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PROJECT MANAGEMENT OVERSIGHT PROGRAM

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CLIN 0005: Spot Report

Subtask 11A: Review of Technical Capacity and Capability
Subtask 32A: Project Capacity Review
Subtask 32E: Project Delivery Method Review
Subtask 33A: Parametric Project Cost Estimate Reviews
Subtask 34A: Project Schedule Review
Subtask 35A: Project Cost Contingency Baseline Review
Subtask 35C: Project Schedule Contingency Review
Subtask 40A: Assessment of Project Cost Risk
Subtask 40B: Assessment of Project Schedule Risk

Grantee: City and County of Honolulu

HONOLULU HIGH-CAPACITY TRANSIT CORRIDOR PROJECT

Date Issued: March 2009 (REVISED FINAL DRAFT)

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LIST OF ACRONYMS

AA	▪	Alternatives Analysis
AACE	▪	Advancement of Cost Engineering
AC	▪	Alternating Current
ACT ID	▪	Activity Identification
BAH	▪	Booz Allen Hamilton
BCE	▪	Base Cost Estimate
BFMP	▪	Bus Fleet Management Plan
BRF	▪	Beta Risk Factor
CC	▪	Community College
CER	▪	Cost Estimating Relationship
CFR	▪	Code of Federal Regulations
CPM	▪	Critical Path Method
DB	▪	Design-Build
DBB	▪	Design-Bid-Build
DC	▪	Direct Current
DEIS	▪	Draft Environmental Impact Statement
DTS	▪	Department of Transportation Services
EDC	▪	Engineering Design Consultant
EIS	▪	Environmental Impact Statement
ENR	▪	Engineering News Record
FAQ	▪	Frequently Asked Questions
FD	▪	Final Design
FEIS	▪	Final Environmental Impact Statement
FFGA	▪	Full Funding Grant Agreement
ft	▪	Foot
FTA	▪	Federal Transit Administration
GCM	▪	General Construction Manager
GEC	▪	General Engineering Consultant
HDOT	▪	State of Hawaii Department of Transportation
HHCTC	▪	Honolulu High-Capacity Transit Corridor
LONP	▪	Letter of No Prejudice
LPA	▪	Locally Preferred Alternative
MOS	▪	Minimum Operating Segment
MOT	▪	Maintenance of Traffic
MOU	▪	Memorandum of Understanding
mph	▪	Miles Per Hour
mphps	▪	Miles Per Hour Per Second
MPS	▪	Master Project Schedule
MS	▪	Microsoft
MSF	▪	Maintenance and Storage Facility
MW	▪	Megawatt
NEPA	▪	National Environmental Policy Act
NTP	▪	Notice to Proceed
OCC	▪	Operations Control Center
OD	▪	Original Duration
PB	▪	Parsons Brinckerhoff
PDP	▪	Project Development Plan

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PE	▪	Preliminary Engineering
PEP	▪	Project Execution Plan
PG	▪	Program Guidance
PHF	▪	Peak Hour Factor
PMC	▪	Project Management Support Consultant
PMO	▪	Project Management Oversight
PMOC	▪	Project Management Oversight Contractor
PMP	▪	Project Management Plan
QA/QC	▪	Quality Assurance / Quality Control
QMP	▪	Quality Management Plan
RAMP	▪	Real Estate and Acquisition Management Plan
RF	▪	Route Foot
RFMP	▪	Rail Fleet Management Plan
RFP	▪	Request For Proposals
ROD	▪	Record of Decision
ROD	▪	Revenue Operations Date
ROW	▪	Right-of-Way
RTD	▪	Rapid Transit Division
SCC	▪	Standard Cost Category
SSMP	▪	Safety and Security Management Plan
SSOA	▪	State Safety Oversight Agency
TCC	▪	Technical Capacity and Capability
TCRP	▪	Transit Cooperative Research Program
TPM	▪	Office of Program Management
TSR	▪	Technical Schedule Review
UH	▪	University of Hawaii
USC	▪	United States Code
WBS	▪	Work Breakdown Structure
YOE	▪	Year of Expenditure

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1.0 EXECUTIVE SUMMARY

1.1 Introduction

The City and County of Honolulu ("City") is requesting to enter into Preliminary Engineering (PE) for the Honolulu High-Capacity Transit Corridor (HHCTC) Project ("Project") in accordance with the Federal Transit Administration (FTA) New Starts requirements. The Project is intended to provide improved mobility in the highly-congested 25-mile east-west corridor along Oahu's south shore between Kapolei and the University of Hawaii at Manoa (UH Manoa). The Project would provide faster, more reliable public transportation services than those currently operating in mixed-flow traffic. The project also would provide an alternative to private automobile travel and improve linkages between Kapolei, Honolulu's urban center, UH Manoa, Waikiki, and the surrounding urban area.

In March 2007, the Federal Transit Administration (FTA) assigned Booz Allen Hamilton (BAH) to serve as the "resident" Project Management Oversight Contractor (PMOC) for the Honolulu Project. On August 11, 2008 the FTA assigned a second PMOC (Jacobs) to provide concentrated oversight efforts in order to inform FTA's decision regarding project approval for potential entry to preliminary engineering. Jacobs is to provide FTA with "information and well-grounded professional opinions regarding the reliability of the project scope, cost, and schedule of the Locally Preferred Alternative."

1.2 Project Description

The "First Project" consists primarily of aerial structure (18.91 miles) but also includes a short retained fill section (0.34 miles). The proposed investment also includes nineteen stations (18 aerial and 1 at-grade), sixty transit vehicles, and both administrative and maintenance facilities. The specific modal technology for this project is steel wheel on steel rail. The City has referred to the mode as a "Light Metro" vehicle. However, the vehicles can be described as automated short heavy rail vehicles with a tight turning radius. For the purposes of this Spot Report, including the transit capacity analyses, the vehicles are identified as a "heavy rail" vehicle, which corresponds with the modal technology identified in the Standard Cost Category workbook estimate provided by the City.

The First Project is planned to be delivered in two phases.

- Phase I
  - East Kapolei to Navy Drum Site Maintenance Base/Leeward Community College (CC)
- Phase II
  - Leeward CC to Puuloa Road (Salt Lake)
  - Puuloa Road (Salt Lake) to Nimitz Highway
  - Nimitz Highway to Ala Moana Center Terminus

The 2007 estimate for the full First Project is approximately $5.2 billion, in Year-of-Expenditure (YOE) dollars. The City's target Revenue Operations Date (ROD) for the First Project is December 2018.

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1.3 Jacobs Scope of Work

Under this Work Order, Jacobs is to provide the following deliverables:

- Subtask 11A: General Review of Grantee's Technical Capacity and Capability
- Subtask 32A: Project Capacity Review
- Subtask 32E: Project Delivery Method Review
- Subtask 33A: Parametric Project Cost Estimate Reviews
- Subtask 34A: Project Schedule Review
- Subtask 35A: Project Cost Contingency Baseline Review
- Subtask 35C: Project Schedule Contingency Review (combined with Subtask 40B)
- Subtask 40A: Assessment of Project Cost Risk
- Subtask 40B: Assessment of Project Schedule Risk (combined with Subtask 35C)

Each of these deliverables comprises individual sections of this Spot Report and is summarized below.

1.3.1 Subtask 11A: Review of Technical Capacity and Capability

Methodology

The PMOC established a methodology to comprehensively review and address the pertinent requirements and documents per the *FTA Project Management Oversight Operating Guidance (PG) #11, Technical Reviews of Grantee Technical Capacity and Capability, Project Management Plan (PMP) Review Products and Procedures;* and the *New Starts Project Planning and Development Checklist of Project Sponsor Submittals to FTA to Enter Preliminary Engineering (Checklist)* developed by FTA in July 2007, and *Technical Review of Grantee Technical Capacity and Capability*, dated March 29, 2007.

Summary of Findings

The PMOC Technical Capacity and Capability (TCC) Assessment is separated into three categories: Document Review, Technical Capacity, and Technical Capability.

(1) Document Review

The PMOC used the FTA document *New Starts Project Planning and Development Checklist of Project Sponsor Submittals to FTA to Enter Preliminary Engineering (PE)* dated August 10, 2007 as a guide to support the TCC document review process. Table 1-1 provides a listing and status of the subcategories of the Project Management Plan in accordance with 49 Code of Federal Regulations (CFR) 633 and FTA's *Project & Construction Management Guidelines*, May 2003 Update. The Real Estate and Acquisition Management Plan (RAMP), Quality Management Plan (QMP), Bus Fleet Management Plan (BFMP), Safety and Security Management Plan (SSMP), and Third Party Agreements and Permits are typically submitted to the FTA as stand-alone documents that supplement the PMP. This list does not include all of the documents needed to satisfy the FTA requirements to enter PE, only the documents necessary to support the PMOC TCC assessment.

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Table 1-1. New Starts Checklist to Enter PE

Project Management Plan (Category)	1st Submittal Date	Latest Rev. Date	Rev No.	Status
Basic Requirements				
Project Sponsor Staff Organization	06/12/07	05/21/08	0	Addressed in PMP Chapter 2
Project Budget		09/11/08	0	Acceptable, requires revision during PE
Project Schedule		09/20/08	0	Acceptable, requires revision during PE
Procedures				
Document Control Procedures				Addressed in PMP Chapters 3 & 7, a separate Document Control Plan, mentioned in the PMP, has not been developed
Change Order Procedures				Addressed in PMP Chapters 6, 7, 10 & 11
Material Testing Procedures				Addressed in PMP Chapter 10
Internal Reporting Procedures				Addressed in PMP Chapter 3
Operational Testing Procedures				Addressed in PMP Chapter 16
Quality Assurance/Quality Control (QA/QC)				Addressed in PMP Chapter 2 & 3, and the QMP. See Plans below
Plans				
PMP	06/12/07	05/21/08	0	Needs revisions to better address contracting delivery methods and related procedures. Need to include PDP and PEP requirements in update to PMP during PE.
RAMP	01/03/08	04/01/08	0	Acceptable, requires revision during PE
QMP	01/03/08	05/12/08	0	Acceptable, requires revision during PE
BFMP	06/12/07	04/04/08	0	Acceptable
SSMP	01/03/08	05/12/08	0	Acceptable, requires revision during PE
Third Party Agreements Mgmt. Plan				Included in PMP, acceptable
RFMP				N/A, no existing rail system

(2) Technical Capacity

The PMOC determined the project sponsor's technical capacity by reviewing the organizational structure and matrix responsibilities of each position listed in the project organization chart contained in the PMP Rev. 0.

The PMOC used the project organizational chart and interviews with project staff to identify the current staff members and project management procedures that have been utilized during the current planning phase. The PMOC concentrated on the roles and responsibilities within the City and its PMC organization. Because the blended project organization consists of several entities described above, the PMOC focused on the coordination and traceability of actions and decisions, and of well-defined and functional relationships. The PMOC reviewed the current procedures being implemented and discussed proposed preliminary engineering, internal control, and design management and reporting procedures.

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Results of the PMOC interviews and project organization review comments are included throughout this report. The PMOC determined that many of the roles and responsibilities, job descriptions, and lines of authority were well documented in the PMP and companion documents but not clearly understood or implemented by project staff.

Not all positions in the project organization chart are filled. The PMOC has identified ~~significant~~ "capacity" issues as several key City and PMC management positions remain vacant or vacated due to retention challenges stemming from the project's geographic location and other related issues. Several of the City positions are currently filled by "Acting" or "Interim" staff members from the PMC team. While these temporary solutions may fill an immediate void, the PMOC believes the resource demands associated with the PE and Final Design phases of an approximate $5 Billion project require full time and concentrated attention, and continuity within the grantee's organization for smooth transition into further phases. The City position vacancies combined with the interim placement of PMC staff will further strain resource availability and utilization as the PMC contract completion date expires in late 2009.

(3) Technical Capability

The PMOC determined the Project sponsor's technical capability by reviewing the resumes and conducting interviews of key management staff members. In addition the PMOC reviewed the Booz Allen Hamilton (BAH) PMOC spot reports, trip reports, and meeting notes. The PMOC concentrated on the relevant rail design and construction experience, and program management experience for each interviewed staff member.

The City key management staff members interviewed by the PMOC maintain a high degree of professional maturity and expertise. While most of the City employees lack mega-program experience, they have established basic defined roles and responsibilities and have so far demonstrated they can work together as a team.

The PMC key management staff members interviewed by the PMOC maintain a high degree of professional maturity and expertise. Several of the members have worked together on other large, successful projects. Also, through the interview process, the PMOC found the PMC key management staff is experienced, has established basic defined roles and responsibilities, and works together as a team. All are essential qualities for a competent and effective project management organization.

While certain challenges are inherent with a blended organizational approach, the PMOC has determined the City and their PMC key management staff, currently in place, is fundamentally sound and capable.

Conclusion

(1) Document Review

As a result of the TCC document review and interviews with City and County of Honolulu, the Project Management Support Consultant (PMC) and the General Engineering Consultant (GEC) staff, the PMOC identified the need to revise the PMP in order to more adequately address contracting strategy methods, recent evolution of organizational and staffing changes and recent revisions to the project scope and vehicle technology. In addition, the PMOC explained that a Project Development Plan and a Project Execution Plan were needed to support the PMP and the "implementation" of the PE and Final Design phases, respectively. The PMOC and FTA agreed to share an annotated PDP Table of Contents with the City to assist with their plan development. The PMOC and FTA notified the City during the September 2008 Risk Assessment Workshop.

The City has partially addressed the FTA's required PMP elements contained in 49 CFR 633. The PMOC recognizes certain policies and procedures will be incorporated into the PMP during the PE and Final Design phases. The PMOC did not prejudice these secondary requirements and concentrated on the primary requirements needed for FTA approval to enter PE.

The PMP and the companion documents will need further revisions when more definitive information evolves during the PE phase in order to support the PMOC's future Entry to Final Design assessment.

It is the PMOC's professional opinion that the PMP Rev. 0 must be revised to include a PDP. The PMOC recommends the next PMP revision be completed and submitted early in the PE phase. The PMP and companion document revisions are not necessary as conditions precedent to enter PE.

(2) Technical Capacity

While the current City staff has demonstrated the capability to manage the work presently being performed by the PMC and the GEC, as work progresses into PE, the City will need to add the necessary staff to be directly accountable for the development of the project design, budget and master schedule. Development of the project design will include quality review and audit of the GEC as well as any engineering design consultants assigned to the project; the monitoring of safety and security design requirements and implementation; and continued oversight of the development of the project real estate acquisition plan, program and processes.

It is the PMOC's professional opinion that the City staff and supporting consultant team members have demonstrated the technical capacity to support the City's continuance of project implementation into the PE phase. While numerous technical capacity issues exist, no technical capacity issues need to be addressed prior to entry into PE. The PMOC does recommend the City implement specific staffing, recruiting and retention

efforts to meet the resource demands required of PE and future project phases and compete this task early in the PE phase.

(3) Technical Capability

The project organization includes a high degree of professional maturity and expertise. Several of the lead managers have worked together on other large, successful projects. Also, through the interview process, the PMOC found the key management staff team is experienced, has established basic defined roles and responsibilities, and can work together as a team. All are essential qualities for a competent and effective project management organization. While certain challenges are inherent with a blended organizational approach, the PMOC has determined the City/PMC team and its GEC are fundamentally sound and capable. The PMOC recognizes the project management team and consultant resource demands will proportionately increase as the project continues.

It is the PMOC's professional opinion that the City staff and supporting consultant team members possess the technical capability to support the City's continuance of project implementation into the PE phase. No technical capability issues need to be addressed prior to entry into PE.

Recommendations

The following recommendations should be considered during the Preliminary Engineering phase:

(1) The PMOC identified the need to revise the PMP in order to more adequately address contracting strategy methods, recent evolution of organizational and staffing changes and recent revisions to the project scope, including the vehicle technology selection. The PMP should be revised to include a PDP and PEP prior to issuance of a Record of Decision.

(2) The PMOC recommends that the key management positions currently occupied by the PMC be filled by City staff no later than issuance of the Record of Decision. The key management positions the City should focus on filling are, in no particular order:

- Chief, Transportation Planning
- Real Estate Acquisition
- Manager of Quality Assurance
- Manager of Safety and Security
- Contracts Administrator

~~(3) The PMOC recommends the City establish a position for a Manager of Project Controls. This position is critical to the program-wide oversight of establishing, monitoring and assessing the program budget and costs, schedule and document management.~~

(4) The PMOC recommends that other City key management positions currently vacant be filled by City staff before preliminary design work advances too far – certainly prior to the issuance of a Record of Decision. Essential design control, contracting principles,

community outreach and other functions should be developed during the PE Phase and should include input from these City new hires. The positions, in no particular order, are:

- Manager of Project Procedures
- Public Information Specialist
- Chief Configuration Management
- Contracts Administrator
- Manager of Administrative Services

(5) The City may encounter difficulty acquiring the experienced staff needed to manage the corridor independently for the long-term assignment, given Hawaii's cost of living, and distance from the mainland. The City should provide a staffing plan for the transfer of PMC positions including the dates by which all PMC staff positions will be filled by City staff. This staffing plan should be developed early during the PE phase.

(6) The PMOC recommends the City establish a regimented training program as the project refines and continues in order to execute a "knowledge transfer" from the project consultants' expertise. This can be done through the development and refreshment of training manuals and related materials, together with a reasoned period of transition by and between consultant and new hire City employee.

1.3.2 Subtask 32A: Project Capacity Review

Methodology

The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #32: Project Scope, Definition and Capacity Review Procedures,* dated March 29, 2007 to assess and evaluate operational capacity of the Project. This analysis employs practices recommended in the *TCRP 100* to evaluate proposed operations and the capacity of the planned rail transit system.

At the most basic level, rail transit capacity is a seemingly simple concept that addresses the question of how many persons can be moved within a period of time. The actual calculation of that capacity, however, is somewhat more complex involving considerations relating to car capacity, train length, maximum train speeds, train acceleration and braking characteristics, station dwell times, operating margin, track configuration, traction power system capacity, and safe following distances between trains. *TCRP 100* defines capacity in two ways for rail transit.

- ***Line capacity***: the maximum number of trains (made up of some number of vehicles forming a 'consist") that can pass a point during an interval of time (i.e., cars per hour). Line capacity is a function of train (or consist) length, maximum train speeds, train acceleration and braking characteristics, station dwell times, operating margin, track configuration and associated speed restrictions, terminal station configuration, and safe following distances between trains. The proposed transit network is a simple double track system operating entirely on exclusive right of way.

- ***Person capacity***: the maximum number of persons that can be carried in one direction past a point during an interval of time under specified operating conditions without

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unreasonable delay, hazard, restriction or uncertainty (i.e. passengers per hour). Person capacity is a function of line capacity and rail car capacity. *Rail car capacity* is a function of the number of seats on each rail car, the amount of usable standing space on each rail car and the acceptable level of crowding among standing passengers. TCRP 100 specifies that 3.2 ft^2 of space per standing passenger is "reasonable service load with occasional body contact. Moving to and from doorways requires some effort"

This document evaluates the proposed Project infrastructure and operation:

- to determine if it provides sufficient *person capacity* to carry the forecast volumes of design year peak period passengers and
- to determine the theoretical *line capacity* (provided a sufficient pool of vehicles were available).

