

Honolulu High-Capacity Transit Corridor Project

Memorandum on O&M Cost Models

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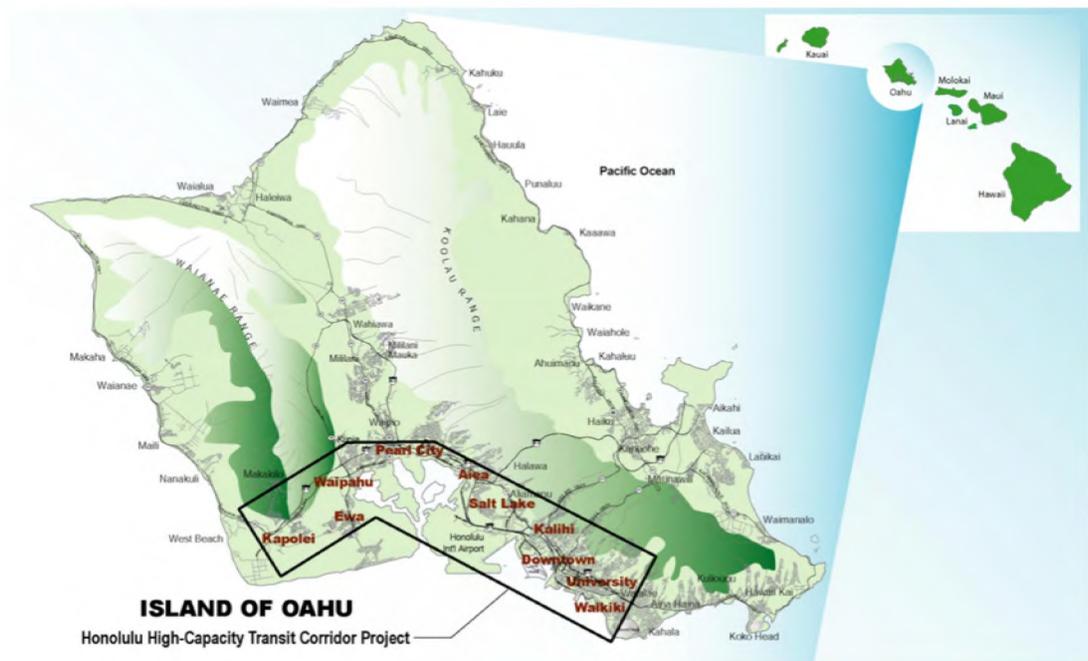
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1 Overview of Service Alternative Being Evaluated

The City and County of Honolulu (the Owner), in cooperation with the Federal Transit Administration (FTA), has conducted an Alternatives Analysis (AA) that culminated in the selection of a Locally Preferred Alternative (LPA). The Owner is in the process of developing the Environmental Impact Statement (EIS) in support of implementing the LPA within the Honolulu High Capacity Transit Corridor (HHCTC).

As depicted in Figure 1, the HHCTC extends from Kapolei in the west to UH Mānoa in the east, and is confined by the Wai‘anae and Ko‘olau Mountain Ranges to the north and the Pacific Ocean to the south. Between Pearl City and A‘iea the corridor's width is less than one mile between the Pacific Ocean and the base of the Ko'olau Mountains.



SOURCES:
ESRI Atlas GIS v4.0 1998; Information Delivery System (IDS), March 1998; City and County of Honolulu, October 1998.

Figure 1-1: Honolulu High Capacity Transit Corridor

Within the corridor a fixed guideway (rail) system will be implemented, which will be supported and complemented by the Owner's existing bus system, TheBus. This memorandum summarizes the development of the O&M (operations and maintenance) cost allocation models for each transit mode with regard to the fixed guideway alternative selected for the corridor, as well as for the Transportation System Management (TSM) alternative as the baseline alternative.

1.1 TSM Alternative

The TSM alternative is the baseline alternative and would provide an enhanced bus system based on a hub-and-spoke route network, conversion of the present morning peak-hour-only zipper-lane to both a morning and afternoon peak-hour zipper-lane operation, and relatively low-cost capital improvements on selected roadway facilities to give priority to buses. The TSM alternative is not a build alternative and therefore does not include the implementation of a fixed guideway system. O&M costs were developed for the TSM bus system operating at 2018 and 2030 demand levels. All O&M costs were developed in 2007 USD.

1.2 Build Alternative

For the build alternative, three fixed guideway alignment variations were studied throughout the AA and EIS phases of the work. These variations are all described graphically in the fixed guideway plans provided in Appendix A. They included the Salt Lake Boulevard Alignment, the Airport alignment, and the combined Salt Lake Boulevard and Airport Alignments.

The fixed guideway variation selected for implementation in the corridor is the Airport alignment. The initial segment of the Airport alignment to be constructed, the First Project, is a portion of the ultimate project, the Full Build, that can be implemented with available funding. The focus of this memorandum is the First Project Airport alignment.

The fixed guideway plans provided in Appendix A describe the Airport Alignment using the legend references "First Project" and "Airport Alignment". The legend reference "Anticipated Future Extensions" refers to future alignment expansions that, when added to the First Project, comprise the Full Build of the ultimate fixed guideway system. As described in the Appendix A plans, the First Project Airport alignment would be implemented between East Kapolei and Ala Moana Center - a distance of about 20 miles - and would have 21 stations.

The Owner's existing bus system, TheBus, will support and complement the selected fixed guideway alternative described above, although perhaps with different service levels and equipment, depending on the service levels of the fixed guideway system, its operating characteristics, and year. Bus system characteristics are described later in this section.

O&M costs were developed for the bus and fixed guideway systems for the First Project operating at 2018 and 2030 demand levels. All O&M costs were developed in 2007 USD.

1.3 Bus System

The bus system that will operate with the selected fixed guideway alternative will complement rail service in the corridor. That bus system, or the bus system operating under the TSM alternative, will be similar to the bus system operating in Honolulu

today. TheBus currently operates 24 hours/day, seven days per week and is expected to operate similar hours once the selected fixed guideway alternative is implemented. The bus agency operates standard (40-foot) diesel buses, articulated diesel (60-foot) buses, and articulated hybrid (60-foot) buses. Depending on the demand year and alternative, the nature of the bus operation will vary, including the number of each bus type, the specific routes, and overall bus operating data.

A bus O&M cost model, based upon detailed, actual TheBus O&M costs from 2005, was developed as a stand-alone model to estimate bus O&M costs associated with the TSM and selected fixed guideway alternatives described in Sections 1.1 and 1.2. The bus model, forecast of bus O&M costs, and this memorandum were developed consistent with Section 4 of the FTA's *Procedures and Technical Methods for Transit Project Planning*, Draft Version 3 dated August 28, 2008. Recommendations provided by the FTA in its memorandum dated July 29, 2008, have been incorporated in the updated bus O&M cost model and this memorandum. Inherent in the team's modeling approach for the fully-allocated bus O&M cost model is that all costs were assumed to be variable in the long-term, and productivities were assumed to continue in the long term.

1.4 Fixed Guideway System

The fixed guideway system to be implemented under the HHCTC Project (HHCTCP) is a fully-automated, elevated, steel wheel/rail system employing the use of one attendant per train. This primarily dual main track light metro system will operate at headways between three and 10 minutes on the trunk line using minimum train consists of two cars, and up to maximum consists of four cars. A typical weekday will include five operating periods over 20 hours, as follows: an "early" period of two hours, an "A.M. peak" period of four hours, a "base" period of seven hours, a "P.M. peak" period of four hours, and a "late" period of three hours. Weekend days will include three periods over an 18-hour operating day. Service level data were developed based on a vehicle capacity of 162 passengers per car.

The development of the O&M cost model for the HHCTC fixed guideway system presented a unique challenge. The anticipated light metro technology for the Honolulu system currently exists in only two locations in North America (JFK AirTrain and Vancouver SkyTrain), thereby limiting the choices of peer systems from which to obtain detailed cost data for the model. Obtaining detailed, actual cost data from either of those two properties or other rapid transit systems that might be considered peer properties to the proposed Honolulu system also proved challenging.

An extensive effort was made in collecting the detailed, actual O&M cost data from the properties mentioned above, as well as from four (4) others: Los Angeles County Metropolitan Transit Authority (LACMTA), Maryland Transit Administration (MTA), Miami-Dade Transit (MDT), and Washington Metropolitan Area Transit Authority (WMATA).

For half of the properties, the study team was not able to collect any data or was able to collect only gross-level data (at a higher level than that typically reported to the National Transit Database).

The study team was able to collect detailed O&M cost data from two properties, but it was either budgetary rather than actual data, comingled data with other modes, or incomplete.

For the final property, WMATA, the study team was able to obtain detailed, actual O&M cost data for the fixed guideway (rapid transit) mode, which was the system used as the basis for the HHCTCP fixed guideway O&M cost model.

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.

