Memorandum

Subject: Review of 2009 Honolulu O&M Cost Methodology

From: Brian McCollom, McCollom Management Consulting, Inc. Brian E McCollom

To: James Ryan, Federal Transit Administration

Date: June 18, 2009

As you requested, I reviewed the Operations and Maintenance Cost Methodology submitted by the City and County of Honolulu (City). The model was developed by Lea+Elliott, Inc. under subcontract to Parsons Brinkerhoff Quade & Douglas, Inc. As part of this effort, I reviewed the following:

- **Honolulu High-Capacity Transit Corridor Project: Memorandum on O&M Cost Models.** The report was dated May 2009.

- **Honolulu High-Capacity Transit Corridor Project: Memorandum on Forecasts of O&M Costs.** The report was dated May 2009.

- **Bus unit costs_HNL esc rates.xls.** The bus model is structured as a series of linked worksheets within a single Excel spreadsheet. Lea+Elliott emailed me this spreadsheet.

- **LRT unit costs_HNL esc rates.xls.** The bus model is structured as a series of linked worksheets within a single Excel spreadsheet. Lea+Elliott emailed me this spreadsheet.

This is the second effort by Honolulu that I have reviewed. I reviewed the initial work performed in 2006 last summer. I summarized my review in a July 29, 2008 memorandum to Ron Fisher entitled **Review of Honolulu O&M Cost Methodology** The following sections provide a summary of my review of the bus and rail models.

BUS MODEL

Bus Costing Model Structure and Development

The bus cost model is based on the operating cost data from City's financial statements for fiscal year 2005. Based on the changes in the CPI between June 2005 and June 2007, the cost data are inflated 10.97% to estimate 2007 costs.

The costing approach uses the following seven types of driving variables in the development of unit costs:

- **Peak Vehicles (PV).** The number of revenue vehicles operated to meet the annual maximum service requirement. Peak vehicles are equivalent to *Vehicles Operated in Maximum Service* which is a service statistic reported in the National Transit Database (NTD). In 2005, there were 416 peak vehicles. The number increased to 424 in 2007 and 439 in 2008.

  Separate unit costs are developed for standard (SB) buses, articulated diesel (AD) buses, and articulated hybrid (AH) buses.

- **Vehicle Revenue Miles (VRM).** The miles that vehicles actually travel while in revenue service. Revenue miles do not include deadhead miles. Separate unit costs are developed for SB, AD, and AH buses.

- **Vehicle Revenue Hours (VRH).** The hours that vehicles actually travel while in revenue service. Revenue hours include layover time, but do not include deadhead time.

- **Maintenance Facilities (MF).** Facilities where maintenance activities are conducted. Honolulu now operates two facilities

- **Unlinked Passenger Trips (PT).** The number of passengers who board public transportation vehicles. Bus passenger trips have increased from 68.1 million in FY 2005 to 69.1 million in FY 2008.

- **Service center (SC).** It is proposed that a light duty service center be constructed to provide routine daily support of vehicle operations, including servicing (fueling, cleaning, farebox handling) and minor vehicle inspections.

- **Terminal (T).** It is proposed that a staging facility be constructed to park vehicles operated only in peak hour service for which it is not cost-effective to deadhead morning buses since they return to service at the same location in the afternoon. This facility includes administrative offices, a bus staging area, and driver reporting and rest areas.

The unit costs for the three bus types (SB, AD, AH) are calculated based on the operating experience in other cities. For AD buses, the unit cost rates for PV and RVM are increased 19 percent and 39 percent, respectively, based on a technical study performed for Honolulu. These increases are between the low increases found in King County (8 percent) and the high rates in Sacramento (50 percent). The unit cost rates for AH buses were reduced by 15 percent from the AD buses based on a recent study performed for the US Department of Energy of AH buses operated in King County.

The development of the unit costs for the service center (SC) variable is estimated using a relationship of capital costs for this facility as a surrogate for operating costs. The capital cost of a SC is 62.5% of the capital cost of a MF. Without detailed information about the operating costs of a SC, the study team assumed that the unit operating cost of a SC will be 62.5% of the unit operating cost of a MF.