Summary of Findings/Conclusion

(1) The planned frequency of 3.5 minutes with 2 car trains is insufficient to serve the 2030 peak-of-the-peak passenger demand. An increase of frequency to 2.8-minute headways or an increase in train capacity is necessary to maintain a design loading standard presented by the Project criteria documentation of 3.2 ft^2 of standing space per standee.

(2) The dwell time assumption of 20 seconds is too short. An estimated dwell time based on the forecast passenger activity is more appropriate ranging between 27 and 41 seconds at each station for a total of 16:20 of dwell time for the peak-of-the-peak train compared with the City's allowance of 11:20.

(3) Together, the end-to-end running time and peak fleet size do not provide sufficient recovery time at terminal stations for trains to reliably turn for their next trip.

(4) The current project scope has a vehicle fleet size of approximately 60 vehicles (with six spares). Operating a 2.8-minute headway through the peak of the morning peak and a 3.5-minute headway otherwise would require 27 trains to maintain. This represents an increase of four trains / eight cars over the proposed service level, thus suggesting a project budget to support a fleet size of up to 68 vehicles, less spares.

(5) With either signaling type (cab-control or moving-block) a 2.8-minute headway is well within the capability of the planned corridor.

(6) The current ridership projections for the project are 5,745 passengers per hour. Depending on the signaling type, the maximum person capacity is either 10,294 or 11,384 passengers per hour, thus would support the anticipated ridership projection.

Recommendations

(1) The Project has substantial documentation for this point in its planning and design, the completion of Alternatives Analysis. PMOC does recommend that the City undertake more detailed demand forecasting for the corridor and build into the rail component of the modeled network capacity constraints that closely resemble, if not altogether mirror, North American rail transit experience. Certainly these constraints need to reflect

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policies and standards planned by the City for the Project, yet PMOC highly recommends rigorous scrutiny by the City of the parameters used by the modelers.

(2) PMOC recommends the use by the City of the *TCRP 100* as a guidance tool in setting capacity constraints for demand forecasting, and assessing viability and functionality of the Project.

1.3.3 Subtask 32E: Project Delivery Method Review

Methodology

The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #32: Project Scope, Definition and Capacity Review Procedures,* dated March 29, 2007 to assess and evaluate the grantee's technical approach for delivering the proposed Project within the constraints of their existing or proposed statutory or organizational procurement authority and in the context of their project strategies, risk analysis, and procurement planning. The PMOC also assessed and evaluated whether the grantee's project delivery method and contracting packaging strategy as defined and implemented in the PMP minimizes project risks and provides the greatest likelihood of implementation success. Specifically, this section of the Spot Report provides an overview of the contracting methodology to be employed during the design, construction, and procurement phases of the project.

Summary of Findings

Table 1-2 and Table 1-3 provide a summary of the consultant contracting methodology and construction/procurement contracting methodology that the City intends to utilize for this Project.

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Table 1-2. Consultant Contract Packaging

SCC	Description	Contract Package	NTP	Contract End	Notes
80.01	PE/EIS	Project-wide	Aug-07	Mar-10	NTP given to PB in August 2007 for EIS
80.02	Final Design	West Oahu/ Farrington Guideway/Utilities Contract (Phase I)[1]	Dec-09	Mar-12	Final Design to be completed by DB contract team
		Maintenance Facility and Storage Yard[1]	Mar-10	Apr-14	Final Design to be completed by DB contract team
		Systems[1]	Apr-10	Dec-18	Final Design to be completed by DB contract team
		Kamehameha Utility & Guideway Design	Apr-10	Aug-11	
		Salt Lake Utility & Guideway Design	Dec-09	Apr-11	
		City Center Utility & Guideway Design	Oct-10	Jan-12	
		West Oahu Station Group	Aug-10	Dec-11	3 stations
		Farrington Station Group	Aug-09	Feb-11	3 stations
		Kamehameha Station Group	Oct-11	Jan-13	2 stations
		Pearl Highlands Station/ Multi-Level Parking Facility	Not yet Defined	Not yet Defined	1 station
		Salt Lake Station Group	Apr-12	Jul-13	4 stations
		City Center Station Group	Mar-10	Jun-11	3 stations
		Kakaako Station Group	Mar-10	Jun-11	3 stations
		H1/H2 Ramps at Pearl Highlands	Not yet Defined	Not yet Defined	Draft Contract Packaging Plan refers to H2 and H1 ramps separately. It is unclear whether one design contract will include both ramps.
80.03	Project Management for Design and Construction (1st Contract)	Project-wide	Apr-07	Oct-09	Contract awarded to InfraConsult in April 2007
	Project Management for Design and Construction (2nd Contract)		Aug-09	Dec-18	Second PMC contract to be awarded
80.04	Construction Administration & Management	Project-wide	Aug-09	Dec-18	

[1]Contract will be Design-Build. All others will be Qualifications Based Selection (QBS).

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Table 1-3. Construction and Equipment Contract Packaging

SCC	Description	Contract Package	Contract Type	NTP	Contract End	Notes
10	Guideway and Track Elements	West Oahu and Farrington Guideway and Utilities Contract	DB	Dec-09	Mar-12	Includes installation of running/third rail
		Kamehameha Contract	DBB	Sep-11	Jun-15	Includes installation of running/third rail
		Salt Lake Contract	DBB	Aug-08	Dec-15	
		City Center Contract	DBB	Mar-13	Aug-16	
20	Stations	West Oahu Station Group	DBB	Jan-12	Apr-14	3 stations; includes park-and-ride lot
		Farrington Station Group	DBB	Mar-11	Apr-14	3 stations; includes park-and-ride lot
		Kamehameha Station Group	DBB	Feb-15	Feb-17	2 stations; includes park-and-ride lot
		Salt Lake Station Group	DBB	Jun-15	Nov-18	4 stations includes park-and-ride lot
		City Center Station Group	DBB	Jul-15	Mar-18	3 stations includes park-and-ride lot
		Kakaako Station Group	DBB	Sep-15	Jun-19	3 stations; includes park-and-ride lot
		Elevators and Escalators (SCC 20.07)	DB	Apr-12	May-19	Procure, install, test, and commission
30	Support Facilities	Maintenance Facility and Storage Yard (SCC 30.01 and 30.03)	DB	Mar-10	Apr-14	Includes procurement of rail for full alignment; two sites under consideration
40	Sitework and Special Conditions	Kamehameha Utility and H1 Ramps Relocation (SCC 40.02)	DBB	Jun-11	Apr-12	
		Salt Lake Utility Relocation (SCC 40.02)	DBB	Feb-11	Jun-13	
		City Center Utility Relocation (SCC 40.02)	DBB	Nov-11	Oct-13	
50	Systems	Train Control and Signaling (SCC 50.01)	DB	Apr-10	Dec-18	To be packaged with revenue vehicles procurement
		Traction Power Supply (SCC 50.03)				
		Traction Power Distribution (SCC 50.04)				
		Communications (SCC 50.05)				
		Central Control (SCC 50.07)				
		Fare Equipment (SCC 50.06)	DBB	Not yet defined	Not yet defined	Install owner furnished equipment
70.02	Vehicles	Heavy Rail Vehicles	DB	Apr-10	Dec-18	To be packaged with systems components

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The contract delivery methodology proposed by the City could be successfully executed. The City does have the statutory authority to award the contract types currently under consideration.

At this phase of the Project, the PMOC cannot provide a detailed opinion on the constructability of the proposed design. Although the base guideway elements are constructible, it cannot be definitively ascertained if they will be constructible throughout all portions of the corridor. However, the PMOC does believe that the conceptual plans have been advanced sufficiently for this phase (pre-PE). However, the PMOC does have some concerns as they relate to design and construction of key elements as well as the overall Project implementation:

- General
  - The PMOC is concerned that the multiple delivery methods being considered for Phase I and Phase II, particularly guideway construction, may not be the most cost-effective means to deliver the Project. The PMOC recognizes that this risk can be mitigated with proper coordination of contracts and sufficient contract language. However, until there is progress with regard to these items, the risk remains.

  - Given that the spread of bidding for Phase I and II will occur over a period of four to five years, the City must ensure it has adequate contingency to account for construction market changes relative to labor, material, and equipment. Contingencies are discussed later in this Spot Report.

  - The PMOC shares the City's concern that there may not be sufficient labor to support the Project without significant increases in unit costs to offset any importation and subsistence of labor to the island. Specifically, the PMOC is concerned that estimates may not be sufficient to offset the need to import labor, especially for specialty systems work and even the guideway construction.

  - The PMOC shares the City's concern that the availability of major materials (fuel, cement, steel, copper, lumber, etc.) will be an issue for the Project and the bids will reflect such uncertainty. The concern is two-fold. First, the global construction market is driving an increase in material costs. Second, the limitation of available materials for an island market may impact cost and schedule. There is a significant cost and time component associated with shipping materials to Hawaii.

  - The PMOC shares the City's concern regarding the availability of construction equipment available to support the Project schedule. There will be numerous contracts being simultaneously executed over the course of the Project. The increase in equipment needs, particularly during the peak years, may result in higher than anticipated unit costs and schedule issues.

- SCC 10 – Guideway and Track Elements
  - From a review of the geotechnical data provided by the City, it is clear that the subsurface conditions are highly variable along the 20-mile corridor. The City should determine whether they will prepare and issue a Geotechnical Baseline Report.

  - Site access to station construction area is constrained. The amount of traffic and pedestrian congestion and close proximity of business and residential properties, particularly along Phase II, will severely restrict the contractors' access, material delivery, and installation. This could result in schedule pressure and increased costs due to loss of contractor productivity. In addition, the City will require the contractors to identify the laydown, or staging, areas for each individual contract.

  - The PMOC cannot determine the adequacy of General Conditions for any of the DB or DBB contracts at this time. The City is still in the process of developing draft contract documents.

  - Final Design of the Phase I line segments and systems components will be performed concurrently by two separate DB contractors. There is concern that the necessary coordination between the DB contractor for the Phase I line segment and the DB system contract can be achieved adequately to prevent delays or cost impacts. The issue is identified to ensure that it is treated appropriately. The PMOC experience is that any and all DB contracting be done with the utmost understanding by the grantee of the certainty of the scope of work it is bidding such that the functional requirements of the products are known as well as the interfaces to avoid post-contracting change orders, confusion between contracts, schedule differentials that cause delay claims, etc. Oftentimes, the benefits of DB contracting get reduced considerably when design changes by the owner are surfaced after contract award, as well as interface scheduling becomes impacted.

  - There may be duplication of design efforts. The typical viaduct superstructure sections of the line segments will generally be uniform throughout the full corridor. By having the DB contractor develop the line segment design for Phase I and an EDC complete the line segment design for Phase II, the City may not realize any potential cost savings from a more efficient Phase II design. The PMOC understands there is no requirement that the viaduct be uniform. However, the PMOC suggests that utilizing a uniform section, where possible, may reduce costs, provide efficiencies in construction, and minimize long-term maintenance costs.

  - The schedule for contracting the DBB work is tight ~~and potentially unattainable due to contractor workload~~. The schedule may have insufficient time to recover from contract document amendments during the bidding process, poor bids, protested bids, real estate acquisition delays, and delays associated with access or permits. It is noted that these activities are not on the current critical path.

However, with further refinement of the schedule, it is expected that some, if not all items, may become critical.

- SCC 20 – Stations, Stops, Terminals, Intermodal
  - Site access to station construction area is constrained.
  - Material and equipment staging/storage areas have not been identified. The PMOC recognizes more definitive information will evolve during the PE phase.
- SCC 30 – Support Facilities: Yards, Shops, Administration Buildings
  - The PMOC shares the City's concern that the uncertainty with the Maintenance and Storage Facility (MSF) location has not been adequately captured in the cost estimate. There will be numerous impacts if the Navy Drum Site cannot be acquired including rail alignment, construction staging (i.e. rail storage), and operational constraints. This should be addressed early in PE.
  - The scope for the Administration Building and Operations Control Center has not been defined. The PMOC recognizes more definitive information will evolve during the PE phase. However, it is typical in AA for a grantee to provide a conceptual design for such a critical facility and its functions. This also provides a "Basis for Design" document for the estimators and subsequent scopes of work for PE phase.
- SCC 40 – Sitework and Special Conditions
  - The City has not finalized any utility agreements. The PMOC recognizes more definitive information will evolve during the PE phase.
  - The City has not incorporated detailed utility adjustment and relocation activities in the Master Project Schedule. The PMOC recognizes more definitive information will evolve during the PE phase.
- SCC 50 – Systems and SCC 70 – Revenue Vehicles
  - Understandably, the scope and criteria for the systems components and revenue vehicles have not been fully defined as the Project remains in the Alternatives Analysis (AA)/Planning phase. These SCC categories should be addressed immediately in PE given the accelerated nature of Phase I and the critical impact any decisions on vehicle and systems technology will have on the overall Project configuration.
- SCC 60 – Right-of-Way
  - The Right-of-Way (ROW) schedule, as defined in the PMP, has not been sufficiently developed. The PMOC recognizes more definitive information will evolve during the PE phase.
  - The PMOC has concerns with the technical capacity (resource availability) of the City's ROW Department to maintain schedule.

- The PMOC has concerns with several significant areas including: temporary construction easements; the "economic remainders" (particularly for properties along Dillingham); and visual/aesthetic impacts of the guideway and stations to adjacent property owners. The City may discover the necessity to acquire more partial or full takes and/or temporary or permanent construction easements than initially planned thus impacting the project budget and schedule.

Conclusion
At this juncture of the development of the Project, and as relates to the Project Delivery Method (PG-32E) assessment, the PMOC concludes that the Project ready to enter the PE Phase of work.

Recommendations
To bring the project up to a satisfactory level of consideration, the PMOC recommends that FTA require the City to address each of the relevant findings in Section 5.0 of this Spot Report, and adequately respond to each. Alternatively, the City should show reasonable cause in not agreeing with a finding(s) and, either, provide a rationale disagreement with the finding(s) or what course of action it intends to take, and when, during the early stages of the PE Phase. The PMOC believes this FTA requirement will protect the Federal interests should PE Phase funding be approved and enable the City to embark on PE efforts with a far more definitive scope of work and overall budget and schedule.

1.3.4 Subtask 33A: Parametric Project Cost Estimate Review

Methodology
The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #33: Characterization of Grantee Project Cost Estimate and Escalation,* dated March 29, 2007 to assess and evaluate the grantee's cost estimate. Specifically, the PMOC completed a review of the project cost estimate to ensure it was:

- Mechanically correct and complete
- Free of any material inaccuracies or incomplete data
- Consistent with relevant, identifiable industry or engineering practices
- Uniformly applied by the grantee's cost estimators and consistent in its method of calculation
- Consistent with the project scope outlined in the appropriate NEPA documents

The PMOC then assessed the integration and traceability of the estimate into the defined scope of the project for the purposes of "baselining" the project estimate as the costs, scope issues and project become more fully defined and developed through progression of project definition. Using the data developed from this analysis, the PMOC made adjustments to the grantee cost estimate for use in the PG-40 Risk Assessment.

The PMOC also reviewed and evaluated the general uniformity in the grantee's escalation of costs from the base year, to the YOE dollars, the escalation factors used to estimate YOE dollars and the soundness of the economic forecasts and escalation factors.

The focus of this evaluation is the City's 2008 Standard Cost Category (SCC) Estimate, referred to within this Spot Report as the *2008 SCC Estimate.* This estimate was prepared by their General Engineering Consultant (GEC) and their subconsultants. However, much of the information used to evaluate this estimate is contained in other supporting project documentation made available to the PMOC.

Summary of Findings

The PMOC reviewed the City's *2008 SCC Estimate* (Table 1-4) that correlates to the scope and values included in the Administrative Draft Environmental Impact Statement (DEIS). The PMOC Cost Estimate Review consists of two primary functions. The first is a review and evaluation of project scope inclusively, as identified in the DEIS. The second is a characterization of the mechanical and fundamental soundness of the cost estimate. The PMOC review also includes an evaluation of the cost estimate source data and its use in the *2008 SCC Estimate*. The cost elements were also reviewed for accuracy and applicability to the project.

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Table 1-4. 2008 SCC Estimate

