

# Memorandum

TO: Hillsborough MPO

FROM: Jacobs Engineering

DATE: October 9, 2012

RE: Post-Referendum Analysis Phase Three: BRT in Managed Lanes Conceptual Capital Costs

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## Introduction

Phase Three of the Post Referendum Analysis consists of evaluating the potential of implementing premium transit using bus rapid transit in managed lanes along the I-275 corridor from Downtown Tampa to Tampa International Airport. The termini of the proposed service are the terminal at Tampa International Airport and the Marion Street Transit Center in Downtown Tampa.

As a part of this evaluation, high level capital cost estimates were developed for BRT service along this route. Specifically, this memorandum documents two capital cost scenarios that reflect a frequent and reduced service plan scenario.

## Capital Cost Estimates

### BRT Capital Cost Estimate Scenarios

For this analysis, a total of two capital cost models were developed. These scenarios were designed to determine the cost differential between utilizing two frequency scenarios (7.5-minute peak/15-minute off-peak and 15-minute peak/30-minute off-peak) when implementing premium transit using BRT technology.

### Methodology

Cost data was developed using multiple resources, including information obtained from FDOT and national examples of transit projects. In line with FTA guidelines and FTA's Standard Cost Categories (SCC), the capital cost estimates utilize a unit cost for each line item where a general scope of work is known. Where work items could not be estimated using quantitative data, items or cost categories were calculated as a percentage, ranging from 5 percent to 20 percent of the base amount.

Unit costs associated with civil or structural construction elements, generally common to both transit and highway construction projects, were obtained from the FDOT's Long Range Estimating System (LRE) database. Unit costs associated with stations and systems construction elements were derived from recent construction bids for transit projects around the country.

Capital cost estimates for the Hillsborough County BRT scenarios were formulated by using the latest revision of FTA's SCC worksheet as the basic format and structure for reporting capital costs. A "high level" evaluation and analysis of the BRT scenarios consisted of the preliminary identification of station locations and development of transit operating plans. This analysis identified the infrastructure

elements needed to prepare the capital cost estimates, such as systems and fleet vehicle requirements. Quantitative data used to calculate capital costs for the scenarios was obtained from aerial measurements using Geographic Information Systems (GIS). Furthermore, the following are additional assumptions used to develop the capital cost estimates:

- Costs are presented in present day (2012)
- Only existing vehicle technologies were considered
- The construction schedule will proceed under normal State of Florida laws, conditions, and rules.

### Capital Cost Categories

As mentioned previously, costs were developed in accordance with FTA’s SCC, developed to establish a consistent format for reporting, estimating, and managing capital costs. The capital cost estimates presented are based on these general category guidelines and are grouped into capital cost estimates categories to align with FTA guidelines, as shown in **Table 1**.

**Table 1: FTA Capital Cost Categories**

FTA Category	Description
10	Guideway and Track Elements
20	Stations, Stops, Terminals, Intermodal
30	Support Facilities: Structures
40	Sitework and Special Conditions
50	Systems
60	Right-of-way, Land, Existing Improvements
70	Vehicles
80	Professional Services
90	Unallocated Contingencies
100	Finance Charges

#### Guideway and Track Elements (Category 10)

Guideway and track elements are components of the transit system where costs are generally quantifiable to an acceptable level of accuracy. Quantities were applied by the measurement of alignment lengths. Guideway elements are grouped by a number of sub-categories based on construction type: at-grade, aerial, and retained cut or fill/underground. For bus technologies, the cost category includes all of the foundational construction elements up to and including the running surface.

#### Guideway Elements

Guideway elements use parametric unit costs based on the scope of work included in the typical cross-section. The parametric guideway cost estimates provide for, but are not limited to, the following construction components:

- Traffic control
- Site work, including clearing, demolition, and earthwork
- Erosion control and soil stabilization
- Drainage
- New roadway construction including striping

- Pedestrian access and protection

#### ***Cost Category Assumptions***

The following assumptions were made in regards to the project:

- Use of managed lanes along existing I-275 corridor is assumed

#### ***Stations, Stops, Terminals, Intermodal (Category 20)***

Station costs include the fixed facilities and/or structures for transit stations. The parametric unit costs developed are based on a general assumption of the types of stations anticipated. Costs for parking are also included in this category.