The discussion of the development of the unit cost for the terminal (T) variable clearly states the difficulty of defining a unit cost. The capital costs for a terminal are comparable to the capital cost of a MF. Since the nature, size, and operation of a terminal is undefined and can vary widely, it is assumed that the unit operating cost of a terminal is the same as a MF. It is stated that, if necessary, this unit cost can be revised once the definition of this facility evolves.

Bus Costing Forecasts

The bus model documented in **Memorandum on O&M Cost Models** is used to estimate the annual bus O&M costs in the **Memorandum on Forecasts of O&M Costs.** The unit cost values used in the estimate were identical to the values shown in the development of the bus cost models.

HHCTCP Estimated Total Annual Bus O&M Costs (2007 USD)				
	Total Cost		Cost/RVH	
	Year 2030	Year 2018	Year 2030	Year 2018
TSM Alternative	$227,576,478	$218,244,051	$110.83	$111.91
Build Alternative, First Project, Airport	$181,161,316	$173,651,194	$108.48	$109.38

The forecast memorandum discusses the forecasts in the context of the historical increase in Honolulu bus operating and maintenance costs. It shows the cost trends per RVH, RVM, and PV from 1999 through 2007.

Bus Costing Observations

- **Good Documentation.** The documentation in the two memoranda provides the detail needed to understand the structure, calibration, and application of the cost models. However, it should be noted that the detailed costs data were aggregated in the memorandum of the model development to make it easy for the reader to understand the basics of the model. The calibration spreadsheet for the bus model is well organized and is easy to understand. It shows that a detailed level of cost items was used.

- **Reasonable Allocation.** The expense line items are logically assigned to key service driving variables.

- **Reasonable Adjustments for RVM Costs.** The RVM unit costs were adjusted to reflect the different operating costs of the SB, AD, and AH buses based on actual operating experience.

- **Questionable Development of Terminal (T) Costs. I**t is assumed that the unit operating costs of a terminal are the same as a MF. However, the description of the terminal functions suggests that most are related to transportation functions such as driver and vehicle dispatching with limited maintenance functions.

  The MF and T unit cost is $843,585. If the T unit cost were adjusted to reflect better transportation functions, it might be less than $500,000. While this adjustment would reduce the cost estimates of the different service alternatives by more than $300,000, this adjustment has an insignificant affect because it represents 0.17 percent of the estimated total cost of the Build Alternative in 2030 ($181.2 million).

- **2005 Cost Data Used.** The bus cost model is based on the operating cost data from City's financial statements for fiscal year 2005. Based on the changes in the CPI between June 2005 and June 2007, the cost data are inflated 10.97% to estimate 2007 costs. However, the FTA guidance requests that the most recent data be used which would be FY 2008 data.

RAIL MODEL

Rail Costing Model Structure and Development

In the prior cost modeling report, the light rail cost model was based on the NTD operating cost data reported by the Sacramento Regional Transit District (SRTD) for fiscal year 2004. FTA commented that the City should describe why costs from one system (e.g., SRTD) or from several systems are used. FTA offered to help the City in obtaining data from other transit systems.

The City attempted to respond to FTA' s comments and documented its efforts (pages 1-3 to 1-4). The proposed light metro technology for the Honolulu system currently exists in only two locations in North America — JFK AirTrain and Vancouver SkyTrain. Lea+Elliott contacted these two systems, but was unable to collect detailed data.

An effort was then made to collect the detailed, actual O&M cost data from four other transit systems:

- Los Angeles County Metropolitan Transit Authority (LACMTA),

- Maryland Transit Administration (MTA),
- Miami-Dade Transit (MDT), and
- Washington Metropolitan Area Transit Authority (WMATA).

Lea+Elliott succeeded in obtaining detailed data only from WMATA. The MTA data were provided only at a gross level, even more aggregate than NTD data. The data from LACMTA and MDT were either budgetary rather than actual data, comingled data with other modes, or incomplete.