SCC	Description	Project Estimate			
		Base Year		YOE	
		Total	Contingency	Total	Contingency
10	**Guideway & Track Elements (Route Miles)**	**1,261,224,594**	**226,489,688**	**1,549,289,729**	**278,220,191**
10.01	Guideway: At-grade exclusive right-of-way	0	0	0	0
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	0	0	0	0
10.03	Guideway: At-grade in mixed traffic	0	0	0	0
10.04	Guideway: Aerial structure	1,103,789,580	196,943,292	1,355,896,379	241,925,365
10.05	Guideway: Built-up fill	0	0	0	0
10.06	Guideway: Underground cut & cover	0	0	0	0
10.07	Guideway: Underground tunnel	0	0	0	0
10.08	Guideway: Retained cut or fill	6,631,081	1,244,479	8,145,627	1,528,720
10.09	Track: Direct fixation	139,213,885	26,126,771	171,010,495	32,094,155
10.10	Track: Embedded	0	0	0	0
10.11	Track: Ballasted	0	0	0	0
10.12	Track: Special (switches, turnouts)	11,590,048	2,175,146	14,237,228	2,671,952
10.13	Track: Vibration and noise dampening	0		0	
20	**Stations, Stops, Terminals, Intermodals**	**262,975,504**	**49,353,559**	**338,165,718**	**63,464,777**
20.01	At-grade station, stop, shelter, mall, terminal, platform	0	0	0	0
20.02	Aerial station, stop, shelter, mall, terminal, platform	199,467,259	37,434,738	256,499,133	48,138,115
20.03	Underground station, stop, shelter, mall, terminal, platform	0	0	0	0
20.04	Other stations, landings, terminals: Intermodal, ferry, trolley, etc.	0	0	0	0
20.05	Joint development	0	0	0	0
20.06	Automobile parking multi-story structure	0	0	0	0
20.07	Elevators, escalators	63,508,245	11,918,821	81,666,585	15,326,662
30	**Support Facilities: Yards, Shops, Admin. Bldgs.**	**117,190,233**	**21,993,513**	**133,868,487**	**25,123,581**
30.01	Administration Building: Office, sales, storage, revenue counting	20,075,571	3,767,655	22,932,682	4,303,859
30.02	Light Maintenance Facility	0	0	0	0
30.03	Heavy Maintenance Facility	97,114,662	18,225,858	110,935,805	20,819,722
30.04	Storage or Maintenance of Way Building	0	0	0	0
30.05	Yard and Yard Track	0	0	0	0
40	**Sitework & Special Conditions**	**643,868,033**	**144,662,152**	**753,546,133**	**169,304,267**
40.01	Demolition, Clearing, Earthwork	31,210,292	7,627,681	36,526,732	8,926,999
40.02	Site Utilities, Utility Relocation	363,610,903	88,865,174	425,549,299	104,002,691
40.03	Haz. mat'l, contam'd soil removal/mitigation, ground water treatments	12,476,369	3,049,179	14,601,625	3,568,584
40.04	Environmental mitigation, e.g. wetlands, historic/archeologic, parks	12,730,112	3,111,193	14,898,591	3,641,161
40.05	Site structures including retaining walls, sound walls	0	0	0	0
40.06	Pedestrian / bike access and accommodation, landscaping	0	0	0	0
40.07	Automobile, bus, van accessways including roads, parking lots	223,840,357	42,008,925	261,969,887	49,164,831
40.08	Temporary Facilities and other indirect costs during construction	0	0	0	0
50	**Systems**	**235,555,047**	**44,207,464**	**302,549,444**	**56,780,544**
50.01	Train control and signals	39,131,195	7,343,892	50,260,529	9,432,574
50.02	Traffic signals and crossing protection	28,875,760	5,419,218	37,088,338	6,960,502
50.03	Traction power supply: substations	50,687,225	9,512,654	65,103,219	12,218,155
50.04	Traction power distribution: catenary and third rail	77,772,372	14,595,821	99,891,674	18,747,030
50.05	Communications	23,635,131	4,435,690	30,357,217	5,697,248
50.06	Fare collection system and equipment	4,763,385	893,962	6,118,143	1,148,214
50.07	Central Control	10,689,979	2,006,227	13,730,324	2,576,820
CONSTRUCTION SUBTOTAL (10 - 50)		**2,520,813,411**	**486,706,376**	**3,077,419,511**	**592,893,360**
60	**ROW, Land, Existing Improvements**	**137,662,191**	**45,887,397**	**160,122,543**	**53,374,181**
60.01	Purchase or lease of real estate	135,163,482	45,054,494	157,216,156	52,405,385
60.02	Relocation of existing households and businesses	2,498,709	832,903	2,906,387	968,796
70	**Vehicles**	**266,143,610**	**51,511,667**	**329,618,886**	**63,797,204**
70.01	Light Rail	0	0	0	0
70.02	Heavy Rail	236,412,673	45,757,292	292,797,118	56,670,410
70.03	Commuter Rail	0	0	0	0
70.04	Bus	0	0	0	0
70.05	Other	0	0	0	0
70.06	Non-revenue vehicles	6,089,670	1,178,646	7,542,057	1,459,753
70.07	Spare parts	23,641,267	4,575,729	29,279,711	5,667,041
80	**Professaonal Services**	**756,244,023**	**146,011,914**	**936,956,318**	**180,902,964**
80.01	Preliminary Engineering	75,624,402	14,601,191	93,695,632	18,090,296
80.02	Final Design	113,436,603	21,901,787	140,543,448	27,135,444
80.03	Project Management for Design and Construction	138,644,738	26,768,851	171,775,325	33,165,543
80.04	Construction Administration & Management	252,081,341	48,670,638	312,318,773	60,300,988
80.05	Professional Liability and other Non-Construction Insurance	37,812,201	7,300,596	46,847,816	9,045,149
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	37,812,201	7,300,596	46,847,816	9,045,149
80.07	Surveys, Testing, Investigation, Inspection	12,604,067	2,433,532	15,615,939	3,015,050
80.08	Start up	88,228,469	17,034,723	109,311,570	21,105,345
SUBTOTAL (10 - 80)		**3,680,863,235**	**730,117,354**	**4,504,117,258**	**890,967,709**
90	**Unallocated Contingency**	**220,851,835**	**220,851,835**	**270,246,065**	**270,246,065**
SUBTOTAL (10 - 90)		**3,901,715,070**	**950,969,189**	**4,774,363,323**	**1,161,213,774**
100	**Finance Charges**	**359,651,000**	**0**	**484,070,859**	**0**
TOTAL PROJECT COST (10 - 100)		**4,261,366,070**	**950,969,189**	**5,258,434,182**	**1,161,213,774**

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(1) Review of Construction Costs

The PMOC team reviewed the *2008 SCC Estimate* and supporting data provided by the City, which included information regarding civil, architectural, track work, utilities, vehicles, and systems components. The estimate is well organized and appears to support the scope described in the DEIS. The level of development of the estimate is very limited and depends heavily on Allowance, Lump Sums, and CERs. The cost estimate quantity unit measures are predominately Rail-Feet, Track-Feet, or Square Feet. The cost estimate quantities were parametrically derived within the Timberline cost estimating software. The cost estimate contains a significant amount of unit pricing from similar transit projects across the US mainland. These prices were adjusted to reflect the Hawaii market and applied to the respective quantity unit measure.

Additionally, the GEC transferred and incorporated cost from the *2007 MK Utility Estimate* for Private Utility Relocations/Removals. However, a 15.0% reduction was taken for an "assumed" franchise sharing with the utility and a 10.0% reduction was included for utility relocation design as this was stated to have been included in the units in the methodology.

Unit costs are standard throughout the estimate and did not take into consideration varying conditions along the alignment. The cost estimate does not account for unforeseen ground conditions or related unusual geotechnical conditions. Some consideration was given structurally to account for variability in grades, structure height, or spans and known geotechnical conditions.

There were some quantity and mechanical errors that were discovered in this review. These are reported in each of the SCC section of this report. Additional cost related issues or risks that were identified as concerns in other sections of this Spot Report are noted below.

(2) Review of General Condition Costs

The GEC generated detailed assemblies for the *2006 Parametric Estimate*. This estimate included the contractor's overhead and profit (General Conditions) in the unit costs as variable percentages dependent upon the individual assembly and estimator's judgment as follows:

- 0.5% to 6.0% for Maintenance of Traffic
- 6.0% to 10.0% for Mobilization/Demobilization
- 0.5% to 4.0% for Minor Utilities

All CER items in the *2008 SCC Estimate* include contractor indirect costs, overhead & profit, and allocated design & construction contingencies, although no specific breakdown of these components is available. However, these General Conditions components from the *2006 Parametric Estimate* are not fully traceable to the *2008 SCC Estimate*. The *2008 SCC Estimate* does not include a separate category or line item(s) for indirect cost and likewise does not contain supporting documentation explaining the

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inclusion of indirect costs within the direct cost line items. Some of the information typically contained in a General Conditions estimate includes:

- Detailed Construction Schedule
- Contracting and delivery strategy (i.e. Design/Build, CM-at-Risk, Multiple Prime, Fast-track, etc.)
- Necessary equipment lists and durations
- Contract requirements for Quality Control/Assurance, Scheduling, Traffic Control, Liquated Damages, Assignment of Risks.
- More detailed information on actual construction required

The PMOC recognizes a detailed line item estimate for General Conditions is not feasible this early in the project. However, it is recommended that the City conduct a review and evaluation of all elements typically associated with General Conditions so these items can further developed in PE and adequately incorporated into the cost estimate.

(3) Review of Quantities

The *2008 SCC Cost Estimate* appears to support the scope described in the DEIS. This cost estimate included both summary sheets and detailed backup in MS Excel for each SCC. The cost estimate criteria document describing the methodology used in developing the estimate was provided and is incorporated into the project estimates. The methodology does not, in any detail, address other assumptions made in developing the estimate, the schedule, and documentation of productivity or unit costs, indirect costs or overhead and profit.

The detailed estimate sheets were reviewed for the individual line items each SCC. Quantity spot checks were not performed on line items or quantities in the *2006 Parametric Estimate* as these are not directly traceable back to the conceptual drawings but were generated by GECs Timberline software in their parametric estimating approach. The PMOC crosschecked the transfer from the detail sheets to the *2008 SCC Estimate* summary sheets of the estimate and found the ~~mechanical~~ accuracy of the estimate is excellent and no math-type discrepancies were identified at this level. However, this does not mean to imply that the entire estimate is mechanically correct. It is a simply one step in the PMOC checking the accuracy of the estimate.

Due to the style of estimate that was prepared – a parametric estimate – an in-depth review and analysis or correlation of project quantities was not developed by the PMOC, as would normally occur in projects in later stages of development and as required by PG-33 (Subtask 33B). The drawings are considered planning documents as they were developed to support the DEIS. Quantities are basically alignment lengths, structure counts, major utilities identified, and other similar broad-style or all-encompassing quantities.

(4) Review of Cost Estimate Escalation

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Escalation factors are of great concern, given the recent financial events impacting the United States' and global economies. The 2008 SCC Estimate includes the following escalation rates:

- 4.85% for FY2009
- 3.55% for FY2010
- 2.90% for FY2011
- 2.80% thru FY2019

These percentages add a value of approximately $997 million to the SCC Base Year Project Costs, including contingency (escalation portion) and finance costs.

The Engineering News Record (ENR) Construction Cost indices indicate an average escalation of 4.7% for the past five years and 4.0% for the past 15 years. ~~The City provided the PMOC with a document listing an expected inflation rate of 2.8% for Hawaii.~~

It is the PMOC's opinion these percentages are trending low. The PMOC believes the City should institute a more conservative and realistic approach of applying substantially higher escalation rates to the *2008 SCC Estimate* as a result of the instabilities and downtrends recently experienced in the United States market and historical data provided by ENR. For purposes of adjusting the cost estimate as input into the Cost Risk Model, the PMOC utilized a rate of 4.85% in 2009, 4.25% for 2010 through 2015, and 2.8% for 2016 through 2019.

(5) PMOC Adjustments to Base Cost Estimate

Based on a review of the above item, the PMOC made adjustments to the Project's direct costs due to omissions in scope or to under valuation of certain cost items. The PMOC has identified adjustments to the Base Cost Estimate (BCE) that can be categorized as Line Item Adjustments, Excise Tax Adjustments, or Escalation Adjustments.

The City's BCE of $5.258 billion (YOE) includes $890.97 million in allocated contingency, $270.25 million in unallocated contingency, and $484.07 million in finance charges. The BCE appears to also have some latent contingency, but the amount cannot be easily quantified at this stage of the project because the SCC line items are based primarily on CERs. To condition the BCE, the PMOC identified the following adjustments:

- Line Item Adjustments – $193.58 million (YOE)
- Excise Tax Adjustment – $81.04 million (YOE)
- Escalation Adjustment – $198.70 million (YOE), based on a rate of 4.85% in 2009, 4.25% for 2010 through 2015, and 2.8% for 2016 through 2019

The input for the Cost Risk Model and basis for the evaluation of project cost contingency is the Adjusted BCE, which is the BCE net of contingencies and finance costs and includes the PMOC adjustments discussed below. To develop the Adjusted BCE (Table 1-5), the following steps were taken:

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- Start with City's BCE (YOE) – $5,258,434,182
- Strip YOE allocated and unallocated contingency – $1,161,213,774
- Deduct YOE financing costs – $484,070,859
- Apply PMOC YOE adjustments as outlined above – $473,324,630
- Result is an Adjusted BCE (YOE) of $4.086 billion

Table 1-5. PMOC Adjustments and Cost Risk Model Input

		Risk Assessment Model Input					
		YOE	PMOC Adjustments				Adjusted
SCC	Description	w/o Contingency	Line Item	Excise Tax	Escalation	Total	Total
10	**Guideway & Track Elements (Route Miles)**	**1,271,069,538**	**0**	**27,299,654**	**71,872,551**	**99,172,205**	**1,370,241,743**
10.01	Guideway: At-grade exclusive right-of-way	0	0	0	0	0	0
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	0	0	0	0	0	0
10.03	Guideway: At-grade in mixed traffic	0	0	0	0	0	0
10.04	Guideway: Aerial structure	1,113,971,014	0	23,925,538	62,989,425	86,914,963	1,200,885,977
10.05	Guideway: Built-up fill	0	0	0	0	0	0
10.06	Guideway: Underground cut & cover	0	0	0	0	0	0
10.07	Guideway: Underground tunnel	0	0	0	0	0	0
10.08	Guideway: Retained cut or fill	6,616,908	0	142,116	374,153	516,269	7,133,177
10.09	Track: Direct fixation	138,916,339	0	2,983,604	7,855,016	10,838,620	149,754,959
10.10	Track: Embedded	0	0	0	0	0	0
10.11	Track: Ballasted	0	0	0	0	0	0
10.12	Track: Special (switches, turnouts)	11,565,276	0	248,396	653,958	902,353	12,467,630
10.13	Track: Vibration and noise dampening	0	0	0	0	0	0
20	**Stations, Stops, Terminals, Intermodals**	**274,700,941**	**0**	**5,899,945**	**18,498,544**	**24,398,489**	**299,099,430**
20.01	At-grade station, stop, shelter, mall, terminal, platform	0	9,184,426	197,260	618,485	10,000,171	10,000,171
20.02	Aerial station, stop, shelter, mall, terminal, platform	208,361,018	(9,184,426)	4,277,856	13,412,684	8,506,114	216,867,132
20.03	Underground station, stop, shelter, mall, terminal, platform	0	0	0	0	0	0
20.04	Other stations, landings, terminals: Intermodal, ferry, trolley, etc.	0	0	0	0	0	0
20.05	Joint development	0	0	0	0	0	0
20.06	Automobile parking multi-story structure	0	0	0	0	0	0
20.07	Elevators, escalators	66,339,923	0	1,424,829	4,467,374	5,892,204	72,232,126
30	**Support Facilities: Yards, Shops, Admin. Bldgs.**	**108,744,906**	**0**	**2,335,591**	**2,289,580**	**4,625,171**	**113,370,077**
30.01	Administration Building: Office, sales, storage, revenue counting	18,628,822	0	400,104	392,222	792,327	19,421,149
30.02	Light Maintenance Facility	0	0			0	0
30.03	Heavy Maintenance Facility	90,116,083	0	1,935,486	1,897,358	3,832,845	93,948,928
30.04	Storage or Maintenance of Way Building	0	0		0	0	0
30.05	Yard and Yard Track	0	0		0	0	0
40	**Sitework & Special Conditions**	**584,241,866**	**119,433,926**	**15,113,340**	**23,748,983**	**158,296,248**	**742,538,115**
40.01	Demolition, Clearing, Earthwork	27,599,732	0	592,779	931,488	1,524,267	29,123,999
40.02	Site Utilities, Utility Relocation	321,546,608	119,433,926	9,471,249	14,883,046	143,788,221	465,334,828
40.03	Haz. mat'l, contam'd soil removal/mitigation, ground water treatments	11,033,041	0	236,964	372,364	609,328	11,642,370
40.04	Environmental mitigation, e.g. wetlands, historic/archeologic, parks	11,257,430	0	241,784	379,937	621,721	11,879,151
40.05	Site structures including retaining walls, sound walls	0	0			0	0
40.06	Pedestrian / bike access and accommodation, landscaping	0	0			0	0
40.07	Automobile, bus, van accessways including roads, parking lots	212,805,055	0	4,570,564	7,182,148	11,752,712	224,557,767
40.08	Temporary Facilities and other indirect costs during construction	0	0	0	0	0	0
50	**Systems**	**245,768,900**	**0**	**5,278,551**	**16,499,359**	**21,777,911**	**267,546,811**
50.01	Train control and signals	40,827,955	0	876,891	2,740,929	3,617,820	44,445,775
50.02	Traffic signals and crossing protection	30,127,836	0	647,077	2,022,591	2,669,668	32,797,503
50.03	Traction power supply: substations	52,885,063	0	1,135,850	3,550,367	4,686,216	57,571,279
50.04	Traction power distribution: catenary and third rail	81,144,644	0	1,742,801	5,447,535	7,190,335	88,334,979
50.05	Communications	24,659,969	0	529,639	1,655,513	2,185,153	26,845,122
50.06	Fare collection system and equipment	4,969,929	0	106,743	333,649	440,392	5,410,321
50.07	Central Control	11,153,505	0	239,552	748,775	988,327	12,141,832
CONSTRUCTION SUBTOTAL (10 - 50)		**2,484,526,151**	**119,433,926**	**55,927,081**	**132,909,017**	**308,270,024**	**2,792,796,175**
60	**ROW, Land, Existing Improvements**	**106,748,362**	**0**	**2,292,710**	**3,278,965**	**5,571,675**	**112,320,037**
60.01	Purchase or lease of real estate	104,810,770	0	2,251,095	3,219,449	5,470,543	110,281,314
60.02	Relocation of existing households and businesses	1,937,592	0	41,615	59,517	101,132	2,038,723
70	**Vehicles**	**265,821,682**	**33,412,366**	**5,709,239**	**19,080,319**	**58,201,925**	**324,023,607**
70.01	Light Rail	0	0	0	0	0	0
70.02	Heavy Rail	236,126,707	30,374,879	5,071,459	16,992,341	52,438,679	288,565,387
70.03	Commuter Rail	0	0	0	0	0	0
70.04	Bus	0	0	0	0	0	0
70.05	Other	0	0	0	0	0	0
70.06	Non-revenue vehicles	6,082,304	3,037,488	130,634	388,744	3,556,866	9,639,169
70.07	Spare parts	23,612,671	0	507,146	1,699,234	2,206,380	25,819,051
80	**Professaonal Services**	**756,053,354**	**40,733,537**	**17,113,152**	**43,434,317**	**101,281,006**	**857,334,360**
80.01	Preliminary Engineering	75,605,336	4,585,389	1,722,313	4,371,344	10,679,045	86,284,381
80.02	Final Design	113,408,003	6,878,083	2,583,469	6,557,015	16,018,568	129,426,571
80.03	Project Management for Design and Construction	138,609,782	8,406,546	3,157,573	8,014,130	19,578,249	158,188,031
80.04	Construction Administration & Management	252,017,785	15,284,629	5,741,042	14,571,145	35,596,817	287,614,601
80.05	Professional Liability and other Non-Construction Insurance	37,802,667	2,292,694	861,156	2,185,672	5,339,522	43,142,190
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	37,802,667	2,292,694	861,156	2,185,672	5,339,522	43,142,190
80.07	Surveys, Testing, Investigation, Inspection	12,600,889	764,231	287,052	728,557	1,779,841	14,380,730
80.08	Start up	88,206,225	229,269	1,899,391	4,820,781	6,949,442	95,155,667
SUBTOTAL (10 - 80)		**3,613,149,549**	**193,579,830**	**81,042,181**	**198,702,619**	**473,324,630**	**4,086,474,178**
90	**Unallocated Contingency**	**0**	**0**	**0**	**0**	**0**	**0**
SUBTOTAL (10 - 90)		**3,613,149,549**	**193,579,830**	**81,042,181**	**198,702,619**	**473,324,630**	**4,086,474,178**
100	**Finance Charges**	**484,070,859**	**0**	**0**	**0**	**0**	**484,070,859**
TOTAL PROJECT COST (10 - 100)		**4,097,220,408**	**193,579,830**	**81,042,181**	**198,702,619**	**473,324,630**	**4,570,545,038**

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Conclusion

In general, the PMOC has found that the current available cost estimate is reasonable and acceptable for a project in the Pre-PE phase. The following specific observations are provided and should be addressed once the Project is advanced to PE.

(1) The PMOC's review of the City's project cost estimate concludes the estimate is not mechanically correct in some instances but is essentially consistent with the project scope identified in the DEIS, although it is not entirely free of inaccuracies.

(2) The PMOC has characterized the project cost data as an AACE "Class 4" estimate due to its mostly parametric nature. The PMOC derived the data elements based on a professional judgment from other projects.

