11. Operating and Maintenance Costs

This section provides an overview of the development and structure of operating and maintenance (O&M) cost-estimating models created for the modern streetcar and bus rapid transit (BRT)/premium bus transit modes proposed with, respectively, Alternatives 2 and 3 and Alternatives 2A and 3A and the resultant order-of-magnitude O&M cost estimates, by alternative.

11.1 Operating and Maintenance Cost Estimating Approach

The O&M cost methodology was structured in accordance with Federal Transit Administration (FTA) guidelines for estimating O&M costs in a "resource build-up" manner as part of the New Starts process, as follows:

- Costs are computed by estimating labor and materials needed to provide a given level of service, and then unit costs are applied to the estimated future labor and materials cost items.
- Costs are calculated based on operating statistics by mode (rather than system-wide for all modes combined).
- Each labor and non-labor expense item is calculated separately, which ensures that equations are mutually exclusive and cover all operating costs.
- Cost items are variable, meaning that cost estimates will change with projected changes in service.

System characteristics and operating statistics serve as driving variables in an O&M cost model. Current expenses are paired with relevant driving variables to derive unit costs that represent current rates of consumption and labor productivity. An O&M cost model uses current unit costs as the basis for estimating future costs of transit alternatives under consideration.

The basic structure of a resource build-up model is a series of line items representing specific labor or non-labor costs. Each item is linked, either directly or indirectly, to an input variable that reflects levels of service or some other system attribute. Examples of level-of-service variables include annual revenue vehicle miles, and the number of vehicles in peak-period service.

Two O&M cost models were developed, one for modern streetcar alternatives and one for BRT/premium bus alternatives, comprising the following functional areas:

- Vehicle Operations: Annual costs associated with vehicle operations such as rail/bus operator and rail/bus operation supervisor wages and fringe benefits, and costs associated with traction power (e.g., electricity or fuel);
- Vehicle Maintenance: Annual costs associated with vehicle maintenance such as mechanic and supervisor wages and fringe benefits, and vehicle maintenance materials (e.g., spare parts, lubricants, tools and uniforms/protective clothing, etc.);
- Non-Vehicle Maintenance: Annual costs associated with right-of-way maintenance, such as technician and supervisor wages and fringe benefits, right-of-way maintainers, vehicle control and communications equipment, maintenance of fare collection and counting equipment, maintenance of passenger facilities, and maintenance materials; and
- Stations: Annual costs associated with station maintenance, such as transit facility maintainers wages and fringe benefits.

Annual costs associated with general administration (i.e., supervision and clerical support associated with finance, purchasing, payroll, human relations, etc.) were not included in the O&M cost models because it was assumed that the modern streetcar or BRT/premium bus alternative would be operated under contract to Nassau County, and these administrative costs would be included in any contract between the County and the transit operator.

The unit costs include an adjustment factor for the differences in regional labor costs, as well as an inflation factor derived from the U.S. Department of Labor, Bureau of Labor Statistics Consumer Price Index, to account for general rise in costs of services and goods to enable costs to be represented in 2012 dollars.

11.1.1 Modern Streetcar O&M Cost Model Development

The cost model is based on the major O&M expense object classes (i.e., cost categories) in the National Transit Database (NTD).[1] Expense line items (i.e., salary and wages, fringe benefits, services, etc.) were assigned to the appropriate functional areas or O&M cost categories. A unit of service (or key supply variable) was assigned to the expense line items. A unit of service may be represented as annual revenue vehicle hours or the total number of the vehicles in peak service. Unit costs representing labor wages and fringe benefits, as well as costs of materials, were developed based on recent operations and service statistics, which are, in turn, based on data obtained from the Fiscal Year (FY) 2010 NTD database. To provide a reasonable average of O&M expenses for the modern streetcar alternatives, five peer fixed-guideway rail systems that are similar to Alternatives 2 and 3 were reviewed.

