Miami • Miami Beach Transportation Corridor Study

Bay Link

December 2004

Operations Plan; Operating and Maintenance Cost Estimating Report

Miami-Dade Metropolitan Planning Organization

and

U.S. Department of Transportation
Federal Transit Administration

MIAMI-MIAMI BEACH (BAY LINK) TRANSPORTATION CORRIDOR STUDY

OPERATIONS PLAN AND O&M COST ESTIMATES REPORT

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1.1 Background

This project considers possible implementation of a fixed-guideway transit system connecting downtown Miami and Miami Beach, and a related fixed-guideway circulator route within South Beach. These fixed guideway routes would replace certain existing bus services, providing higher capacity, reduced travel times, and more regular service, compared with the replaced bus services.

The Federal Transit Administration (FTA), in cooperation with the Miami-Dade Metropolitan Planning Organization (MPO), previously completed the Alternatives Analysis and Draft Environmental Impact Statement (AA/DEIS), dated October 2002. The AA/DEIS documents the Phase I development process for the Miami-Miami Beach Transportation Corridor (Bay Link) Study. The project investigated the feasibility of implementing a rapid transit connection between downtown Miami and south Miami Beach. The DEIS phase of development provided:

- The engineering, conceptual design and analysis necessary to define the proposed alternatives and support the DEIS analysis and evaluation;
- The analysis necessary to identify adverse social, economic, and environmental impacts and opportunities to avoid, minimize, and mitigate those impacts;
- The implementation of a collaborative public involvement program necessary to gain support for the project and to reach consensus on an LPA for advancement into the Preliminary Engineering and Final Environmental Impact Statement (PE/FEIS) phase of development;
- Documentation of the development, selection, and adoption of the Locally Preferred Alternative (LPA); and,
- The development of a financial plan.

The AA/DEIS report describes the alternatives considered and the process leading to the selection of the LPA. The report includes: the purpose and need for the study; the formulation of goals, objectives and measures for evaluation; descriptions of the physical alignments; conceptual station locations; conceptual operating plans for the No-Build, TSM/Baseline and the Build (LPA) Alternatives, which also includes several design options; and provides a review of the evaluation process and a summary. It also includes the capital cost estimates, operating and maintenance (O&M) cost estimates, forecast of transit riders, and the results of the user benefit calculations prepared for the proposed alternatives.

The public hearing for the Bay Link project was held on December 3, 2002. After an extensive public outreach process based on the goals and objectives supporting the Purpose and Need and the analysis contained in the DEIS, the MPO Governing Board selected the LPA on September 25, 2003. The adopted light rail (Streetcar) system was endorsed by the cities of Miami and Miami Beach.

In April of 2004 the MPO Board approved an amendment to the consultant's contract for Phase 2 of the Bay Link Study. Phase 2 consists of refining the LPA description and preparing the Preliminary Engineering/Final Environmental Impact Statement (PE/FEIS) request to the Federal Transit Administration (FTA) along with the supporting documentation. The refined LPA is described in Section 2.3.2.

1.2 *Project Description*

The alternatives evaluated for the Bay Link DEIS phase included a No-Build, TSM/Baseline, Bus Rapid Transit (BRT) and several Light Rail Transit (LRT) alternatives. A Draft Locally Preferred Alternative Report was produced in October 2002. The focus of this report is on the refinement of the No-Build, TSM/Baseline and the LPA proposed for use in the PE/FEIS Phase of Development and the New Starts Report. The Bay Link Project is currently reflected in the Miami-Dade LRTP and the PE/FEIS phase is included in the Transportation Improvement Program (TIP). The system is currently scheduled to start operations in 2023. The design year for analysis of the Bay Link alternatives extends to 2025. The earliest the project could be placed in service, assuming reprioritization in the current LRTP and TIP, would be 2012.

The No Build Alternative assumes continuation of existing public transportation services, and implementation of previously approved additional projects if they are scheduled to become operational within the forecast year for this project. The No-Build Alternative includes the existing highway and transit facilities, transit services, and those transit and highway improvements planned and programmed in the Miami-Dade MPO 2025 LRTP to be implemented by the 2025 design year. This alternative provides the baseline for establishing the environmental impacts of the project. All projects and improvements identified in the No-Build Alternative are also included in the build alternatives.

The TSM/Baseline Alternative The Baseline Alternative is defined as low cost, operation-oriented improvements to address transportation problems identified within the corridor. It also provides a baseline against which all of the "Build" alternatives are evaluated. As a consequence, the TSM alternative has been designed to approximate as closely as possible the service and service levels provided by the build alternative short of significant capital investment in guideway. The Baseline Alternative includes all of the highway and transit improvements identified under the No-Build Alternative.

When the East-West Multimodal Corridor Study DEIS was prepared, the TSM/Baseline Alternative consisted of low-cost operational improvements on SR 836, improved bus transit services, new transit centers, additional express bus routes, and new park-and-ride facilities. The highway improvements have subsequently been completed and are now part of the No-Build Alternative. Over 500 MDT buses and the Miami Beach Electrowave buses provide transit service in the study area over an extensive network of streets, major arterials and highways. As a result of the local combined bus frequencies, a number of the major roadways within the study area are currently saturated with bus service.

As a consequence, the defined TSM Alternative includes a number of limited road and street improvements along Washington Avenue, Alton Road, 5th Street, Biscayne Boulevard, Flagler Street, and NW 1st Avenue. These improvements consist of:

- Additional left-turn lanes and lengthened turning queues;
- Additional traffic signals and phasing modifications;
- Consolidation of bus stops at "station/superstop" locations similar to those identified for the streetcar LPA;
- Some removal of on-street parking (with off-street replacement lots);
- Improvements to access for buses and pedestrians;
- Signal pre-emption at key choke points.
- A new Bus Transfer Facility just south of 17th Street on the west side of Washington Avenue;

- Extension of West Avenue through to Dade Boulevard for traffic mitigation; and,
- Modification of the Terminal Island and MacArthur Causeway (Intercoastal Waterway) bridges to provide extra capacity for buses to mitigate these choke points.

The bus network for the TSM/Baseline Alternative is the same as for the No-Build Alternative.

Locally Preferred Alternative: Based on the goals and objectives supporting the Purpose and Need and the DEIS analysis, the MPO Board adopted the LPA, a light rail (Streetcar) system, endorsed by the cities of Miami and Miami Beach on September 25, 2003. Phase 2 of the project, consisting of refining the LPA description, began in April 2004. A Preliminary Engineering/Final Environmental Impact Statement (PE/FEIS) request to the Federal Transit Administration (FTA) along with the supporting documentation will be prepared. Both the previous and current phases have benefited from an extensive public outreach process.

As currently refined, the LPA is a streetcar network including the Causeway Connector, connecting downtown Miami with Miami Beach (South Beach), and the Beach Circulator, a local circulation line within South Beach. The Causeway Connector is in the form of a two-way loop within downtown Miami, partly following separate streets, a two-track connector line across MacArthur Causeway, and a counter-clockwise one-way loop within South Beach. The Beach Circulator is a clockwise one-way loop, partly on streets shared with the Causeway Connector and partly on separate streets.

2.0 System Operations

The streetcar alignment used for operations planning is shown in Figure 1. The downtown clockwise loop would follow Biscayne Boulevard southbound, NE 1st Street, NW 1st Avenue, NE 3rd Street, NE 1st Avenue, and NE 9th Street, returning to Biscayne Boulevard northbound. The counter-clockwise loop would turn from southbound Biscayne Boulevard onto NE 9th Street, then Miami Avenue, NE 3rd Street, Miami Avenue, SE 1st Street, and Biscayne Boulevard northbound. The downtown tracks would be in traffic lanes shared with other vehicles. Parts of the loops would also be shared with the proposed Miami Streetcar, which would approach downtown southbound on NE 2nd Avenue, turn west onto 9th Street, and follow the Causeway Connector counter-clockwise loop to SE 1st Street, then returning to the north via NE 1st Avenue.