(3) As noted herein, the PMOC identified a ~~significant~~ risk associated with the cost estimate General Conditions based on a lack of definition.

(4) The PMOC found a significant understatement of costs with regards to the Excise Tax value included in the Estimate.

(5) The PMOC found a shortfall in the value calculated for the Public Utility relocations as a result of not including all costs from the base 1992 Original Estimate.

(6) The Project staff noted in the September 2008 Risk Assessment Workshop that the Private Utilities would be fully funded by Project. However, the 2007 MK Utility Estimate that was used to prepare the 2008 SCC Estimate was reduced by 15% to account for "suspected franchise agreements" with the utility owners.

(7) The PMOC found the percentages used by the City for escalation in their 2008 SCC Estimate are too conservative.

Recommendations

(1) The PMOC recommends that the City prepare a detailed bottoms-up estimate during early PE. In addition, they should perform quality assurance checks to verify scope inclusivity and that SCC categories are escalated in accordance with the Master Project Schedule. The cost estimate and Basis of Estimate should provide more justification and backup documentation supporting the quantification and assumptions for the "soft costs" and related General Conditions for the project.

(2) The PMOC recommends the City develop a separate cost estimate (or detail assembly) for the General Excise Tax and/or Use Tax. It is recommended that an approach similar to that used for the 1992 Original Estimate be used that assesses these taxes against the entire contract value.

(3) The PMOC recommends the City recalculate the parametric values for the unit costs they have included for Relocation and Removal of the Public Utilities in their 2008 SCC Estimate and adjust their budget accordingly.

(4) The PMOC recommends the City investigate the suspect parametric quantities in the Systems Estimate (SCC 50) that do not sum to a whole number.

(5) The PMOC recommends the City increase their estimate to include the 15% reduction removed from the Private Utility SCCs as a result of the franchise sharing agreement as this is in direct contradiction to their contracting strategy as explained in the September 2008 Risk Assessment Workshop.

(6) The PMOC recommends the City recalculate the values for soft costs once the above adjustments are made to their estimate.

(7) The PMOC recommends the City reconsider the values utilized for escalation to develop the Year of Expenditure costs for their 2008 SCC Estimate, and to incorporate the likelihood that escalation will be high for the next several years as a result of the recent global financial crisis.

1.3.5 Subtask 34A: Project Schedule Review

Methodology

The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #34: Project Schedule Review procedures,* dated March 29, 2007 to assess and evaluate the City's project schedule.

Jacobs has developed and refined a standard Technical Schedule Review (TSR) report format based on senior program management experience, the evolution of scheduling software packages, and program experience on other federal programs. The TSR provides a standard reporting format for various types of schedules such as design schedules, construction schedules and Master Integrated Program Schedules. In addition, the TSR reviews the contractual requirements set by the project sponsor and evaluates the overall program user(s) conformance of schedule management execution.

The review of the Project schedule addresses seven subcategories as identified in the PG-34 (Subtask 34A):

- Schedule
- Technical Review
- Resource Loading
- Project Calendars
- Interfaces
- Project Critical Path
- Critical Areas of Concern

The TSR categories characterize each element in the project/program schedule, from schedule development, performance measurement, through post project archive record documentation. Jacobs tailored the TSR format to better synchronize with the PG-34A. The result is a combination of the PG-34 plus additional review categories contained in the "Technical Review"

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subcategory, listed above. The schedule review will evaluate the efficiency and effectiveness of the project sponsor's project implementation during any phase of the project life cycle. According to the PG-34, the schedule review will also:

> *"...evaluate the completeness, consistency, and adequacy of the project sponsor schedule and make recommendations to the project sponsor on redirecting or reprioritizing its efforts to correct the inadequately defined areas."*

The schedule review also validates the inclusivity of the Project scope and characterizes individual project elements within the current Project phase. It also validates the program management's readiness to enter and implement the next major program phase, the PE phase. The report findings result in a compilation of tabular and graphical reports and conclude with a list of PMOC recommendations for Project sponsor action.

Summary of Findings

The City submitted a proposed construction schedule titled "HHCTP As of August 25.xer" in early August 2008. The PMOC conducted a preliminary schedule review and produced a list of comments to the City during the September 2008 Risk Assessment Workshop. The City incorporated most of the PMOC comments in a revised schedule, titled "CITY.PRX", on September 20, 2008. The PMOC schedule review is based on the revised MPS file "CITY.PRX". The schedule technical data and summary dates are included in the Table 1-6 and Table 1-7, and the Summary Schedule is shown as Figure 1-1.

Table 1-6. Schedule Summary

Schedule Item	MPS
Number of activities	202
Number of activities in longest path	16
Started activities	0
Completed activities	0
Number of relationships	322
Percent complete	0 %
Number of hammocks	1
Number of early constraints	3
Number of late constraints	2
Number of mandatory constraints	1
Data date	September 15, 2008
Start date	September 15, 2008
Imposed finish date	N/A
Latest calculated early finish	December 18, 2018

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Table 1-7. Summary Schedule Dates

Description	Start Date	Finish Date
Preliminary Engineering		
PE Request thru FTA Approval	15SEP08	31DEC08
PE thru ROD	31DEC08	28AUG09
Design Build Procurement		
MSF (thru issuance of NTP)	16SEP08	01MAR10
Guideway (thru issuance of NTP)	16SEP08	17JAN10
Systems (thru issuance of NTP)	16SEP08	24APR10
Final Design		
Final Design (FD) Request thru FTA Approval	24APR09	05JAN10
Full Funding Grant Agreement (FFGA)		
Application thru Approval	24APR10	26FEB11
Construction		
Start	20DEC09	
Vehicle (Design/Manufact./Deliver/Test/Commission)	25APR10	18DEC18
System (Design/Manufact./Install/Test/Commission)	25APR10	18DEC18
Open Farrington Section		15DEC12
Open East Kapolei Pearl Highlands		16APR14
Open to Aloha Stadium		26MAR17
Open to Ala Moana Center		18DEC18

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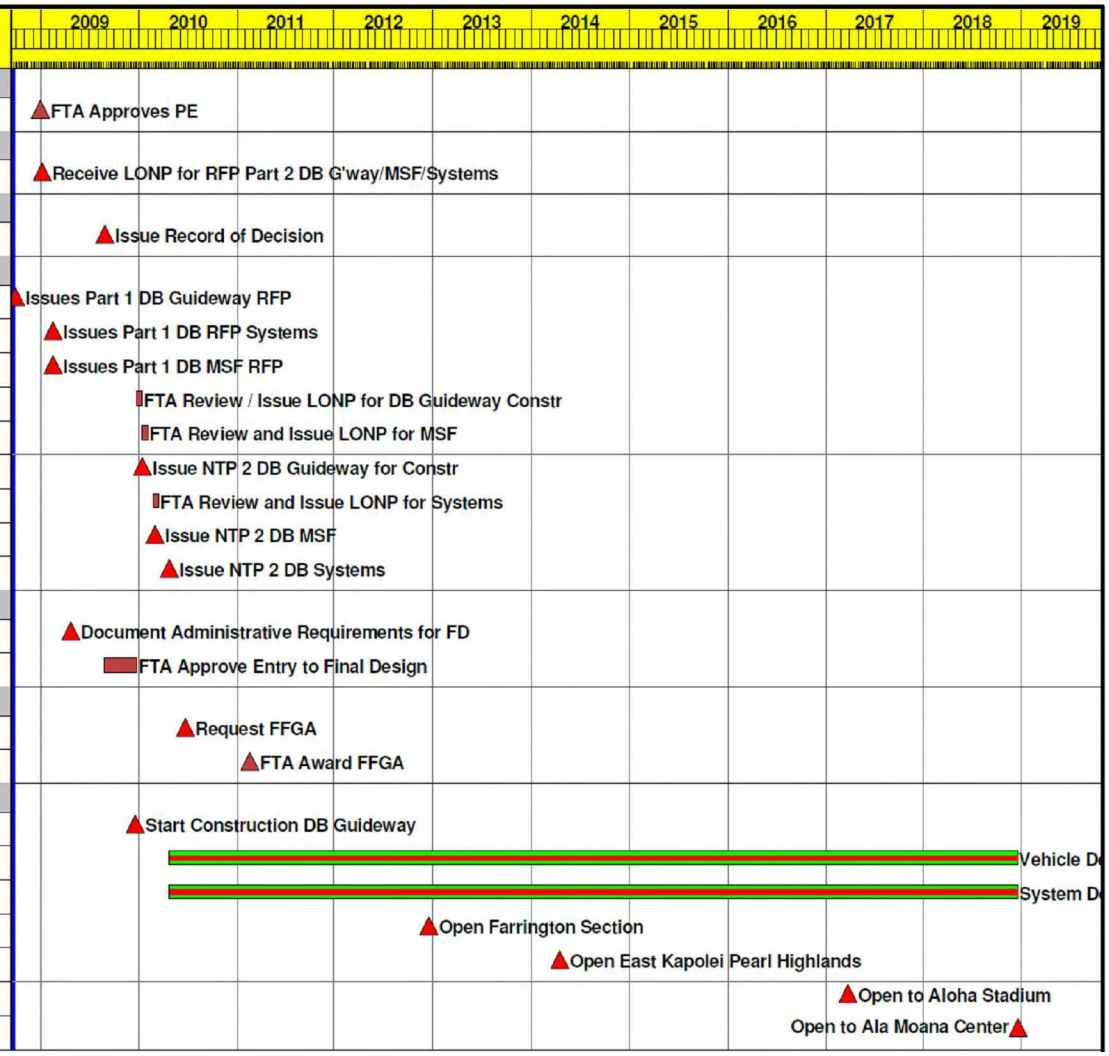
Figure 1-1. Summary Schedule

Activity Description	Orig Dur	Early Start	Early Finish
READINESS FOR PELIMINARY ENGINEERING			
FTA Approves PE	0	31DEC08	
ADVANCED CONCEPTUAL ENGINEERING			
Receive LONP for RFP Part 2 DB	0	05JAN09	
EIS & PRELIMINARY ENGINEERING			
Issue Record of Decision	0		28AUG09
DB PROCUREMENT			
Issues Part 1 DB Guideway RFP	0	30SEP08	
Issues Part 1 DB RFP Systems	0	13FEB09*	
Issues Part 1 DB MSF RFP	0	13FEB09*	
FTA Review / Issue LONP for DB Guideway Constr	21	27DEC09	16JAN10
FTA Review and Issue LONP for MSF	21	15JAN10	04FEB10
Issue NTP 2 DB Guideway for Constr	0	17JAN10	
FTA Review and Issue LONP for Systems	21	24FEB10	16MAR10
Issue NTP 2 DB MSF	0	01MAR10	
Issue NTP 2 DB Systems	0	25APR10	
READINESS FOR FINAL DESIGN			
Document Administrative Requirements for FD	0	25APR09	
FTA Approve Entry to Final Design	120	29AUG09	26DEC09
FULL FUNDING GRANT AGREEMENT			
Request FFGA	0	25JUN10	
FTA Award FFGA	0	20FEB11	
CONSTRUCTION & RELATED ACTIVITIES			
Start Construction DB Guideway	0	20DEC09	
Vehicle Design/Manufacture/Test/Commission	3,160	25APR10	18DEC18
System Design/Manufacture/Instal/Test/Commission	3,160	25APR10	18DEC18
Open Farrington Section	0	15DEC12*	
Open East Kapolei Pearl Highlands	0		16APR14
Open to Aloha Stadium	0		26MAR17
Open to Ala Moana Center	0		18DEC18



Conclusion

The City's Master Project Schedule, "CITY.PRX", dated September 20, 2008, lacks detail for the PMOC to completely address all of PG-34 requirements, many of which are construction phase specific. The PMOC has determined the need to revise the current MPS but acknowledges that the next MPS revision can be addressed early in the PE phase.

It is the PMOC's professional opinion that the Master Project Schedule is sufficient in detail to support the PMOC's determination that the City has demonstrated the schedule review requirements necessary to enter the PE phase.

Recommendations

- Approval to Enter PE Phase

  No specific recommendations necessary for conditional approval to enter PE have been identified.

- Early PE Phase

  The PMOC recommends the following comments be addressed and incorporated into the Master Project Schedule no later than the first sixty (60) days of the PE phase:

  (1) The MPS requires more activity detail for the following critical project components:
  - Utilities – exploration, adjustment, abandonment and or relocation
  - Real Estate Acquisitions – identification, appraisals
  - Systems Integration – traction power, signals and communications, train control
  - Startup and Testing
  - Operational Commissioning and Training
  - Vehicle Procurement – procurement, design, manufacturing, delivery, testing
  - Construction Material Procurements

  (2) The MPS should utilize multiple schedule calendars (a feature of the scheduling software) for various types of work related to the PE, Final Design, procurement and construction of varying types of work, especially during the construction phase. The additional calendars can be assigned to special activities and events such as City board meetings for special actions and contract awards, public outreach meetings, FTA review periods and FTA (federal) holidays, overnight or off-peak weekends or hours for material handling and installation that impact traffic and the public in general, etc.

  (3) The WBS should be modified to crossover with the Project budget and cost breakdown structure once developed and implemented.

  (4) The Activity Code Structure should be expanded and completed.

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(5) The Basis of Estimate should include activity duration assumptions and identification of latent contingency within each activity duration.

(6) The MPS should include all Third Party Agreements development and execution.

(7) Schedule activities for the City's staffing plan should be inserted including all efforts associated with recruiting, training, and transitioning between the PMC and the City key management staff positions.

(8) The number of constraint dates and should be reduced, and the use of mandatory constraint dates should be avoided.

(9) The City should baseline the MPS and commence monthly progress status update reporting.

- Approval to Enter Final Design Phase

  The PMOC recommends the following comments be addressed and incorporated into the Master Project Schedule prior to entrance into the Final Design phase:

  (1) The City should define a consistent WBS, reporting format, and update frequency for the current MPS. These "standards" should be applied to the design consultants, construction contractors, and vendors to ensure schedule reporting standardization as the Project continues.

  (2) The City should address schedule software settings in the contractual specifications and requirements when applicable during the design and construction phases.

  (3) The utilization of manpower and equipment resource loading and budget/cost loading should be addressed.

1.3.6 Subtask 40A: Assessment of Project Cost Risk

Methodology

The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #40: Risk Management Products and Procedures,* dated March 29, 2007 complete a cost risk analysis of the Project. Full details of this review may be found at Section 8.0 of this Spot Report.

The PMOC evaluated the City's Base Cost Estimate (BCE) to determine what programmatic risks it poses to FTA's accomplishment of its core accountabilities to simulate mitigation scenarios and maximize the application and effectiveness of the City's contingency.

The PMOC established a programmatic "management baseline" for evaluating the reliability of the City BCE given the various elements of uncertainty associated with the effectiveness and

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efficiency of the City's project implementation. The PMOC identified, assessed, and evaluated the uncertainties in the project scope, schedule and cost estimate based upon the PMOC review and analysis of City's data under PG-32, 33 and 34.

Based upon this analysis, the PMOC translated those data findings and related information into Level 1 probability distributions of the project cost estimate as developed through an empirically established, random variable model. The PMOC also applied theoretical decision concepts, such as expected value of perfect information and expected value of imperfect information, to simulate the effects of grantee mitigation throughout the project implementation. This grantee mitigation is based on the premise that risk mitigation is a sequential process assuming the following risks are mitigated in the following sequence:

- Requirements Risks
- Design Risks
- Market Risks
- Early Construction Risks (composed of Geotechnical/Utility risks/ right-of-entry)
- Mid-Range Construction Risks (associated with coordination of contractors)
- Start-Up or Substantial Completion of Construction Risks

The PMOC identified all allocated and unallocated contingencies and escalation that represent costs most likely not to be incurred in the most optimistic scenario. Where the PMOC developed information using other risk assessment products to identify scope, cost or schedule elements with a high degree of likelihood (in excess of 90%) ~~of~~ required grantee cost estimate adjustment, the "unadjusted base" cost was modified accordingly to produce an "adjusted base" cost. The net result is the Adjusted BCE, which is net of all contingency and finance costs. Contingency risks are addressed in the Executive Summary section that follows, and which further impacts the BCE.

Summary of Findings

This Level 1 statistical risk analysis results in a most optimistic total project cost of $5.24 billion at this Pre-PE phase (or the baseline phase of the project). After adding back the finance costs of $484.07 million, the statistically most optimistic Total Project Cost becomes $5.72 billion at this early project stage of development. The most pessimistic estimate for the total project cost at this pre-PE phase is $10.39 billion. After adding back the finance costs of $484.07 million, the statistically most pessimistic Total Project Cost becomes $10.87 billion.

The Level 1 statistical risk analysis was used to forecast the total project cost at the following Project phases:

- Baseline – Entry into PE (Q3/2008)
- Entry into Final Design (Q4/2009)
- FFGA Award (Q1/2011)
- 50% Construction (Q2/2014)
- 90% Construction (Q4/2017)

In this risk-informed dynamic analysis, the BRF values for the different project phases were applied in accordance with PG-40 and in part through FTA program experience with other projects and the identified risks that could cause cost escalation. Figure 1-2 depicts how the

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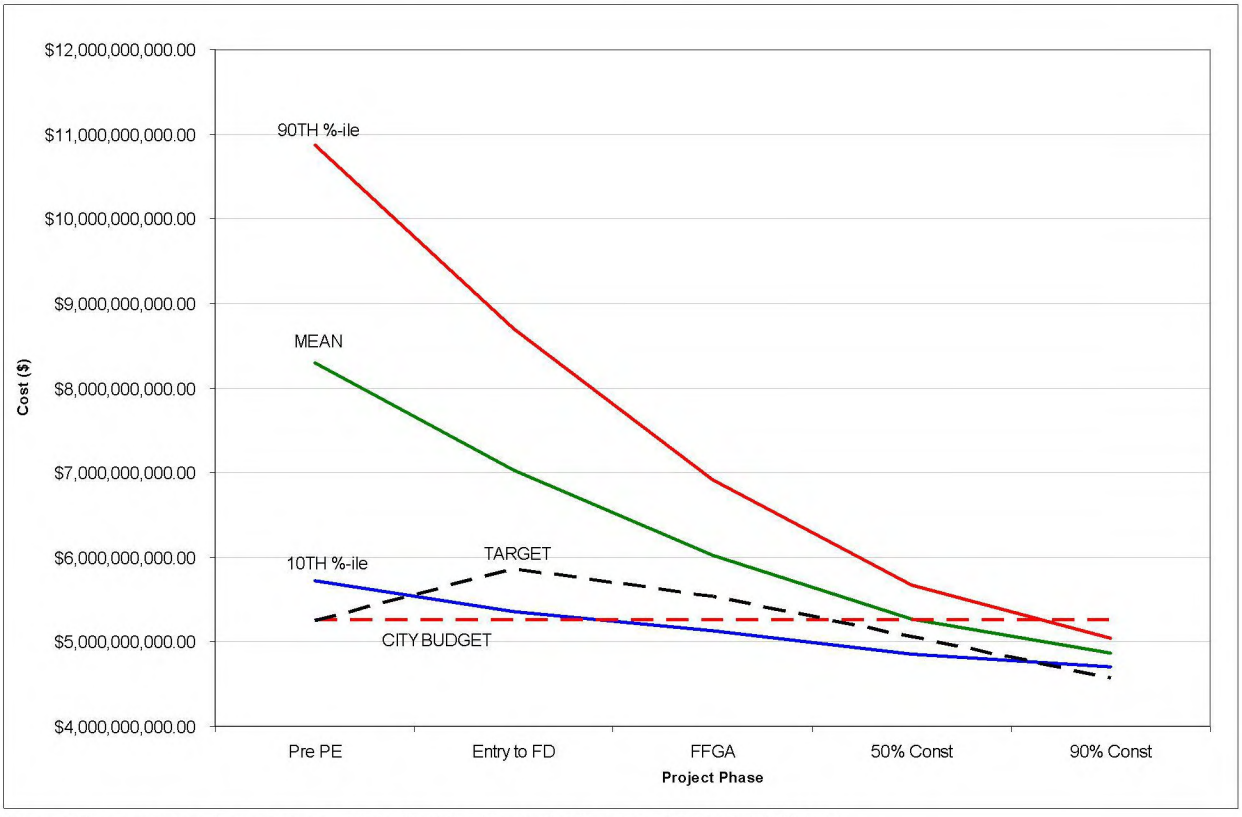
values of the 10th, 50th (mean), and 90th percentiles of the total project cost change during the life of the project. These values (i.e., projected costs) drop as the requirements, design, and market risks are eliminated from the project through the advancement of the design analysis, engineering applications and the availability of firm bids. The City budget is shown as $5.258 billion.