The basis for the O&M cost model used to estimate the O&M costs of the modern streetcar Alternatives 2 and 3 is a "calibration system," which can be defined as the combination of actual O&M expenses with system and service statistics for a recent 12-month period. Once structured into a series of expense items and unit costs, a model can estimate costs for any set of statistics representing a future transit alternative for that mode. It is implicitly assumed that the calibration-year rates of consumption and labor productivity will continue into the future.

The five peer fixed-guideway rail systems that were reviewed were identified based on their similarity to Alternatives 2 and 3 in terms of their operating statistics such as fleet size, number of vehicles in daily operation, annual revenue train hours and train miles, route length, one-way travel times, average operating speed, number of stations, and number of lines in the system (see Section 8.1.5). In addition, peer systems were selected considering their physical and operational characteristics relative to those proposed for Alternatives 2 and 3. The peer systems are new, primarily at-grade systems. Rights-of-way types for the peer systems range from operating in roadways, in semi-exclusive alignment and/or with mixed traffic, to exclusive alignments such as former rail rights-of-way. The peer systems serve similar types of major activity centers (i.e., universities, intermodal centers, large malls, etc.), and have average operating speeds and service plans comparable to Alternatives 2 and 3. It is recognized that no one peer system matches the Nassau Hub Study's modern streetcar alternatives' operating parameters exactly; the range of selected peer systems provided a diversity that allowed the cost model's averaging ability to mitigate any specific cost anomalies attributable to one of the peer systems.

[1] The National Transit Database is the FTA's primary national database for statistics on the transit industry.

The peer systems used as the basis for unit costs and productivity ratios are the Tacoma Link (Tacoma, WA), the South Lake Union Streetcar (Seattle, WA), Newark Light Rail (Newark, NJ), METRORail (Houston, TX), and the Hiawatha Line (Minneapolis, MN).

11.1.2 BRT/Premium Bus O&M Cost Model Development

In 2011, Nassau County entered into a contract for the operation and maintenance of its bus services with Veolia Transportation, a private transportation provider. The new system is the Nassau Inter County Express (NICE) Bus. Unlike the modern streetcar Alternatives 2 and 3, detailed NTD data regarding NICE Bus operations are not available (NICE Bus began operations in January 2012). However, Veolia Transportation provided the Study Team with the hourly cost for its fixed-route operations. The cost per vehicle hour under the current contract between Nassau County and Veolia Transportation is $112.32.[2] Using this unit cost and applying the same unit cost as was used for modern streetcar stations since the stations would contain the same features and elements,[3] a two-variable O&M cost model was developed to calculate the annual O&M cost for the BRT/premium bus alternatives.

11.2 O&M Cost Methodology

11.2.1 Key Supply Variables

The modeling effort began with the selection of key driving supply variables. The key supply variables that were used to drive related expense items (i.e., cost items) are described below. The key variables focus primarily on the modern streetcar alternatives as there are more variables in the modern streetcar model; variables used for the BRT/premium bus are noted, as applicable.

- Annual Revenue Vehicle Hours represent the total number of hours during 1 year in which vehicles operate with revenue service (i.e., the time in which the vehicles are available for travel by the general public). Vehicle operating costs are closely related to the amount of time transit vehicles spend in revenue operation, as these costs are largely driven by the labor costs of operators. Per NTD reporting instructions, revenue service includes layover time at terminals since an operator is on duty during rest periods. For the BRT/premium bus alternatives, the equivalent operating statistic, annual revenue vehicle hours, was used to estimate annual O&M costs.
- Annual Revenue Vehicle Miles represents the mileage that vehicles (i.e., modern streetcars) travel during 1 year in revenue service. Propulsion power costs are largely driven by the distance traveled by vehicles, which has a nearly direct relationship to the power consumed for locomotion and is a good surrogate for other constant power requirements (e.g., vehicle heating, ventilation and air conditioning [HVAC], lighting of vehicle, etc.). Vehicle maintenance costs are closely related to the total revenue mileage traveled by vehicles in the fleet, as the cost of maintaining vehicles is largely driven by the wear and tear on the vehicle fleet.

