of Round Trips (Express Bus only)	Fleet Requirement	Peak Vehicles Required	Off Peak Vehicles Required	Peak Vehicle Revenue Hours	Off Peak Vehicle Revenue Hours	Total Revenue Hours	Peak Vehicle Revenue Miles	Off Peak Vehicle Revenue Miles	Total Revenue Miles	
1	1	Inbound		8.48	8.57	17.22	17.22	30	2	30	30	53.05	50.81			4	4	3	4,160	12,054	16,214	39,831	120,785	160,616
1-	1	Outbound		8.48	13.27	17.22	17.22	30	2		30	53.23	50.74											
2	2	Inbound		13.64	13.83	6.85	6.85	60	1	20	34	73.13	70.68			3	2	4	2,080	17,236	19,316	23,222	199,677	222,898
2-	2	Outbound		13.64	14.93	18.28	18.28	60	1		34	73.48	70.61											
2.CITY-	2	Inbound		8.9	15.77	0.00	0.00	30	2		NA	54.55	NA			4	4	0	4,160	0	4,160	40,652	0	40,652
2.CITY-	2	Outbound		8.9	9.37	0.00	0.00	30	2		NA	54.74	NA											
3	3	Outbound		7.42	15.50	19.83	18.33	30	2	20	NA	50.03	NA			4	3	0	3,120	0	3,120	27,803	0	27,803
3PP	3	Inbound		7.42	15.50	19.83	18.33	24	3		NA	49.89	NA											
3.OP	3	Inbound		7.42	15.50	19.83	18.33	NA			27	NA	47.82			0	0	4	0	24,059	24,059	0	223,820	223,820
3.OP-	3	Outbound		7.42	15.50	19.83	18.33	NA			27	NA	47.89											
4	4	Outbound		6.06	15.77	19.97	19.38	24	3	20	NA	45.36	NA			4	4	0	4,160	0	4,160	34,427	0	34,427
4P	4	Inbound		6.65	15.77	19.97	19.38	24	3		NA	46.79	NA											
4.OP	4	Outbound		6.98	15.77	19.97	19.38	NA			27	NA	47.92			0	0	3	0	18,437	18,437	0	163,725	163,725
4.OP-	4	Inbound		6.98	15.77	19.97	19.38	NA			27	NA	46.4											
5.SOUTH				NA	15.77	19.97	19.38	NA			NA	NA	NA			0	0	0	0	0	0	0	0	0
5.NORTH				NA	15.77	19.97	19.38	NA			NA	NA	NA											
6	6	Inbound		4.96	12.22	15.02	15.38			10														
6	6	Outbound		4.96	13.72	17.29	15.42																	
6.DNTN	6	Inbound		5.29	12.82	1.05	2.28	30	2		17	40.4	40.13			3	3	5	3,120	17,528	20,648	24,251	137,319	161,570
6.DNTN-	6	Outbound		5.29	13.42	0.58	0.57	30	2		17	41.27	40.9											
6.EAST	6	Inbound		9.01	12.40	14.82	15.50	40	2		60	63.67	59.37			3	3	2	3,120	9,601	12,721	27,574	85,223	112,797
6.WEST	6	Outbound		8.24	13.03	16.00	15.55	40	2		60	53.44	50.28											
6.EAST#2	6	Inbound		7.78	11.43	15.22	15.25	30	2		80	57.24	54.12			4	3	1	3,120	4,557	7,677	27,334	49,052	76,385
6.WEST#2	6	Outbound		8.87	14.70	18.58	15.28	30	2		80	56.79	53.17											
7.EAST	7	Outbound		9.1	10.53	0.00	0.00	40	2	15	40	43.43	39.97			3	2	2	2,080	5,477	7,557	25,743	73,647	99,390
7.EAST#2	7	Outbound		9.37	10.53	0.00	0.00	40	2		40	46.11	42.45											