Figure 1-2. Plot of Cost Risk Model Project Forecasts and Target Values



Note: The target values are associated with the analysis completed per PG-35A.

Conclusion

With this Adjusted BCE and the Beta Risk Factors applied in the Cost Risk Model, using both more static statistical and more dynamic risk-informed analyses, the end result is a Pre-PE phase budget that Jacobs believes is sufficient and, therefore, recommends a Total Project Budget of $5.72 billion at this time. However, this analysis must be supported by an assessment of the contingency per PG-35 to confirm the adequacy of the total Project budget as discussed in Section 9.0 of this Spot Report.

It is recognized that estimate will undergo significant refinement once the project advances into the PE phase. Over the course of the Project, the Cost Risk Model indicates that it is possible for the Project to be implemented within the current budget with totally effective. The primary mitigation method is chiefly design development and is the preferred method to achieve project cost targets. Secondary mitigation is the amount of additional contingency that must be funded based on the expected risks, as discussed in Section 9.0.

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1.3.7 Subtask 35A: Project Cost Contingency Baseline Review

Methodology

The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #35: Project Contingency and Third Party Profit Review Procedures,* dated March 29, 2007 to assess and evaluate the City's cost contingency. Per PG-35, the PMOC shall fully identify, describe, and analyze the adequacy of the City's cost contingency. Full details of this review may be found at Section 9.0 of this Spot Report.

Summary of Findings

The Base Year (2008 dollars) and Year-of-Expenditure (YOE) contingencies for the Project are shown in Table 1-4. For the purposes of this analysis, the allocated contingency for each SCC category was individually escalated using the inflation factors by cost category from the SCC workbook to YOE. The PMOC used the same inflation factors identified by the City within the SCC Workbook for escalation of the individual line items in developing their YOE estimates. The unallocated contingency was escalated as well from Base Year to YOE using the same methodology. The charts and tables in this report are based on YOE and the City's ROD of 2018.

As noted in Section 1.3.4, the PMOC made adjustments to the Project's direct costs due to omissions in scope or under valuation of certain cost items. In addition, the PMOC attempted to identify latent contingencies included in the direct cost estimate. However, given that the estimate is based solely on Cost Estimating Relationships, latent contingency amounts were not readily identified. The PMOC adjustments summed to $473.2 million (YOE), as shown in Table 1-5.

Conclusion

The estimation of the required cost contingency needs to recognize the mitigation capacity available at each phase of project development throughout the life of project. The recommended contingency in the BCE must be adequate to support the project through project close-out. In this Spot Report, a contingency amount is recommended for inclusion in the BCE at the current phase of the project. Management of contingency will be accomplished using a Project Execution Plan with project-specific strategies to be developed at a later phase. The Project Execution Plan is to be built upon an analysis of contingencies and planning of contingency replenishment. Table 1-8 summarizes the results of the contingency analyses performed for this Project.

Table 1-8. Contingency Analysis Summary

Analysis Method	Resulting Percentage of Adjusted BCE	Calculated Contingency (YOE)	Calculated Total Project Cost (YOE)
Forward Pass	30.0%	$1,226,000,000	$5,796,456,038
Cost Risk Model	28.2%	$1,152,000,000	$5,722,573,115
Backward Pass	27.9%	$1,140,000,000	$5,710,545,038

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Recommendations

Based on these analyses, the PMOC recommends a minimum contingency of $1.226 billion (YOE), which is 30% of the Adjusted BCE amount of $4.086 billion (YOE). This results in a Total Project Budget of $5.80 billion (YOE), an increase of $538.0 million (YOE), or 10.1%, over the City's current budget. ~~This equates to an 11% Level of Confidence in the Cost Risk Model after deducting the finance costs.~~

1.3.8 Subtask 35C: Project Schedule Contingency Review & Subtask 40B: Assessment of Project Schedule Risk

Methodology

The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #35: Project Contingency and Third Party Profit Review Procedures,* dated March 29, 2007 to assess and evaluate the City's schedule contingency. The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #40: Risk Management Products and Procedures,* dated March 29, 2007 complete a schedule risk analysis of the Project.

The role of the PG-40B product is to establish a programmatic management baseline for evaluating the reliability of the grantee project schedule and its components given the various elements of uncertainty associated with the effectiveness and efficiency of the grantee's project schedule for project implementation. The PMOC identified, assessed and evaluated the uncertainties in the project schedule using a Monte Carlo simulation model was used that is fully scalable in terms of BCE/SCC/WBS/Contract packaging levels depending upon the project phase. Input for the model was based on observational data, professional judgment, and intermediate analysis. The result was probability distributions of the project schedule. The PMOC then identified and analyze the adequacy of the City's schedule contingencies per the requirements of PG-35C.

Summary of Findings

A quantified schedule risk analysis was performed on the *"CITY.PRX"* schedule. This technique provides a means to determine schedule risk as a function of risk associated with the activities that make up the schedule. The CPM schedule is comprised of a network of activities logically sequenced to identify the longest critical path, start to completion. The schedule risk assessment techniques takes the planning process another step further accounting for uncertainty by using a range of durations to complete each activity instead of a single point duration. It calculates the overall schedule duration by developing a probabilistic distribution for each activity's duration, then totals the durations on the longest critical path. These ranges are then combined to determine the overall schedule duration.

The activity duration probability distributions were aggregated using PertMaster, a simulation program that uses a Monte Carlo type probability algorithm. The Monte Carlo sampling technique method is described below:

- Activity durations are randomly selected from an appropriate frequency distribution
- Project length and critical path data are calculated based on the sampled durations
- The procedure is repeated several thousand times (simulation runs) using a computer

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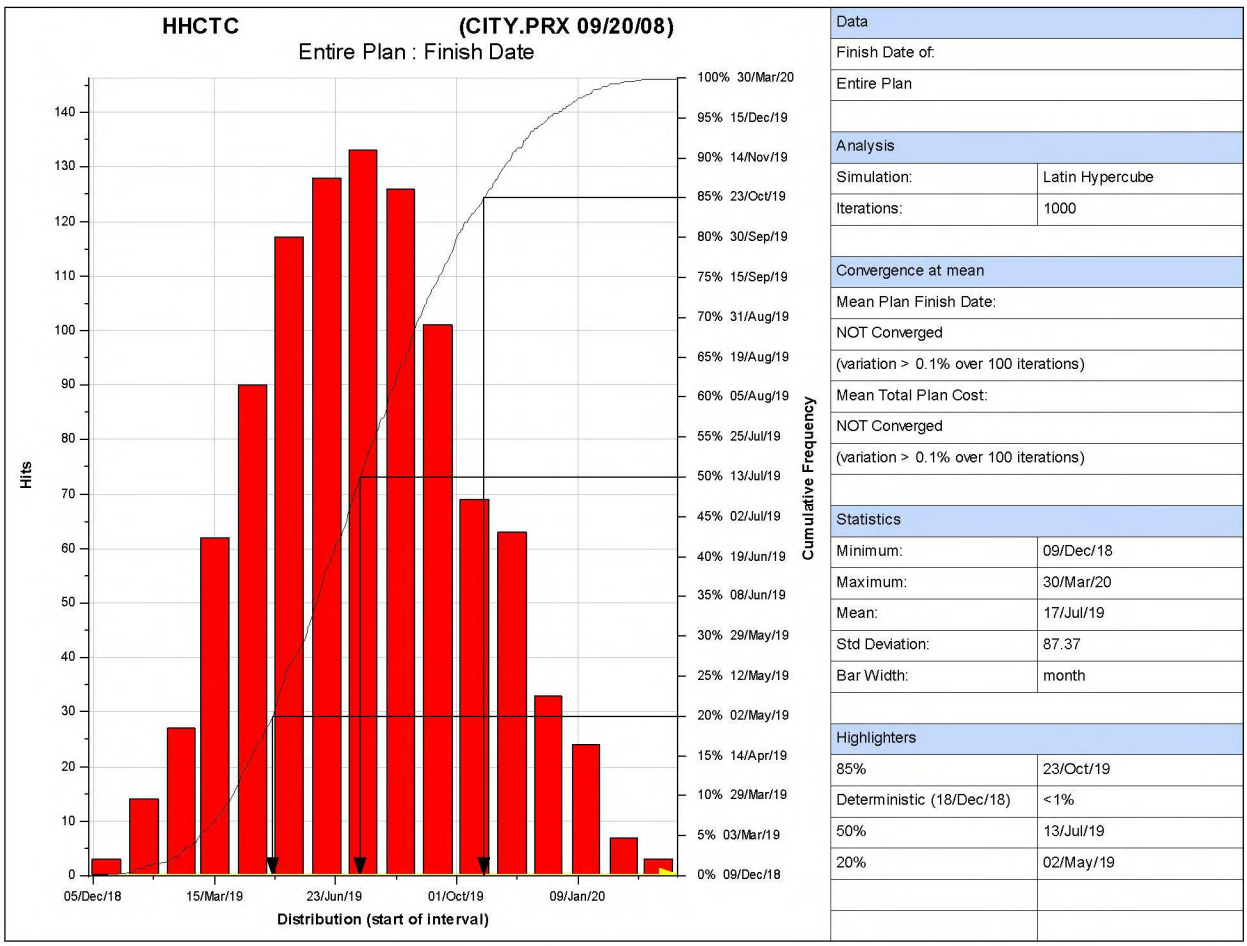
and a record is kept of the critical path data generated

- An average project duration and standard deviation are calculated based on the simulated data
- The probability of meeting a certain date is then calculated

The computer simulation gives a more reliable estimate since it takes into account the effect of near-critical paths. For each activity, a record is kept of the proportion of simulation runs in which the activity is critical. This proportion is called the "Criticality Index". For instance, if an activity was critical in 3,000 simulation runs out of 10,000 total simulation runs, the Criticality Index = 0.3. The results of the analysis are shown in Figure 1-3.

Figure 1-3. Finish Date Distribution



In addition to calculation of the ROD date, to assess the schedule mitigation capacity of the project, the schedule distribution was calculated for each of the schedule milestones described in Table 1-4. The distribution for these milestones was calculated in the same manner as for the ROD date. An optimistic date for achieving the milestone is the 20th percentile; high confidence of achievement is at the 85th percentile. Data are also shown for the median date (50th percentile) and the maximum date from the calculation.

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Table 1-9. Probability of Achievement Date of Schedule Milestones

Project Timeframe	Activity ID	Schedule Finish Date	Milestone Achievement Date – Percentile Rank			
			20th	50th	85th	Maximum
Entry into PE	N270	31DEC08	22JAN09	04FEB09	18FEB09	12MAR09
Entry into Final Design	D240	26DEC09	02APR10	01MAY10	07JUN10	12AUG10
FFGA Award	F270	26FEB11	12JUL11	25AUG11	15OCT11	17JAN12
Construction RODs						
Open Farrington Section	* I160	15DEC12	11NOV12	11NOV12	11NOV12	11NOV12
Open East Kapolei Pearl Highlands	I165	16APR14	01AUG14	11SEP14	04NOV14	09MAR15
Open to Aloha Stadium	I170	26MAR17	14AUG17	17OCT17	09JAN18	06JUL18
Open to Ala Moana Center	I999	18DEC18	02MAY19	13JUL19	23OCT19	30MAR20

*Mandatory constraint date in the City schedule distorted the triangular distribution of dates.

Conclusion

The schedule risk analysis was based on the City's *"CITY.PRX"* schedule. The PMOC's schedule risk analysis, generated by the aggregation of activity duration probability distributions determined there is less than a 1% chance of achieving Revenue Operation Date (ROD) by the project completion date/ROD of December 18, 2018. The analysis indicates there is an 85% probability of achieving ROD by October 23, 2019. The earliest calculated date for achieving ROD is December 5, 2018. The latest calculated date for achieving ROD is March 30, 2020. Based on the current MPS and the results of the schedule risk analysis and contingency analysis, the PMOC recommends a project completion date (ROD) no earlier than November 14, 2019.

Although a delay in the Project schedule would typically correlate to increased costs, the overall impact cannot be determined at this time because the primary cost drivers resulting from schedule delays are "soft costs". Since these "soft costs" are only a percentage of the construction value of the Project, their impact cannot be assessed until a staffing plan or more detailed estimate is developed.

Recommendations

- Conditional Approval to Enter PE

  The PMOC has determined that there are no conditional requirements needed prior to the Entry into PE, though the PMOC has provided the following suggestions be incorporated into the Master Project Schedule during the next revision.

  (1) Technical Schedule Review:
  - Do not use mandatory constraints
  - Reduce the amount of constraints used
  - Increase the amount of activities in the longest critical path
  - Do not use activity durations greater than 2 months

  (2) Provide monthly schedule updates.

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(3) Self perform PertMaster or similar Schedule Risk Analysis on the Master Project Schedule at least once per quarter. In addition, seek consultant, vendor and construction contractor input on critical schedule activity durations (Best Case, Worst Case, Most Likely) to support the Schedule Risk Analysis.

(4) Greatly expand the detail for Vehicle and Systems procurement, installation, testing and commissioning. The PMOC recognizes more definitive information will evolve during the PE phase.

(5) Incorporate for schedule activity detail for early construction packages such as interagency agreements, early site-work packages, early utility adjustment packages, etc.

(6) Provide more backup documentation explaining the justification of activity original durations.

(7) Provide more activity detail for ROW acquisitions by contract segment.

(8) Seek FTA review and comment on schedule activities that indicate "FTA Review".

(9) Provide a summarized group of activities that are 100% complete for the past two years for a historical record.

(10) Allow more float contingency for construction contractor bid and award process for Design-Bid-Build and for Design-Build procurements to allow for bidding extensions, contract document addendums, etc.

(11) Provide more interim milestones within each contract segments. These milestones can be used as a means to support earned value measurement and general progress status reporting.

(12) The Master Project Schedule should be "baselined" early in the PE phase. The baseline should be used during subsequent monthly progress updates for variance reporting and to support the justification of recovery schedule efforts. Like wise, the City should incorporate schedule revisions to address any necessary means or methods of schedule recovery to account for any delays/schedule impacts realized to date.

- During the Early PE Phase

  The PMOC recommends the following comments, in addition to the Subtask 34A recommendations, be addressed and incorporated into the Master Project Schedule no later than the first sixty (60) days of the PE phase.

(1) The City MPS interim milestone activities representing the incremental Revenue Operation Dates should be consistently used and labeled as finish milestones. The City should evaluate the necessity of each milestone and how each milestone impacts the overall project. The milestones are:

- Open Farrington Section
- Open East Kapolei Pearl Highlands
- Open to Aloha Stadium
- Open to Ala Moana Center

(2) Develop and submit a schedule mitigation plan for at least three (3) months of schedule recovery for the following project milestones:

- Request to Enter Final Design
- FFGA Application, Review and Award Process
  - Open Farrington Section
  - Open East Kapolei Pearl Highlands
  - Open to Aloha Stadium
  - Open to Ala Moana Center

(3) Develop and submit a schedule mitigation plan for at least four (4) months of schedule recovery for the following project phases:

- Start-up and Testing (MSF)
- Start-up and Testing (Entire project alignment)

(4) Develop and submit a project contingency management procedure that identifies how and at what level the City senior management will control the contingency levels for the project.

(5) Evaluate the Vehicle/Systems procurement, Design/Build and Design/Bid/Build contracting strategies to determine if incentives can be included to increase the reliability of schedule performance for these vendors/contractors.

1.4 Conclusion

The PMOC recognizes that components of this Project are further advanced than for a typical project in the pre-PE phase. The PMOC is of the opinion that the Project scope, schedule, and budget are sufficiently developed to allow the Project to advance into the PE phase. ***However, based on the cost risk and contingency analyses completed and presented within this Spot Report, the PMOC concludes that the Total Project Budget at this phase should be $5.80 billion (YOE) with a total contingency of $1.226 billion (YOE). ~~This equates to an 11% Level of Confidence in the Cost Risk Model after deducting the finance costs and 30% total contingency of the Adjusted BCE.~~***

It is recognized that estimate will undergo significant refinement once the project advances into the PE phase. Over the course of the Project, the Cost Risk Model indicates that it is possible for the Project to be implemented within the current budget with totally effective. The primary mitigation method is chiefly design development and is the preferred method to achieve project

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cost targets. Secondary mitigation is the amount of additional contingency that must be funded based on the expected risks.

The Schedule Risk Assessment indicates there is an 85% probability of achieving ROD by October 23, 2019, which is a delay of approximately 10 months from the City's plan. The PMOC also recommends that the schedule be modified to reflect a higher probability of achieving the Revenue Operations Date. ***Based on the current MPS and the results of the schedule risk analysis and contingency analysis, the PMOC recommends a project completion date (ROD) no earlier than July 2019, which corresponds to a 50% Level of Confidence at this time.***

The City should develop a Project Development Plan (PDP) to guide them in implementation of the PE phase. The PDP will provide the essential processes to be used, their anticipated costs and schedule, and various metrics to satisfactorily measure performance in attaining the planned delivery of products and completion. The major goal of the PDP, for both the City and the FTA, is to complete the Project within budget and on schedule by delivering the Project through each phase of its development and implementation with the project contingency (cost and time) within targets, completion criteria satisfied, risk mitigation scope accomplished, and mitigation capacity available. The PDP document is, therefore, the development of a distinct product called for by the PMP, which details recommendations for specific tasks and outcomes to advance this project through completion of PE and meeting the entry into the Final Design phase requirements of the FTA. Prior to advancing into Final Design, should the project be so considered, the City shall develop a Project Execution Plan pursuant to FTA requirements.