A fixed guideway O&M cost model was developed as a separate model to estimate fixed guideway O&M costs associated with the selected build alternative described in Section 1.2. The fixed guideway model, forecast of fixed guideway O&M costs, and this memorandum were developed consistent with Section 4 of the FTA's *Procedures and Technical Methods for Transit Project Planning*, Draft Version 3 dated August 28, 2008. Recommendations provided by the FTA in its memorandum dated July 29, 2008, have been incorporated in the new fixed guideway O&M cost model and this memorandum. Specifically, the study team has utilized a more similar peer property and technology (to Honolulu) upon which to base costs, and has developed a fully-allocated O&M cost model based upon detailed, actual cost data from the appropriate peer property. Inherent in the team's modeling approach for the fully-allocated fixed guideway O&M cost model is that all costs were assumed to be variable in the long-term, and productivities were assumed to continue in the long term.

While the O&M cost data obtained from the other properties were not used as the basis for the fixed guideway O&M cost model, values calculated from those properties' data were used to develop productivity ratios in the model, as well as resulting total O&M cost ratios for the selected build alternative discussed above. In that sense development of the fixed guideway model has not been wholly based on one property but adjusted against similar data for a range of peer properties. This process is explained in detail in Sections 3.4 and 3.6 herein.

2 Development of Bus O&M Cost Model

2.1 Selection of Key Driving Supply Variables

The key driving supply variables for costs in the bus model include peak vehicles (PV), revenue vehicle hours (RVH), revenue vehicle miles (RVM), unlinked passenger trips (PT), and maintenance facilities (MF). These primary variables were selected because they are the key drivers of bus costs in the current "TheBus" system, and are expected to remain that way for the future operation of TheBus. Variables for PV and RVM were each further broken down according to standard bus (SB), articulated diesel (AD) bus, and articulated hybrid (AH) bus since the operating costs among these bus types, which are operated as part of TheBus system today, are different. The MF driving variable was further broken down into service centers (SC) and terminals (T) since it was anticipated that these types of facilities would be required to support bus operations in the alternatives. The complete list of key driving supply variables are provided in the table below.

Table 2-1: Bus O&M Cost Model Key Driving Supply Variables

PV, SB	peak vehicle, standard bus
PV, AD	peak vehicle, articulated diesel bus
PV, AH	peak vehicle, articulated hybrid bus
RVH	revenue vehicle hour
RVM, SB	revenue vehicle mile, standard bus
RVM, AD	revenue vehicle mile, articulated diesel bus
RVM, AH	revenue vehicle mile, articulated hybrid bus
MF	maintenance facility
SC	service center
T	terminal
PT	unlinked passenger trip

2.2 Data Assembled

Detailed, actual O&M cost data were obtained for TheBus operation for fiscal year 2005 from the Owner's Department of Transportation Services. Actual line item expenses and salaries were provided for each of six (6) departments: Executive Office, Finance & Administration, Planning & Marketing, Maintenance, Transportation, and Materials Management. After receiving the data, a diesel fuel appropriation of \$3.88M (2005 USD) was added to account for the increase in fuel costs expected to be incurred by the agency during the following year. No other adjustments were made to the data. None of the data were considered joint expenses (allocated or shared by mode) since the costs are fully dedicated to the bus mode.

Service level data was also provided by the Owner. Other service data not provided by the Owner was obtained from the National Transit Database (NTD). Where data was obtained from the Owner, it was confirmed that such data was identical to that reported to the NTD.

2.3 Assignment of Expense Items

Expense line items were assigned to one of five key driving supply variables, as described in the table below. No new activities not part of current operations were contemplated in the bus costing model.

Table 2-2: Aggregated Fully Allocated Bus O&M Cost Model, Assignment of Expense Items

Expense Line Item	Annual Expenses (2005)	PV	RVH	RVM	MF	PT
Executive Office						
Management Fee	\$ 392,500	X				
Finance & Administration						
Wages	\$ 2,259,563		X			
Fringe Benefits	\$ 797,384		X			
Insurance Trust Fund Contribution	\$ 9,366,000	X				
Expenses	\$ 983,229		X			
Planning & Marketing						
Wages	\$ 2,156,316					X
Fringe Benefits	\$ 824,059					X
Expenses	\$ 604,953					X
Maintenance						
Administration Wages	\$ 345,856	X				
Kalihi Garage - Management Wages	\$ 767,049				X	
Kalihi Garage - Mechanic Wages	\$ 6,501,442			X		
Pearl City Garage - Management Wages	\$ 753,335				X	
Pearl City Garage - Mechanic Wages	\$ 6,010,827			X		
Unit Repair Wages	\$ 1,930,748			X		
Overtime & Sick Leave Buy Back	\$ 301,770			X		
Payroll taxes	\$ 1,283,283			X		
Fringe Benefits	\$ 4,874,715			X		
Diesel Fuel	\$ 15,883,755			X		
Travel	\$ 4,224	X				
Expenses	\$ 3,927,706			X		
Transportation						
Administration Wages	\$ 292,676		X			
Kalihi Division - Management Wages	\$ 876,490		X			
Safety & Training Wages	\$ 202,188		X			
Halawa Division - Management Wages	\$ 585,396		X			
Training Instruction Wages	\$ 199,680		X			
Road Supervision & Radio Control Wages	\$ 1,450,290		X			
Driver Wages	\$ 39,120,224		X			
Overtime & Sick Leave Buy Back	\$ 4,910,498		X			
Payroll taxes	\$ 3,686,599		X			
Fringe Benefits	\$ 13,727,889		X			
Expenses	\$ 237,927		X			
Materials Management						
Purchasing Wages	\$ 315,098			X		
Materials Management Wages	\$ 181,895			X		
Overtime & Sick Leave Buy Back	\$ 2,884			X		
Payroll taxes	\$ 38,608			X		
Fringe Benefits	\$ 212,946			X		
Revenue Vehicle Parts	\$ 6,183,701			X		
Expenses	\$ 1,259,725			X		
Totals	\$ 133,453,428					
Supply Variable Values		416	1,365,082	18,388,911	2	67,406,827

2.4 Calculations of Unit Costs

Following the assignment of line item expenses to key driving variables, the annual cost for each line item expense was divided by the resource variable value to obtain the unit cost for that line item and key driving supply variable. This is an important step in the process of creating the model since ultimately unit costs will be applied to future service levels to estimate total annual O&M bus costs for those operating scenarios and years.

All of the line item unit costs were then summed (by driving supply variable) to arrive at a total unit cost for each of the five base supply variables (PV, RVH, RVM, MF, and PT). These unit costs were validated against previous year service levels.

Following the initial calibration of the five base supply variables, unit costs were then calculated for each of the three bus types (SB, AD, and AH) for the PV and RVM driving supply variables since the unit costs to operate and maintain the three bus types are different. Since the Owner did not have cost data by bus type, the team used other data points in allocating the PV and RVM unit cost data among the three bus types.

Data relative to the operating cost differences between standard and articulated diesel buses were obtained from earlier project information and studies. These data indicate that articulated buses are more costly to operate than standard diesel buses. For example, King County Metro Transit has experienced that articulated diesel buses are 8% more costly to operate than standard diesel buses. A report from another project states, without citation, that articulated diesel buses are 50% more costly to operate than standard diesel buses. Still another report indicates that the value is 39% higher for RVM and 19% higher for PV, which is consistent with "operating experience elsewhere." The study team believes that the 8% cost premium for operating articulated diesel buses experienced by King County Metro Transit is too low to be used in the bus O&M cost model and has adopted the 39% premium for RVM and 19% premium for PV. The team believes that these are conservative estimates of the cost premiums that will be incurred operating articulated diesel buses as compared to standard diesel buses, as previously used on past cost estimating exercises for the project. (Note: unit costs are the same for RVH since a single bus operator typically earns the same wage regardless of the length of vehicle being operated).

In addition to premiums for the articulated diesel buses, a fairly recent study by the National Renewable Energy Laboratory (NREL) on King County articulated hybrid buses¹ indicates that there is a 15% cost reduction in operating articulated hybrids as compared to articulated diesel buses.

The cost premiums (for articulated diesels over standard diesels) and cost discounts (for articulated hybrids over articulated diesels) discussed above were used in the calculation of PV and RVM unit costs for each of the bus types in the model.

¹ U.S. Department of Energy, "King County Metro Transit Hybrid Articulated Buses: Final Evaluation Results," National Renewable Energy Laboratory, December 2006.

Further analysis of maintenance facility unit costs was also conducted. As cited in the "Bus Operations & Maintenance Facility Requirements Draft Technical Memorandum" dated September 2006, the project expects that full support bus facilities (MF), service centers (SC), and terminals (T) would be required to support bus operations in the alternatives. These facilities are defined as:

MF - includes total vehicle service and maintenance base functions designed with state-of-the-art equipment.

SC - includes a light duty service center designed to provide routine daily support of vehicle operations, including downloading of farebox data and content, fueling, vehicle washing and minor vehicle inspections.