7.WEST	7	Inbound		8.95	10.53	0.00	0.00	40	2		40	43.78	40.81			3	2	2	2,080	5,477	7,557	25,799	72,582	98,380
7.WEST#2	7	Inbound		10.43	10.53	0.00	0.00	40	2		40	49.97	46.94											
8.EB					0.00	0.00	0.00																	
8.WB					0.00	0.00	0.00																	
10.EB	10	Inbound		3.83	15.68	18.70	18.70	30	2	30	30	29.95	28.66			2	2	2	2,080	12,045	14,125	15,757	94,893	110,650
10.WB	10	Outbound		3.72	15.68	18.70	18.70	30	2		30	29.85	28.84											
11.EAST	11	Outbound		3.15	7.00	6.32	0.00	30	2	30	30	20.47	18.39			2	1	1	1,040	2,148	3,188	9,014	20,676	29,690
11.WEST	11	Inbound		2.26	7.00	6.32	0.00	30	2		34	16.98	15.34											
16.EAST_PK	16	Inbound		6.97	9.92	0.00	0.00	17	4	15	NA	38.52	NA			5	4	0	4,160	0	4,160	47,323	0	47,323
16.WEST_PK	16	Outbound		6.26	9.92	0.00	0.00	20	3		NA	31.26	NA											
16.EAST_OP	16	Inbound		4.13	9.92	0.00	0.00	NA			60	NA	24.51			0	0	1	0	2,578	2,578	0	27,081	27,081
16.WEST_OP	16	Outbound		3.42	9.92	0.00	0.00	NA			60	NA	18.62											
18.1	18	Inbound		3.63	8.33	0.00	0.00	60	1	60	60	15.31	14.78			1	1	1	1,040	2,167	3,207	15,830	33,854	49,683
18.2	18	Outbound		7.06	8.33	0.00	0.00	60	1		60	26.83	26.27											
-18.2					8.33	0.00	0.00																	
-18.1					8.33	0.00	0.00																	
19.EB	19	Inbound		10.77	8.22	0.00	0.00	60	1	60	240	61.75	60.62			3	2	1	2,080	2,136	4,216	22,015	22,967	44,982
19.WB	19	Outbound		10.4	8.53	0.00	0.00	60	1		240	58.26	57.53											
22	22	Inbound		6.26	9.57	11.92	11.92	120	1	60	NA	38.76	NA			1	1	0	1,040	0	1,040	10,090	0	10,090
22-	22	Outbound		6.26	9.57	11.92	11.92	120	1		NA	38.67	NA											
24.EAST	24	Inbound		5.4	13.48	15.20	15.20	30	2	30	80	36.62	36.19			2	1	1	1,040	5,086	6,126	9,202	47,082	56,283
24.EAST#2	24	Inbound		6.88	13.48	15.20	15.20	NA			80	NA	43.41											
24.WEST#1	24	Outbound		5.46	13.48	15.20	15.20	40	2		120	36.48	36.05			3	2	1	2,080	5,086	7,166	19,082	47,710	66,791
24.WEST#2	24	Outbound		6.94	13.48	15.20	15.20	120	1		60	44.62	43.27											
26.EB	26	Inbound	Express	11.37	0.00	0.00	0.00	20	3	20	NA	33.54	NA			7	4	4	2,153	0	2,153	42,934	0	42,934
26.WB	26	Outbound	Express	12.22	0.00	0.00	0.00	30	2		NA	37.43	NA											
27.EB	27	Inbound	Express	9	0.00	0.00	0.00	20	3	20	NA	34.48	NA			9	4	4	2,756	0	2,756	42,916	0	42,916
27.WB	27	Outbound	Express	9.34	0.00	0.00	0.00	20	3		NA	36.18	NA											
28	28	Inbound	Express	7.68	0.00	0.00	0.00	60	1	60	NA	28.85	NA			2	1	1	495	0	495	7,987	0	7,987