2.0 INTRODUCTION

Report Date	March 17, 2009 (REVISED FINAL DRAFT)
Project Name / Location	Honolulu High-Capacity Transit Corridor Project Honolulu, Hawaii
Project Sponsor	City and County of Honolulu
Project Management Oversight Contractor (PMOC) firm	Jacobs Engineering Group Inc.
Person providing this report	Tim Mantych, PE (MO, IL)
Length of time PMOC has been assigned to this project:	Since August 11, 2008

The Federal Transit Administration (FTA) has contracted Jacobs to provide Project Management Oversight Contractor (PMOC) services on FTA's New Starts and major capital projects. This Task Order provides FTA's Office of Program Management (TPM) in Washington, DC with Project Management Oversight services for programmatic services and products for contract level plans, quality management systems and reporting, white papers, ancillary support, information technology services and status reporting. Subject to the issuance of individual Work Orders by the Contracting Officer's Technical Representative, the Contractor shall also provide PMO services for FTA's Regional Offices' grantees and their major capital projects to the extent that the PMOC has no conflicts of interest. Task Order No. 12 was executed by FTA on July 10, 2007 for the performance of on-going PMOC oversight services. Work Order 5G was issued to Jacobs August 11, 2008 to provide the deliverables contained within this Spot Report.

2.1 Project Background

The City and County of Honolulu ("City" or "Grantee") is requesting to enter into Preliminary Engineering (PE) for the Honolulu High-Capacity Transit Corridor (HHCTC) Project ("Project") in accordance with the Federal Transit Administration (FTA) New Starts requirements. The Project is intended to provide improved mobility in the highly-congested 25-mile east-west corridor along Oahu's south shore between Kapolei and the University of Hawaii at Manoa (UH Manoa). The Project would provide faster, more reliable public transportation services than those currently operating in mixed-flow traffic. The project also would provide an alternative to private automobile travel and improve linkages between Kapolei, Honolulu's urban center, UH Manoa, Waikiki, and the surrounding urban area. Drivers and bus riders in the corridor currently experience 42,000 daily hours of delay.

The Alternatives Analysis (AA) for the Project was initiated in August 2005 and the Honolulu High-Capacity Transit Corridor Project Alternatives Analysis Report was presented to the Honolulu City Council in October 2006. The purpose of the report was to provide the City Council with the information necessary to select a mode and general alignment for high-capacity transit service on Oahu. The report summarized the results of the AA that was conducted following the FTA's planning guidance. The report provided information on the costs, benefits, and impacts of four alternatives:

- No Build Alternative
- Transportation Systems Management Alternative

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- Managed Lane Alternative
- Fixed Guideway Alternative

During November and December 2006, public meetings were held on the AA. On December 22, 2006, the Honolulu City Council enacted Ordinance No. 07-001, which selected a fixed guideway alternative from Kapolei to the UH Manoa and Waikiki as the Locally Preferred Alternative (LPA) for the Project. Ordinance 07-001 identified a specific alignment for the majority of the corridor but left options open in two locations. At the western end of the corridor, the LPA selection identified two alignments (described in the AA Report as Section I – Saratoga Avenue/North-South Road and Kamokila Boulevard), with the notation "as determined by the city administration before or during preliminary engineering." In the center of the corridor, the LPA selection also identified two alignments (described in the AA Report as Section III – Salt Lake Boulevard and Aolele Street), also with the notation "as determined by the city administration before or during preliminary engineering."

The LPA selection was made recognizing that currently-identified revenue sources, including revenues from the 0.5 percent General Excise Tax surcharge in place from January 1, 2007 through December 31, 2022, and a reasonable expectation of FTA New Starts funds, would not be sufficient to fund the capital cost of the LPA. Thus a financially feasible Minimum Operable Segment (MOS) needed to be chosen. On February 27, 2007, the Honolulu City Council selected as the MOS, East Kapolei to Ala Moana Center, via Salt Lake Boulevard (Resolution 07-039, FD1(c)). The MOS is referred to as the "First Project".

2.2 Project History

Following is a history of the Project:

- 1968 – Oahu Transportation Plan recommended a rail system with a 1980 horizon year.
- 1972 – Phase I of a Preliminary Engineering Evaluation Program for a rapid transit system between Pearl City and Hawaii Kai was completed, and Phase II, which included an analysis of alternatives, was completed in 1976.
- 1982 – A Final Environmental Impact Statement (FEIS) was finalized.
- 1990 – An AA and a Draft Environmental Impact Statement (DEIS) were completed for the Honolulu Rapid Transit Program with a horizon year of 2005.
- 1991 – A Super Turnkey procurement was issued.
- 1992 – An updated FEIS was completed in July 1992 and a Record of Decision (ROD) was issued. However, as a result of a lack of support from the City Council to establish a dedicated local funding source for the project, FTA denied funding and the project was suspended.
- 2000 – An AA report was developed for a bus rapid transit system for the Honolulu Primary Corridor Project.
- January 1, 2007 – A 0.5% surcharge on the Hawaii General Excise Tax went into effect.
- July 1, 2007 – The City created the Rapid Transit Division (RTD) within the Department of Transportation Services (DTS) through enactment of the City's Fiscal Year 2008 Executive Operating Budget and Program.

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- August 24, 2007 – The City executed a GEC contract for $85 million to perform National Environmental Policy Act (NEPA) documentation, pre-PE and PE activities.
- February 22, 2008 – The City's Technology Selection Panel recommended the use of steel-wheel on steel-rail technology based on request for information industry responses submitted in January. Subsequently, Mayor Hannemann directed DTS to base the DEIS on steel-wheel on steel-rail technology.
- September 2008 – Pre-Preliminary Engineering (PE) Risk Assessment performed.
- November 2008 – A ballot measure was passed that, in part, approved the development of a "steel wheel on steel rail" transit system for the City of Honolulu.
- 2009 – Request to Enter PE.

2.3 Project Description

The "First Project" consists primarily of aerial structure (18.91 miles) but also includes a short retained fill section (0.34 miles). The proposed investment also includes nineteen stations (18 aerial and 1 at-grade), sixty transit vehicles, and both administrative and maintenance facilities. The specific modal technology for this project is steel wheel on steel rail. The City has referred to the mode as a "Light Metro" vehicle. However, the vehicles can be described as automated short heavy rail vehicles with a tight turning radius. For the purposes of this Spot Report, including the transit capacity analyses, the vehicles are identified as a "heavy rail" vehicle, which corresponds with the modal technology identified in the Standard Cost Category workbook estimate provided by the City.

The First Project is planned to be delivered in two phases.

- Phase I
  - East Kapolei to Navy Drum Site Maintenance Base/Leeward Community College (CC)
- Phase II
  - Leeward CC to Puuloa Road (Salt Lake)
  - Puuloa Road (Salt Lake) to Nimitz Highway
  - Nimitz Highway to Ala Moana Center Terminus

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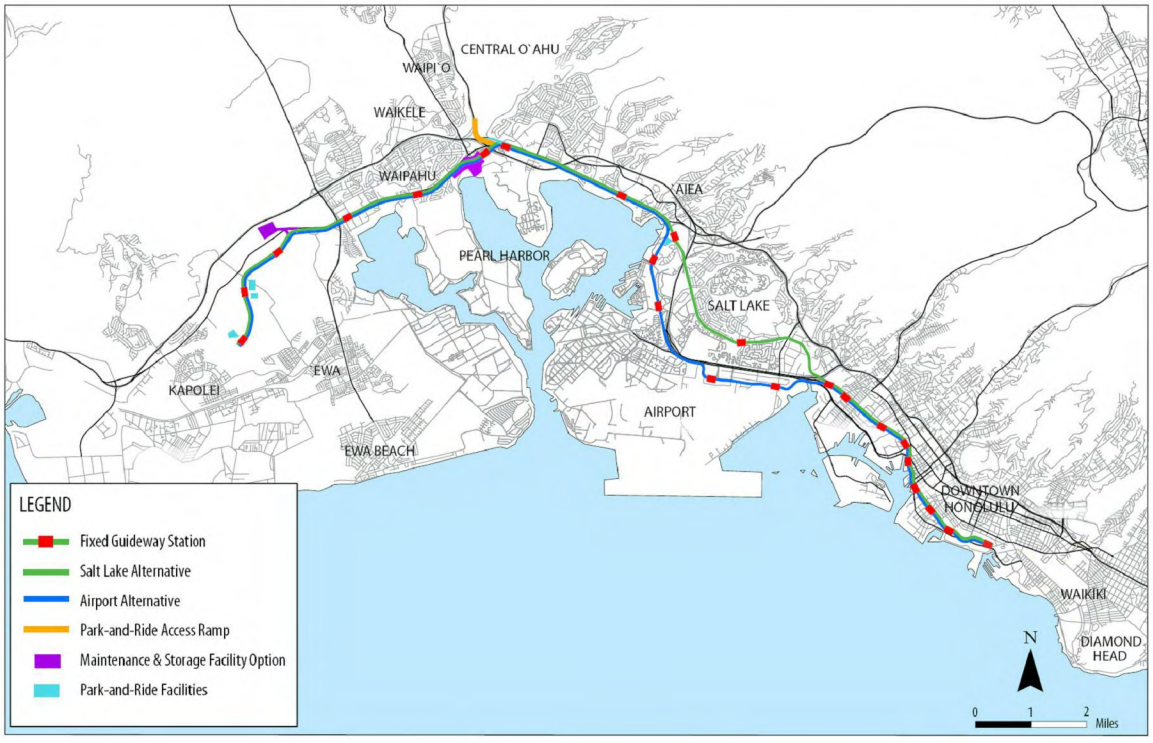
Figure 2-1. First Project as Identified in ADEIS



The 2007 estimate for the full First Project is approximately $5.2 billion, in Year-of-Expenditure (YOE) dollars. The City's target Revenue Operations Date for the First Project is December 2018.

Following is a summary of the proposed Project component characteristics at the time this Spot Report was prepared:

Guideway

- Exclusive guideway:
  - Majority of guideway will be elevated structure consisting of concrete box sections
  - Short (1.19 miles) at-grade section in location of Maintenance and Storage Facility will include no grade crossings
- Double-track mainline
- Maximum speed: 55 miles per hour (mph)
- Crossovers spaced at approximately 2 miles
- Pocket Track at Aloha Stadium Station
- Third Track at Ala Moana Station
- At-grade Junction for Merging and Diverging Routes
- Seamless Merging of Parallel Main Lines and Branch Lines

Stations

- 19 aerial stations

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- 13 side platform with mezzanines
- Five (5) side platform without mezzanines
- One center platform with mezzanine
- Station length: 250 to 300 feet
- Mezzanine at all aerial stations
- Barrier-free

Maintenance and Storage Facility

- Initial construction will accommodate 80 revenue vehicles
- Maximum capacity of site is 150 revenue vehicles
- Yard movements will be manually controlled, except for departure/receiving tracks
- Shop Facility will include administrative and operational offices for the agency, including Operations Control Center (OCC)
- Facility will be designed and commissioned to achieve Leadership in Energy and Environmental Design Green Building Rating System Silver Certification, and will be operated in accordance with FTA Sustainable Maintenance and Operational Standards

Revenue Vehicles

- Heavy rail ~~or Light Rail Rapid Transit vehicle (proposed)~~
- Approximate number of vehicles: 60
- Standard gauge, steel wheel on steel rail
- Fully automated, manual operation possible (hostler panel)
- Nominal vehicle dimensions:
  - Length: 60 feet
  - Width: 10 feet
  - Height: Up to 13.3 feet
  - Floor Height: 3.77 feet above top of rail (at entry)
- Nominal Passenger Capacity: 190 per vehicle
- Electric traction via third rail, nominal 750V direct current (DC) supply, all axles powered
- Semi-permanently coupled, bi-directional trainsets
- Wide gangways between end and middle cars
- 2 to 3 double passenger plug doors per side (per car)
- Manual crew doors with steps
- Dynamic / regenerative braking
- Alternating current (AC) propulsion
- 30+ year design life

Systems

- Traction power
  - Distribution system will consist of substations and main line track power distribution facilities

    - Approximately 20 Traction Power Substations will be spaced at approximately one mile intervals along the alignment with ratings in the range of 2 megawatt (MW) to 5 MW
    - Power distribution system will be based on a 750-volt direct current (DC) third rail system
- Train control
    - Automatic train control technology
    - Driverless train operation
    - Two-minute Design Headway
    - Bi-directional operation
    - Fall-back manual train operation
    - Parallel and branch main lines
    - Mid-line Maintenance and Storage Facilities
    - Accurate station stopping
    - Operations Control Center
- Communications
    - Supervisory Control and Data Acquisition System
    - Optical Fiber Transmission System
    - Radio System
    - Telephone System
    - Public Address System
    - Variable Message Sign System
    - Closed Circuit Television System
    - Fire and Intrusion Alarm Systems
    - Maintenance Management Information System
- Fare Collection
    - Fare system will be integrated with the fare structure on the City's existing bus system
    - Proof of payment system

2.4 Project Management Oversight Contractors (PMOC)

In March 2007, the FTA assigned Booz Allen Hamilton (BAH) to serve as the "resident" Project Management Oversight Contractor (PMOC) for the Honolulu Project. On August 11, 2008 the FTA assigned a second PMOC (Jacobs) to provide concentrated oversight efforts in order to inform FTA's decision regarding project approval for potential entry to preliminary engineering. Jacobs is to provide FTA with "information and well-grounded professional opinions regarding the reliability of the project scope, cost, and schedule of the LPA". Unless otherwise stated in this Spot Report, any references to "PMOC" are specific to Jacobs.

2.4.1 PMOC Deliverables

Table 2-1 provides a summary of the deliverables, as governed by the applicable FTA Program Guidance (PG), to be provided under this Work Order by Jacobs.

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Table 2-1. Jacobs Deliverables

Subtask	Description
10C	Individual Work Order Level Implementation Plan
11A	General Review of Grantee's Technical Capacity and Capability
32A	Project Capacity Review
32E	Project Delivery Method Review
33A	Parametric Project Cost Estimate Reviews
34A	Project Schedule Review
35A	Project Cost Contingency Baseline Review
35C	Project Schedule Contingency Review
40A	Assessment of Project Cost Risk
40B	Assessment of Project Schedule Risk

This Spot Report is organized such that each deliverable comprises a separate chapter.

2.4.2 PMOC Activities

Following is a summary of Jacobs' activities associated with this Work Order:

- August 11-13, 2008 – Attended Kick-off Meeting in San Francisco, California. Attendees included representatives from FTA Region IX, the City, Project Management Support Consultant (PMC), General Engineering Consultant (GEC), and BAH.
- August 27, 2008 – Participated in conference call with the City to discuss the Project cost estimate.
- September 8-12, 2008 – During a trip to Honolulu, Hawaii, Jacobs completed the following activities:
  - Performed staff interviews to support the PG-11A product
  - Participated in a project tour
  - Met with key staff to discuss various aspects of the Project including alignment, structural configuration, utilities, and project controls
  - Participated in a Risk Assessment Workshop (two days)

2.5 Evaluation Team

The main agencies involved in the Project are FTA, the City and County of Honolulu (City), Booz Allen Hamilton (resident PMOC), and Jacobs (PMOC for this Work Order). Appendix A presents the Evaluation Team (e.g. primarily the participants of the Risk Assessment Workshop).

2.6 Documents Reviewed

Appendix B provides a listing of the project-related documents that were utilized during development of this Spot Report.

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3.0 SUBTASK 11A: REVIEW OF TECHNICAL CAPACITY AND CAPABILITY

3.1 Methodology

The PMOC established a methodology to comprehensively review and address the pertinent requirements and documents per the *FTA Project Management Oversight Operating Guidance (PG) #11, Technical Reviews of Grantee Technical Capacity and Capability, Project Management Plan (PMP) Review Products and Procedures;* and the *New Starts Project Planning and Development Checklist of Project Sponsor Submittals to FTA to Enter Preliminary Engineering (Checklist)* developed by FTA in July 2007, and *Technical Review of Grantee Technical Capacity and Capability*, dated March 29, 2007.

The PMOC Technical Capacity and Capability (TCC) Assessment is separated into three categories: Document Review, Technical Capacity, and Technical Capability.

The PMOC reviewed the PMP and companion documents as part of the ***document review*** process.

The PMOC determined the project sponsor's ***technical capacity*** by reviewing the organizational structure and matrix responsibilities of each position listed in the project organization chart contained in the PMP Rev. 0.

The PMOC determined the Project sponsor's ***technical capability*** by reviewing the resumes and conducting interviews of key management staff members. In addition the PMOC reviewed the Booz Allen Hamilton (BAH) PMOC DRAFT spot reports, trip reports, and meeting notes. The PMOC concentrated on the relevant rail design and construction experience, and program management experience for each interviewed staff member.

Starting on August 12, 2008, the Jacobs PMOC interviewed the PMOC (BAH) and was briefed on the existing supporting documents and reports used to support their TCC review assessment and determinations. The Jacobs PMOC conducted on-site interviews to support the TCC and risk assessment deliverables on September 8-12, 2008 at the City/Project Management Support Consultant (PMC) offices in Honolulu.

The methodology for conducting the TCC Assessment consists of performing several steps as follows:

(1) Kick-off Meeting in an Francisco, California – August 12, 2008
(2) Document gathering – August 12 thru September 18, 2008
(3) PMOC Teleconference (BAH and Jacobs) with PMC – August 27, 2008
(4) On site interviews – September 8-12, 2008
(5) Site tour – September 9, 2008
(6) PMOC submits DRAFT TCC Assessment Report to FTA for review and comment
(7) PMOC revises report to reflect FTA comments
(8) PMOC submits REVISED DRAFT report to FTA
(9) FTA authorizes release to project sponsor

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(10) Project Sponsor reviews and comments
(11) PMOC takes project sponsor comments under advisement
(12) PMOC submits FINAL TCC Assessment Report
(13) Project sponsor action based on TCC Assessment Report findings

The documents identified in Appendix B were utilized to complete the TCC Assessment.

3.2 Document Review

The PMOC used the FTA document *New Starts Project Planning and Development Checklist of Project Sponsor Submittals to FTA to Enter Preliminary Engineering (PE)* dated August 10, 2007 as a guide to support the TCC document review process. Table 3-1 provides a listing and status of the subcategories of the Project Management Plan in accordance with 49 Code of Federal Regulations (CFR) 633 and FTA's *Project & Construction Management Guidelines*, May 2003 Update. The Real Estate and Acquisition Management Plan (RAMP), Quality Management Plan (QMP), Bus Fleet Management Plan (BFMP), Safety and Security Management Plan (SSMP), and Third Party Agreements and Permits are typically submitted to the FTA as stand-alone documents that supplement the PMP. This list does not include all of the documents needed to satisfy the FTA requirements to enter PE, only the documents necessary to support the PMOC TCC assessment.

This project is a rail starter system; therefore, a Rail Fleet Management Plan (RFMP) does not yet exist. This plan will be developed much later in the project once the Final Design and definitive rail vehicles are established.