[2] Veolia Transportation's cost per vehicle hour was compared to FY2010 NTD data for similar systems in the Northeast, i.e., MBTA (Boston, MA), Bee-Line Bus (Westchester County, NY), NFTA (Niagara Falls, NY), and the former MTA LI Bus (Nassau County, NY). The review found that the NICE Bus system's aggregate cost is comparable to these systems (MBTA: $142.96 per vehicle hour, NFTA: $114.23 per vehicle hour, Westchester Bee Line: $159.17 per vehicle hour, and MTA LI Bus: $128.05 per vehicle hour).

[3] The station O&M unit cost is based on the average station O&M costs for Salt Lake City, St. Louis, Denver, San Jose, Portland, Sacramento, Los Angeles, and Baltimore in 2012 dollars.

- Track Miles are the best indicator of the physical size of the system. A track mile is equal to 1 mile of single track.[4] Non-vehicle maintenance cost is focused on the maintenance of the system's infrastructure (i.e., track, signals, and communications). This operating statistic is used as an input in calculating the costs of track maintenance labor, materials and supplies because the numbers of staff and materials needed to maintain trackage are directly related to the number of tracks and the length of the alignment.
- Number of Stations represent the total number of stations along the alignment. Costs associated with station maintenance include labor costs, maintenance materials and supplies, and contracted services. This variable applies to both the modern streetcar and BRT/premium bus alternatives.

The following sections outline the steps that were followed to develop the O&M cost models.

11.2.2 Data Assembled

Following the selection of key driving supply variables, recent operations and expense data for the five peer systems were obtained from the FY 2010 NTD. These data were used in the development of the functional areas (i.e., O&M cost categories) including expense line items, unit costs, and productivity ratios, and were used as inputs to the O&M cost model.

11.2.3 Expense Line Items and Unit Costs

Following the identification of the functional areas, the next step was to record peer system expenses in a series of line items. Once line items were established, each one was assigned a key supply variable as its most relevant cost driver, as shown in Table 11-1.

Table 11-1: Modern Streetcar O&M Cost Categories, Associated Cost Items, and Key Supply Variables

Cost Category and Cost Item	Key Supply Variable
Vehicle Operations	
Operations Salaries & Wages	• Annual Revenue Vehicle Hours
Fringe Benefits	• Annual Revenue Vehicle Hours
Utilities (Propulsion Power)	• Annual Revenue Vehicle Miles
Services	• Annual Revenue Vehicle Hours
Other Expenses	• Annual Revenue Vehicle Hours
Vehicle Maintenance	
Salaries & Wages	• Annual Revenue Vehicle Miles
Fringe Benefits	• Annual Revenue Vehicle Miles
Services	• Annual Revenue Vehicle Miles
Maintenance Materials and Supplies	• Annual Revenue Vehicle Miles
Other Expenses	• Annual Revenue Vehicle Miles
Non-Vehicle Maintenance-of-Way	
Salaries & Wages	• Track Mileage
Fringe Benefits	• Track Mileage
Services	• Track Mileage
Other Materials and Supplies	• Track Mileage
Other Expenses	• Track Mileage
Stations	
Transit Facility Maintainers	• Number of Stations
Maintenance Materials and Supplies	• Number of Stations
Contracted Services	• Number of Stations

Source: Jacobs, 2012.

[4] A two-track section that is 1 mile in length would be calculated as 2 track miles.

The next step in the O&M cost model development was to obtain base-year (FY 2010) cost data for the development of unit costs, including NTD cost and service data from peer fixed-guideway rail systems for the modern streetcar Alternatives 2 and 3.

Base-year costs for each expense line item were assigned to the associated service variables and unit costs, and productivity ratios were calculated.