The alignment across MacArthur Causeway would have exclusive right of way from Biscayne Boulevard to 5th Street. Along the causeway, it would be located south of the existing roadway and grade separated from the connecting streets on Watson Island and Terminal Island.

The Causeway Connector alignment in South Beach would be routed via 5th Street, Washington Avenue, 17th Street, and Alton Road, all in lanes shared with other traffic. The Beach Circulator, also in shared lanes, would be routed via Alton Road, Lincoln Road to the west, West Avenue, Dade Boulevard, 22nd Street, Collins Avenue, 17th Street, Washington Boulevard, and South Pointe Drive, then returning to Alton Road.

The yard and shop site would be located just to the north of N.E. 17th Street and west of I-95. The yard lead will run along N.E. 17th St.

Stations served by the Causeway Connector and the Beach Circulator would be as listed in Table 1, below.

Figure 1: Bay Link Streetcar Locally Preferred Alternative

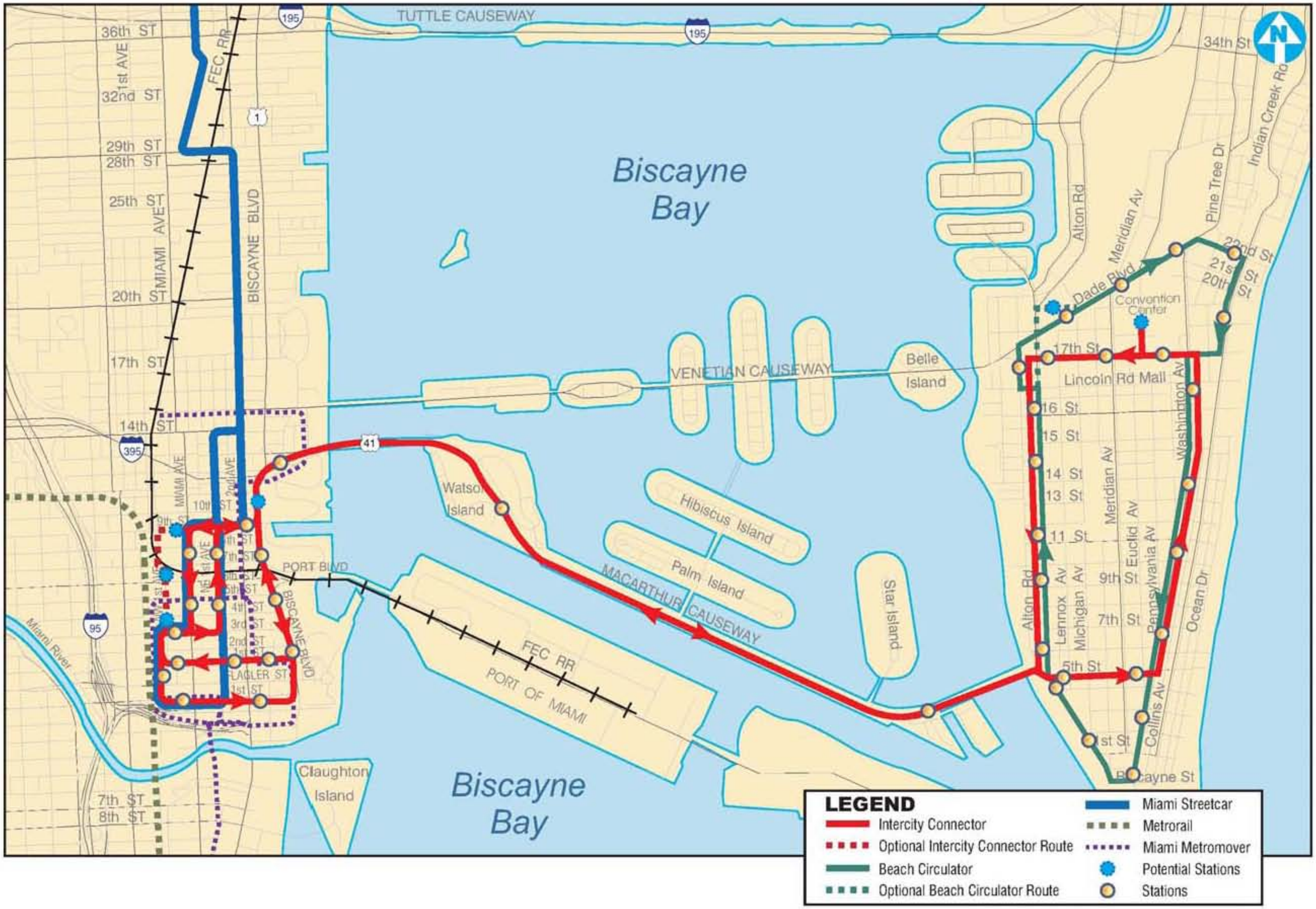


Table 1: Stations Locations Configurations

No.	Name	Type[(1)]	Configuration	Location[(2)]
1	5th St/Alton Rd	R	Curbside	MB
2	5th St/Euclid Ave	R	Median	MB
3	Washington Ave/7th St	R/BC	Center	MB
4	Washington Ave/10th St	R/BC	Center	MB
5	Washington Ave/14th St	R/BC	Center	MB
6	Washington Ave/Lincoln Rd	R/BC	Center	MB
7	17th St/Drexel Ave (Convention Center) [(3)]	R	Median	MB
8	17th St/Meridian Ave	R	Median	MB
9	17th St/Alton Rd	R	Median	MB
10	Alton Rd/16th St	R/BC	Center	MB
11	Alton Rd/Espanola Way	R/BC	Center	MB
12	Alton Rd/12th St	R/BC	Center	MB
13	Alton Rd/9th St	R/BC	Center	MB
14	Alton Rd/6th St	R/BC	Curbside split	MB
15	Terminal Island	R	Aerial center	MB
16	Watson Island	R	Aerial side	M
17	Museum Park/Performing Arts	R	Center	M
18	Park West	R	Curbside split	M
19	Miami Ave/NE 8th St	R/MSC	Curbside	M
20	Miami Ave/NE 5th St	R/MSC	Curbside	M
21	NW 3rd St/NW 1st Ave	R/MSC	Curbside	M
22	Government Center *(NW 1st Ave and NW 1st St)*	R/MSC	Curbside split	M
23	SW 1st St/Miami Ave	R/MSC	Curbside	M
24	SE 1st St/SE 3rd Ave	R/MSC	Curbside	M
25	Bayfront *(Biscayne Blvd and NE 1st St)*	R	Curbside	M
26	Bayside *(Biscayne Blvd)*	R	Curbside split	M
27	American Airlines Arena *(Biscayne Blvd)*	R	Curbside split	M
28	NE 1st St/NE 3rd Ave	R	Curbside	M
29	NE 1st St/NE 1st Ave	R	Curbside	M
30	NE 1st Ave/NE 5th St	R/MSC	Curbside	M
31	NE 1st Ave/NE 8th St	R/MSC	Curbside	M
32	Alton Rd/5th St	BC	Curbside	MB
33	West Ave	BC	Curbside	MB
34	Dade Blvd/Michigan Ave	BC	Median	MB
35	Dade Blvd/Meridian Ave	BC	Median	MB
36	Dade Blvd/Washington Ave	BC	Median	MB
37	22nd St/Collins Ave	BC	Curbside	MB
38	Collins Ave/19th St	BC	Curbside	MB
39	Washington Ave/3rd St	BC	Median	MB
40	South Pointe	BC	Median	MB
41	Alton Rd/2nd St	BC	Median	MB
42	Convention Center (*special event*)	R	Center	MB

Note:

1) Type refers to the Regional Line (Causeway Connector) (R), Beach Circulator (BC), and/or the Miami Streetcar (MSC).
2) Location refers to City of Miami (M) or City of Miami Beach (MB).
3) An additional alignment spur and station are provided at the Convention Center for large special events.
4) 26 total stations in Miami Beach; 16 total stations in Miami.
5) 19 total Beach Circulator stations (9 shared; 10 single).
6) 8 Miami Bay Link and Miami Streetcar shared stations
7) An optional station on Biscayne Boulevard between N.E. 10th and N.E. 11th Streets will be evaluated during PE/FEIS.