28-	28	Outbound	Express	7.68	0.00	0.00	0.00	60	1		NA	28.24	NA											
29.EB	29	Inbound	Express	12.94	0.00	0.00	0.00	11	5	12	NA	36.7	NA			11	7	7	3,513	0	3,513	74,789	0	74,789
29.WB	29	Outbound	Express	13.21	0.00	0.00	0.00	15	4		NA	36.99	NA											
32.EAST	32	Inbound		4.16	15.32	19.62	19.50	10	6	10	20	24.73	24.08			5	5	2	5,200	12,033	17,233	55,564	131,998	187,562
32.WEST	32	Outbound		4.7	15.32	19.62	19.50	10	6		20	25.02	24.38											
34.NORTH	34	Outbound		3.91	15.33	18.80	18.87	17	4	20	19	24.01	22.11			3	3	2	3,120	11,891	15,011	28,675	119,818	148,493
34.SOUTH	34	Inbound		3.32	15.33	18.80	18.87	20	3		20	23.19	20.94											
37.NORTH	37	Outbound		5.61	15.07	18.72	18.90	13	5	12	20	29.84	29.14			5	5	3	5,200	17,620	22,820	55,234	191,316	246,550
37.SOUTH	37	Inbound		5.55	15.07	18.72	18.90	13	5		22	33.2	32.53											
45	45	Outbound		3.17	15.55	0.00	18.40	24	3	20	30	26.36	24.58			3	2	2	2,080	10,000	12,080	14,929	77,157	92,086
45-	45	Inbound		3.17	15.55	0.00	18.40	24	3		30	26.64	24.72											
53	53	Outbound		3.83	13.72	17.29	15.42																	
53	53	Inbound		3.97	12.22	15.02	15.38																	
56.EAST	56	Outbound		9.74	11.37	0.00	0.00	120	1	60	NA	46.28	NA			1	1	0	1,040	0	1,040	13,488	0	13,488
56.WEST	56	Inbound		11.46	11.37	0.00	0.00	60	1		NA	51.8	NA											
61					0.00	0.00	0.00																	
-61					0.00	0.00	0.00																	

Name	Group	Direction	Type	Off-Peak Hours of Operation			Existing																		
				Distance	Weekday	Saturday	Sunday	PK Headway	Pk Vehicles/Hr	Combined Headway	OP Headway	End-to-End Travel PK Travel time	End-to-End Travel OP Travel time	Number of Round Trips (Express Bus only)	Fleet Requirement	Peak Vehicles Required	Off Peak Vehicles Required	Peak Vehicle Revenue Hours	Off Peak Vehicle Revenue Hours	Total Revenue Hours	Peak Vehicle Revenue Miles	Off Peak Vehicle Revenue Miles	Total Revenue Miles		
62.CS	62	Outbound		6.81	14.75	19.35	18.83	NA			80	NA	34.53			0	0	1	0	5,821	5,821	0	68,875	68,875	
62.CS-	62	Inbound		6.81	14.75	19.35	18.83	NA			80	NA	34.53												
63.CSQ	63	Outbound		7.97	14.75	19.35	18.83	40	2	12	48	42.38	39.05			3	2	2	2,080	11,641	13,721	23,464	142,555	166,019	
63.CSQ-	63	Inbound		7.97	14.75	19.35	18.83333333	40	2		48	42.4	39.05												
63.CWB	63	Outbound		5.1	15.53	18.55	18.60	24	3		60	29.41	26.5			3	2	1	2,080	5,970	8,050	21,605	68,942	90,547	
63.CWB-	63	Inbound		5.1	15.53	18.55	18.60	24	3		60	29.51	26.5												