Per station unit costs include, but are not limited to, the following construction components:

- Station platforms (center); platform lengths determined by length and number of transit vehicles and operating characteristics
- Elevated concrete footings, columns, pier caps, superstructure, platform slabs, steel reinforcement, and pedestrian barriers
- Station platform canopy(ies)
- Standard amenities (e.g., lighting, electrical, mechanical, signage, furnishings, and other amenities)

#### ***Cost Category Assumptions***

The following assumptions were made in regards to the project:

- No underground stations
- Station platform dimensions for BRT vehicles:
  - 200' x 18' center platform, elevated
- Elevated station costs include elevators serving the station platform
- No parking for center platform stations in interstate right-of-way

#### ***Support Facilities: Yards, Shops, Administrative Buildings (Category 30)***

This cost category includes all costs associated with vehicle storage and maintenance buildings, vehicle maintenance and repair facilities, administrative support buildings, and general equipment associated with such facilities.

#### ***Cost Category Assumptions***

The following assumptions were made in regards to the project:

- Use of existing facilities with no additional facilities immediately required; therefore, no additional costs are included

#### ***Sitework and Special Conditions (Category 40)***

This cost category includes all costs associated with the following:

- Demolition, clearing, and grubbing
- Utility relocations
- Hazardous materials mitigation including contaminated soils and groundwater removal
- Environmental mitigation, including wetlands, cultural assets protection, etc.
- Site structures including bridges
- Landscaping, bike/pedestrian access, and accommodations

- Roadway construction, including modification of road facility in/around major crossings, stations, etc.

The following sub-categories cover many unknown or non-quantifiable elements in transit construction projects.

### *Pedestrian/Bike Access and Accommodation, Landscaping*

Landscaping and bike/pedestrian access and associated design elements are generally unknown at this phase of project development. This category includes sidewalks, signage, public artwork, etc. As a result, this cost category is calculated as 3 percent of the base amount of Categories 10 through 30.

### **Systems (Category 50)**

This includes all electrical and mechanical systems to control and operate the transit system. This includes all costs associated with the following sub-categories:

- Communications line – system providing operational support for transit service including public address system, telephone system, variable message signs, radio receivers, etc.
- Fare collection – provides for self-service or off-board fare collection including ticket vending machines and all associated hardware
- Central control – provision for facilities to provide remote monitoring of bus operations; this item may or may not be required depending on operations plans

### *Cost Category Assumptions*

The following assumptions were made in regards to the project:

- Signal system and communication line lengths correspond to length of the proposed route
- One fare collection unit per station platform
- Signal prioritization (includes traffic controller assembly, vehicle detection (video), and associated hardware)
- Existing signal modification (includes traffic controller assembly, vehicle detection (video), and associated hardware)

### **Right-of-way (Category 60)**

The right-of-way cost category includes all land acquisition and associated costs required to purchase property needed for construction, operation, and maintenance of the transit system. Costs include fee acquisition, easements, relocation costs, business damages, etc. Right-of-way cost estimates were calculated by multiplying the estimated square footage of acquisition for each alternative by the corresponding geographic area unit cost.

### *Cost Category Assumptions*

The following assumptions were made in regards to the project:

- BRT service are assumed to operate within existing right-of-way along I-275 and Memorial Highway
- Transit stations are assumed to be located within the existing right-of-way

### **Vehicles (Category 70)**

This includes all revenue and non-revenue vehicles. Unit cost development is based on historical data from recent transit projects.

### *Cost Category Assumptions*

Vehicle requirements for each scenario are shown in **Table 2**.

**Table 2: Vehicle Requirements**

Scenario	Frequencies	Number of Vehicles
1	7.5/15	10
2	15/30	5

- HART to provide supporting bus service (not included)
- Bus Rapid Transit vehicle cost from historical data from recent transit projects; \$694,055 per vehicle

### Professional Services (Category 80)

Professional services costs are calculated as a percentage of the base amount totals of Categories 10 through 50. Per FTA, the sub-categories and associated percent multipliers listed below include costs for all professional, technical, and management services associated with the design and construction of the fixed guideway throughout preliminary engineering, final design, and construction the project.