An alignment option that would extend service along NE 9th Street to NW 1st Avenue and south to tie in with the proposed alignment at NE 3rd Street has been proposed for analysis as part of the PE/FEIS phase of development. This alignment would offer some operational advantages over the current proposed alignment and as a consequence would probably result in shorter run times and lower O&M cost.

3.0 Train Running Times

Preliminary estimates of streetcar running times were made, for use in operations planning and travel demand forecasting.

3.1 Estimation Method

A spreadsheet model was used to estimate running times. The spreadsheet employs tables of typical streetcar acceleration and deceleration times and distances, formulae for calculation of allowable speed on curves with or without superelevation, an average station dwell time, tabulation of the track alignment including station locations and curve locations including the radius and length of each, and judgment-based entries for traffic-related delay, based on the conceptual analysis of each intersection.

3.2 Traffic Priority and Delay

Traffic-related delay is difficult to predict without the benefit of detailed traffic data and microsimulation of consequent traffic conditions that will occur during the PE/FEIS phase of project development. In an ideal case, the transit operation would have the capability to preempt other traffic at traffic signals and thus would not be subject to delay at all. In practice this is seldom the case, and in fact any in-street transit operation can and will encounter interference in the form of other vehicles that may occupy the trackway for a variety of reasons and for varying periods of time, whether priority or preemption capability is provided or not.

Whether or not to allow traffic signal priority or preemption by transit vehicles is a decision affected not only by traffic conditions but also by characteristics of the transit operations themselves.

A major design goal is the minimization of traffic signal delay of the rail car movements without creating secondary adverse effects for general traffic. This applies to the streets that will host the tracks and the cross streets. The project should include enhancing and upgrading the traffic signal system to accomplish that goal.

Unlike many LRT systems in which the tracks are within street rights-of-way but in reserved lanes, virtually all of the trackage in Miami Beach will be installed in general traffic lanes. Consequently, any delay reduction of rail car movement along a particular street that might be achieved by means of traffic signal timing would also be experienced by other vehicular traffic traveling in the same direction on that street. Good traffic signal coordination will be beneficial to both modes and poor coordination will be detrimental to both modes.

Nevertheless, there are two aspects of the rail operation that should be taken into account as delay reduction measures are being developed. One is relatively obvious while the other is not.

The most obvious one is the need to recognize the ramifications of the station stops that will take place in a general traffic lane. Whenever a rail car stops at a station, that car and those vehicles traveling immediately behind it will experience some delay.

If the signal coordination were designed to disregard those phenomena and to provide a progression in which a “green band” would move along the street at a constant speed, a rail car could fall behind the band while stopped at the station. Vehicles traveling behind it in the same lane might also fall behind the band. All affected movements would then have to await the next signal cycle before they could proceed.

However, if the signals were coordinated to slow the progress of the green band at each station, a rail car and the vehicles immediately behind it might remain within the green band. Both a constant speed and the above described variable speed progression should be analyzed.

The less obvious aspect of the rail operation is the relationship between the two routes that would be operated in Miami Beach. The Causeway Connector will operate frequently during the peak periods and will also serve passengers in downtown Miami and those traveling between the two cities. The Beach Circulator will run less frequently and will not serve Miami or intercity passengers.

A delay in Miami Beach occurring on the Causeway Connector would have considerably broader impact than one occurring on the Beach Circulator. On that basis the signal progression should favor the Causeway Connector, but not necessarily in total disregard of secondary impacts.

Not just the Beach Circulator cars would be moving in a direction opposite to a signal progression favoring the Causeway Connector. Nominally half of the vehicle traffic on 5th Street, 17th Street, Alton Road and Washington Avenue would also travel counter to that direction. Furthermore, the signal timing on the tracked streets will affect traffic movements along intersecting streets. A comprehensive analysis will be needed during the PE/FEIS phase of development, to determine the degree to which the Causeway Connector travel direction should be favored.

For this operations analysis, there is no formal assumption of traffic signal timing that would favor either the Causeway Connector or the Beach Circulator. The running time estimates are, as explained in the next section below, based on operating within the general traffic conditions anticipated to exist on the streets used by the two routes.

A traffic operations assessment of the alignments was made to address preferred means of fitting the alignment into the street system, including how to position the streetcars at intersections where the streetcars make turns. According to the current plans all trackage in Miami Beach will be installed in street lanes that are open to general traffic. While this will result in some impediment to rail operation, there will also be some advantages. If the tracks are properly configured the rail cars will be able to execute their turning movements along, rather than across the path of the vehicles at intersections. No special signal phases will be needed and there will be minimal impact on intersection capacity.

The alignment plan as it stands at the time of preparing this document includes the following features, to address these configuration issues:

- Upon entering 5th Street from MacArthur Causeway, the Causeway Connector would be in the curb lane. At Jefferson Avenue, streetcars would shift to the left lane, in preparation for making the left turn onto Washington Avenue, where the line would run in the left lane with stations in the median.
- On 17th Street, the line would run in the left lane, with stations in a median right of way otherwise used for left turning traffic.
- The Causeway Connector would run in the left lane of Alton Road from 17th Street to 8th Street, where it would shift to the curb lane. After a stop at 6th Street the line would shift to the left lane from which it would make the turn across 5th Street into the exclusive right of way alongside MacArthur Causeway.
- The Beach Circulator would run southbound on Washington Avenue in the left lane. At 5th Street the curb lane of Washington is for right turns only, and the left lane carries the streetcar across 5th and into the curb lane south of 5th.
- The Beach Circulator continues in curb lanes until reaching 8th Street in Alton Road, where it shifts to the left lane, finally turning left from that lane onto the westbound curb lane of Lincoln Road, followed by a right turn on West Avenue, again in the curb lane.

- At Dade Boulevard the line turns into the left lane, with stations located in the median, finally turning onto 22nd Street in the curb lane.
- From 22nd Street, the Beach Circulator turns to the curb lane of Collins Avenue, turns right into the left lane of 17th Street, and finally left into the left lane of Washington Avenue.

3.3 Estimated Station-to-Station Times

For purposes of train running time estimates, given the above considerations, allowances have been made for traffic-related delay, generally added to station dwell times. Station dwell times themselves have been set at 20 seconds, which is typically adequate as an average stopped time including door opening and closing times.

Trains are assumed to stop at every station. Leaving each station, they accelerate at typical rates for the type of vehicle, to the maximum speed consistent with the normal maximum speed for traffic on the street, if distance permits this speed to be reached before having to slow for the next station or for a speed-restricted curve. Trains decelerate as necessary to stop at stations or to slow as they approach speed-restricted curves. When slowing for a curve, they must reach the curve speed limit upon entry into the curve, and not exceed that speed until the entire length of the train has cleared the curve. The estimated running times have been made with the assumption that trains would be two cars in length. A sensitivity test showed that the use of shorter trains would have a negligible effect on running times – about six tenths of a minute for the Causeway Connector.

Tables 2, 3 and 4 provide the estimated running times.