T - includes a location to park vehicles based elsewhere when it is not cost-effective to deadhead those vehicles over extensive distances when they will be returning to service at the same location on the same day and have no intermediate assignments for that day. This facility includes administrative offices, a bus staging area, and driver reporting and rest areas.

Development of unit costs for the MF key driving supply variable was performed as discussed previously. Development of unit costs for the SC and Terminal supply variables is estimated using a relationship of capital costs for those facilities as a surrogate for operating costs. As described in the bus facility memorandum referenced above, 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.

Determining operating cost for a Terminal was more unclear. The bus facility memorandum cites capital costs for Terminals that are comparable to the capital cost of a MF, and further states, "Total cost [of a Terminal] could be significantly higher with further refinement of terminal needs, or lower if a joint development project selling air rights is possible. The San Francisco Transbay Terminal Redevelopment Project cost is estimated at \$1.754 billion in 2003 dollars." Because the nature, size, and operation of a Terminal in the HHCTCP is undefined and can vary widely, the study team concluded that the unit operating cost of a Terminal in the model should be the same as a MF. If necessary, this unit cost can be revised once the definition of this facility evolves.

Once all of the unit costs were developed, they were then again validated against previous years' service levels.

The final step in the calibration of the bus O&M cost model involved the calculation and assignment of productivity ratios for each line item expense. Work hours for each expense category (Vehicle Operations, Vehicle Maintenance, Non-Vehicle Maintenance, and General Administrative) and quantities (gallons) for diesel fuel expenditures were assigned to the line item expenses, where applicable, to determine productivity ratios that might be helpful in the development and analysis of

productivity ratios in the fixed guideway O&M cost model. The resultant productivity ratios and resource unit costs are provided in Table 2-3.

Table 2-3: Aggregated Fully Allocated Bus O&M Cost Model, Productivity Ratios and Resource Unit Costs

Expense Line Item	Annual Expenses (2005)	Supply Variable Unit Cost Rate					Productivity Ratio			Resource Unit Cost
		PV	RVH	RVM	MF	PT	Resource Variable	Resource Value	Resource/Supply	
Executive Office										
Management Fee	\$ 392,500	\$ 943.51					PV	416	1.0000	\$ 943.51
Finance & Administration										
Wages	\$ 2,259,563		\$ 1.66				GAWH	196,096	0.1437	\$ 11.52
Fringe Benefits	\$ 797,384		\$ 0.58				GAWH	196,096	0.1437	\$ 4.07
Insurance Trust Fund Contribution	\$ 9,366,000	\$ 22,514.42					PV	416	1.0000	\$ 22,514.42
Expenses	\$ 983,229		\$ 0.72				RVH	1,365,082	1.0000	\$ 0.72
Planning & Marketing										
Wages	\$ 2,156,316					\$ 0.03	GAWH	196,096	0.0029	\$ 11.00
Fringe Benefits	\$ 824,059					\$ 0.01	GAWH	196,096	0.0029	\$ 4.20
Expenses	\$ 604,953					\$ 0.01	PT	67,406,827	1.0000	\$ 0.01
Maintenance										
Administration Wages	\$ 345,856	\$ 831.38					PV	416	1.0000	\$ 831.38
Kalihi Garage - Management Wages	\$ 767,049				\$ 383,524.50		MF	2	1.0000	\$ 383,524.50
Kalihi Garage - Mechanic Wages	\$ 6,501,442			\$ 0.35			VMWH	516,671	0.0281	\$ 12.58
Pearl City Garage - Management Wages	\$ 753,335				\$ 376,667.50		MF	2	1.0000	\$ 376,667.50
Pearl City Garage - Mechanic Wages	\$ 6,010,827			\$ 0.33			VMWH	516,671	0.0281	\$ 11.63
Unit Repair Wages	\$ 1,930,748			\$ 0.10			VMWH	516,671	0.0281	\$ 3.74
Overtime & Sick Leave Buy Back	\$ 301,770			\$ 0.02			VMWH	516,671	0.0281	\$ 0.58
Payroll taxes	\$ 1,283,283			\$ 0.07			VMWH	516,671	0.0281	\$ 2.48
Fringe Benefits	\$ 4,874,715			\$ 0.27			VMWH	516,671	0.0281	\$ 9.43
Diesel Fuel	\$ 15,883,755			\$ 0.86			GDF	6,383	0.0003	\$ 2,488.60
Travel	\$ 4,224	\$ 10.15					PV	416	1.0000	\$ 10.15
Expenses	\$ 3,927,706			\$ 0.21			RVM	18,388,911	1.0000	\$ 0.19
Transportation										
Administration Wages	\$ 292,676		\$ 0.21				VOWH	2,106,803	1.5434	\$ 0.14
Kalihi Division - Management Wages	\$ 876,490		\$ 0.64				VOWH	2,106,803	1.5434	\$ 0.42
Safety & Training Wages	\$ 202,188		\$ 0.15				VOWH	2,106,803	1.5434	\$ 0.10
Halawa Division - Management Wages	\$ 585,396		\$ 0.43				VOWH	2,106,803	1.5434	\$ 0.28
Training Instruction Wages	\$ 199,680		\$ 0.15				VOWH	2,106,803	1.5434	\$ 0.10
Road Supervision & Radio Control Wages	\$ 1,450,290		\$ 1.06				VOWH	2,106,803	1.5434	\$ 0.69
Driver Wages	\$ 39,120,224		\$ 28.66				VOWH	2,106,803	1.5434	\$ 18.57
Overtime & Sick Leave Buy Back	\$ 4,910,498		\$ 3.60				VOWH	2,106,803	1.5434	\$ 2.33
Payroll taxes	\$ 3,886,599		\$ 2.70				VOWH	2,106,803	1.5434	\$ 1.75
Fringe Benefits	\$ 13,727,889		\$ 10.06				VOWH	2,106,803	1.5434	\$ 6.52
Expenses	\$ 237,927		\$ 0.17				RVH	1,365,082	1.0000	\$ 0.17
Materials Management										
Purchasing Wages	\$ 315,098		\$ 0.02				GAWH	196,096	0.0107	\$ 1.61
Materials Management Wages	\$ 181,895		\$ 0.01				GAWH	196,096	0.0107	\$ 0.93
Overtime & Sick Leave Buy Back	\$ 2,884		\$ -				GAWH	196,096	0.0107	\$ 0.01
Payroll taxes	\$ 38,608		\$ -				GAWH	196,096	0.0107	\$ 0.20
Fringe Benefits	\$ 212,946		\$ 0.01				GAWH	196,096	0.0107	\$ 1.09
Revenue Vehicle Parts	\$ 6,183,701		\$ 0.34				GAWH	196,096	0.0107	\$ 0.34
Expenses	\$ 1,259,725		\$ 0.07				RVM	18,388,911	1.0000	\$ 0.40
Totals	\$ 133,453,428	\$ 24,299.47	\$ 50.79	\$ 2.66	\$ 760,192.00	\$ 0.052				
Supply Variable Values		416	1,365,082	18,388,911	2	67,406,827				

Acronyms in the "Resource Variable" column of Table 2-3 that are not already defined in previous sections include:

- GAWH - General Administrative Work Hours;
- VMWH - Vehicle Maintenance Work Hours;
- GDF - Gallons of Diesel Fuel; and
- VOWH - Vehicle Operations Work Hours.

2.5 Estimation of Inflation Rates

The model was developed using FY2005 costs. All bus O&M costs are required to be stated in 2007 USD, regardless of forecast year (2018, 2030, or other). This required an escalation of FY2005 costs to 2007 costs, which was accomplished using the Honolulu-area Consumer Price Index (CPI) values from U.S. Bureau of Labor Statistics reports CUURA426SA0 and CUUSA426SA0. Inflation was assumed to be the same for all line items in the model, 10.97%.

2.6 Final Estimated Bus O&M Unit Costs

The resulting final unit costs from the fully allocated bus O&M cost model are provided in Table 2-4.

Table 2-4: Estimated Bus O&M Unit Costs

HHCTCP Estimated Bus O&M Unit Costs	
Key Driving Supply Variable	Est. Unit Cost (2007 USD)
Revenue vehicle mile, SB	\$ 2.81
Revenue vehicle mile, AD	\$ 3.91
Revenue vehicle mile, AH	\$ 3.32
Peak vehicle, SB	\$ 26,443
Peak vehicle, AD	\$ 31,467
Peak vehicle, AH	\$ 26,747
Revenue vehicle hour	\$ 56.36
Maintenance facility	\$ 843,585
Service center	\$ 527,241
Terminal	\$ 843,585
Unlinked passenger trip	\$ 0.059
SB = Standard Bus AD = Articulated Diesel Bus AH = Articulated Hybrid Bus	

3 Development of Fixed Guideway O&M Cost Model

As discussed in Section 1, the study team obtained detailed, actual fixed guideway O&M cost data for the WMATA fixed guideway system, which were used as the basis for developing the fixed guideway O&M cost model for the HHCTCP. Productivity ratios and other data from the bus O&M cost model, as well as similar data from other rapid transit systems, were used in the development and analysis of unit costs in the fixed guideway costing model to ensure that fixed guideway O&M costs accurately represented the costs required for the ongoing operations and maintenance of the system anticipated to be implemented in Honolulu.