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Table 3-1. New Starts Checklist to Enter PE

Project Management Plan (Category)	1st Submittal Date	Latest Rev. Date	Rev No.	Status
Basic Requirements				
Project Sponsor Staff Organization	06/12/07	05/21/08	0	Addressed in PMP Chapter 2
Project Budget		09/11/08	0	Acceptable, requires revision during PE
Project Schedule		09/20/08	0	Acceptable, requires revision during PE
Procedures				
Document Control Procedures				Addressed in PMP Chapters 3 & 7, a separate Document Control Plan, mentioned in the PMP, has not been developed
Change Order Procedures				Addressed in PMP Chapters 6, 7, 10 & 11
Material Testing Procedures				Addressed in PMP Chapter 10
Internal Reporting Procedures				Addressed in PMP Chapter 3
Operational Testing Procedures				Addressed in PMP Chapter 16
Quality Assurance/Quality Control (QA/QC)				Addressed in PMP Chapter 2 & 3, and the QMP. See Plans below
Plans				
PMP	06/12/07	05/21/08	0	Needs revisions to better address contracting delivery methods and related procedures. Need to include PDP and PEP requirements in update to PMP during PE.
RAMP	01/03/08	04/01/08	0	Acceptable, requires revision during PE
QMP	01/03/08	05/12/08	0	Acceptable, requires revision during PE
BFMP	06/12/07	04/04/08	0	Acceptable
SSMP	01/03/08	05/12/08	0	Acceptable, requires revision during PE
Third Party Agreements Mgmt. Plan				Included in PMP, acceptable
RFMP				N/A, no existing rail system

The PMOC (BAH) conducted all initial document reviews as they were incrementally submitted starting in June 2007. The PMOC (BAH) provided review comments for multiple draft revisions of each document until a final draft was issued and given a Revision 0 status. BAH then submitted to the FTA *Spot Report #2 – Honolulu PE Entry Readiness Report (FINAL)*, dated October 2008 that concluded:

> *Based on meetings and workshops with the City management and staff, documentation reviews, and site visits and tours, it is the PMOC's professional opinion that the City has successfully addressed all the requirements necessary to demonstrate the technical capacity and capability to effectively manage the PE phase of capital project development.*

BAH did identify several areas of concern that the City must address in early stages of the PE phase to ensure effective management and delivery of the project.

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3.2.1 Project Management Plan

The FTA requires that grantees develop and implement a written PMP for each major capital projects funded by FTA. Specifically, Title 49 of the United States Code (USC) Section 5327 of Chapter 53, entitled Project Management Oversight, requires a PMP as a condition of Federal financial assistance for major capital projects. This section also lists the minimum subject categories a recipient's PMP shall include.

Moreover, the grant applicant must agree to carry out the PMP as approved by FTA. Nevertheless, the PMP is a dynamic document for managing engineering, design, construction, and start-up of a project. Periodic updating is required as the City develops and implements the project. The minimum required contents of a PMP are stipulated in Title 49 CFR Part 633 Subpart C Section 633.25 as provided below. At a minimum, a recipient's PMP shall include:

(1) A description of adequate recipient staff organization, complete with well-defined reporting relationships, statements of functional responsibilities, job descriptions, and job qualifications
(2) A budget covering the project management organization, appropriate consultants, property acquisition, utility relocation, systems demonstration staff, audits, and such miscellaneous costs as the recipient may be prepared to justify
(3) A construction schedule
(4) A document control procedure and recordkeeping system
(5) A change order procedure which includes a documented, systematic approach to the handling of construction change orders
(6) A description of organizational structures, management skills, and staffing levels required throughout the construction phase
(7) Quality control and quality assurance programs
(8) Material testing policies and procedures
(9) Plan for internal reporting requirements including cost and schedule control procedures
(10) Criteria and procedures to be used for testing the operational system or its major components
(11) Periodic updates of the Plan, especially related to project budget and schedule, financing, ridership estimates and status of local efforts to enhance ridership;
(12) The recipient's commitment to make monthly submission of project budget and project schedule to the Secretary
(13) Safety and security management {this subsection added by SAFETEA-LU, P.L. 109-59}

In addition, 49 CFR Section 633.27 describes the implementation of a project management plan:

a. Upon approval of a PMP by the Secretary the recipient shall begin implementing the plan.
b. If a recipient must modify an approved project management plan, the recipient shall submit the proposed changes to the Secretary along with an explanation of the need for the changes.

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c. A recipient shall submit periodic updates of the PMP to the Secretary. Such updates shall include, but not be limited to:
   (i) Project budget
   (ii) Project schedule
   (iii) Financing, both capital and operating
   (iv) Ridership estimates, including operating plan
   (v) Where applicable, the status of local efforts to enhance ridership when estimates are contingent, in part, upon the success of such efforts
d. A recipient shall submit current data on a major capital project's budget and schedule to the Secretary on a monthly basis.

The PMP development, PMOC (BAH) document review and re-submittal history is listed below.

- Preliminary Draft submitted to FTA – June 12, 2007
- Revised Draft re-submitted to FTA – September 14, 2007
- PMP Revision Workshop with PMOC – October 16, 2007
- Revised Draft re-submitted to FTA – December 20, 2007
- Final Draft submitted to FTA – March 17, 2008
- Revised Final Draft submitted to FTA – May 21, 2008 (PMP, Rev. 0)

PMOC Assessment

As a result of the TCC document review and interviews with City and County of Honolulu, the PMC and the General Engineering Consultant (GEC) staff, the PMOC identified the need to revise the PMP in order to more adequately address contracting strategy methods, recent evolution of organizational and staffing changes and recent revisions to the project scope and vehicle technology. In addition, the PMOC explained that a Project Development Plan (PDP) and a Project Execution Plan (PEP) were needed to support the PMP and the "implementation" of the PE and Final Design phases. The PMOC and FTA notified the City during the September 2008 Risk Assessment Workshop that they would share an annotated PDP Table of Contents with the City to assist with their plan development.

The City has partially addressed the FTA's required PMP elements contained in 49 CFR 633. The PMOC recognizes certain policies and procedures will be incorporated into the PMP during the PE and Final Design phases. The PMOC did not prejudice these secondary requirements and concentrated on the primary requirements needed for FTA approval to enter PE.

It is the PMOC's professional opinion that the PMP Rev. 0 must be revised to include a PDP and PEP during the PE phase and prior to issuance of a Record of Decision.

The PMP and the companion documents will need further revisions as more definitive information evolves during the PE phase in order to support the PMOC's future "Entry to Final Design Review" report.

3.2.2 Real Estate Acquisition and Management Plan (RAMP)

The PMOC reviewed the City Real Estate Plan, Revision 0 dated May 22, 2008, to ensure that it contained procedures to identify, certify, appraise, acquire, and manage all real estate required

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for the construction and operation of the Project. The PMOC reviewed the RAMP in accordance with FTA Circular 5010.1C, dated October 1, 1998. This Circular directs that all acquisition and relocation necessary for the development of a transportation system shall be conducted in compliance with the Uniform Act of 1970, as amended, and codified in 42 USC Chapter 24.

The RAMP development, PMOC (BAH) document review, and re-submittal history is listed below.

- Preliminary Draft submitted to FTA – January 3, 2008
- RAMP Revision Workshop with PMOC – January 16, 2008
- Final Draft submitted to FTA – April 17, 2008
- Revised Final Draft submitted to FTA – May 22, 2008 (RAMP, Rev. 0)

PMOC Assessment

The quality of the City organization and the proposed personnel are all adequate to meet the needs of the project. The City has extensive experience as an agency with the program, and the personnel proposed share that experience in implementing real estate acquisition projects under the Uniform Act.

As the project proceeds into PE and Final Design, the RAMP will need further revision to incorporate the necessary refinements identified in the Right-of-Way (ROW) plan. At this time the City has identified 205 partial and full takes. The ROW schedule is currently under development and a summary schedule will be incorporated into the Master Project Schedule as a result of the PMOC's TCC review.

The current RAMP, Revision 0, dated May 22, 2008 as reviewed by the PMOC (BAH) during document development and as reviewed by the PMOC (Jacobs) meets the FTA's minimal requirements and guidelines.

It is the PMOC's professional opinion that the RAMP is sufficient in detail to support the City's continuance of project implementation into the PE phase.

3.2.3 Quality Management Plan (QMP)

The Project Quality Management Plan was reviewed in accordance with FTA's fifteen elements of a Quality Assurance/Quality Control Program as defined in the Federal Transit Administration's Report FTA-IT-90-5001-02.1, *Quality Assurance and Quality Control Guidelines*, February 2002 Final Report.

The QMP development, PMOC (BAH) document review, and re-submittal history is listed below.

- Preliminary Draft submitted to FTA – January 3, 2008
- QMP Revision Workshop with PMOC – January 16, 2008
- Final Draft submitted to FTA – April 15, 2008 (QMP Rev. 0)

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PMOC Assessment
The current QMP, Revision 0 dated April 15, 2008, as reviewed by the PMOC (BAH) during document development and as reviewed by the PMOC (Jacobs) meets the FTA's minimal requirements and guidelines.

It is the PMOC's professional opinion that the QMP is sufficient in detail to support the City's continuance of project implementation into the PE phase.

3.2.4 Rail Fleet Management Plan (RFMP)

The City has not yet developed a RFMP. However, it has developed a set of assumptions which will form the basis of a RFMP once certain decisions on vehicle type and operating parameters are further developed.

PMOC Assessment
The City will be required to submit a fully developed RFMP for review in support of entry into Final Design to ensure that the City will have adequate service to meet the transit demand for the years following construction of the New Starts project.

3.2.5 Bus Fleet Management Plan (BFMP)

The FTA issued a memorandum in May 1999 to Regional Administrators titled *Guidance: Bus Fleet Management Plan for New Starts*. FTA's objective in issuing such guidance was to ensure that bus service would not be degraded during design and construction of a grantee's rail project. It further stated that the BFMP should address how the grantee will:

- Maintain a bus fleet and facilities for the level of service and area currently served
- Establish quality of service measures and adequate monitoring of the bus service
- Provide capital and operating funds that will be required for bus service in the area.

To affectively assess and monitor a grantee's bus fleet management and performance, FTA requires the grantee to give a clear explanation of its bus system status in the past, at present, and as projected in the near future in major areas such as ridership, service standards, peak level of service requirements and operating spares, operations & maintenance performance vis-à-vis standards, operations & maintenance staffing, future service / facilities expansions, and funding sources for fleet procurements / rehabilitation projects. These need to be demonstrated with appropriate historical data (as reported to the National Transit Database) for the periods of 3-5 years prior to rail construction, and projections for the duration of the rail construction and at least 1-3 years after the rail service begins.

The BFMP development, PMOC (BAH) document review, and re-submittal history is listed below.

- Preliminary Draft submitted to FTA – June 12, 2007
- Review Comment Discussion with PMOC – June 13, 2007
- Revised Draft submitted to FTA – January 3, 2008
- Revision Workshop with PMOC – January 15, 2008
- Final Draft submitted to FTA – April 4, 2008 (BFMP Rev. 0)

PMOC Assessment
The current BFMP, Revision 0 dated April 4, 2008, as reviewed by the PMOC (BAH) during document development and as reviewed by the PMOC (Jacobs) meets the FTA's minimal requirements and guidelines.

It is the PMOC's professional opinion that the BFMP is sufficient in detail to support the City's continuance of project implementation into the PE phase.

3.2.6 Safety and Security Management Plan (SSMP)

FTA's New Starts program requires that each project receiving FTA funding develop an SSMP for submittal to FTA. FTA has issued guidelines for SSMPs contained in Circular 2500.1, issued on June 21, 2007 and effective as of August 1, 2007, to assist grantees in developing these documents.

The SSMP development, PMOC (BAH) document review, and re-submittal history is listed below.

- Preliminary Draft submitted to FTA – January 3, 2008
- PMOC Review Comments to City – April 15, 2008
- Final Draft submitted to FTA – May 12, 2008 (SSMP, Rev. 0)
- City Approval and document signatures – May 12, 2008

PMOC Assessment
The current SSMP, Revision 0 dated May 12, 2008, as reviewed by the PMOC (BAH) during document development and as reviewed by the PMOC (Jacobs) meets the FTA's minimal requirements and guidelines.

A State Safety Oversight Agency (SSOA) has not been identified, although the FTA and City believe the State Department of Transportation will most likely control and oversee this function. The responsibility for designation of the SSOA resides with the Governor.

It is the PMOC's professional opinion that the SSMP is sufficient in detail to support the City's continuance of project implementation into the PE phase.

3.2.7 Contingency Management Plan

The City has not developed a Contingency Management Plan at this time.

PMOC Assessment
It is expected that the City will develop a Contingency Management Plan based on the Pre-Pre Risk Assessment that is addressed in this Spot Report. The Contingency Management Plan should, therefore, be developed early in PE.

3.3 Technical Capacity

3.3.1 Organizational Approach

Chapter 2 of the PMP titled "Project Organization and Staffing" provides an overview of the management staffing, functions and responsibilities, use of consultants, and interface with outside agencies needed to effectively and efficiently implement the Project. The identified entities presented in the PMP Chapter 2 include:

- City and County of Honolulu (City)
- Project Management Support Consultant (PMC)
- General Engineering Consultant (GEC)
- Engineering Design Consultants (EDC)
- General Construction Manager (GCM)
- System Suppliers and Construction Contractors

3.3.2 City and County of Honolulu Organization

The Department of Transportation Services (DTS) is the City agency responsible for applying for FTA assistance, managing FTA grants, and overseeing compliance with FTA's programmatic requirements. The DTS is responsible for planning, managing, implementing the Project.

On July 1, 2007, the City formed the Rapid Transit Division (RTD) that falls under DTS. The RTD is responsible for the day-to-day management and oversight of the project from the EIS through construction, including all actions and project deliverables required by the FTA New Starts Program, and will interface with other City departments as needed. The RTD is headed by Mr. Toru Hamayasu, DTS Second Deputy Director, as the Project Executive. The project staff consists of full-time City employees supplemented with staff from the PMC. Initially the PMC will fill key project roles pending the hiring of full-time City staff.

~~The City Council is considering an amendment to the City Charter to create a Transit Authority. In order for the Transit Authority to be created and operational on July 1, 2009, the measure must be placed on the 2008 general election ballot. A draft charter amendment has been developed for City Council review. The Transit Authority would be a semi-autonomous City agency responsible for planning, design, construction, operation, maintenance, and expansion of the fixed-guideway mass transit system. As proposed, the Transit Authority would have the following authority and functions:~~

- ~~Full and complete control of all real and personal property used or useful in connection with the fixed-guideway system~~
- ~~Full and complete authority to plan, manage, control, administer, operate, maintain, repair and expand the fixed-guideway system, including extensions~~
- ~~Authority to make and execute contracts and other instruments~~
- ~~Authority to prepare and issue warrants~~
- ~~Authority to promote, create and assist development projects near fixed-guideway system stations~~

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- ~~Authority to apply for, receive and accept grants of property, money and services and other assistance~~

~~Other functions of the Transit Authority are still being discussed. City employees holding positions with the RTD would be transferred to the transit authority.~~

3.3.3 Project Management Approach

The City currently relies heavily on the PMC and the GEC and will continue to do so during the PE phase. The EDCs and the GCM will be procured during the PE phase.

The PMP describes the management structure needed to assure that the Project has adequate organization, management skills, and staff to manage and implement this project. The project team members include a blended organization of the City, a PMC, and a GEC as presented in the Figure 3-1.

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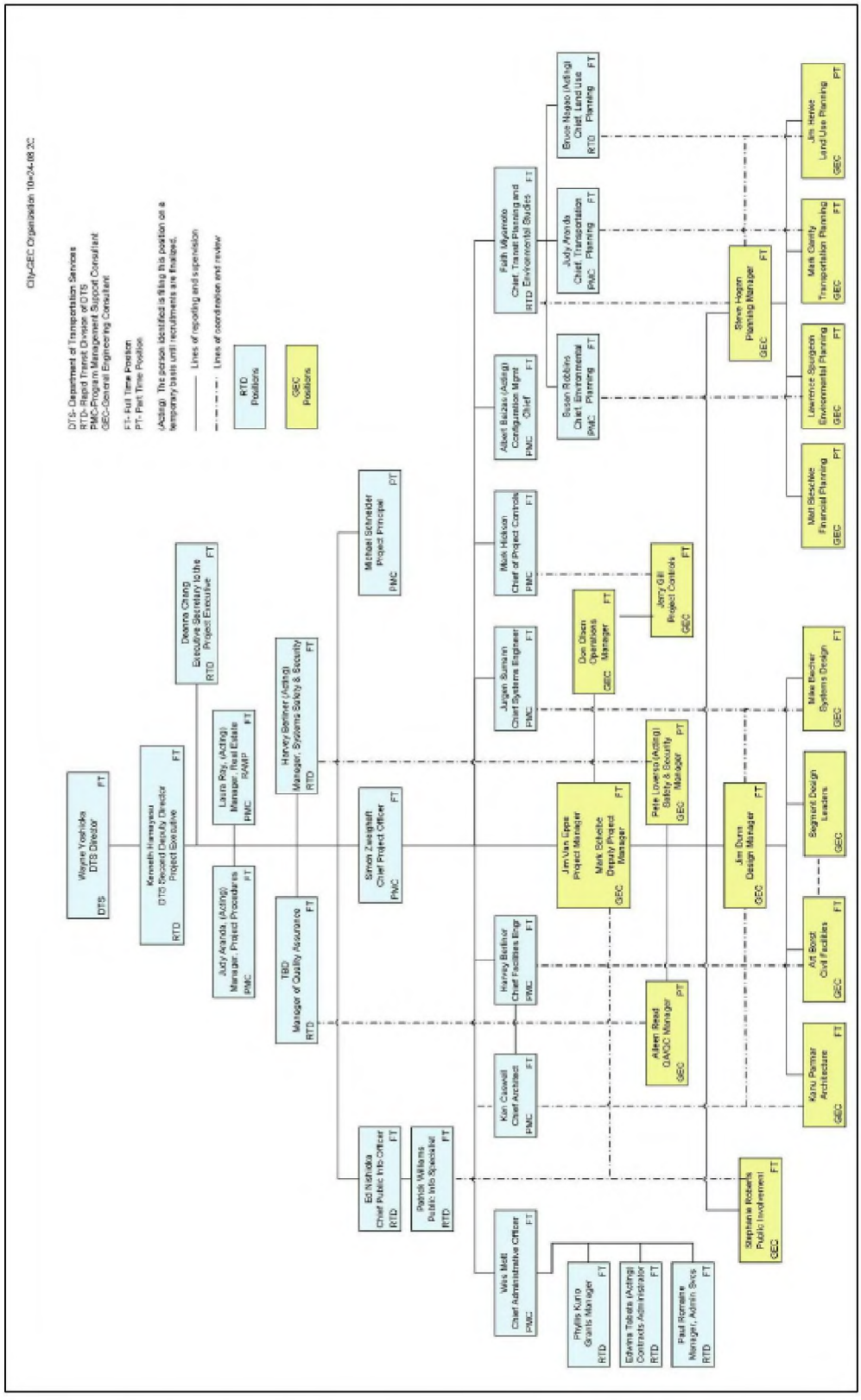
Figure 3-1. City & GEC Project Organization Chart



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The City's long-term strategy is to hire locally and have the PMC train new City staff using the consultant's expertise in an effort to ensure that the new hires are capable of managing the City's consultants effectively. Although there is no set timetable for replacing the PMC with City staff, the City has begun to advertise city positions currently filled by the PMC. The need for PMC staff will diminish as the City fills key management positions. Until such time, the City continues to supplement its staff with PMC staff.