Table 2: Running Time Estimates, Causeway Connector, Clockwise Miami Loop

Station No.	Station Name	From previous station:		
		Miles	Minutes	Mi/Hr
17	Museum Park/Performing Arts			
27	American Airlines Arena	0.36	1.79	12.05
26	Bayside	0.19	1.28	8.90
28	NE 1st St/NE 3rd Ave	0.30	1.50	11.97
29	NE 1st St/NE 1st Ave	0.16	1.21	8.05
22	Government Center	0.17	1.15	8.97
21	NE 3rd St/NW 1st Ave	0.22	2.28	5.72
30	NE 1st Ave/NE 5th St	0.26	1.67	9.45
31	NE 1st Ave/NE 8th St	0.20	1.22	9.81
18	Park West	0.21	1.54	8.07
17	Museum Park/Performing Arts	0.29	1.85	9.38
16	Watson Island	0.89	1.95	27.38
15	Terminal Island	1.98	3.25	36.52
1	5th St/Alton Rd	0.52	1.79	17.31
2	5th St/Meridian Ave	0.29	1.36	12.91
3	Washington Ave/7th St	0.23	1.74	7.90
4	Washington Ave/10th St	0.30	1.39	13.18
5	Washington Ave/14th St	0.28	1.32	12.62
6	Washington Ave/Lincoln Rd	0.35	1.59	13.37
7	17th St/Drexel Ave	0.24	1.76	8.27
8	17th St/Meridian Ave	0.21	1.17	10.98
9	17th St/Alton Rd	0.22	1.19	11.25
10	Alton Rd/16th St	0.23	1.72	7.92
11	Alton Rd/Espanola Wy	0.23	1.20	11.30
12	Alton Rd/12th St	0.25	1.26	11.94
13	Alton Rd/9th St	0.19	1.11	10.17
14	Alton Rd/6th St	0.27	1.38	11.61
15	Terminal Island	0.58	2.33	14.90
16	Watson Island	1.98	3.28	36.14
17	Museum Park/Performing Arts	0.89	1.95	27.42
	Totals	**12.48**	**48.21**	**15.53**

Table 3: Running Time Estimates, Causeway Connector, Counter-Clockwise Miami Loop

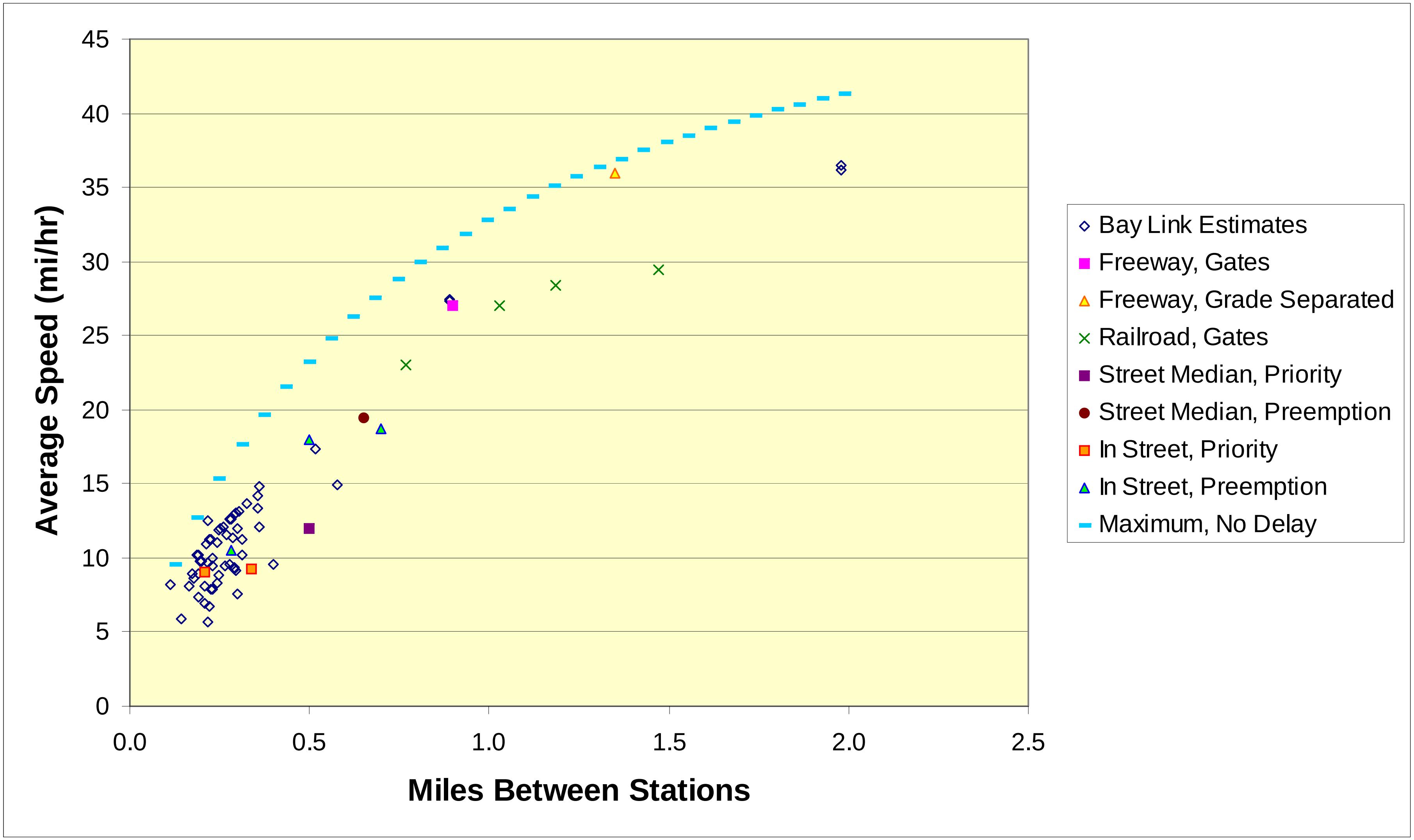
Station No.	Station Name	From previous station:		
		Miles	**Minutes**	**Mi/Hr**
17	Museum Park/Performing Arts			
18	Park West	0.29	1.93	9.14
19	Miami Ave/NE 8th St	0.31	1.85	10.18
20	Miami Ave/NE 5th St	0.20	1.21	9.75
21	NE 3rd St/NW 1st Ave	0.14	1.45	5.94
22	Government Center	0.21	1.79	6.97
23	SE 1st St/Miami Ave	0.19	1.56	7.37
24	SE 1st St/NE 3rd Ave	0.29	1.51	11.37
25	Bayfront	0.29	1.90	9.21
26	Bayside	0.22	1.34	9.66
27	American Airlines Arena	0.18	1.25	8.61
17	Museum Park/Performing Arts	0.36	1.47	14.80
16	Watson Island	0.89	1.95	27.38
15	Terminal Island	1.98	3.25	36.52
1	5th St/Alton Rd	0.52	1.79	17.31
2	5th St/Meridian Ave	0.29	1.36	12.91
3	Washington Ave/7th St	0.23	1.74	7.90
4	Washington Ave/10thSt	0.30	1.39	13.18
5	Washington Ave/14th St	0.28	1.32	12.62
6	Washington Ave/Lincoln Rd	0.35	1.59	13.37
7	17th St/Drexel Ave	0.24	1.76	8.27
8	17th St/Meridian Ave	0.21	1.17	10.98
9	17th St/Alton Rd	0.22	1.19	11.25
10	Alton Rd/16th St	0.23	1.72	7.92
11	Alton Rd/Espanola Way	0.23	1.20	11.30
12	Alton Rd/12th St	0.25	1.26	11.94
13	Alton Rd/9th St	0.19	1.11	10.17
14	Alton Rd/6th St	0.27	1.38	11.61
15	Terminal Island	0.58	2.33	14.90
16	Watson Island	1.98	3.28	36.14
17	Museum Park/Performing Arts	0.89	1.95	27.42
	Totals	**12.81**	**49.99**	**15.37**