3.1 Selection of Key Driving Supply Variables

Key driving supply variables were identified for the fixed guideway O&M cost model, which included peak vehicles (PV), revenue train hours (RTH), revenue vehicle miles (RVM), unlinked passenger trips (PT), directional route miles (RM), stations (S), and maintenance facilities (MF). These variables were selected because they are typically the key drivers in rapid rail systems, and are expected to be the key drivers of fixed guideway O&M costs in Honolulu.

3.2 Data Assembled

Detailed, actual O&M cost data were obtained for WMATA's fixed guideway operation for fiscal year 2006. Actual line item expenses and salaries were provided for ten (10) primary categories: Labor, Fringe Benefits, Services, Materials and Supplies Consumed, Utilities, Casualty and Liability Costs, Taxes, Miscellaneous Expenses, Expense Transfers, and Leases and Rentals.

After examining the data, line item expenses for interlocking operator wages and fringe benefits were eventually removed from the model. Interlocking operators are used by WMATA at/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.

Line item expenses for vehicle operator wages during snow operations were also eventually removed from the model as that type of weather is not expected in Honolulu.

No other adjustments were made to the data. The costs include all fixed guideway-related costs, including those joint expenses shared by mode that were already allocated to the fixed guideway costs obtained from WMATA.

Service level data for WMATA was obtained from the National Transit Database.

3.3 Assignment of Expense Items

Expense line items were ultimately assigned to one of seven key driving supply variables, as described in the table below.

Table 3-1: Aggregated Fully Allocated Fixed Guideway O&M Cost Model, Assignment of Expense Items

Expense Line Item	Annual Expenses (2006)	RTH	RVM	PV	RM	S	MF	PT
Labor								
Operators Wages	\$ 32,127,792	X						
General Administrative Wages	\$ 99,358,552			X				
General Administrative Wages - PT	\$ 181,609			X				
Maintenance Worker Wages	\$ 137,410,042		X					
Maintenance Worker Wages - PT	\$ 48,217		X					
Station Manager Wages	\$ 26,504,044					X		
Fringe Benefits								
FICA	\$ 21,432,580			X				
General Administrative	\$ 35,370,794			X				
Worker's Comp and Other Fringes	\$ 21,804,344			X				
Operators	\$ 50,147,818	X						
Maintenance	\$ 24,314,491		X					
LTD Insurance	\$ 360,804		X					
Station Managers	\$ 4,704,698					X		
Services								
Pkg Lot, Smart Card, and Prof. Claims Adjusters	\$ 6,781,147							X
Other Professional Services	\$ 11,344,854			X				
Medical Services	\$ 268,616	X						
Temporary Maintenance and Laborers	\$ 770,572				X			
Continuous Maintenance, Rev. & Svc. Vehicles	\$ 1,023,450		X					
Continuous Maintenance, Garage & Shop Eqpt.	\$ 487,185						X	
Continuous Maintenance, Stations	\$ 14,000,611					X		
Materials and Supplies Consumed								
Fuel, Lubricants, and Revenue Vehicle Parts	\$ 18,672,857		X					
Office & Admin Supplies	\$ 7,337,008			X				
Escalator/Elevator Parts and Other Station Supplies	\$ 6,279,483					X		
Shop Supply Materials	\$ 629,295						X	
Revenue Collection Eqpt Parts & Ticket Stock	\$ 1,383,776							X
Track & Way Materials	\$ 6,589,759				X			
Utilities								
Propulsion Power	\$ 34,950,907		X					
Utilities Other than Propulsion Power	\$ 23,097,996					X		
Heating Oil	\$ 83,791						X	
Casualty and Liability Costs								
Public Liability & Physical Damage Insur. Prem.	\$ 5,505,513		X					
Payouts, Unins. Pub. Liab. & Phys. Damage Sett.	\$ 2,401,245							X
Taxes								
Vehicle Licensing and Registration Fees	\$ 6,110				X			
Miscellaneous Expenses								
Dues, Travel, Advertising, & Other Misc. Expenses	\$ 2,691,866			X				
Parking Violations	\$ 1,868				X			
Free Fare Media	\$ 260							X
Expense Transfers								
Printing, Emp. Phones, and Capital/Nonop. Costs	\$ (6,220,143)			X				
Shop Vendors Materials and Supplies	\$ (430)						X	
Leases and Rentals								
Operating Yards Other Equipment	\$ 666,590						X	
Data Processing Facilities - Other Eqpt.	\$ 475,322					X		
Other General Administration Facilities Eqpt.	\$ 1,738,468			X				
Totals	\$ 594,713,562							
Supply Variable Values		509,875	63,577,383	758	212	86	6	274,767,272

3.4 Calculation of Unit Costs and Productivity Ratios

While assembling the original WMATA cost data, the key driving supply variables were initially assigned to all line item expenses, including for costs related to the interlocking operator wages and fringe benefits, as well as vehicle operator wages for snow operations. The annual cost for each line item expense was then divided by the resource variable value to obtain the unit cost for that line item and key driving supply variable. All of the line item unit costs were then summed to arrive at a total unit cost for each of the seven supply variables above. These unit costs were then validated against previous and future year service levels. Upon validation of the unit costs, the interlocking and vehicle operator snow-related wage costs discussed in Section 3.2 were removed in preparation for the next step in further calibrating the model.

Developing unit costs is an important step in the process of creating the model since ultimately unit costs will be applied to future service levels to estimate total annual O&M fixed guideway costs for future operating scenarios.

The next step in calculating unit costs involved the development and assignment of productivity ratios. Productivity data and factors were developed using work hour and propulsion power information for rapid transit systems at the MTA, BART, MDT, and LACMTA. These, in conjunction with the productivity ratios for WMATA developed in the model, as well as applicable productivity ratios developed in the HHCTCP bus O&M cost model, were all compared and used in determining the appropriate productivity ratios to be applied in the fixed guideway model. The resultant productivity ratios and resource unit costs are provided in Table 3-2. Where productivity ratios were adjusted away from the original WMATA ratios in the model, those changes are hi-lited in purple in Table 3-2. The productivity ratios ultimately employed are reflected in the column "Resource/Supply (Final)" within the table. Following is a discussion of the most significant expense items and how they were handled.

Revenue operator wages (and fringes) - Revenue operator wages and associated fringe benefits cost data are clearly separated in the model from other salary, wage, and fringe benefit expenses. For revenue operator wages and fringes, RTH was assigned as the key driving supply variable, and vehicle operator work hours (VOWH) was used as the resource variable in determining productivity ratios. The productivity ratios (VOWH/RTH) analyzed for these line item expenses ranged from 1.54 from the bus cost model up to 10.66 for the MTA rapid transit system. The average of the range for the rapid transit properties was 7.51 (the WMATA costs in the model yielded a productivity ratio of 8.23). The study team believed that the productivity ratio for MDT's rapid transit system, 4.96, reflected a conservative and reasonable ratio to be applied in the fixed guideway model, which represents a reduction in productivity of 3.25 times, as compared to the bus mode in Honolulu.

Vehicle maintenance wages (and fringes) - Vehicle maintenance wages and fringe benefits are lumped together with all other maintenance wages and fringes in the detailed costs obtained from WMATA. Because of this, the key driving supply variable of RVM was assigned to these line item expenses, and total maintenance work hours (TMWH) was used as the resource variable in determining productivity ratios (TMWH/RVM) for these line item expenses. Productivities for all peer properties ranged from .084 to .092, with BART falling outside the range at .038. The study team concluded that the average, .078, would be a reasonable and conservative value

for use in the model, and close to the original WMATA value of .085.

Revenue propulsion power and electricity - The line item expense for revenue propulsion power is described as a stand-alone entry in the data, as is a separate line item expense for all other electricity costs. RVM was assigned as the key driving supply variable to the revenue propulsion power line item, and energy consumption (EC) was used as the resource variable in determining productivity ratios. The peer property productivity ratios (EC/RVM) analyzed for this line item expense ranged from 4.68 (BART) to 14.14 (LACMTA), with WMATA at 7.40 and the average at 8.17. The study team believes that with the smaller, more efficient, newer-technology vehicles specified for the Honolulu system, the productivity ratio for this line item will be lower (i.e., higher productivity) and the team has therefore used 5.74 in the model, which is the productivity ratio of like data for the MTA rapid transit system. The other line item electricity expense (for all other electricity costs besides propulsion power) was assigned to the S key driving variable since stations are the biggest driver of these costs (escalators, elevators, lights, TVMs, etc.). A productivity ratio of 1.00 was used for this line item expense since other productivity ratios were not available.

Revenue vehicle parts - Line item expenses for revenue vehicle parts were generally assigned the RVM key driving supply variable. A productivity ratio of 1.00 was used for these line item expenses since other productivity ratios were not available. The largest line item expense for revenue vehicle parts, as a percentage of total O&M costs, is one-half of one percent.