- Preliminary Engineering 5 percent
- Final Design 10 percent
- Project Management for Design and Construction 5 percent
- Construction Administration and Management 7 percent
- Insurance 3 percent
- Legal/Permits/Review Fees by other agencies, cities, etc. 0.5 percent
- Surveys, Testing, Investigation, Inspection 2 percent
- Agency Force Account Work 1 percent

### Unallocated Contingencies (Category 90)

An unallocated contingency is an allowance for unknown or uncertain project costs inherent at this planning stage of project development. While allocated contingencies are assumed to address uncertainty in specific parametric unit cost developments, the unallocated contingency is considered compensation for unknowns or changes in project scope and schedule. A 10 percent contingency multiplied on the base amount totals for Categories 10 through 70 is assumed.

### Finance Charges (Category 100)

Specific financing is unknown at this stage of project development. As a result, no financing charges are assumed at this time.

### Allocated Contingencies

Due to fluctuations in labor and commodity costs, contingencies of 5 percent to 20 percent are added onto each item's unit cost. Allocated contingency allowances are directly related to the level of known detail regarding project design information and the level of difficulty in establishing unit costs for individual work items. The percentage selected in each category is based on national best practices, professional judgment, and knowledge of historic cost variations for work items. **Table 3** lists the allocated contingency percentages that were utilized by cost category.

**Table 3: Allocated Contingency Percentages for Planning Estimates**

FTA Cat.	Description	Allocated Contingency Percentage
20	<i>Stations, Stops, Terminals, Intermodal</i>	
	Stations	20%
	Parking (Surface and Structured)	10%
	Pedestrian Overpass	10%
40	<i>Sitework and Special Conditions</i>	
	Landscaping & Bike/Pedestrian Access and Accommodation	5%
50	Systems	15%
70	Vehicles	10%

### Capital Cost Estimating Results

The capital cost estimates were computed using a simple cost model to tabulate the item costs and contingencies. The systems requirements, stations, and vehicle requirements were entered into the aforementioned capital cost model to tabulate total dollar amounts by scenario. The results of the capital cost estimations for each scenario is provided in **Table 4**.

**Table 4: Downtown Tampa to Tampa International Airport BRT Capital Cost Estimates**

FTA Cat.	Description	Headways (7.5/15)	Headways (15/30)
10	GUIDEWAY & TRACK ELEMENTS	\$0	\$0
20	STATIONS, STOPS, TERMINALS, INTERMODAL	\$34,182,000	\$34,182,000
30	SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	\$0	\$0
40	SITWORK & SPECIAL CONDITIONS	\$897,278	\$897,278
50	SYSTEMS	\$5,662,755	\$5,662,755
60	ROW, LAND, EXISTING IMPROVEMENTS	\$0	\$0
70	VEHICLES	\$7,634,605	\$3,817,303
80	PROFESSIONAL SERVICES	\$11,478,334	\$11,478,334
90	UNALLOCATED CONTINGENCY	\$4,120,424	\$3,773,396
100	FINANCE CHARGES	\$0	\$0
<b>Total Project Cost (10-100)</b>		<b>\$63,975,396</b>	<b>\$59,811,066</b>

Date: October 4, 2012

To: Hillsborough County MPO

From: Connetics Transportation Group

Re: Post-Referendum Analysis Phase Three: BRT in Managed Lanes Operating Plans and O&M Cost Analysis

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Under Phase 3 of the 2035 Plan Post-Referendum Analysis, Connetics Transportation Group (CTG) was tasked to develop and evaluate potential Bus Rapid Transit (BRT) operating plans and estimate operating and maintenance (O&M) costs for a proposed transit corridor that connects Downtown Tampa to the Westshore area and Tampa International Airport. This memo addresses the following elements of the BRT service concept:

- Alignment and station assumptions;
- Two service plan scenarios;
- BRT travel time estimates;
- Service requirements (peak/fleet vehicle requirements, annual revenue bus-hours and bus-miles); and
- BRT O&M cost estimates.