62.HSNORTH	62	Inbound		5.33	15.53	18.55	18.60	40	2	15	80	28.87	26.12			1	1	1	1,040	5,970	7,010	11,520	70,551	82,072	
62.HSSOUTH	62	Outbound		5.5	15.53	18.55	18.60	NA			240	NA	28.87												
64.NORTH	64	Inbound	Express	10.27	0.00	0.00	0.00	24	3	20	NA	33.83	NA			12	4	3	0	4,035	0	4,035	65,863	0	65,863
64.SOUTH	64	Outbound	Express	10.84	0.00	0.00	0.00	40	2		NA	43.77	NA												
66.EB	66	Inbound	Express	9.37	0.00	0.00	0.00	40	2	30	NA	38.56	NA			4.5	2	2	0	1,361	0	1,361	21,657	0	21,657
66.WB	66	Outbound	Express	9.14	0.00	0.00	0.00	60	1		NA	31.21	NA												
67	67	Inbound	Express	7.9	11.57	0.00	0.00	40	2	30	NA	43.38	NA			4	3	2	0	1,503	0	1,503	16,432	0	16,432
67-	67	Outbound		7.9	11.57	0.00	0.00	40	2		NA	43.36	NA												
70.NORTH	70	Inbound		9.44	13.82	17.43	16.92	60	1	60	40	42.18	40.66			2	2	2	2,080	10,757	12,837	26,169	140,573	166,742	
70.SOUTH	70	Outbound		10.04	13.82	17.43	16.92	30	2		34	50.72	48.78												
70FHSPW					13.82	17.43	16.92																		
70FHSPN					13.82	17.43	16.92																		
71	71	Inbound		7.62	10.50	13.62	1.53	40	2	30	34	33.38	32.02			2	2	2	2,080	7,036	9,116	28,554	100,458	129,012	
71-	71	Outbound		7.62	10.50	13.62	1.53	40	2		34	33.23	32.02												
72	72	Inbound		6.56	13.67	0.00	0.00	40	2	30	NA	32.39	NA			2	2	0	2,080	0	2,080	25,319	0	25,319	
72-	72	Outbound		6.56	13.67	0.00	0.00	40	2		NA	32.28	NA												
73	73	Inbound		7.26	16.10	19.12	19.12	40	2	30	30	34.06	32.04			2	2	2	2,080	12,348	14,428	26,582	167,881	194,463	
73-	73	Outbound		7.26	16.10	19.12	19.12	40	2		30	34.11	32.04												
74.NORTH	74	Inbound		5.54	15.48	18.57	18.57	24	3	20	40	31.71	30.85			4	3	2	3,120	11,913	15,033	30,844	121,263	152,107	
74.SOUTH	74	Outbound		7.17	15.48	18.57	18.57	24	3		40	45.43	44.07												
81.EB	81	Inbound	Express	12.53	0.00	0.00	0.00	60	1	60	NA	44.93	NA			2.5	2	1	0	928	0	928	16,192	0	16,192
81.WB	81	Outbound	Express	12.38	0.00	0.00	0.00	120	1		NA	40.7	NA												
82	82	Inbound	Express	22.06	0.00	0.00	0.00	40	2	30	NA	62.2	NA			3	4	3	0	1,598	0	1,598	34,414	0	34,414
82-	82	Outbound	Express	22.06	0.00	0.00	0.00	40	2		NA	60.72	NA												
84	84	Inbound	VCU	3.93	6.25	11.00	11.00				#DIV/0!														
86	86	Outbound	VCU	0.99	15.00	0.00	0.00				#DIV/0!														
86.S	86	Inbound	VCU	1.33	15.00	0.00	0.00				#DIV/0!														
87	87	Outbound	VCU	1.33	15.13	0.00	0.00				#DIV/0!														
87-	87	Inbound	VCU	1.33	15.13	0.00	0.00				#DIV/0!														