Expense line items exceeding five percent (5%) of total operating costs - There are five line item expenses in the cost model data that exceed 5% of total operating costs. They are: maintenance wages, vehicle operator fringe benefits, propulsion power, and general management/administrative salaries and fringe benefits. All of these have been already discussed in the paragraphs above except for the last two, general/administrative salaries and fringe benefits. The PV key driving supply variable was assigned to these line item expenses, and general administrative work hours (GAWH) was used as the resource variable in determining productivity ratios. The GAWH/PV productivity ratio for the existing bus system in the bus cost model was 472.52. The peer rapid transit properties yielded productivity ratios ranging from 655.01 to 2,517.11, with the average being 1,463.64 and

WMATA being 1,123.80. The study team believes that the productivity ratio of GAWH/PV will likely decrease for the fixed guideway system (as compared to the bus system), but that a conservative and reasonable estimate is that the ratio will be no more than twice what it is under the bus system. Therefore, a productivity ratio of 945.04 was used in the fixed guideway model for the general administrative salaries and fringe benefits line item expenses.

FICA - PV was assigned as the key driving supply variable to the FICA line item expense, and total work hours (TWH) was used as the resource variable in determining its productivity ratio. The peer property productivity ratios (TWH/PV) analyzed for this line item expense ranged from 10,455 (BART) to 16,365 (MTA), with WMATA at 13,768 and the average at 13,368. The study team believes that the average, 13,368, is a reasonable and conservative value for use in the model. That value is also very close to the original WMATA value of 13,768.

In addition to the significant line item expenses reviewed above, each of the other line item expenses in the cost model were examined for the possibility of assigning updated productivity ratios.

Once all of the productivity ratios were incorporated into the model, the overall unit costs were updated based on those ratios and the new resource unit costs.

Table 3-2: Aggregated Fully Allocated Fixed Guideway O&M Cost Model, Productivity Ratios and Resource Unit Costs

Expense Line Item	Annual Expenses (2006)	Supply Variable Unit Cost Rate							Productivity Ratio				Resource Unit Cost	
		RTH	RVM	PV	RM	S	MF	PT	Resource Variable	Resource Value	Resource/Supply (WMATA)	Resource/Supply (Final)		
Labor														
Operators Wages	\$ 32,127,792	\$ 63.01								VOWH	4,195,241	8,2280	4,9600	\$ 7.66
General Administrative Wages	\$ 99,358,552			\$ 131,080						GAWH	851,841	1,123,8008	945,0410	\$ 116.64
General Administrative Wages - PT	\$ 161,609			\$ 213						PV	758	1,0000	1,0000	\$ 213.20
Maintenance Worker Wages	\$ 137,410,042		\$ 2.16							TMWH	5,389,130	0,0848	0,0777	\$ 25.50
Maintenance Worker Wages - PT	\$ 48,217		\$ 0.00							RVM	63,577,383	1,0000	1,0000	\$ 0.00
Station Manager Wages	\$ 26,504,044					\$ 308,187				S	86	1,0000	1,0000	\$ 308,187.00
Fringe Benefits														
FICA	\$ 21,432,580			\$ 28,275						TWH	10,436,212	13,768,0897	13,368,1722	\$ 2.05
General Administrative	\$ 35,370,794			\$ 46,663						GAWH	851,841	1,123,8008	945,0410	\$ 41.52
Worker's Comp and Other Fringes	\$ 21,804,344			\$ 28,766						PV	758	1,0000	1,0000	\$ 28,766.00
Operators	\$ 50,147,618	\$ 98.35								VOWH	4,195,241	8,2280	4,9600	\$ 11.95
Maintenance	\$ 24,314,491		\$ 0.38							TMWH	5,389,130	0,0848	0,0777	\$ 4.51
LTD Insurance	\$ 360,804		\$ 0.01							RVM	63,577,383	1,0000	1,0000	\$ 0.01
Station Managers	\$ 4,704,698					\$ 54,706				S	86	1,0000	1,0000	\$ 54,706.00
Services														
Pkg Lot, Smart Card, and Prof. Claims Adjusters	\$ 6,781,147							\$ 0.02		PT	274,767,272	1,0000	1,0000	\$ 0.02
Other Professional Services	\$ 11,344,854			\$ 14,941						PV	758	1,0000	1,0000	\$ 14,941.00
Medical Services	\$ 268,616	\$ 0.53								RTH	509,875	1,0000	1,0000	\$ 0.53
Temporary Maintenance and Laborers	\$ 770,572				\$ 3,638					RM	212	1,0000	1,0000	\$ 3,638.21
Continuous Maintenance, Rev. & Svc. Vehicles	\$ 1,023,450		\$ 0.02							RVM	63,577,383	1,0000	1,0000	\$ 0.02
Continuous Maintenance, Garage & Shop Eqpt.	\$ 487,185						\$ 81,198			MF	6	1,0000	1,0000	\$ 81,197.53
Continuous Maintenance, Stations	\$ 14,000,611					\$ 162,798				S	86	1,0000	1,0000	\$ 162,798.00
Materials and Supplies Consumed														
Fuel, Lubricants, and Revenue Vehicle Parts	\$ 18,672,857		\$ 0.29							RVM	63,577,383	1,0000	1,0000	\$ 0.29
Office & Admin Supplies	\$ 7,337,008			\$ 9,679						PV	758	1,0000	1,0000	\$ 9,679.00
Escalator/Elevator Parts and Other Station Supplies	\$ 6,279,483					\$ 73,017				S	86	1,0000	1,0000	\$ 73,017.00
Shop Supply Materials	\$ 629,295						\$ 104,883			MF	6	1,0000	1,0000	\$ 104,883.00
Revenue Collection Eqpt Parts & Ticket Stock	\$ 1,383,776									PT	274,767,272	1,0000	1,0000	\$ 0.01
Track & Way Materials	\$ 6,589,759				\$ 31,113					RM	212	1,0000	1,0000	\$ 31,113.00
Utilities														
Propulsion Power	\$ 34,950,907		\$ 0.55							EC	470,583,400	7,4017	5,7427	\$ 0.07
Utilities Other than Propulsion Power	\$ 23,097,996					\$ 28,581				S	86	1,0000	1,0000	\$ 268,581.00
Heating Oil	\$ 83,791						\$ 13,965			MF	6	1,0000	1,0000	\$ 13,965.11
Casualty and Liability Costs														
Public Liability & Physical Damage Insur. Prem.	\$ 5,505,513		\$ 0.09							RVM	63,577,383	1,0000	1,0000	\$ 0.09
Payouts, Unins. Pub. Liab. & Phys. Damage Sett.	\$ 2,401,245							\$ 0.01		PT	274,767,272	1,0000	1,0000	\$ 0.01
Taxes														
Vehicle Licensing and Registration Fees	\$ 6,110				\$ 29					RM	212	1,0000	1,0000	\$ 28.85
Miscellaneous Expenses														
Dues, Travel, Advertising, & Other Misc. Expenses	\$ 2,691,866			\$ 3,551						PV	758	1,0000	1,0000	\$ 3,551.00
Parking Violations	\$ 1,868				\$ 9					RM	212	1,0000	1,0000	\$ 8.82
Free Fare Media	\$ 260							\$ 0.00		PT	274,767,272	1,0000	1,0000	\$ 0.00
Expense Transfers														
Printing, Emp. Phones, and Capital/Nonop. Costs	\$ (6,220,143)			\$ (8,206)						PV	758	1,0000	1,0000	\$ (8,206.00)
Shop Vendors Materials and Supplies	\$ (430)							\$ (72)		MF	6	1,0000	1,0000	\$ (71.67)
Leases and Rentals														
Operating Yards Other Equipment	\$ 666,590						\$ 111,098			MF	6	1,0000	1,0000	\$ 111,098.33
Data Processing Facilities - Other Eqpt.	\$ 475,322					\$ 5,527				S	86	1,0000	1,0000	\$ 5,527.00
Other General Administration Facilities Eqpt.	\$ 1,738,468			\$ 2,293						PV	758	1,0000	1,0000	\$ 2,293.00
Totals	\$ 594,713,562	\$ 161.89	\$ 3.49	\$ 257,255	\$ 34,789	\$ 632,816	\$ 311,072	\$ 0.04						
Supply Variable Values		509,875	63,577,383	758	212	86	6	274,767,272						

Acronyms in the "Resource Variable" column of Table 3-2 that are not already defined in previous sections include:

EC - Electrical Power Consumption; TMWH - Total Maintenance Work Hours; and TWH - Total Work Hours.

3.5 Estimation of Inflation Rates / Geographic Adjustments

After the model was calibrated as described in Section 3.4, the unit costs were escalated and geographically adjusted. The model was developed using Washington, D.C.-area FY2006 costs. All fixed guideway O&M costs are required to be stated in Honolulu-area 2007 USD, regardless of forecast year (2018, 2030, or other). This first required an escalation of Washington, D.C.-area FY2006 costs to Washington, D.C.-area 2007 costs, which was accomplished using the Washington, D.C.-area Consumer Price Index (CPI) values from U.S. Bureau of Labor Statistics reports CUURA311SA0 and CUUSA311SA0. Inflation was assumed to be the same for all line items in the model, 2.86%.