The cost model documentation discussed the similarities and differences between the WMATA system and the proposed Honolulu system as follows (page 1-4):

> *WMATA's metro is a larger fixed guideway system than anticipated for Honolulu, but has a similar operation (automated train operations with one attendant per train),is a steel wheel/rail system, maintains staff in stations, and operates multiple-car consists. The economic profiles of Washington, D.C. and Honolulu, HI are also nearly identical.*
>
> *The areas where WMATA are dissimilar to the fixed guideway system anticipated for Honolulu include WMATA's line item expenses for interlocking operators, vehicle operator wages related to snow operations, and its lower electricity costs. These dissimilarities were all considered and addressed in the development of the fixed guideway O&M costs.*

The light rail cost model is based on the NTD operating cost data reported by WMATA for fiscal year 2006. Based on the changes in the CPI between June 2006 and June 2007, the cost data are first inflated 2.86% to estimate 2007 costs for WMATA.

Two line item expenses were removed from the model calibration:

- **Interlocking Operator Wages and Fringe Benefits.** Interlocking operators are used by WMATA at or near stations and interlockings to direct rail traffic between automated and non-automated territories. Since the Honolulu system will be fully automated, this work force will not be necessary.

- **Vehicle Operator Wages During Snow Operations.** This type of weather will not occur in Honolulu..

The costing approach uses the following seven driving variables in the development of unit costs:

- **Revenue Train Hours (RTH).** The hours that trains actually travel while in revenue service. Revenue hours include layover time, but do not include deadhead time.

- **Passenger Vehicle (Car) Miles.** The miles that passenger cars actually travel while in revenue service. Revenue miles do not include deadhead miles.

- **Peak Vehicles (PV).** The number of revenue vehicles operated to meet the annual maximum service requirement. Peak vehicles are equivalent to *Vehicles Operated in Maximum Service* which is a service statistic reported in the National Transit Database (NTD). WMATA operated 758 PV in 2006.

- **Directional Route-Miles (RM).** The mileage in each direction over which trains travel while in revenue service. Directional route-miles are a measure of the route path and are computed with

regard to direction of service, but without regard to the number of rail tracks existing in the right-of-way. WMATA operated on 212 RM in 2006.

- **Passenger Stations (S).** A passenger boarding/alighting facility with a platform. WMATA had 86 stations in 2006

- **Maintenance Facilities (MF).** Facilities where maintenance activities are conducted. WMATA operates six facilities.

- **Unlinked Passenger Trips (PT).** The number of passengers who board public transportation vehicles.

The resulting unit costs are examined for reasonableness in productivity ratios. Productivity data related to work hour and propulsion power were obtained and used from MTA, BART (San Francisco), MDT, and LACMTA. Additionally, comparisons with the Honolulu bus model are made. The key productivity adjustments are:

Productivity Ratio Adjustments to Unit Costs

	Variable	WMATA Value	Change	Percent
Revenue Operators Wages (and Fringes)	RTH	$161.89	$64.09	-39.6%
Vehicle Maintenance Wages (and Fringes)	RVM	$3.49	$0.21	-6.0%
Revenue Propulsion Power	RVM	$3.49	$0.12	-3.4%
General/Administrative Salaries (and Fringes)	PV	$257,255	$28,273	-11.0%
FICA	PV	$257,255	$822	-0.3%

- **Revenue Operators Wages (and Fringes).** The productivity ratio of vehicle operator work hours (VOWH) to revenue train hours is used. We assume that these hours are mislabeled and represent vehicle operations work hours which cover not only operators, but supervisors, station attendants, and police security.

  The average for the four systems is 7.51, while WMATA operated at 8.23. It is assumed for the model development that the MDT ratio of 4.96 is the most appropriate value.

  This adjustment has a major impact on the unit cost per RTH because these wages and fringes costs represent 99.7 percent of the total expenses assigned to this variable. This reduces the 2006 cost per RTH from $161.89 to $97.78. If the average productivity value (7.51) for the systems is selected, the change will be smaller, from $161.89 to $147.77.