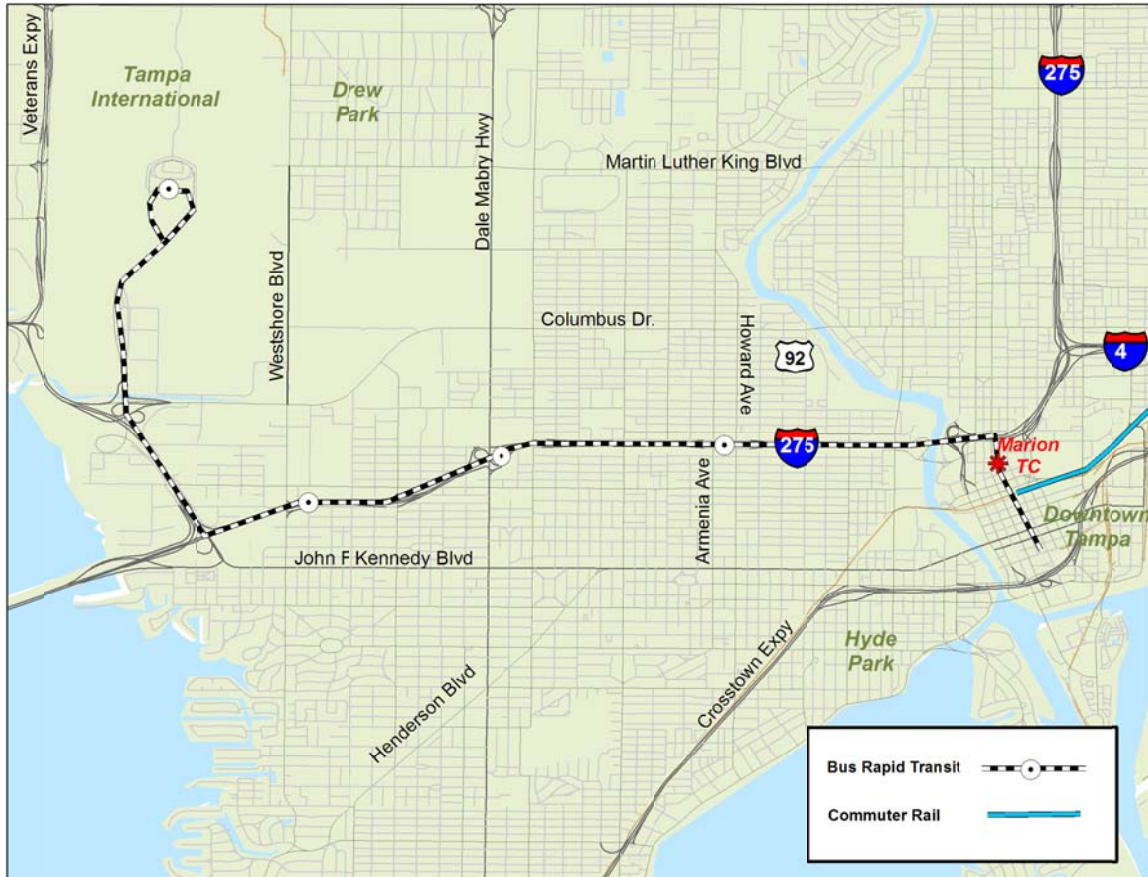
An additional analysis was conducted of a potential Hybrid Rail service connecting the University of South Florida to Downtown Tampa using existing freight rail tracks. This analysis is discussed in a separate memo.

#### **A. Alignment and Station Assumptions**

Figure 1 shows the general alignment and new stations proposed for the BRT. From Tampa International Airport, buses would travel to the I-275/Westshore Boulevard Station, continue eastbound along I-275 stopping at BRT stations near Cypress Street/Himes Avenue/Dale Mabry Highway and Howard Avenue/Armenia Avenue while enroute to Downtown Tampa. In the Downtown, buses would stop at the Marion Transit Center and use the Marion Transit Parkway to Whiting Street. Connections to a potential Hybrid Rail service would occur at Polk Street.



**Figure 1**  
**General Alignment and Station Assumptions**





**B. Service Plan Scenarios**

Table 1 presents the two service plan scenarios considered. The assumptions reflect service frequencies coordinated with proposed Hybrid Rail scenarios whereby every other train could be scheduled to potentially arrive/depart in conjunction with BRT arrivals and departures.

**Table 1: Service Frequency Assumptions  
Frequent vs. Reduced Service Scenarios**

Day	Time Period	Hours	Frequent Service Scenario	Reduced Service Scenario
Weekday	AM Peak	5:30-8:30 a.m.	7.5 min.	15 min.
	Midday	8:30 a.m.-3:30 p.m.	15 min.	30 min.
	PM Peak	3:30-6:30 p.m.	7.5 min.	15 min.
	Evening	6:30-10:30 p.m.	60 min.	60 min.
Saturday	Day	5:30 a.m.-6:30 p.m.	30 min.	30 min.
	Evening	6:30-10:30 p.m.	60 min.	60 min.
Sunday	Day	7:30 a.m.-6:30 p.m.	30 min.	30 min.
	Evening	6:30-8:30 p.m.	60 min.	60 min.