After the unit costs were escalated to 2007 USD, a geographic adjustment of costs from the Washington, D.C. area to the Honolulu area needed to be analyzed. The study team assessed the local economies of these areas using the Economic Research Institute's (ERI) 2007 Geographic Reference Report. The profiles of these two cities are provided in Appendix B. As can be seen by the reports, the economic profiles of the two cities are very similar. Salary and wage levels for the two cities are nearly identical, with cost of living structures for Washington, D.C. being slightly higher than Honolulu. The study team also examined the primary labor agreement at WMATA (188 pages) and for TheBus in Honolulu (60 pages) and found that the WMATA labor agreement has more detail and requirements than that for TheBus, which is perhaps due to the larger size of the WMATA system and local bargaining unit characteristics. The impact of these labor agreements on overall costs is not apparent; however the top hourly rate for a WMATA train operator, adjusted for the Honolulu locale differs by less than 3%. In consideration of these facts, the study team took a conservative approach to geographic adjustments in the cost model by not adjusting costs since the economic differences between the cities appear to be relatively insignificant.

The study team found that the average industrial price of electricity in Honolulu is approximately 3.0% higher than in Washington, D.C.² As the last step in adjusting unit costs, this premium was applied in the model for all line item expenses relative to electrical power.

3.6 Validation and Comparison of Fixed Guideway Costs

Once the fixed guideway O&M costs were forecast for the selected fixed guideway alternative, the model then compared the total operating cost per each of the driving supply variables to the same cost ratios of the peer properties. This was conducted in part to validate the model's forecasting accuracy. In general, the cost ratios for forecasts generated by the model were similar in almost all areas to those of the peer properties. The most significant difference existed in the cost per RTH, the values of

² Energy Information Administration (EIA); Average Industrial Price of Electricity by State, 2006; Report released October 22, 2007.

which are about half for the HHCTCP fixed guideway alternative as compared to the peer properties. The reason for this is due in part to the larger number of RTH operated under the HHCTCP alternative, which is the result of operating smaller consists (approximately half the size of the consists operated at the peer properties) on more frequent headways. This drives up the annual number of RTH, which spreads the total operating cost over a greater number of hours, thereby yielding a lesser cost per RTH than the peer properties. This phenomenon could change as project operating requirements evolve. The difference in total operating cost per RTH could also be explained in part by the productivities estimated in the fixed guideway O&M cost model (based on existing TheBus operator productivities), which are more efficient than those of the peer properties. The table of cost ratio comparisons is provided in Appendix C.

3.7 Final Estimated Fixed Guideway O&M Unit Costs

The resulting final unit costs from the fully allocated fixed guideway O&M cost model are provided in Table 3-3.

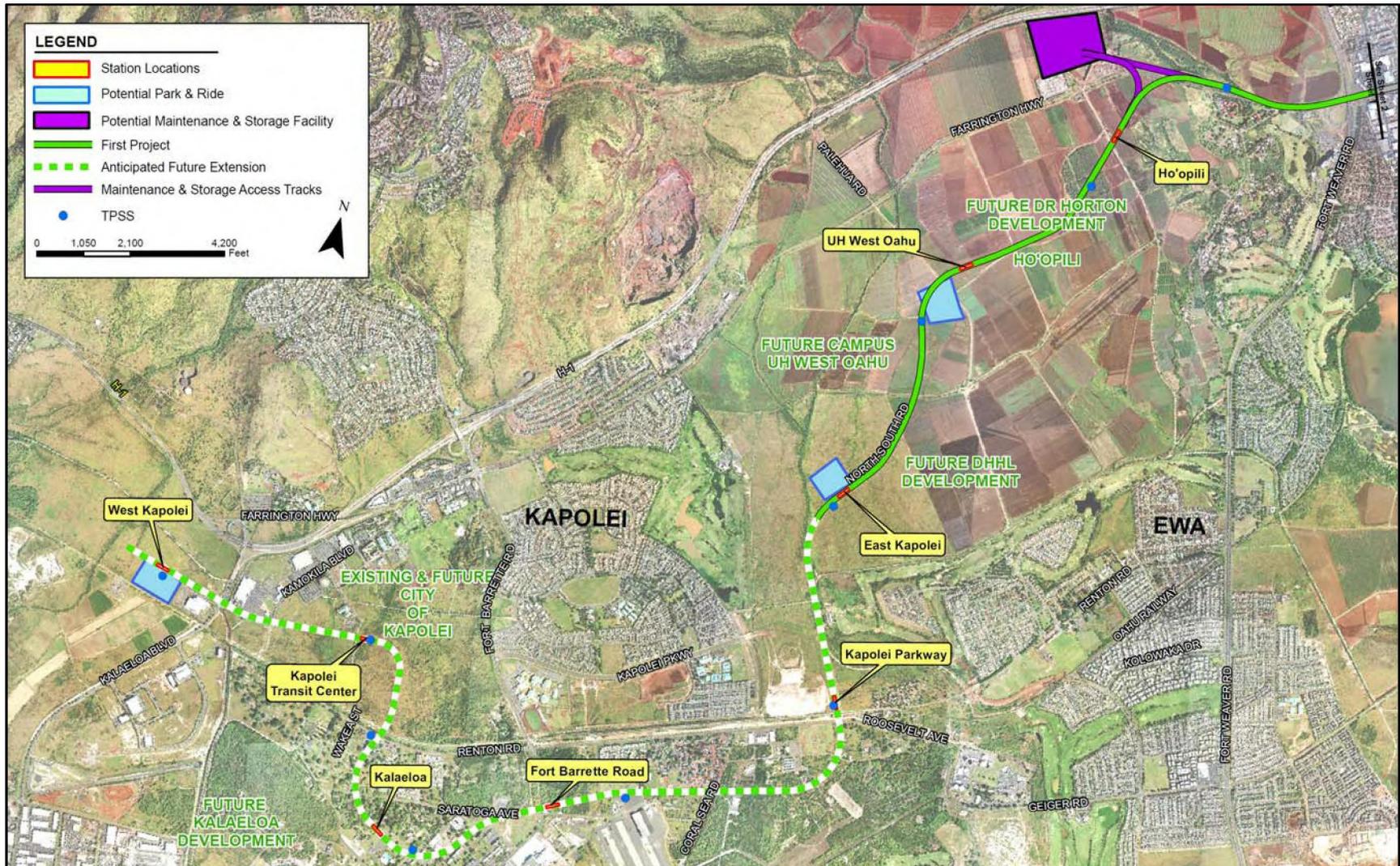
Table 3-3: Estimated Fixed Guideway O&M Unit Costs