91	91	Outbound		12.21	7.92	0.00	0.00	60	1	60	48	51.04	49.05			2	2	2	2,080	4,117	6,197	29,964	61,392	91,356	
91-	91	Inbound		12.21	7.92	0.00	0.00	60	1		48	50.67	49.2												
93	93	Outbound		2.44	8.50	0.00	0.00	30	2	30	NA	10.64	NA			1	1	0	1,040	0	1,040	14,350	0	14,350	
93-	93	Inbound		2.44	8.50	0.00	0.00	30	2		NA	10.58	NA												
95.NORTH	95	Inbound	Express	25.18	0.00	0.00	0.00	60	1	60	NA	56.06	NA			4	2	2	0	1,821	0	1,821	50,918	0	50,918
95.SOUTH	95	Outbound	Express	23.78	0.00	0.00	0.00	120	1		NA	48.99	NA												
99	99	Outbound		0.84	0.00	0.00	0.00	10	6	10	10	8.11	7.52			2	2	1	2,080	0	2,080	12,753	0	12,753	
99-	99	Inbound		0.84	0.00	0.00	0.00	10	6		10	8.33	7.4												
101	101	Inbound		2.84	5.13	0.00	0.00	NA			30	NA	11.24			0	0	1	0	1,335	1,335	0	20,234	20,234	
101-	101	Outbound		2.84	5.13	0	0	NA			30	NA	11.24												
999.BRT	999	Inbound		6.85	0	0	0	NA			NA	NA	NA	NA		0	0	0	0	0	0	0	0	0	
999.BRT-	999	Outbound		6.76	0	0	0	NA			NA	NA	NA	NA											
<b>Total</b>										<b>30</b>						<b>131</b>	<b>112</b>	<b>61</b>	<b>106,482</b>	<b>279,945</b>	<b>386,427</b>	<b>1,263,018</b>	<b>2,979,846</b>	<b>4,242,864</b>	

**APPENDIX C:  
ESTIMATES OF KEY DRIVING  
SUPPLY VARIABLES FOR THE  
NO BUILD AND BUILD ALTERNATIVES**

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Name	Group	Direction	Type	Off-Peak Hours of Operation			No Build (Split Route 6 and 53)																
				Distance	Weekday	Saturday	Sunday	PK Headway	Pk Vehicles/Hr	Combined Headway	OP Headway	End-to-End Travel PK Travel time	End-to-End Travel OP Travel time	Number of Round Trips (Express Bus only)	Fleet Requirement	Peak Vehicles Required	Off Peak Vehicles Required	Peak Vehicle Revenue Hours	Off Peak Vehicle Revenue Hours	Total Revenue Hours	Peak Vehicle Revenue Miles	Off Peak Vehicle Revenue Miles	Total Revenue Miles
62.CS	62	Outbound		6.81	14.75	19.35	18.83	NA			80	NA	34.53		0	0	1	0	5,821	5,821	0	68,875	68,875
62.CS-	62	Inbound		6.81	14.75	19.35	18.83	NA			80	NA	34.53										
63.CSQ	63	Outbound		7.97	14.75	19.35	18.83	40	2	12	48	42.38	39.05		3	2	2	2,080	11,641	13,721	23,464	142,555	166,019
63.CSQ-	63	Inbound		7.97	14.75	19.35	18.83333333	40	2		48	42.4	39.05										
63.CWB	63	Outbound		5.1	15.53	18.55	18.60	24	3		60	29.41	26.5		3	2	1	2,080	5,970	8,050	21,605	68,942	90,547
63.CWB-	63	Inbound		5.1	15.53	18.55	18.60	24	3		60	29.51	26.5										
62.HSNORTH	62	Inbound		5.33	15.53	18.55	18.60	40	2	15	80	28.87	26.12		1	1	1	1,040	5,970	7,010	11,520	70,551	82,072
62.HSSOUTH	62	Outbound		5.5	15.53	18.55	18.60	NA			240	NA	28.87										
64.NORTH	64	Inbound	Express	10.27	0.00	0.00	0.00	24	3	20	NA	33.83	NA	12	4	3	0	4,035	0	4,035	65,863	0	65,863