The basic formula used for calculating O&M costs is as follows:

O&M Expense = Unit Cost [$/quantity] x Service Quantity

Once each system's unit costs were developed, averages were calculated for use in the O&M cost model. For the modern streetcar O&M cost model, unit costs were averaged with a simple average among all five peer systems. However, labor unit costs were weighted before averaging to account for regional differences in labor costs. Regional cost-of-labor factors were developed using average hourly wages for each metropolitan area, as reported in the Occupational Employment Statistics database compiled by the Bureau of Labor Statistics.[5] These factors are shown in Table 11-2.

Table 11-2: Cost of Labor Adjustments by Metropolitan Area

Metropolitan Area	Cost of Labor Factor
Nassau County, NY	**1.00**
Tacoma, WA	0.90
Seattle, WA	1.07
Newark, NJ	1.05
Houston, TX	0.91
Minneapolis, MN	0.98

Source: U.S. Bureau of Labor Statistics, 2012.

Using these data, unit costs and the model's base-year costs were calculated. All unit costs use a 5 percent inflation factor, derived from the U.S. Bureau of Labor Statistics Consumer Price Index to represent 2012 dollars. Table 11-3 shows the O&M cost model used to estimate O&M costs for the modern streetcar Alternatives 2 and 3.

[5] Metropolitan Area Wage Estimates, Occupational Employment Statistics, Bureau of Labor Statistics. May 2011. http://www.bls.gov/oes/current/oessrcma.htm

Table 11-3: Modern Streetcar O&M Cost Model - FY2012 Unit Costs

Cost Item	Resource Variable	Average Unit Cost (FY 2010)		Average Unit Cost (FY 2012)	
Operating Expenses					
Vehicle Operations					
Operations Salaries & Wages	Annual Revenue Vehicle Hours	$63.69	*per Revenue Vehicle Hour*	$66.88	*per Revenue Vehicle Hour*
Fringe Benefits	Annual Revenue Vehicle Hours	$41.25	*per Revenue Vehicle Hour*	$43.31	*per Revenue Vehicle Hour*
Utilities (Propulsion Power)	Annual Revenue Vehicle Miles	$0.73	*per Revenue Vehicle Mile*	$0.77	*per Revenue Vehicle Mile*
Services	Annual Revenue Vehicle Hours	$4.08	*per Revenue Vehicle Hour*	$4.29	*per Revenue Vehicle Hour*
Other Expenses	Annual Revenue Vehicle Hours	$0.37	*per Revenue Vehicle Hour*	$0.39	*per Revenue Vehicle Hour*
Vehicle Maintenance					
Salaries & Wages	Annual Revenue Vehicle Miles	$2.05	*per Revenue Vehicle Mile*	$2.16	*per Revenue Vehicle Mile*
Fringe Benefits	Annual Revenue Vehicle Miles	$1.33	*per Revenue Vehicle Mile*	$1.40	*per Revenue Vehicle Mile*
Services	Annual Revenue Vehicle Miles	$0.34	*per Revenue Vehicle Mile*	$0.35	*per Revenue Vehicle Mile*
Maintenance Materials and Supplies	Annual Revenue Vehicle Miles	$0.90	*per Revenue Vehicle Mile*	$0.94	*per Revenue Vehicle Mile*
Other Expenses	Annual Revenue Vehicle Miles	$0.24	*per Revenue Vehicle Mile*	$0.25	*per Revenue Vehicle Mile*
Non-Vehicle Maintenance					
Salaries & Wages	Track Mileage	$7,612.38	*per Track Mile*	$60,493.00	*per Track Mile*
Fringe Benefits	Track Mileage	$37,806.65	*per Track Mile*	$39,696.98	*per Track Mile*
Services	Track Mileage	$14,476.67	*per Track Mile*	$15,200.50	*per Track Mile*
Other Materials and Supplies	Track Mileage	$3,897.41	*per Track Mile*	$4,092.28	*per Track Mile*
Other Expenses	Track Mileage	$44.63	*per Track Mile*	$46.86	*per Track Mile*
Station Maintenance					
Transit Facility Maintainers	Stations	$57,238.00	*per Station Maintainer*	$60,100.00	*per Station Maintainer*
Materials and Supplies	Stations	$5,932.00	*per Station*	$6,229.00	*per Station*
Contract Services	Stations	$4,675.00	*per Station*	$4,909.00	*per Station*

Source: Jacobs, 2012.