Table 4: Running Time Estimates, Beach Circulator

Station No.	Station Name	From previous station:		
		Miles	Minutes	Mi/Hr
14	Alton Rd/6th St			
13	Alton Rd/9th St	0.30	1.36	12.99
12	Alton Rd/12th St	0.19	1.11	10.23
11	Alton Rd/Espanola Wy	0.25	1.25	11.85
10	Alton Rd/16th St	0.23	1.37	10.02
33	West Ave	0.22	1.98	6.73
34	Dade Blvd/Michigan Ave	0.31	1.66	11.29
35	Dade Blvd/Meridian Ave	0.22	1.04	12.49
36	Dade Blvd/Washington Ave	0.26	1.29	12.06
37	22nd St/Collins Ave	0.25	1.68	8.80
38	Collins Ave/18th St	0.28	1.74	9.55
6	Washington Ave/Lincoln Rd	0.40	2.50	9.53
5	Washington Ave/14th St	0.36	1.51	14.14
4	Washington Ave/10th St	0.28	1.33	12.66
3	Washington Ave/7th St	0.30	1.39	13.18
39	Washington Ave/3rd St	0.33	1.44	13.63
40	South Pointe	0.23	1.46	9.49
41	Alton Rd/2nd St	0.30	2.36	7.59
32	Alton Rd/4th St	0.24	1.33	11.06
14	Alton Rd/6th St	0.11	0.83	8.22
	Totals	5.05	28.63	10.58

Running Time Validation: The reasonableness of the running time estimates can be validated by comparison with data from existing light rail systems. The data used for validation document the relationship between station-to-station distance and average speed for that station-to-station link, for a variety of right of way and traffic control strategies. Figure 2 illustrates the existing system data and the estimates for Bay Link (before adding recovery time).

Figure 2: Average Speed of Operation – Actual Examples and Bay Link Estimates



4.0 Train Operation

4.1 Normal Service Strategy

For ordinary "back and forth" routes, trains are assigned added time for layover (normally, time required by operating rules for operator break time) and recovery (an allowance for trips that experience greater than anticipated running time) at the end of each one-way trip. The total round-trip layover and recovery time is set to result in a total round trip time that is a multiple of the planned headway (time between successive trains). In the case of loop operation at the end of a transit line, either the loop service is interrupted to insert layover and recovery time, or at least recovery time, or, alternatively, more generous allowance is made for station dwell time, to assure that trains will be able to maintain schedule. If only recovery time is added, operator break time is provided by the use of a "drop-back" operator, a technique in which one or more extra train operators are assigned to the designated end-of-line station. The extra train operator replaces the operator of an arriving train. The replaced operator, after completing his or her assigned break time, is available to replace the operator of the next arriving train.

Upon study of projected ridership patterns (see Section 5 of this report), it was found that there are suitable locations on both the Causeway Connector and the Beach Circulator where layover and recovery time can be introduced with effect on minimal numbers of passengers. This operating practice will be preferable to arbitrary lengthening of station dwell times, which would increase trip times for most passengers.

For the Causeway Connector, the estimated downtown clockwise and downtown counter-clockwise loop round trip times are 48 and 50 minutes, respectively. For a five-minute headway, allowance for recovery time and minimal layover (possibly still necessitating the use of drop-back crews) requires that both loops be scheduled as 55-minute round trips. The layover and recovery time would be added probably at the Government Center Station and one of the adjacent stations. These station choices could be revised if experience indicates opportunities for improvement due to differences in numbers of passengers affected (see discussion in Section 5 of modeled use of the two downtown loops versus expected actual use). Two stations would be used because the layover and recovery time, five to seven minutes, would equal or exceed the minimum scheduled headway of five minutes. A train would stop for not more than four minutes at one of these stations and for the remaining layover/recovery time at the other.

The necessity to split the layover and recovery time could be avoided by providing an off-line track, but this would require any on-board passengers to disembark before moving the streetcar to that track. Passengers would then wait for a train to re-enter the station and continue its journey. Another alternative would be to provide two tracks at the station used for layover; trains would use the tracks alternately. If the station platform could be located between the two tracks, passengers could save time by crossing to the train about to depart. These strategies pose various physical difficulties, however. They might be investigated during preliminary engineering but need not be resolved at this stage in project development.

The Beach Circulator's estimated round trip time is 29 minutes. For a five-minute headway, the layover and recovery time would be six minutes, giving a total round trip time of 35 minutes. In this case, the planned storage track on Commerce Street could be used as a layover and recovery track if connections can be provided to allow streetcar movements from Alton to Commerce eastbound, and from Commerce to Washington. In that case, passengers traveling down Washington would disembark at South Pointe Station and wait for the next departing streetcar. The empty streetcar would continue to Alton, turn onto Commerce, stop for layover and recovery time, and then proceed back onto Washington, re-entering revenue service at the South Pointe Station.

4.2 Provisions for Operational Flexibility

To add operational flexibility, a "wye" connection has been added to the plans at the NE 1st Street - NW 1st Avenue intersection to allow clockwise trains to transfer to the counterclockwise loop, and counterclockwise trains to transfer to the clockwise loop. This will allow service to be relegated to only the Biscayne side of the loops or to only the Miami Ave. - NE 1st Ave. side of the loops if need be.

At the Miami Beach Convention Center, there is an opportunity to combine special event service with a link between the Causeway Connector and the Beach Circulator, by means of a track along Convention Center Drive between 17th Street and Dade Boulevard. This track would be the normal route from the streetcar yard & shop, located in Miami west of I-95, to the Beach Circulator. In addition to the connecting track there would be a siding near 17th Street, joining the connecting track at both ends, and long enough to accommodate four streetcars.

A track on 17th Street across Washington Avenue would be the normal return route from the Beach Circulator to the streetcar yard & shop in Miami.

As previously mentioned, a storage track would be located on Commerce Street between Washington Avenue and Alton Road.

Special event trackwork would be located at the American Airlines Arena.

5.0 Ridership Forecasts

Year 2025 travel demand forecasts were prepared for the No Build, TSM, and LPA alternatives. The forecasts use 2005, 2015, and 2025 total trip forecasts and the mode choice and trip assignment models of the Miami-Dade Metropolitan Planning Organization, together with highway and public transportation networks. The networks represent the three alternatives. MPO matrices of total person trips include three trip purposes, these being home-based work (HBW), home-based non-work (HBNW), and non-home-based (NHB)

The travel demand model components used in the analysis of transit ridership include the mode choice model and the trip assignment model. The former splits trips between highway and transit. The result of the mode choice process is the creation of zone-to-zone person trips (linked trips) according to their probable choice of mode. These results are provided in Table 5.

Table 5: Predicted Person Trips by Mode

Mode and Purpose	2025			2015		2005	
	LPA	TSM	No Build	LPA	No Build	LPA	No Build
Auto							
HBW	2,248,872	2,251,022	2,250,818	1,958,987	1,960,656	1,770,179	1,771,624
HBNW	4,528,232	4,530,493	4,530,508	4,218,495	4,220,701	3,752,594	3,754,644
NHB	2,604,236	2,606,029	2,606,052	2,269,712	2,271,381	2,031,986	2,033,581
Total	9,381,340	9,387,543	9,387,379	8,447,194	8,452,738	7,554,760	7,559,849
Transit							
HBW	131,255	129,106	129,309	116,864	115,195	109,715	108,270
HBNW	113,482	111,221	111,206	105,983	103,777	98,170	96,120
NHB	57,794	56,001	55,978	51,509	49,840	47,274	45,679
Total	302,531	296,328	296,493	274,357	268,812	255,159	250,069
Total							
HBW	2,380,127	2,380,127	2,380,127	2,075,851	2,075,851	1,879,894	1,879,894
HBNW	4,641,714	4,641,714	4,641,714	4,324,478	4,324,478	3,850,764	3,850,764
NHB	2,662,030	2,662,030	2,662,030	2,321,221	2,321,221	2,079,260	2,079,260
Total	9,683,871	9,683,871	9,683,871	8,721,550	8,721,550	7,809,918	7,809,918

Source: PB – Corradino (August 2004)

The next step in ridership forecasting is to assign transit person trips to the transit networks, which provides estimates of the use of each transit submode, including specifics such as boarding station or stop, direction of travel, alighting station or stop, locations where transfers from one transit mode to another occur, and, through further analysis, transit system use characteristics by time of day.