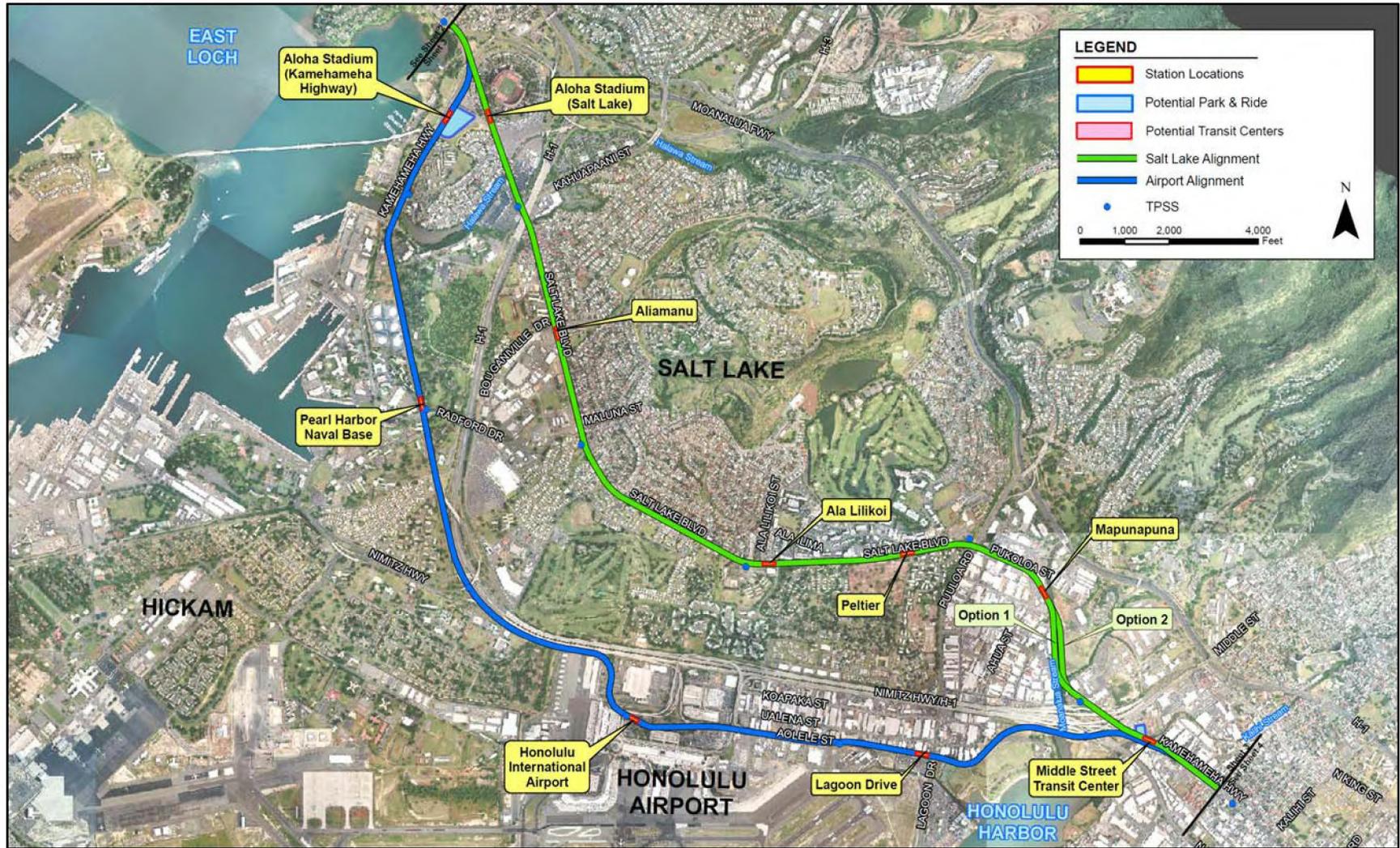
HHCTCP Estimated Fixed Guideway O&M Unit Costs	
Key Driving Supply Variable	Est. Unit Cost (2007 USD)
Revenue Train Hour (RTH)	\$ 100.60
Revenue Vehicle Mile (RVM)	\$ 3.26
Peak Vehicle (PV)	\$ 234,687
Directional Route Mile (RM)	\$ 35,784
Station (S)	\$ 904,484
Maintenance Facility (MF)	\$ 319,968
Unlinked Passenger Trip (PT)	\$ 0.040

4 Conclusion

The focus of this memorandum has been a summary of the methodology used in developing the HHCTCP O&M cost models. Reporting and discussion on forecasts of O&M costs are provided in the HHCTCP Preliminary Memorandum on Forecasts of O&M Costs dated May 2009.

Appendix A - Fixed Guideway Alignment Plan





Appendix B - Economic Profiles: Honolulu, HI and Washington, D.C.

HONOLULU, HAWAII 21.18N, 157.51W

Honolulu is located on the southeastern coast of Oahu Island, partially encircled by the Koolau and Waianee mountains. Honolulu is the state capital and coextensive with Honolulu County.

Approx CDP Population 378,000
 Approx MSA Population 914,000

Major crops include pineapple, sugar, flowers/ nursery products, vegetables and melons, macadamia nuts, coffee, and papaya. Major products include printing & publishing, stone/ glass/ clay, beverages, concrete/ gypsum/ plaster, apparel, candy and confections.

Metro Area Percentage Employment by Industry

Construction	3.9	Fin, R.E. & Ins	7.1
Public Admin	26.7	Manufacturing	2.3
Whls & Retail Trade	12.1	Admin Svc, Health	43.3
Trans, Util & Warhs	3.6	Agric, Forest & Fsh	.9
Mining	.1		

Metro Area Major Private Sector Employers

BancWest Corp	Hawaiian Airlines Inc
Bank of Hawaii	Marriott International
Kyo-Ya Co Ltd	Aloha Airgroup Inc
McDonald's	Tony Hawaii Auto Group
Schuler Homes	Prince Resorts Hawaii

Metro Area Workforce Demographics

Metro Unemployment 2.7 %

Weather Normals - Fahrenheit & Inches

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min Temp	66.	65.	67.	69.	70.	72.	74.	74.	74.	72.	70.	67.
Max Temp	80.	81.	82.	83.	85.	87.	88.	89.	89.	87.	84.	81.
Rainfall	3.6	2.2	2.2	1.5	1.1	.5	.6	.4	.8	2.3	3.0	3.8

City Crime Rates

Robberies	90.2/100,000	Homicides	2.9/100,000
Rapes	24.5/100,000	Assaults	158.9/100,000

City Housing - Own or Rent

Median Sale Price 2,200 sq ft Residence	\$ 1069204.
Apartment Rental 900 sq ft Residence	\$ 1785./month

Health Care Costs

	Individual	Family
HMO	\$ 524./month	\$ 896./month
Indemnity	\$ 675./month	\$ 1123./month

Per Diem Allowances - City

Estimated Hotel Cost	\$ 150./day
Estimated Food and Other Costs	\$ 92./day

Cost of Living Analyses vs. U.S. Average Level

National COL @:	10712.	24000.	48000.	72000.
Rent/Utilities	11958.	22567.	37105.	48024.
Taxes Fd/St/Py	1768.	5076.	10291.	16934.
Consumables	5610.	10133.	19039.	26117.
Transportation	704.	2128.	5090.	8672.
Health Services	739.	1340.	2225.	2600.
Miscellaneous	0.	59.	2701.	6779.
vs City Total:	20779.	41303.	76451.	109126.

Effective Income/Payroll & Sales Tax Rates

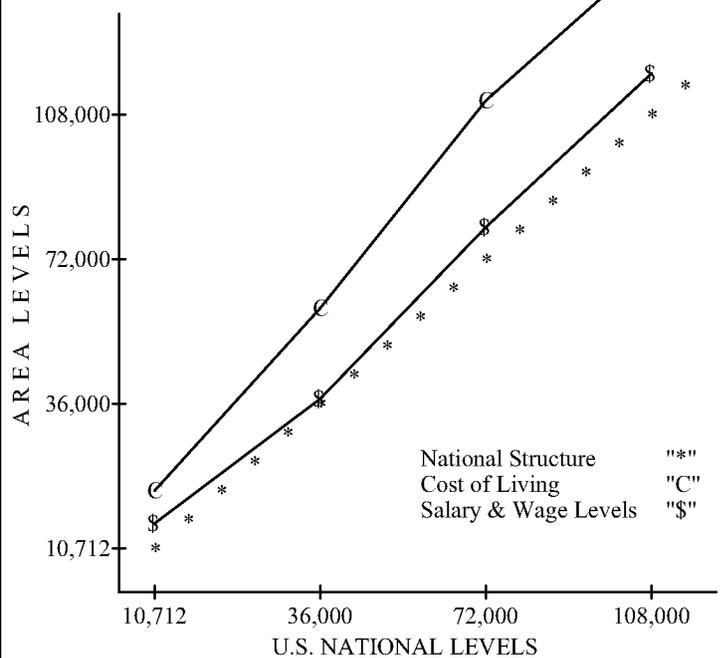
Fd/St/Lc I Tax	16.5 %	21.1 %	21.4 %	23.5 %
Combined Sales/Use Taxes - City Center				4.00 %

Area Structures

	Cost of Living
\$14,040 - \$24,000	1.545 x n + 4234.
\$24,001 - \$48,000	1.464 x n + 6155.
\$48,001 & above	1.361 x n + 11101.

("n" = U.S. National)

COMPARED WITH THE U.S. NATIONAL AVERAGE



Time Series Analysis Median Base Salaries

Accountant	52694.	Janitor	25509.
Accounting Clerk	34128.	Librarian	54301.
Administrative Assistant	43298.	Light Truck Driver	30429.
Aircraft Mechanic	57228.	Machine Tool Operator	39016.
Automobile Mechanic	46896.	Machinery Mechanic	38951.
Bank Teller	25969.	Machinist General	47852.
Benefits Analyst	55630.	Maintenance Helper	24893.
Biologist	57886.	Maintenance Worker	31491.
Bookkeeper	34744.	Market Research Analyst	63655.
Bus Driver	37004.	Materials Handler	30471.
Buyer/Purchasing Agent	57299.	Mechanical Engineer	77477.
Carpenter (Gen/Maint)	41815.	Medical Lab Technician	39784.
Cashier	27112.	Messenger	25267.
Chemical Engineer	79099.	Millwright	52248.
Chemical Technician	48813.	Office Manager	49228.
Chemist	66737.	Order Clerk	33870.
Civil Engineer	69025.	Painter/Paperhanger	40040.
Computer Operator	38414.	Payroll Clerk	39055.
Computer Programmer	69051.	PC Specialist	52971.
Computer Programmer Lead	91419.	Personnel Analyst	56140.
Construction Worker	37215.	Personnel Clerk	35242.
Controller, Top Corporate	131038.	Pharmacist	100746.
Corporate Attorney	104415.	Physical Therapist	65530.
Cost Estimator	58609.	Physician	168860.
Data Entry Operator	28481.	Physicist, PhD	103227.
Dental Assistant	35493.	Plumber	46467.
Dental Hygienist	61652.	Primary School Teacher	49822.
Drafter	52044.	Production Supervisor	65572.
Electrical Engineer	82119.	Property Manager	63154.
Electrician - Certified	54644.	Receptionist	28457.
Electronics Assembler	28294.	Registered Nurse	62161.
Electronics Technician	50955.	Sales Representative	50721.
Engineering Technician	49370.	Secondary School Teacher	54380.
Executive Secretary	40859.	Secretary	34318.
File Clerk	27272.	Secretary to CEO	57693.
Food Service Worker	23740.	Security Guard	31098.
Fork Lift Operator	28697.	Shipping Clerk	33544.
Gate Guard	27340.	Stationary Engineer	49167.
General Clerk	32295.	Systems Analyst	68464.
General/Institution Cook	26018.	Systems Analyst Lead	90717.
Graphic Designer	54767.	Tool & Die Maker	52170.
Heavy Truck Driver	38160.	Warehouse Worker	29362.
Insurance Claims Adjuster	50360.	Welder	41717.
Internal Auditor	62107.	Word Processor	34666.