64.SOUTH	64	Outbound	Express	10.84	0.00	0.00	0.00	40	2		NA	43.77	NA										
66.EB	66	Inbound	Express	9.37	0.00	0.00	0.00	40	2	30	NA	38.56	NA	4.5	2	2	0	1,361	0	1,361	21,657	0	21,657
66.WB	66	Outbound	Express	9.14	0.00	0.00	0.00	60	1		NA	31.21	NA										
67	67	Inbound	Express	7.9	11.57	0.00	0.00	40	2	30	NA	43.38	NA	4	3	2	0	1,503	0	1,503	16,432	0	16,432
67-	67	Outbound		7.9	11.57	0.00	0.00	40	2		NA	43.36	NA										
70.NORTH	70	Inbound		9.44	13.82	17.43	16.92	60	1	60	40	42.18	40.66		2	2	2	2,080	10,757	12,837	26,169	140,573	166,742
70.SOUTH	70	Outbound		10.04	13.82	17.43	16.92	30	2		34	50.72	48.78										
70FHSPW					13.82	17.43	16.92																
70FHSPN					13.82	17.43	16.92																
71	71	Inbound		7.62	10.50	13.62	1.53	40	2	30	34	33.38	32.02		2	2	2	2,080	7,036	9,116	28,554	100,458	129,012
71-	71	Outbound		7.62	10.50	13.62	1.53	40	2		34	33.23	32.02										
72	72	Inbound		6.56	13.67	0.00	0.00	40	2	30	NA	32.39	NA		2	2	0	2,080	0	2,080	25,319	0	25,319
72-	72	Outbound		6.56	13.67	0.00	0.00	40	2		NA	32.28	NA										
73	73	Inbound		7.26	16.10	19.12	19.12	40	2	30	30	34.06	32.04		2	2	2	2,080	12,348	14,428	26,582	167,881	194,463
73-	73	Outbound		7.26	16.10	19.12	19.12	40	2		30	34.11	32.04										
74.NORTH	74	Inbound		5.54	15.48	18.57	18.57	24	3	20	40	31.71	30.85		4	3	2	3,120	11,913	15,033	30,844	121,263	152,107
74.SOUTH	74	Outbound		7.17	15.48	18.57	18.57	24	3		40	45.43	44.07										
81.EB	81	Inbound	Express	12.53	0.00	0.00	0.00	60	1	60	NA	44.93	NA	2.5	2	1	0	928	0	928	16,192	0	16,192
81.WB	81	Outbound	Express	12.38	0.00	0.00	0.00	120	1		NA	40.7	NA										
82	82	Inbound	Express	22.06	0.00	0.00	0.00	40	2	30	NA	62.2	NA	3	4	3	0	1,598	0	1,598	34,414	0	34,414
82-	82	Outbound	Express	22.06	0.00	0.00	0.00	40	2		NA	60.72	NA										
84	84	Inbound	VCU	3.93	6.25	11.00	11.00			60													
86	86	Outbound	VCU	0.99	15.00	0.00	0.00			#DIV/0!													
86.S	86	Inbound	VCU	1.33	15.00	0.00	0.00			30													
87	87	Outbound	VCU	1.33	15.13	0.00	0.00			#DIV/0!													
87-	87	Inbound	VCU	1.33	15.13	0.00	0.00			60													
91	91	Outbound		12.21	7.92	0.00	0.00	60	1		48	51.04	49.05		2	2	2	2,080	4,117	6,197	29,964	61,392	91,356
91-	91	Inbound		12.21	7.92	0.00	0.00	60	1	10	48	50.67	49.2										
93	93	Outbound		2.44	8.50	0.00	0.00	30	2		NA	10.64	NA		1	1	0	1,040	0	1,040	14,350	0	14,350
93-	93	Inbound		2.44	8.50	0.00	0.00	30	2		NA	10.58	NA										
95.NORTH	95	Inbound	Express	25.18	0.00	0.00	0.00	60	1		NA	56.06	NA	4	2	2	0	1,821	0	1,821	50,918	0	50,918
95.SOUTH	95	Outbound	Express	23.78	0.00	0.00	0.00	120	1		NA	48.99	NA										