- **Vehicle Maintenance Wages (and Fringes).** The productivity ratio of total maintenance work hours (TMWH) to revenue vehicle miles is used. The average for the four systems is .0777, while WMATA operated at .0848. However, the values for three of the four systems range from 0.084 to 0.092 with MDT outside the range at 0.038. It is assumed for the model development that the average of 0.0777 is the most appropriate.

  This adjustment has an impact on the unit cost per RVM because these wages and fringes costs represent 73.9 percent of the total expenses assigned to this variable. This reduces the 2006 cost per RTH from $3.49 to $3.28.

- **Revenue Propulsion Power.** The productivity ratio of energy consumption (EC) to revenue vehicle miles is used. The units for energy consumption are not defined in the memorandum.

  The average for the four systems is 8.17, while WMATA operated at 7.40. However, the values for the four systems range from 4.68 (BART) to 14.14 (LACMTA). It is assumed for the model development that the MTA value of 5.74 was more reflective of the proposed Honolulu system.

  This adjustment has an impact on the unit cost per RVM because propulsion power costs represent 15.8 percent of the total expenses assigned to this variable. This reduces the 2006 cost per RTH from $3.49 to $3.37.

- **General/Administrative Salaries (and Fringes).** The productivity ratio of total G/A hours (GASWH) to peak vehicles (PV) is used. The average for the four systems is 1,463 while WMATA operated at 1,124 and the Honolulu bus system operated at 473. The values for the systems ranged from 655 to 2,517. It is assumed for the model development that Honolulu will be twice its bus system value or 945.

  This adjustment has an impact on the unit cost per PV because these wages and fringes costs represent 69.1 percent of the total expenses assigned to this variable. This reduces the 2006 cost per PV from $257,255 to $228,982.

- **FICA.** The productivity ratio of total work hours (TWH) to peak vehicles (PV) is used. The average for the four systems was 13,368, while WMATA operated at 13,768. The values for the systems ranged from 10,455 to 16,365. The average of 13,368 is assumed for the model development.

  This adjustment has little impact on the unit cost per PV because of the average value is only 2.9 percent lower than the WMATA value. This reduces the 2006 cost per PV only $822 from $257,255 to $256,433.

Rail Costing Forecasts

The bus model documented in **Memorandum on O&M Cost Models** is used to estimate the annual rail O&M costs in the **Memorandum on Forecasts of O&M Costs.** The unit cost values used in the estimate were identical to the values shown in the development of the bus cost models.

HHCTCP Estimated Total Annual Rail O&M Costs (2007 USD)				
	Total Cost		Cost/RTH	
	Year 2030	Year 2018	Year 2030	Year 2018
Build Alternative, First Project, Airport	$79,423,423	$69,489,577	$698.88	$581.65

The forecast memorandum discusses the reasonableness of the rail forecasts in comparison to the total operating and maintenance costs per key driving service variable for five heavy rail properties. In terms of the two key driving service variables — RTH and RVM, the following arguments are made:

- **Revenue Train Hours (RTH).** The wide differences between the forecast and system values are attributed to the smaller train consists operated by the proposed Honolulu system which are stated to be half the size of the HR consists.

Total Operating and Maintenance Unit Costs (2007 USD) Heavy Rail System Comparison						
	RTH	RVM	PV	PT	S	RM
Existing Systems						
WMATA HR	$1,277	$9.45	$810,378	$2.29	$7,368,784	$2,992,046
BART HR	$1,860	$7.13	$887,640	$4.21	$10,672,320	$2,195,740
LACMTA HR	$1,475	$14.59	$1,248,117	$2.14	$5,460,511	$2,738,814
Maryland HR	$1,287	$10.68	$936,118	$3.84	$3,610,740	$1,719,400
Miami-Dade HR	$1,501	$9.65	$822,745	$4.61	$3,664,954	$1,791,755
Average	**$1,480**	**$10.30**	**$940,999**	**$3.42**	**$6,155,462**	**$2,287,551**
Forecast Values						
2030 First Project, Airport	$699	$9.21	$1,058,979	$2.10	$3,782,068	$1,967,387
2018 First Project, Airport	$582	$10.16	$1,240,885	$2.19	$3,309,028	$1,721,317
Forecast Values As Percent of Averages						
2030 First Project, Airport	47.2%	89.4%	112.5%	61.4%	61.4%	86.0%
2018 First Project, Airport	39.3%	98.6%	131.9%	64.0%	53.8%	75.2%