The trip assignment process resulted in the following predicted use of each sub-mode:

Table 6: Transit Boardings by Sub-Mode

Sub-Mode	**2025**			**2015**		**2005**	
	LPA	**TSM**	**No Build**	**LPA**	**No Build**	**LPA**	**No Build**
Metrorail	120,473	116,426	116,437	104,350	100,827	93,542	90,053
Metromover	29,639	23,967	23,780	27,089	100,827	24,643	19,649
Bus	301,339	327,591	327,950	271,414	296,428	254,776	278,124
Tri-Rail	418	409	402	337	342	271	238
Bay Link	20,075			18,648		17,107	
Total	471,944	468,393	468,569	421,838	498,424	390,339	388,064

Source: PB – Corradino (August 2004)

Bay Link Streetcar ridership details show on board, boarding, and alighting passengers at each station, by trip purpose and direction of travel, for each of three services – the Causeway Connector with the clockwise downtown loop, the Causeway Connector with the counter-clockwise downtown loop, and the Beach Circulator.

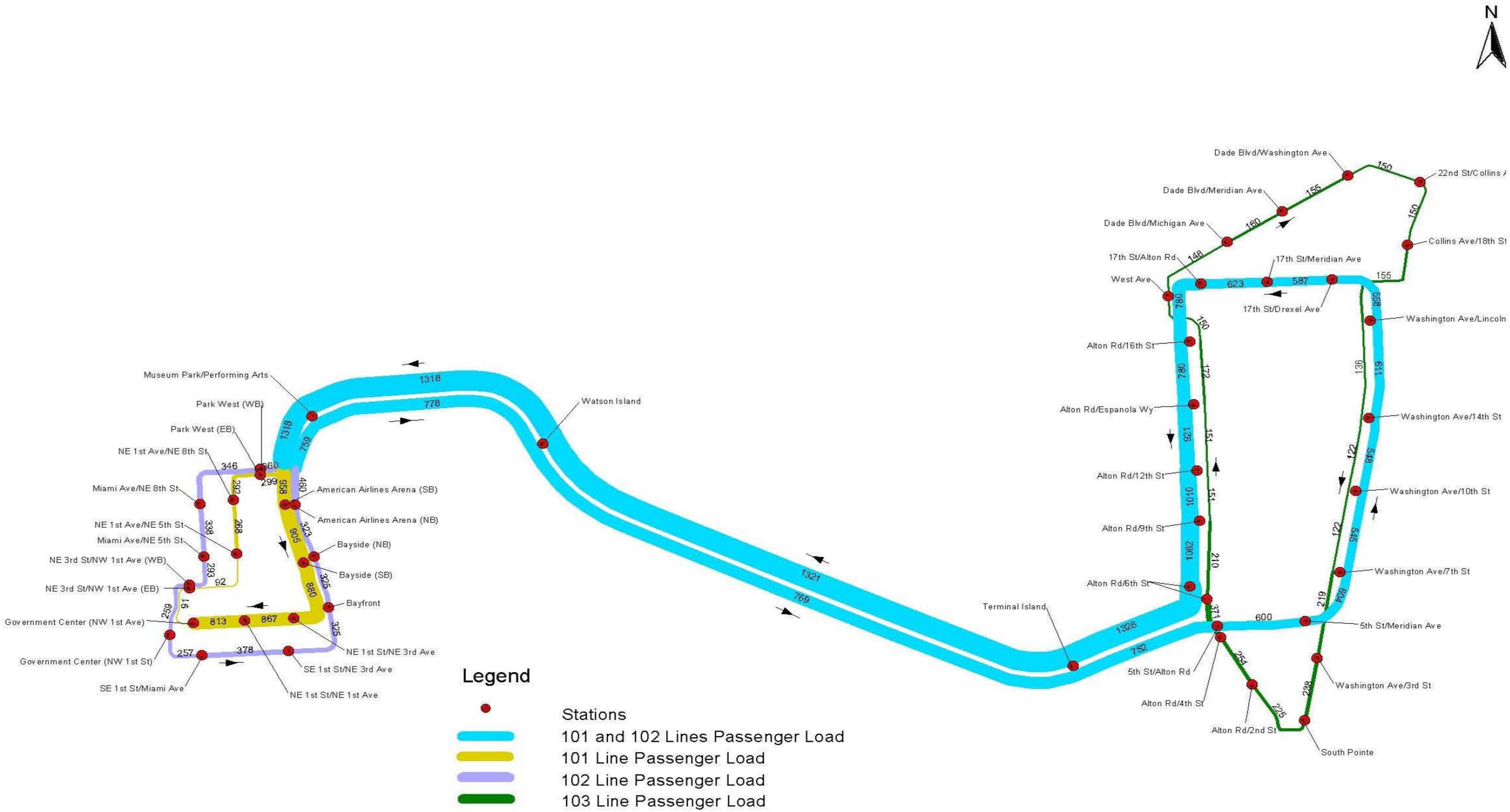
Because of the modeling methodology, the indicated differences between use of the downtown clockwise and counter-clockwise services is overstated. The methodology results in assigning all trips to the loop offering the best travel time, while in reality many passengers would be best served by taking the first streetcar to arrive at their originating stop. For trips originating in Miami Beach, fewer trips would choose the clockwise loop, which is projected to have maximum loads twice those of the counter-clockwise loop. For trips originating in downtown Miami, passengers would have to choose their loop direction, but would tend to select the less-used direction if it offered similar travel time.

The importance of this point lies in the fact that the estimated peak hour maximum passenger flow on the downtown clockwise Causeway Connector route is 958 passengers, or 160 passengers per train if there are six trains per hour (ten-minute headway). Allowing for variation in train loading within the peak hour, trains would be overloaded, some seriously over capacity, if there were only one car per train. The forecasted maximum flow for the downtown counter-clockwise route is only 480 passengers (80 passengers per train), however, and a significant leveling of the two differing maximum loads would place all trains within capacity, without requiring use of two-car trains. Combined peak hour line loads are shown in Figure 3.

These projected 2025 passenger volumes are near the maximum for single-car trains, and therefore it is possible that either closer headways or longer trains will be required at some time in the future. For this reason, design and construction of stations to accommodate two-car trains appears advisable. Longer stations also could prove useful when serving passengers going to and from special events at venues served by the Bay Link Streetcar.

The Beach Circulator forecast indicates a maximum peak hour flow of 371 passengers, or 31 per train if there are 12 trains per hour (five-minute headway). As for the Causeway Connector, special event traffic could place significantly higher demands on the route for brief periods of time.

Figure 3: Projected Year 2025 Peak Hour Passenger Line Loads, Bay Link Streetcar



6.0 Fleet Size, LPA Bay Link Streetcar

6.1 Vehicle Capacity

The vehicle type selected for use in planning the project is the Skoda vehicle currently used by the Portland Streetcar. This vehicle is about 67 feet long and has a capacity of 41 seated passengers and 90 standing passengers (at four persons per square meter – about 2.5 square feet per standee).

6.2 Headways, Consists, Peak Vehicles, and Fleet Size

The number of trains required to operate the Bay Link services is ultimately a function of rail vehicle capacity, train round trip times, and peak-period passenger volumes, or more specifically, the maximum train loading (passengers per hour per direction) that occurs on each of the two lines. Based on earlier Bay Link studies, the capacity-based peak-period train headway would be five minutes. The round trip time and the peak-period headway determine the number of trains required to operate each line. Interpretation of the current passenger forecasts indicate that single streetcars operating at five-minute peak-period headways will offer the required capacity on the Causeway Connector (two routes, each at ten-minute headway), and more than is required on the Beach Connector, as demonstrated in Section 5, above. The entire service therefore requires operation of eleven streetcars on the Causeway Connector and seven streetcars on the Beach Connector (see below). The Causeway Connector streetcars would alternate between the clockwise and counterclockwise loops.