99	99	Outbound		0.84	0.00	0.00	0.00	10	6		10	8.11	7.52		2	2	1	2,080	0	2,080	12,753	0	12,753
99-	99	Inbound		0.84	0.00	0.00	0.00	10	6		10	8.33	7.4										
101	101	Inbound		2.84	5.13	0.00	0.00	NA			30	NA	11.24		0	0	1	0	1,335	1,335	0	20,234	20,234
101-	101	Outbound		2.84	5.13	0	0	NA			30	NA	11.24										
999.BRT	999	Inbound		6.85	0	0	0	NA			NA	NA	NA		0	0	0	0	0	0	0	0	0
999.BRT-	999	Outbound		6.76	0	0	0	NA			NA	NA	NA										
<b>Total</b>										<b>30</b>					<b>133</b>	<b>115</b>	<b>60</b>	<b>109,602</b>	<b>282,067</b>	<b>391,668</b>	<b>1,292,191</b>	<b>2,996,733</b>	<b>4,288,923</b>



			Off-Peak Hours of Operation					Build (Split Route 6 and 53)																
Name	Group	Direction	Type	Distance	Weekday	Saturday	Sunday	PK Headway	Pk Vehicles/Hr	Combined Headway	OP Headway	End-to-End Travel PK Travel time	End-to-End Travel OP Travel time	Number of Round Trips (Express Bus only)	Fleet Requirement	Peak Vehicles Required	Off Peak Vehicles Required	Peak Vehicle Revenue Hours	Off Peak Vehicle Revenue Hours	Total Revenue Hours	Peak Vehicle Revenue Miles	Off Peak Vehicle Revenue Miles	Total Revenue Miles	
62.CS	62	Outbound		6.81	14.75	19.35	18.83	NA			80	NA	34.53			0	0	1	0	5,821	5,821	0	68,875	68,875
62.CS-	62	Inbound		6.81	14.75	19.35	18.83	NA			80	NA	34.53											
63.CSQ	63	Outbound		7.97	14.75	19.35	18.83	40	2	12	48	42.38	39.05		3	2	2	2,080	11,641	13,721	23,464	142,555	166,019	
63.CSQ-	63	Inbound		7.97	14.75	19.35	18.83333333	40	2		48	42.4	39.05											
63.CWB	63	Outbound		5.1	15.53	18.55	18.60	24	3		60	29.41	26.5		3	2	1	2,080	5,970	8,050	21,605	68,942	90,547	
63.CWB-	63	Inbound		5.1	15.53	18.55	18.60	24	3		60	29.51	26.5											
62.HSNORTH	62	Inbound		5.33	15.53	18.55	18.60	40	2	15	80	28.87	26.12		1	1	1	1,040	5,970	7,010	11,520	70,551	82,072	
62.HSSOUTH	62	Outbound		5.5	15.53	18.55	18.60	NA			240	NA	28.87											
64.NORTH	64	Inbound	Express	10.27	0.00	0.00	0.00	24	3	20	NA	33.83	NA	12	4	3	0	3,969	0	3,969	65,863	0	65,863	
64.SOUTH	64	Outbound	Express	10.84	0.00	0.00	0.00	40	2		NA	42.49	NA											
66.EB	66	Inbound	Express	9.37	0.00	0.00	0.00	40	2	30	NA	37.28	NA	4.5	2	2	0	1,336	0	1,336	21,657	0	21,657	
66.WB	66	Outbound	Express	9.14	0.00	0.00	0.00	60	1		NA	31.21	NA											
67	67	Inbound	Express	7.9	11.57	0.00	0.00	40	2	30	NA	42.1	NA	4	3	2	0	1,474	0	1,474	16,432	0	16,432	
67-	67	Outbound		7.9	11.57	0.00	0.00	40	2		NA	42.96	NA											
70.NORTH	70	Inbound		9.44	13.82	17.43	16.92	60	1	60	40	42.18	40.66		2	2	2	2,080	10,757	12,837	26,408	141,906	168,314	
70.SOUTH	70	Outbound		10.04	13.82	17.43	16.92	30	2		34	49.88	47.94											
70FHSPW					13.82	17.43	16.92																	