- **Revenue Vehicle Miles (RVM).** The forecast values are within 11 percent of the system average and within the range of the observed values.

Data also are presented for existing light rail systems. However, no similar unit comparisons are made except for total cost per revenue vehicle hour. It is stated that:

> *While no single LR peer property provides an exact match to all of the forecast data for the selected fixed guideway alternative, each of the LR peer properties have at least one aspect of their operation in common with the selected HHCTCP fixed guideway system. This comparison reinforces the fact that the forecast operating costs for the selected fixed guideway alternative are reasonable, fall within the tolerance of operating costs for similar systems, and therefore limit the risk of underestimating O&M costs on the project.*

Using the data provided in the memorandum for the light rail systems, the following table was prepared that shows the total operating and maintenance costs per key driving service variable for the seven light rail properties. In terms of the two key driving service variables — RTH and RVM, the following observations can be made when comparing the heavy rail and light rail data:

- **Revenue Train Hours (RTH).** The forecast unit costs for the proposed Honolulu system fall between the high unit cost values for the heavy rail systems and the low unit cost values for the light rail systems.

- **Revenue Vehicle Miles (RVM).** The forecast values unit costs for the proposed Honolulu system fall within the range of the observed values for both heavy and light rails systems when the unusually high costs for the NJ Transit River Line and PAT services are excluded.

Total Operating and Maintenance Unit Costs (2007 USD) Light Rail System Comparison						
	RTH	RVM	PV	PT	S	RM
Existing Systems						
Bi-State	$382	$8.30	$917,804	$2.36	$1,389,108	$564,182
NJ Transit River Line	$532	$25.74	$1,539,414	$6.79	$2,076,419	$781,155
PAT	$421	$22.57	$748,526	$6.00	$1,706,640	$900,127
SRTD	$581	$11.49	$846,857	$3.27	$988,000	$642,602
SEPTA	$139	$15.10	$444,205	$2.04	$1,253,644	$684,636
TriMet	$281	$11.22	$909,333	$2.04	$1,169,143	$774,511
Utah Transit Authority	$295	$9.29	$569,370	$1.61	$1,047,640	$702,172
Average	**$376**	**$14.82**	**$853,644**	**$3.44**	**$1,375,799**	**$721,341**
Forecast Values						
2030 First Project, Airport	$699	$9.21	$1,058,979	$2.10	$3,782,068	$1,967,387
2018 First Project, Airport	$582	$10.16	$1,240,885	$2.19	$3,309,028	$1,721,317
Forecast Values As Percent of Averages						
2030 First Project, Airport	186.0%	62.2%	124.1%	61.0%	274.9%	272.7%
2018 First Project, Airport	154.9%	68.6%	145.4%	63.6%	240.5%	238.6%

Rail Costing Observations

- **Good Documentation.** The documentation in the two memoranda provides the detail needed to understand the structure, calibration, and application of the cost models. However, it should be noted that the detailed costs data were aggregated in the memorandum of the model development to make it easy for the reader to understand the basics of the model. The calibration spreadsheet for the rail model is well organized and is easy to understand. It shows that a detailed level of cost items was used.

- **Reasonable Allocation.** The expense line items are logically assigned to key service driving variables. The only exception is the FICA expense line item that might have been allocated to the RTH, RVM, PV, and S variables in proportion to wage expenses related to operators, maintenance worker, general administrative, and station managers.