**C. Travel Time Estimates**

Estimated travel times for the BRT service are presented in Table 2. Maximum speeds in the downtown are assumed to be 15 mph and delays are added for signalized intersections at 20 seconds per traffic signal. End-to-end travel time is 22 minutes at an overall average speed of 25.7 mph.

Travel time on downtown segments between Whiting Street and Polk Street is estimated to be 4:47 at an average speed of 4.7 mph. From Polk Street to Tampa International Airport, the travel time is estimated to be 17:20 at an average speed of 25.7 mph.

It also merits some mention that BRT buses on downtown segments would operate similar to other HART bus routes. For example, existing bus schedules indicate it currently takes 7 minutes to travel from Whiting Street to the Marion Transit Center and the travel time estimate of 6:51 closely approximates this existing condition.

**Table 2:  
BRT Travel Time Estimates  
(Westbound)**

Station	Max Spd. (mph)	Dist. Feet	Distance (miles) Incr. Total	Run Time (hr:min:sec)	Delay Time (hr:min:sec)	Dwell Time (hr:min:sec)	Total Time (hr:min:sec)
<b>Whiting Street (begin Marion Transit Pkwy)</b>			<b>0.00</b>			<b>0:00:00</b>	<b>0:00:00</b>
	15	1,976	0.37	0:01:37	0:02:40		
<b>Polk Street (Hybrid Rail Station)</b>			<b>0.37</b>			<b>0:00:30</b>	<b>0:04:47</b>
End Marion Transit Pkwy at Tyler Street	15	574	0.11	0:00:30	0:00:20		
	15	881	0.17	0:00:44	0:00:00	0:00:00	0:05:37
<b>Marion Transit Center</b>			<b>0.65</b>			<b>0:00:30</b>	<b>0:06:51</b>
I-275 on ramp at Tampa Street	15	1,588	0.30	0:01:16	0:01:00		
	55	7,470	1.41	0:02:03	0:00:00	0:00:00	0:09:07
<b>I-275/Howard Avenue/Armenia Avenue</b>			<b>2.37</b>			<b>0:00:30</b>	<b>0:11:40</b>
	55	7,070	1.34	0:02:04	0:00:00		
<b>I-275/Cypress Street/Himes Avenue</b>			<b>3.70</b>			<b>0:00:30</b>	<b>0:14:14</b>
	55	6,255	1.18	0:01:54	0:00:00		
<b>I-275 / Westshore Boulevard</b>			<b>4.89</b>			<b>0:00:30</b>	<b>0:16:38</b>
Ramp from I-275 to Memorial Highway	45	2,376	0.45	0:00:51	0:00:20		
	45	8,184	1.55	0:02:07	0:00:00	0:00:00	0:17:49
Begin Terminal Loop			6.89			0:00:00	0:19:56
	35	4,752	0.90	0:01:41	0:00:00		
<b>Tampa International</b>			<b>7.79</b>			<b>0:00:30</b>	<b>0:22:07</b>
<b>TOTAL</b>			<b>7.79</b>	<b>0:14:47</b>	<b>0:04:20</b>	<b>0:03:00</b>	<b>0:22:07</b>
						<b>Avg Speed (mph) =</b>	<b>21.1</b>
<i>Westbound Segments from Whiting Street to Polk Street</i>			<i>0.37</i>	<i>0:01:37</i>	<i>0:02:40</i>	<i>0:00:30</i>	<i>0:04:47</i>
						<i>Avg Speed (mph) =</i>	<i>4.7</i>
<i>Westbound Segments from Polk Street to Tampa International</i>			<i>7.41</i>	<i>0:13:10</i>	<i>0:01:40</i>	<i>0:02:30</i>	<i>0:17:20</i>
						<i>Avg Speed (mph) =</i>	<i>25.7</i>

*Notes:*

- 1. Maximum 15 mph assumed in Downtown.*
- 2. Delays assume 20 seconds per signalized intersection throughout the Downtown.*

**D. Service Requirements**

Table 3 summarizes bus requirements for the two BRT scenarios. Peak/fleet requirements were estimated by assuming a 20 percent spare ratio, as well as a minimum of 20 percent recovery time. Annual bus-hours and bus-miles were calculated based on the service plans presented in Section B of this memo.