70FHSPN					13.82	17.43	16.92																	
71	71	Inbound		7.62	10.50	13.62	1.53	40	2	30	34	33.38	32.02		2	2	2	2,080	7,036	9,116	28,554	100,458	129,012	
71-	71	Outbound		7.62	10.50	13.62	1.53	40	2		34	33.23	32.02											
72	72	Inbound		6.56	13.67	0.00	0.00	40	2	30	NA	32.39	NA		2	2	0	2,080	0	2,080	25,319	0	25,319	
72-	72	Outbound		6.56	13.67	0.00	0.00	40	2		NA	32.28	NA											
73	73	Inbound		7.26	16.10	19.12	19.12	40	2	30	30	34.06	32.04		2	2	2	2,080	12,348	14,428	26,582	167,881	194,463	
73-	73	Outbound		7.26	16.10	19.12	19.12	40	2		30	34.11	32.04											
74.NORTH	74	Inbound		5.54	15.48	18.57	18.57	24	3	20	40	30.09	29.23		4	3	2	3,120	11,913	15,033	32,500	127,976	160,476	
74.SOUTH	74	Outbound		7.17	15.48	18.57	18.57	24	3		40	43.12	41.76											
81.EB	81	Inbound	Express	12.53	0.00	0.00	0.00	60	1	60	NA	43.65	NA	2.5	2	1	0	900	0	900	16,192	0	16,192	
81.WB	81	Outbound	Express	12.38	0.00	0.00	0.00	120	1		NA	39.42	NA											
82	82	Inbound	Express	22.06	0.00	0.00	0.00	40	2	30	NA	60.92	NA	3	4	3	0	1,576	0	1,576	34,414	0	34,414	
82-	82	Outbound	Express	22.06	0.00	0.00	0.00	40	2		NA	60.32	NA											
84	84	Inbound	VCU	3.93	6.25	11.00	11.00			60														
86	86	Outbound	VCU	0.99	15.00	0.00	0.00		#DIV/0!															
86.S	86	Inbound	VCU	1.33	15.00	0.00	0.00		#DIV/0!	30														
87	87	Outbound	VCU	1.33	15.13	0.00	0.00		#DIV/0!															
87-	87	Inbound	VCU	1.33	15.13	0.00	0.00		#DIV/0!	60														
91	91	Outbound		12.21	7.92	0.00	0.00	60	1		48	50.55	48.56		2	2	2	2,080	4,117	6,197	30,136	61,756	91,892	
91-	91	Inbound		12.21	7.92	0.00	0.00	60	1	10	48	50.58	49.11											
93	93	Outbound		2.44	8.50	0.00	0.00	30	2		NA	10.64	NA		1	1	0	1,040	0	1,040	14,350	0	14,350	
93-	93	Inbound		2.44	8.50	0.00	0.00	30	2		NA	10.58	NA											
95.NORTH	95	Inbound	Express	25.18	0.00	0.00	0.00	60	1		NA	55.63	NA	4	2	2	0	1,799	0	1,799	50,918	0	50,918	
95.SOUTH	95	Outbound	Express	23.78	0.00	0.00	0.00	120	1		NA	48.14	NA											
99	99	Outbound		0.84	0.00	0.00	0.00	10	6		10	7.83	7.24		2	2	1	2,080	0	2,080	12,910	0	12,910	
99-	99	Inbound		0.84	0.00	0.00	0.00	10	6		10	8.41	7.48											
101	101	Inbound		2.84	5.13	0.00	0.00	NA			30	NA	11.24		0	0	1	0	1,335	1,335	0	20,234	20,234	
101-	101	Outbound		2.84	5.13	0	0	NA			30	NA	11.24											
999.BRT	999	Inbound		6.85	0	0	0	10	6		15	31.69	31.69		7	6	4	6,240	21,840	28,080	79,693	0	79,693	
999.BRT-	999	Outbound		6.76	0	0	0	10	6		15	32.25	32.25											
<b>Total</b>										<b>30</b>					<b>134</b>	<b>112</b>	<b>59</b>	<b>108,228</b>	<b>278,865</b>	<b>387,094</b>	<b>1,327,813</b>	<b>2,865,715</b>	<b>4,193,528</b>	