- **Reasonable Productivity Adjustments for Maintenance/General Administrative Wages (and Fringes) and Propulsion Power.** These productivity adjustments are clearly explained and defensible rationales are provided.

- **Questionable Productivity Adjustments for Revenue Operator Wages (and Fringes).** The average productivity ratio for the four systems is 7.51 VOWH/RTH while WMATA operated at 8.23 VOWH/RTH. It is assumed for the model development that the MDT ratio of 4.96 is the most appropriate value.

  This adjustment has a major impact on the unit cost per RTH and reduces the 2007 cost per RTH from $166.52 to $100.60. If the average productivity value (7.51) for the systems is selected, the change will be smaller, from $166.52 to $152.04.

  This is the major adjustment that is made to the WMATA data and it has a dramatic affect on the forecast costs. If the average is used, the estimated annual rail O&M costs for 2030 increase $5.9 million from $79.4 to $85.3 million. Similar increases occur for the 2018 forecasts.

HHCTCP Estimated Total Annual Rail O&M Costs (2007 USD) Impact of Revenue Operator Wages (and Fringes) Adjustment				
	Total Cost		Cost/RTH	
	Year 2030	Year 2018	Year 2030	Year 2018
Current Model (4.96 VOWH/RTH)	$79,423,423	$69,489,577	$698.88	$581.65
Model Using Average (7.51 VOWH/RTH)	$85,269,270	$75,635,114	$750.32	$633.09
Difference	$5,845,847	$6,145,537	$51.44	$51.44

- **Questionable Productivity Adjustments for FICA.** The productivity adjustment only reduced the PV variable by only 0.3% and, therefore, is insignificant. This adjustment has little impact on the unit cost per PV because of the average value is only 2.9 percent lower than the WMATA value.

  A better way to model the FICA costs is to allocate them to the allocated to the RTH, RVM, PV, and S variables in proportion to wage expenses related to operators, maintenance workers, general administrative staff, and station managers. The resource driver for each FICA category then is the direct wage expense.

- **Questionable 2030 RTH.** The estimated annual RTH for 2030 appear inconsistent with the estimates of the other key service variables. While annual RVM and PV increase more than 25 percent between 2018 and 2030, RTH actually decline by 4.9 percent.

Key Annual Service Variables			
	2018	2030	Percent Change
RTH	119,470	113,644	-4.9%
RVM	6,839,970	8,623,989	26.1%
PV	56	75	33.9%

  It is possible that longer consists are planned to be used in 2030 which would increase RVM at a faster rate than RTH. However, it seems unlikely that RTH would decline and, instead, would at least stay at the 2018 level.

- **2005 Cost Data Used.** The light rail cost model is based on the NTD operating cost data reported by WMATA for fiscal year 2006. Based on the changes in the CPI between June 2006 and June 2007, the cost data are first inflated 2.86% to estimate 2007 costs for WMATA. However, the FTA guidance requests that the most recent data be used which would be FY 2008 data.

- **More FTA Research is Needed on Rail Costing.** The major issue in the development of the rail model was obtaining detailed, actual cost that could be applied to the proposed Honolulu rail system. It was argued that the technology proposed for Honolulu currently exists in only two locations in North America. Efforts made to obtain detailed cost data were unsuccessful (note: FTA offered to help obtain these data, but no FTA assistance was requested).

  In the absence of directly applicable data, efforts were made to collect detailed data from four other rail systems. For several reasons, detailed data could only be obtained from one transit system — WMATA. It is appears that reasonable efforts were made to modify the data to provide reasonable estimates for the Honolulu system.

  However, the technical difficulty still remains in model and in this review: *How should data for a heavy rail system with 758 rail cars, 86 stations, and 212 route miles be modified to apply to a proposed light rail system with 75 rail cars, 21 stations, and 40 route miles?*

The knowledge and research on this topic is limited. I believe that expecting a project sponsor to produce such research is unreasonable. However, it is reasonable for FTA to conduct this research so that: 1) the research is not repeated for every rail project: and 2) consistent and technically-competent approaches can be used in all projects.