For the Bay Link Streetcar, therefore, the fleet size estimate is as follows:

Round trip time, Causeway Connector:	55 minutes for each of two routes
Round trip time, Beach Circulator:	35 minutes
Shortest headway operated:	5 minutes on the combined Causeway Connector routes; 5 minutes on the Beach Circulator route
Trains to operate the Causeway Connector loop:	11
Trains to operate the Beach Circulator loop:	7
Total trains:	18
Spare trains:	4
Total trains:	22

The allowance for spare equipment was calculated using the typical transit system range of 15 to 20 percent, with further consideration given to actual operations requirements. The total of four spare trains would allow two trains to be withheld from service for maintenance, while two (one for the Causeway Connector and one for the Beach Circulator, but usable interchangeably) would be in reserve for operating contingencies such as a breakdown or abnormally-extended running times.

7.0 Weekday and Annual Service, LPA Bay Link Streetcar

7.1 Service Periods and Hours of Operation

For the Bay Link Streetcar, the assumed hours of service are 5:30 A.M. to 2:00 A.M. Monday through Saturday, and 7:00 A.M to 11:00 P.M. on Sundays. Headways would be ten minutes except during Monday through Friday peak periods. The peak-period headway would be five minutes, and this is assumed to apply from 6:30 to 9:30 A.M. and 3:30 to 6:30 P.M. The assumed hours of service and the peak periods might be redefined based on later planning or actual operating experience.

These assumptions provide the basis for calculation of annual operating statistics, for use as input to the estimation of operating and maintenance cost (O&M Cost). These results are given in Table 7.

Also needed in O&M cost calculation are the number of stations and track miles. The Bay Link stations are listed in Table 1, which identifies 42 in total. Several have separate platforms for each direction of travel, however, and this results in a total of 48 station platforms, which is the number used in estimating O&M cost. Normal revenue service uses a total of 20.11 track miles. The features described in Section 4.2 add 0.47 miles of track. Track connecting from the Bay Link Streetcar to the yard & shop, approximately one mile in length, has not been counted in estimating Bay Link O&M costs. It is assumed that the Miami Streetcar, a mainland Miami project, would be implemented before the Bay Link Streetcar project and would be responsible for both the capital cost and the maintenance cost of this non-revenue-service link.

Table 7: Estimated 2025 Operating Statistics

	Causeway Connector		**Beach Circulator**	**Totals**
	Clockwise Downtown	**Counter-Clockwise Downtown**		
Round Trip Distance (miles)	12.48	12.81	5.05	30.34
Round Trip Schedule Time (minutes)	55	55	35	
Headway, Weekday Peak Period (minutes)	10	10	5	
Headway, All Other Times (minutes)	20	20	10	
Round Trips, Weekday	79.5	79.5	159	
Round Trips, Saturday, Holiday	61.5	61.5	123	
Round Trips, Sunday	48.0	48.0	96.0	
Annual Revenue Vehicle Miles	328,218	336,897	265,625	930,740
Annual Non-Revenue Vehicle Miles				50,145
Total Annual Vehicle Miles				980,885
Annual Vehicle Hours	24,108	24,108	30,683	78,899

Source: Parsons Brinckerhoff (September 2004)

8.0 Weekday and Annual Service, Other Transit Sub-Modes

For the No Build, TSM, and LPA alternatives, system measures and weekday operating statistics have been taken directly from the travel demand forecasting 2025 networks. The weekday data have been expanded from weekday to annual using a factor of 306, which also has been used for expansion of the weekday passenger forecasts. Table 8 provides a listing of passenger stations for the fixed-guideway transit sub-modes. Tables 9 through 14 provide weekday operating statistics for the revenue service of the six transit sub-modes. For modes using trains, vehicle miles used in O&M cost estimation have been obtained by multiplying train miles times average train length.

Table 8: Numbers of Transit Stations

Sub-Mode No.	Sub-Mode Name	No-Build	TSM	LPA
4	Local Bus			
5	Metrorail	34	34	34
5	Bay Link			42*
6	Express Bus			
7	Tri-Rail	5	5	5
8	Metromover	17	17	17

*Six are split side-platform stations; there are 48 station platforms in all.
Source: Parsons Brinckerhoff (August 2004)

Table 9: Metrorail Weekday Operating Statistics, 2025

	Revenue Train Miles	Route Miles	Revenue Train Hours	Trains in Service
No Build				
Peak (4 Hours)	6,480	139.0	212	53
Off-Peak (16 Hours)	12,992	139.0	464	29
Total Weekday	19,472		676	
TSM				
Peak (4 Hours)	6,480	139.0	212	53
Off-Peak (16 Hours)	12,992	39.0	464	29
Total Weekday	19,472		676	
LPA				
Peak (4 Hours)	6,480	139.0	212	53
Off-Peak (16 Hours)	12,992	139.0	464	29
Total Weekday	19,472		676	

Source: PB – Corradino (September 2004)

Table 10: Metromover Weekday Operating Statistics, 2025

	Train Miles	Route Miles	Train Hours	Trains in Service
No Build				
Peak (4 Hours)	964	9.1	100	25
Off-Peak (16 Hours)	2,416	9.1	272	17
Total Weekday	3,380		372	
TSM				
Peak (4 Hours)	964	9.1	100	25
Off-Peak (16 Hours)	2,416	9.1	272	17
Total Weekday	3,380		372	
LPA				
Peak (4 Hours)	964	9.1	100	25
Off-Peak (16 Hours)	2,416	9.1	272	17
Total Weekday	3,380		372	

Source: PB – Corradino (September 2004)

Table 11: Local Bus Weekday Operating Statistics, 2025

	Vehicle Miles	Route Miles	Vehicle Hours	Vehicles
No Build				
Peak (4 Hours)	34,124	3,221.5	3,532	883
Off-Peak (16 Hours)	93,632	2,895.4	7,920	495
Total Weekday	127,756		11,452	
TSM				
Peak (4 Hours)	34,124	3,221.5	3,528	882
Off-Peak (16 Hours)	93,632	2,895.4	7,920	495
Total Weekday	127,756		11,448	
LPA				
Peak (4 Hours)	32,764	3,129.8	3,368	842
Off-Peak (16 Hours)	89,184	2,803.9	7,584	474
Total Weekday	121,948		10,952	

Source: PB – Corradino (September 2004)

Table 12: Express Bus Weekday Operating Statistics, 2025

	Vehicle Miles	Route Miles	Vehicle Hours	Vehicles
No Build				
Peak (4 Hours)	6,680	282.1	432	108
Off-Peak (16 Hours)	6,208	218.5	368	23
Total Weekday	12,888		800	
TSM				
Peak (4 Hours)	6,680	282.1	440	110
Off-Peak (16 Hours)	6,208	218.5	368	23
Total Weekday	12,888		808	
LPA				
Peak (4 Hours)	6,368	256.3	408	102
Off-Peak (16 Hours)	5,376	192.7	304	19
Total Weekday	11,744		712	

Source: PB – Corradino (September 2004)

Table 13: Tri-Rail Weekday Operating Statistics, 2025

	Train Miles	Route Miles	Train Hours	Trains in Service
No Build				
Peak (4 Hours)	292	44.1	12	3
Off-Peak (16 Hours)	480	29.4	32	2
Total Weekday	772		44	
TSM				
Peak (4 Hours)	292	44.1	12	3
Off-Peak (16 Hours)	480	29.4	32	2
Total Weekday	772		44	
LPA				
Peak (4 Hours)	292	44.1	12	3
Off-Peak (16 Hours)	480	29.4	32	2
Total Weekday	772		44	

Source: PB – Corradino (September 2004)

9.0 Cost of Operation and Maintenance

9.1 Cost Models

The costing methodology for this Bay Link study was derived from the models used earlier in Bay Link light rail and other Miami analysis. Those models are documented in the *Draft O&M Cost Methodology Report*, April 2002 and *Miami North Corridor Metrorail Extension FEIS, Operating and Maintenance Cost Estimate Report*, August 2004. The models are based on logical allocation of various costs of system operation and maintenance among a set of independent system variables. The original costs in this process were obtained in part from Miami-Dade Transit wage data for 2001 and in part from analysis of the 1998 FTA data for US transit systems, including ten light rail systems in the case of modeling of Bay Link light rail O&M cost. Cost data from these systems were the average of the reported costs of those systems, with updating to represent year 2002 costs. Subsequent updating for the second above-referenced source used Miami-Dade Transit wage data for 2003. For the present study, a final adjustment was made to represent 2004 costs.