11.2.4 Variable Quantities for Modern Streetcar Alternatives 2 and 3

A service plan defining the operation of the modern streetcar Alternatives 2 and 3 was created and used in the calculation of units of service, which were used as input to the O&M cost models. Table 11-4 presents a summary of the basic operating parameters for Alternatives 2 and 3.

Table 11-4: Operating Parameters of Modern Streetcar Alternatives 2 and 3

Operating Parameter	Alternative 2 Mineola and Hempstead, via Source Mall area	Alternative 3 Mineola and Hempstead, via South Street
Alignment Length (route miles)	7.1	6.5
Average Operating Speed (mph)	13.0	14.0
End-to-End One-Way Run Time (minutes)	32.8	28.1
Minimum Layover Time at Terminals (each end)	17	15/16
Round Trip Cycle Time During Peak Periods (Weekdays) (minutes)	100	80
Weekday Peak Headways (minutes)	10	10
Peak Vehicles in Service	10	8
Peak Consist Size (# of vehicles)	1	1
Spare Ratio (15% of peak vehicle requirement)	2	2
Total Fleet Size	12	10
Total Number of Stations	18	14
Total Revenue Train/Vehicle Hours (Annual)	53,893	42,515
Total Revenue Train/Vehicle Miles (Annual)	411,942	377,130

Source: Jacobs, 2012.

11.2.5 Variable Quantities for BRT/Premium Bus Alternatives 2A and 3A

A service plan defining the operation of the BRT/premium bus alternatives was created and used in the calculation of units of service, which were used as input to the O&M cost models. Table 11-5 presents a summary of the basic operating parameters for the BRT/premium bus alternatives.

Table 11-5: Operating Parameters of BRT/Premium Bus Alternatives 2A and 3A

Operating Parameter	Alternative 2A Mineola and Hempstead, via Source Mall area	Alternative 3A Mineola and Hempstead, via South Street
Alignment Length (route miles)	8.5	6.8
Average Operating Speed (mph)	11.7	11.7
End-to-End One-Way Run Time (minutes)	43.4	34.8
Recovery Time at Each End for Peak Period (minutes)	6.5	5
Recovery Time at Each End on Off-peak Period (minutes)	9	10
Weekday Peak Headways (minutes)	10	10
Peak Buses in Service	10	8
Spare Ratio (15% of peak vehicle requirement)	2	2
Total Fleet Size	12	10
Total Number of Stations	21	16
Total Revenue Vehicle Hours (Annual)	50,268	42,515
Total Revenue Vehicle Miles (Annual)	493,170	394,536

Source: Jacobs, 2012.

11.3 O&M Cost Results

Based on the service plans defined for the modern streetcar Alternatives 2 and 3, the annual O&M costs were estimated to be $10.6 million and $8.9 million, respectively. The annual O&M costs for BRT/premium bus Alternatives 2A and 3A were estimated to be $5.9 million and $5.0 million, respectively. All costs were estimated in 2012 dollars. A summary of the annual O&M cost by alternative is presented in Table 11-6.

Table 11-6: Annual O&M Cost Summary by Alternative
(millions of dollars [2012])

	Alternative 2 Modern Streetcar Mineola to Hempstead via Source Mall	**Alternative 3 Modern Streetcar Mineola to Hempstead via South Street**
Vehicle Operations	$6.5	$5.2
Vehicle Maintenance	$2.1	$1.9
Non-Vehicle Maintenance	$1.7	$1.6
Station Maintenance	$0.3	$0.2
Total	**$10.6**	**$8.9**
Operation, Maintenance and Administration (fixed rate)	$5.6	$4.7
Station Maintenance	$0.3	$0.3
Total	**$5.9**	**$5.0**

Source: Jacobs, 2012.