**Table 3:  
BRT Operating Plan and Requirements**

Scenario	Run Time (minutes)	Distance (miles)	Headway				Vehicles		Daily		Annual		Daily Buses		
			Day	Peak	Base	Eve	Peak	Total	Bus-Miles	Bus-Hrs	Bus-Miles	Bus-Hrs	Peak	Base	Eve
Whiting St. to Tampa International <i>15 peak/30 midday</i>	22.1	7.79	M-F	15	30	60	4	5	654.3	42.0	166,200	10,670	4	2	1
			Sat	30	30	60			466.7	26.1	23,800	1,330	2	2	0
			Sun	30	30	60			373.3	22.0	22,400	1,320	2	2	0
<b>ESTIMATED TOTALS:</b>										<b>212,400</b>	<b>13,320</b>	<b>4</b>	<b>2</b>	<b>1</b>	
Whiting St. to Tampa International <i>7.5 peak/15 midday</i>	22.1	7.79	M-F	7.5	15	60	8	10	1,246.5	80.0	316,600	20,320	8	4	1
			Sat	15	15	60			872.5	52.0	44,500	2,650	4	4	0
			Sun	30	30	60			373.3	22.0	22,400	1,320	2	2	0
<b>ESTIMATED TOTALS:</b>						<b>8</b>	<b>10</b>			<b>383,500</b>	<b>24,290</b>	<b>8</b>	<b>4</b>	<b>1</b>	

**E. Annual O&M Cost Estimates**

Table 4 summarizes potential O&M costs in 2012 dollars. Unit costs are based on FY 2010 NTD reports for HART and inflated by 4.88 percent per the Bureau of Labor Statistics CPI index for the greater Tampa area.

Prior cost estimation work completed by CTG staff on light rail projects around the country suggest that light rail maintenance costs can average \$120,000 per year. For this project, we assumed BRT station maintenance costs to be approximately two-thirds of the average light rails station costs (i.e., \$80,000 per station). Table 4 applies this unit cost to the four proposed new stations along I-275 (3 new BRT stations) and at Tampa International (1 new BRT station):

- Howard Avenue/Armenia Avenue
- Cypress Street/Himes Avenue
- Westshore Boulevard
- Tampa International Airport

Using the statistical estimates from the BRT operating plan and requirements (refer to Table 3), total O&M costs for the proposed BRT service are estimated to be \$1.78 million for the reduced service scenario (i.e., 15 Peak / 30 Base) and \$2.98 million for the frequent service scenario (7.5 Peak / 15 Base).

**Table 4:  
Potential O&M Cost Estimates for BRT Scenarios (2012 dollars)**

Expense Category	Driving Variable	FY 2010 Unit Cost	FY 2012 Unit Cost	Scenario: 15 Peak / 30 Base			Scenario: 7.5 Peak / 15 Base		
				Quantity	Unit	Costs	Quantity	Unit	Costs
Vehicle Operations	Rev-Bus Hours	\$47.90	\$50.24	13,320	Rev-Bus Hours	\$669,200	24,290	Rev-Bus Hours	\$1,220,300
Vehicle Maintenance	Rev-Bus Miles	\$1.28	\$1.34	212,400	Rev-Bus Miles	\$285,100	383,500	Rev-Bus Miles	\$514,800
Non-Vehicle Maintenance	Peak Buses	\$18,679	\$19,591	4	Peak Buses	\$78,400	8	Peak Buses	\$156,700
General Administration	40% of Above Costs	40%	40%	n/a	40% of Above Costs	\$413,100	n/a	40% of Above Costs	\$756,700
Station Maintenance	3 Stations	\$80,000	\$83,904	4	Stations	\$335,600	4	Stations	\$335,600
Total Costs						\$1,781,400			\$2,984,100

Notes:

(1) FY 2012 Unit Cost reflect CPI inflation of 4.88%

(2) Unit costs for station maintenance assume 2/3<sup>rd</sup>s of typical LRT maintenance costs per station (\$120k)