The independent system variables used in the light rail O&M cost model are peak vehicles (number of vehicles in operation during peak periods), directional route miles, annual vehicle miles, and annual vehicle hours.

The Bay Link Streetcar system would use a smaller and less expensive vehicle than does the typical light rail system. The smaller size and cost result in lower energy consumption per vehicle mile operated, and lower maintenance cost per vehicle operated. Operator costs per vehicle hour may be the same as for light rail, unless the streetcar system has a higher average number of vehicles per train. General and administrative costs might be unchanged overall, but would be spread over a larger number of vehicle hours. Non-vehicle maintenance may be larger absolutely and per route mile, due to the increased number of stations in the current streetcar plan, compared with the 2002 light rail plan.

Taking account of these various considerations, initial O&M cost model revisions were made as shown in Table 14.

Table 14: Bay Link Streetcar Initial O&M Cost Model

	2002 LRT	Vehicle Size Factor	2004/2002 Price Factor	2004 Streetcar
Per Peak Vehicle	$83,123	0.764	1.069	$67,868
Per Track Mile	$96,590	1.050	1.069	$108,430
Per Vehicle Mile	$5.19	0.789	1.069	$4.38
Per Vehicle Service Hour	$52.92	0.950	1.069	$53.75

Source: Parsons Brinckerhoff

The streetcar route has closer station spacing than did the Bay Link service in the earlier light rail study, and in fact closer spacing than is typical of US light rail systems. For this reason, the cost model was further revised to separate the cost per directional route mile into two components, one being related to cost per unit of route length, and the other related to cost per station (actually, per station platform, because for side platform streetcar stations each platform is effectively a complete and separate unit. Finally, because streetcar service may be operated as single-car or multi-car trains, the allocation of costs to vehicle miles and vehicle hours was redefined to use vehicle miles and *train* hours as the independent variables. In the absence of specific cost detail, this re-definition was made without adjustment in the unit costs.

The earlier studies did not include Tri-Rail service, but the networks now being used in the Bay Link study include a small amount of Tri-Rail commuter rail service. Because the magnitude was small and was the same in each of the three alternatives (No Build, TSM, and LPA) it was sufficient to prepare a simple cost model based on recent (2002) FTA data for the Tri-Rail system.

The resulting O&M cost models and their application to the system and service variables are as follows, in Table 15.

Table 15: Annual O&M Costs (2004 Dollars)

Independent Variable	Unit Cost, 2004$	No Build		TSM		LPA	
		Annual Units	Annual Cost	Annual Units	Annual Cost	Annual Units	Annual Cost
Bay Link Streetcar							
Peak Vehicles	$67,868	0	$ -	0	$ -	18	$ 1,241,352
Track Miles	$48,900	0	$ -	0	$ -	20.58	$ 983,379
Station Platforms	$27,900	0	$ -	0	$ -	48	$ 1,339,200
Vehicle Miles	$4.38	0	$ -	0	$ -	980,884	$ 4,141,790
Train Hours	$53.75	0	$ -	0	$ -	78,899	$ 4,082,208
Total Annual Cost			$ -		$ -		$ 11,787,929
MetroRail							
Platform Hours (trains)	$37.50	206,856	$ 7,757,100	206,856	$ 7,757,100	206,856	$ 7,757,100
Total Train Hours	$17.53	270,981	$ 4,750,303	270,981	$ 4,750,303	270,981	$ 4,750,303
Rail Vehicles	$97,231	318	$ 30,919,458	318	$ 30,919,458	318	$ 30,919,458
Vehicle Miles	$2.77	43,234,842	$ 119,760,512	43,234,842	$ 119,760,512	43,234,842	$ 119,760,512
Passenger Boardings	$0.06	35,746,159	$ 2,144,770	35,742,782	$ 2,144,567	36,985,211	$ 2,219,113
Stations	$504,598	34	$ 17,156,332	34	$ 17,156,332	34	$ 17,156,332
Yards	$713,937	1	$ 713,937	1	$ 713,937	1	$ 713,937
Rail Track Miles	$90,425	139	$ 12,569,075	139	$ 12,569,075	139	$ 12,569,075
Total Annual Cost			$ 195,771,487		$ 195,771,284		$ 195,845,830
MetroMover							
Vehicle Hours	$19.79	113,832	$ 2,252,735	113,832	$ 2,252,735	113,832	$ 2,252,735
Rail Vehicles	$127,972	25	$ 3,199,300	25	$ 3,199,300	25	$ 3,199,300
Vehicle Miles	$7.12	1,034,280	$ 7,364,074	1,034,280	$ 7,364,074	1,034,280	$ 7,364,074
Passenger Boardings	$0.06	7,300,460	$ 438,028	7,357,869	$ 441,472	9,099,173	$ 545,950
Stations	$68,383	17	$ 1,162,511	17	$ 1,162,511	17	$ 1,162,511
Yards	$79,320	1	$ 79,320	1	$ 79,320	1	$ 79,320
Rail Track Miles	$188,657	1.80	$ 339,583	1.80	$ 339,583	1.80	$ 339,583
Total Annual Cost			$ 14,835,550		$ 14,838,995		$ 14,943,473
Bus							
Revenue Hours	$36.80	3,749,112	$ 137,967,322	3,750,336	$ 138,012,365	3,569,184	$ 131,345,971
Vehicle Hours	$9.20	4,197,537	$ 38,617,343	4,198,908	$ 38,629,951	3,996,088	$ 36,764,013
Vehicle Miles	$1.69	48,184,658	$ 81,432,072	48,184,658	$ 81,432,072	45,802,902	$ 77,406,904
Passenger Boardings	$0.06	100,680,650	$ 6,040,839	100,570,437	$ 6,034,226	92,511,073	$ 5,550,664
Garages	$569,291	4	$ 2,277,164	4	$ 2,277,164	4	$ 2,277,164
Total Vehicles	$33,799	991	$ 33,494,809	991	$ 33,494,809	991	$ 33,494,809
Total Annual Cost			$ 299,829,549		$ 299,880,587		$ 286,839,526
Tri-Rail							
Revenue Train Hours	$253.50	13,464	$ 3,413,124	13,464	$ 3,413,124	13,464	$ 3,413,124
Revenue Vehicle Miles	$3.851	236,232	$ 909,729	236,232	$ 909,729	236,232	$ 909,729
Directional Route Miles	$11,130	29.40	$ 327,222	29.40	$ 327,222	29.40	$ 327,222
Stations	$11,130	5	$ 55,650	5	$ 55,650	5	$ 55,650
Total Annual Cost			$ 4,705,725		$ 4,705,725		$ 4,705,725
Total, All Transit Services			**$ 515,142,311**		**$ 515,196,591**		**$ 514,438,808**

Source: Parsons Brinckerhoff