WASHINGTON, D. C. 38.53N, 77.00W

The District of Columbia is located at the confluence of the Potomac and Anacostia rivers between Maryland and Virginia. "The District" is the national capital, lies 32 miles southwest of Baltimore and is part of the Washington-Arlington-Alexandria MSA and the Washington-Baltimore-Northern Virginia CSA.

Approx City Population	549,000
Approx MSA Population	4,139,000
Approx CSA Population	8,240,000

Major industry includes government employment and services, tourism and high technology.

Metro Area Percentage Employment by Industry

Construction	6.8	Fin, R.E. & Ins	4.0
Public Admin	25.0	Whls & Retail Trade	9.8
Admin Svc, Health	49.1	Trans, Util & Warhs	4.9
Agric, Forest & Fsh	.3		

Metro Area Major Private Sector Employers

McDonald's	Marriott International
Northrop Grumman Corp	SAIC
Verizon	CSC
Wal-Mart	May Department Stores
Interstate Hotels	Bearing Point Inc

Metro Area Workforce Demographics

Metro Unemployment	3.4 %
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Weather Normals - Fahrenheit & Inches

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Min Temp	27.	29.	38.	46.	57.	67.	71.	70.	63.	50.	41.	32.
Max Temp	40.	44.	55.	65.	74.	83.	87.	87.	80.	69.	58.	47.
Rainfall	2.7	2.7	3.2	2.7	3.7	3.4	3.8	3.9	3.3	3.0	3.1	3.1
Snowfall	7.2	6.8	3.3	.3	.0	.0	.0	.0	.0	.0	1.1	3.9

City Crime Rates

Robberies	552.3/100,000	Homicides	35.8/100,000
Rapes	39.4/100,000	Assaults	697.9/100,000

City Housing - Own or Rent

Median Sale Price 2,200 sq ft Residence	\$ 851901.
Apartment Rental 900 sq ft Residence	\$ 2134./month

Health Care Costs

	Individual	Family
HMO	\$ 458./month	\$ 859./month
Indemnity	\$ 622./month	\$ 1047./month

Per Diem Allowances - City

Estimated Hotel Cost	\$ 166./day
Estimated Food and Other Costs	\$ 64./day

Cost of Living Analyses vs. U.S. Average Level

National COL @:	10712.	24000.	48000.	72000.
Rent/Utilities	14258.	26821.	47444.	63808.
Taxes Fd/St/Py	1321.	4276.	9220.	16012.
Consumables	4269.	7655.	14192.	19247.
Transportation	720.	2161.	5100.	8590.
Health Services	722.	1300.	2130.	2460.
Miscellaneous	.0.	59.	2701.	6779.
vs City Total:	21290.	42272.	80787.	116896.

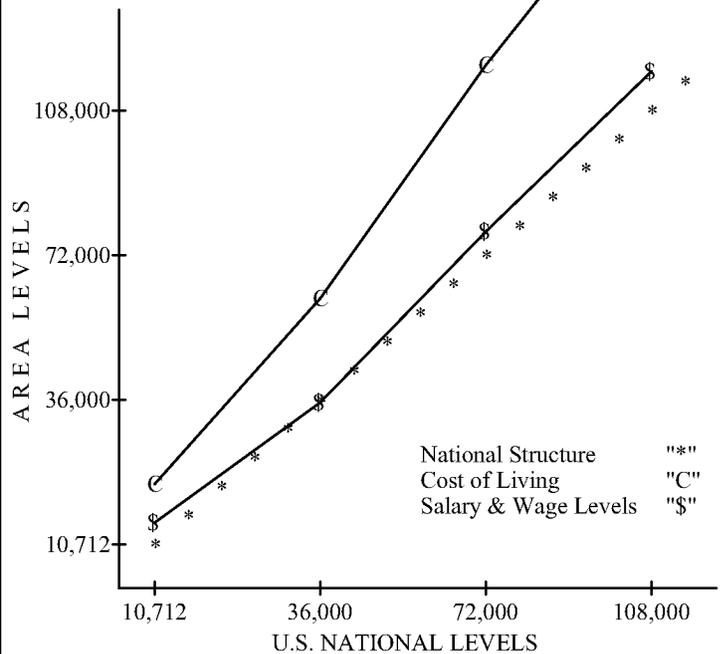
Effective Income/Payroll & Sales Tax Rates

Fd/St/Lc I Tax	12.3 %	17.8 %	19.2 %	22.2 %
Combined Sales/Use Taxes - City Center				5.80 %

Area Structures

	Cost of Living
\$14,560 - \$24,000	1.579 x n + 4376.
\$24,001 - \$48,000	1.605 x n + 3757.
\$48,001 & above	1.505 x n + 8569.
	("n" = U.S. National)

COMPARED WITH THE U.S. NATIONAL AVERAGE



Time Series Analysis Median Base Salaries

Accountant	51166.	Janitor	24469.
Accounting Clerk	32918.	Librarian	52769.
Administrative Assistant	41931.	Light Truck Driver	29282.
Aircraft Mechanic	55748.	Machine Tool Operator	37722.
Automobile Mechanic	45467.	Machinery Mechanic	37659.
Bank Teller	24906.	Machinist General	46407.
Benefits Analyst	54121.	Maintenance Helper	23884.
Biologist	56417.	Maintenance Worker	30326.
Bookkeeper	33524.	Market Research Analyst	62287.
Bus Driver	35745.	Materials Handler	29323.
Buyer/Purchasing Agent	55819.	Mechanical Engineer	76352.
Carpenter (Gen/Maint)	40473.	Medical Lab Technician	38477.
Cashier	26022.	Messenger	24239.
Chemical Engineer	78003.	Millwright	50728.
Chemical Technician	47351.	Office Manager	47759.
Chemist	65423.	Order Clerk	32664.
Civil Engineer	67752.	Painter/Paperhanger	38729.
Computer Operator	37131.	Payroll Clerk	37760.
Computer Programmer	67778.	PC Specialist	51438.
Computer Programmer Lead	90540.	Personnel Analyst	54640.
Construction Worker	35952.	Personnel Clerk	34012.
Controller, Top Corporate	130855.	Pharmacist	100030.
Corporate Attorney	103764.	Physical Therapist	64196.
Cost Estimator	57152.	Physician	169341.
Data Entry Operator	27367.	Physicist, PhD	102555.
Dental Assistant	34259.	Plumber	45046.
Dental Hygienist	60249.	Primary School Teacher	48343.
Drafter	50527.	Production Supervisor	64238.
Electrical Engineer	81076.	Property Manager	61778.
Electrician - Certified	53118.	Receptionist	27344.
Electronics Assembler	27184.	Registered Nurse	60767.
Electronics Technician	49457.	Sales Representative	49226.
Engineering Technician	47899.	Secondary School Teacher	52849.
Executive Secretary	39534.	Secretary	33105.
File Clerk	26179.	Secretary to CEO	56221.
Food Service Worker	22787.	Security Guard	29940.
Fork Lift Operator	27580.	Shipping Clerk	32344.
Gate Guard	26246.	Stationary Engineer	47699.
General Clerk	31116.	Systems Analyst	67181.
General/Institution Cook	24954.	Systems Analyst Lead	89825.
Graphic Designer	53243.	Tool & Die Maker	50651.
Heavy Truck Driver	36881.	Warehouse Worker	28233.
Insurance Claims Adjuster	48872.	Welder	40377.
Internal Auditor	60712.	Word Processor	33446.

Appendix C - Comparison of Fixed Guideway Total Cost Ratios

HR Peer Properties Total Actual Operating Cost Per (2007 USD)						
	RTH	RVM	PV	PT	S	RM
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

HHCTCP Fixed Guideway Total Forecast Operating Cost Per (2007 USD)						
	RTH	RVM	PV	PT	S	RM
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