PMOC Assessment:
The PMOC used the project organizational chart and interviews with project staff to identify the current staff members and project management procedures that have been utilized during the current planning phase. The PMOC concentrated on the roles and responsibilities within the City and its PMC organization. Because the blended project organization consists of several entities described above, the PMOC focused on the coordination and traceability of actions and decisions, and of well-defined and functional relationships. The PMOC reviewed the current procedures being implemented and discussed proposed preliminary engineering, internal control, and design management and reporting procedures.

Results of the PMOC interviews and project organization review comments are included throughout this report. The PMOC determined that many of the roles and responsibilities, job descriptions, and lines of authority were well documented in the PMP and companion documents but not clearly understood or implemented by project staff.

Not all positions in the project organization chart are filled. The PMOC has identified ~~significant~~ "capacity" issues as several key City and PMC management positions remain vacant or vacated due to retention challenges stemming from the project's geographic location and other related issues. Several of the City positions are currently filled by "Acting" or "Interim" staff members from the PMC team. While these temporary solutions may fill an immediate void, the PMOC believes the resource demands associated with the PE and Final Design phases of an approximate $5 Billion project require full time and concentrated attention, and continuity within the grantee's organization for smooth transition into further phases. The City position vacancies combined with the interim placement of PMC staff will further strain resource availability and utilization as the PMC contract completion date expires in late 2009.

Table 3-2 lists the key management positions for the City, PMC and the GEC and includes the status of each position. The column titled "Mission Critical" describes, in the PMOC's opinion, positions needing to be filled ***prior*** to Entry into PE as denoted with "Yes". Any persons temporarily filling these mission critical positions is acceptable for the short term but should be filled with permanent staff no later than issuance of the Record of Decision. The mission critical denotation of "Near" describes those positions that must be filled prior to the issuance of the Record of Decision during the PE phase.

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Table 3-2. Key Management Positions

Position Title	Status	Mission Critical	Comment
City			
Project Executive w/ Secretary	Filled	Yes	
Chief, Transit Planning/Environmental Studies	Filled	Yes	
Grants Manager	Interim	Yes	~~Interim City employee with dual roles~~ Position was filled on December 16, 2008
Chief, Transportation Planning	Interim	Yes	Interim PMC employee with dual roles
Real Estate Acquisition	Interim	Yes	Interim PMC employee with dual roles
Manager Quality Assurance	Interim	Yes	Interim PMC employee with multi roles
Manager Systems Safety & Security	Interim	Near	Interim PMC employee with dual roles
~~Manager Project Procedures~~	~~Vacant~~	~~Near~~	
Public Information Specialist	Filled	Near	
Chief, Configuration Mgmt.	Vacant	Near	
Contracts Administrator	Vacant	Near	
Mgr, Admin. Services	Vacant	Near	
PMC			
Chief Project Officer	Filled	Yes	
Project Principal	Filled	Yes	
Chief Administrative Officer	Filled	Yes	
Chief, Project Controls	Filled	Yes	Filled 09/15/08
Chief, Public Info Officer	Filled	Yes	
Chief Architect	Filled	Yes	Filled August 2008
Chief Environmental Planning	Filled	Yes	
Chief Land Use Planning	Filled	Yes	
GEC (partial listing)			
Project Manager	Filled	Yes	
Deputy Project Manager	Filled	Yes	
Mgr. Project Controls	Filled	Yes	
Manager, QA/QC	Filled	Yes	
Manager, Safety & Security	Filled	Yes	
Planning Manager	Filled	Yes	

More than half of the City's key management positions are either vacant or temporarily filled with interim staff members from the PMC, which share other position duties and responsibilities.

The City stated it will extend the PMC contract as necessary to address staffing vacancies. The PMOC's primary technical capacity concern rests on the City's lack of "ownership and direction" to manage the project and independently protect their capital investment interests, ~~especially when the City transforms into a rail operational transit agency~~.

The PMOC recommendations address the need for the City to focus on staffing plans, candidate recruiting and employee retention. ~~In addition, the PMOC recommends the City establish a position for a Manager of Project Controls. This position is critical to the program-wide oversight of establishing and monitoring the Program budget and costs, schedule and document management.~~

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It is the PMOC's professional opinion that the Project organization, staffing, and management approach meets the technical capability to support the City's continuance of project implementation into the PE phase. However, ~~significant~~ technical capacity issues remain as several key City management positions remain vacant or filled by interim City or PMC employees sharing multiple duties. The PMOC recommends all positions be permanently filled no later than issuance of the Record of Decision.

3.4 Technical Capability (Staff Interviews)

The PMOC determined the project sponsor's technical capability by reviewing the resumes and conducting interviews of key management staff members. The PMOC concentrated on the relevant rail design and construction, and program management experience for each interviewed staff member.

The interviews with project management team members serve two equally important purposes. First, the interview process provides information on the manager's background and how it relates to the current job scope and assignment. Although employment and educational history can be gleaned from a resume or an individual's biography, only with a thorough discussion with the manager supported in a question and answer format can the true picture of an individual's strengths and weaknesses be determined. Second, the interview helps the PMOC understand the manager's function within the organization, taking the position out of the one-dimensional plane of an organization chart and focusing on the multi-functional roles that most managers assume in a matrix organization such as this project is currently organized.

The PMOC used the following interview questions as a guideline to conduct interviews with project management team members during the September 2008 Risk Assessment Workshop. The PMOC tailored many of the questions for specific management discipline representatives during the interviews, as some questions were not applicable to some staff members.

(1) Since the purpose of this interview is to assess the project sponsor staff's technical capacity and capability to carry out activities in accordance with the PMP, briefly, what is your background and professional experience with projects of similar type and magnitude?
(2) What do you see as your role and responsibilities in this project?
(3) What is your reporting relationship with other members of the project team?
(4) Do you see any areas of conflict resulting from the proposed reporting structure?
(5) If so, what would you recommend to mitigate these issues?
(6) What do you see as the major issues related to this project?
(7) What do you see as the major risks related to this project?
(8) What preliminary recommendations do you present to deal with these risks?
(9) How familiar are you with the role of the FTA and the PMOC in this project?
(10) Do you believe that the organization and the organizational relationships indicated in the PMP are most appropriate for this project?
(11) How do you plan to conduct QA oversight as part of your QA/QC?
(12) What measures and management tools will you implement to ensure that this project will be designed and constructed on time and within budget?

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(13) Hypothetically, if this project were trending behind schedule and/or over budget, what steps would you take to correct the problem?
(14) What level of authority do you have over supporting organizational resources?
(15) Briefly describe the management infrastructure that exists in your organization that helps in the control of the project (i.e. cost, schedule, document control).
(16) What forms of internal oversight exists?
(17) What type of change control procedures exist?

The PMOC interviewed the following key staff members as part of the technical capacity and capability review assessment. Some of the positions identified in the Project organization chart remain vacant or have been voluntarily vacated.

- City Employees
  - Project Executive – Toru Hamayasu
  - Chief, Transit Planning and Environmental Studies – Faith Miyamoto
  - Grants Manager – Phyllis Kurio ~~(Interim)~~
    ~~*[City employee temporarily filling position.]*~~
  - Manager of Real Estate Acquisitions – Tom Miyata (Interim)
    [City employee temporarily filling position and supported by Laura Ray, a PMC employee.]
  - Chief of Configuration Management – Vacant
  - Manager of Project Procedures – Vacant
  - Contracts Administrator – Edwina Tabata (Interim)
    [City employee temporarily filling position and supported by Laura Ray, a PMC employee.]

- PMC Employees (InfraConsult LLC) Temporarily Filling City Positions
  - Manager of Quality Assurance – Harvey Berliner (Interim)
  - Manager of Safety and Security – Harvey Berliner (Interim)
  - Chief Transportation Planning – Judy Arranda (Interim)

- PMC Employees (InfraConsult LLC)
  - Chief Project Officer – Simon Zweighaft (interview performed via telephone after workshop was completed)
  - Chief Public Information Officer – Elisa Yadao
  - Chief Administrative Officer – Wes Mott
  - Chief Architect – Ken Caswell
  - Chief Facilities Engineer – Harvey Berliner
  - Chief Systems Engineer – Jurgen Sumann

PMOC Assessment

The City key management staff members interviewed by the PMOC maintain a high degree of professional maturity and expertise. While most of the City employees lack mega-program experience, they have established basic defined roles and responsibilities and have so far demonstrated they can work together as a team.

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The PMC key management staff members interviewed by the PMOC maintain a high degree of professional maturity and expertise. Several of the members have worked together on other large, successful projects. Also, through the interview process, the PMOC found the PMC key management staff is experienced, has established basic defined roles and responsibilities, and works together as a team. All are essential qualities for a competent and effective project management organization.

While certain challenges are inherent with a blended organizational approach, the PMOC has determined the City and their PMC key management staff, currently in place, is fundamentally sound and capable.

It is the PMOC's professional opinion that the City staff and supporting consultant team members possess the technical capability to support the City's continuance of project implementation into the PE phase, however, technical capacity issues remain as several key City management positions remain vacant or filled by interim City or PMC employees sharing multiple duties. The PMOC recommends all positions be permanently filled no later than issuance of the Record of Decision planned.

3.5 Conclusion

3.5.1 Document Review

As a result of the TCC document review and interviews with City and County of Honolulu, the Project Management Support Consultant (PMC) and the General Engineering Consultant (GEC) staff, the PMOC identified the need to revise the PMP in order to more adequately address contracting strategy methods, recent evolution of organizational and staffing changes and recent revisions to the project scope and vehicle technology. In addition, the PMOC explained that a Project Development Plan and a Project Execution Plan were needed to support the PMP and the "implementation" of the PE and Final Design phases, respectively. The PMOC and FTA agreed to share an annotated PDP Table of Contents with the City to assist with their plan development. The PMOC and FTA notified the City during the September 2008 Risk Assessment Workshop.

The City has partially addressed the FTA's required PMP elements contained in 49 CFR 633. The PMOC recognizes certain policies and procedures will be incorporated into the PMP during the PE and Final Design phases. The PMOC did not prejudice these secondary requirements and concentrated on the primary requirements needed for FTA approval to enter PE.

The PMP and the companion documents will need further revisions when more definitive information evolves during the PE phase in order to support the PMOC's future Entry to Final Design assessment.

It is the PMOC's professional opinion that the PMP Rev. 0 must be revised to include a PDP. The PMOC recommends the next PMP revision be completed and submitted early in the PE phase. The PMP and companion document revisions are not necessary as conditions precedent to enter PE.

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3.5.2 Technical Capacity

While the current City staff has demonstrated the capability to manage the work presently being performed by the PMC and the GEC, as work progresses into PE, the City will need to add the necessary staff to be directly accountable for the development of the project design, budget and master schedule. Development of the project design will include quality review and audit of the GEC as well as any engineering design consultants assigned to the project; the monitoring of safety and security design requirements and implementation; and continued oversight of the development of the project real estate acquisition plan, program and processes.

It is the PMOC's professional opinion that the City staff and supporting consultant team members have demonstrated the technical capacity to support the City's continuance of project implementation into the PE phase. While numerous technical capacity issues exist, no technical capacity issues need to be addressed prior to entry into PE. The PMOC does recommend the City implement specific staffing, recruiting and retention efforts to meet the resource demands required of PE and future project phases and complete this task early in the PE phase.

3.5.3 Technical Capability

The project organization includes a high degree of professional maturity and expertise. Several of the lead managers have worked together on other large, successful projects. Also, through the interview process, the PMOC found the key management staff team is experienced, has established basic defined roles and responsibilities, and can work together as a team. All are essential qualities for a competent and effective project management organization. While certain challenges are inherent with a blended organizational approach, the PMOC has determined the City/PMC team and its GEC are fundamentally sound and capable. The PMOC recognizes the project management team and consultant resource demands will proportionately increase as the project continues.

It is the PMOC's professional opinion that the City staff and supporting consultant team members possess the technical capability to support the City's continuance of project implementation into the PE phase. No technical capability issues need to be addressed prior to entry into PE.

3.6 Recommendations

(1) The PMOC identified the need to revise the PMP in order to more adequately address contracting strategy methods, recent evolution of organizational and staffing changes and recent revisions to the project scope, including the vehicle technology selection. The PMP should be revised to include a PDP and PEP prior to issuance of a Record of Decision.

(2) The PMOC recommends that the key management positions currently occupied by the PMC be filled by City staff no later than issuance of the Record of Decision. The key management positions the City should focus on filling are, in no particular order:

- Chief, Transportation Planning

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- Real Estate Acquisition
- Manager of Quality Assurance
- Manager of Safety and Security
- Contracts Administrator

~~(3) The PMOC recommends the City establish a position for a Manager of Project Controls. This position is critical to the program-wide oversight of establishing, monitoring and assessing the program budget and costs, schedule and document management.~~

(4) The PMOC recommends that other City key management positions currently vacant be filled by City staff before preliminary design work advances too far – certainly prior to the issuance of a Record of Decision. Essential design control, contracting principles, community outreach and other functions should be developed during the PE Phase and should include input from these City new hires. The positions, in no particular order, are:

- Manager of Project Procedures
- Public Information Specialist
- Chief Configuration Management
- Contracts Administrator
- Manager of Administrative Services

(5) The City may encounter difficulty acquiring the experienced staff needed to manage the corridor independently for the long-term assignment, given Hawaii's cost of living, and distance from the mainland. The City should provide a staffing plan for the transfer of PMC positions including the dates by which all PMC staff positions will be filled by City staff. This staffing plan should be developed early during the PE phase.

(6) The PMOC recommends the City establish a regimented training program as the project refines and continues in order to execute a "knowledge transfer" from the project consultants' expertise. This can be done through the development and refreshment of training manuals and related materials, together with a reasoned period of transition by and between consultant and new hire City employee.

4.0 SUBTASK 32A: PROJECT CAPACITY REVIEW

4.1 Purpose and Objective

When a new or extension of an existing rail transit system is proposed, it is imperative to study whether that proposed system will be adequate in size and operating characteristics for its projected ridership. The forecasting of the rail transit system capacity and the minimum sustainable headway can be a time consuming process requiring the utilization of expensive software packages. Addressing this cost and analysis issue, the Transportation Research Board commissioned TCRP 100, *Transit Capacity and Quality of Service Manual, Report 100 (TCRP100).* This compendium of Industry Best Practice provides a proven toolbox of transit capacity assessment methodologies and established a common FTA and industry-accepted approach to review both current and proposed transit services across a wide range of critical issues, including transit capacity. Implementation of this process will highlight potential problem areas and provide the Grantee sufficient time to develop mitigation strategies prior to expending significant design costs.

4.2 Methodology

The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #32: Project Scope, Definition and Capacity Review Procedures,* dated March 29, 2007 to assess and evaluate operational capacity of the Project. This analysis employs practices recommended in the *TCRP 100* [1] to evaluate proposed operations and the capacity of the planned rail transit system.

At the most basic level, rail transit capacity is a seemingly simple concept that addresses the question of how many persons can be moved within a period of time. The actual calculation of that capacity, however, is somewhat more complex involving considerations relating to car capacity, train length, maximum train speeds, train acceleration and braking characteristics, station dwell times, operating margin, track configuration, traction power system capacity, and safe following distances between trains. *TCRP 100* defines capacity in two ways for rail transit.

- ***Line capacity***: the maximum number of trains (made up of some number of vehicles forming a 'consist") that can pass a point during an interval of time[2] (i.e., cars per hour). Line capacity is a function of train (or consist) length, maximum train speeds, train acceleration and braking characteristics, station dwell times, operating margin, track configuration and associated speed restrictions, terminal station configuration, and safe following distances between trains. The proposed transit network is a simple double track system operating entirely on exclusive right of way.

- ***Person capacity***: the maximum number of persons that can be carried in one direction past a point during an interval of time under specified operating conditions without

[1] Kittleson and Associates et al, Transit Capacity and Quality of Service Manual: 2nd Edition (TCRP Report 100) Transportation Research Board, Washington DC. 2003
[2] Ibid. (Page 5-2)

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unreasonable delay, hazard, restriction or uncertainty[3] (i.e. passengers per hour). Person capacity is a function of line capacity and rail car capacity. *Rail car capacity* is a function of the number of seats on each rail car, the amount of usable standing space on each rail car and the acceptable level of crowding among standing passengers. TCRP 100 specifies that 3.2 ft^2 of space per standing passenger is "reasonable service load with occasional body contact. Moving to and from doorways requires some effort"[4]

This document evaluates the proposed Project infrastructure and operation:

- to determine if it provides sufficient *person capacity* to carry the forecast volumes of design year peak period passengers and
- to determine the theoretical *line capacity* (provided a sufficient pool of vehicles were available).

4.2.1 Document Review

The PMOC relied on the documents identified in Appendix B to prepare this analysis.

4.2.2 Project Specifications

The City forecasts that the Project will attract 88,000 daily weekday passengers by year 2030[5]. The design criteria and planned service levels for 2030 are listed below for what is described as having rail cars that are of the "high-floor light metro transit vehicle type" and "vehicle trainsets…bi-directional and fully automated".[6] Generally, this equates for analysis using Report 100 as a heavy rail system.

- **Rail Car specifications**
  - Dimensions[7]
    - Length: 60 feet
    - Width: 10 feet
  - Seating: 50 passengers[8]
  - Suitable standing space: 378 square feet[9]
  - Doors
    - Style: bi-parting[10]
    - Width: 48.0 to 66.0 inches[11]
    - Configuration: "two to three per side directly opposite the doors on the other side"[12]
  - Performance[13]

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[3] Ibid. (Page 5-5)
[4] Ibid. (Page 5-27)
[5] HHCTC Environmental Impact Statement, August 1, 2008. (Table 3-26)
[6] HHCTCP Draft Chapter 17, Revenue Vehicle Design Criteria, August 1, 2008 (Page 5)
[7] HHCTCP Design Criteria – Revenue Vehicle, August 1, 2008. Draft (Page 7)
[8] Ibid. (Page 18)
[9] Ibid. (Table 12-4)
[10] Ibid. (Page 5)
[11] Ibid. (Page 7)
[12] Ibid. (Page 19)
[13] Ibid. (Page 19)

        - Acceleration: 3.00 miles per hour per second (mphps)
        - Deceleration: 2.2 mphps from 55 to 45 mph, 3.0 mphps from 45 mph to complete stop
        - Maximum speed: 55 mph
    - Layover time: between two and eleven minutes at each terminal[13]
    - Estimated vehicle capacity based on 3.2 square feet per standing passenger (ft^2/p)[14]
        - 50 seated passengers
        - 118 standing passengers (based on stated floor space)
        - 168 total passengers
- **Estimated running time[15]**
    - Dwell time: 20 seconds per station
    - Eastbound: 38:28 (including dwell times)
    - Westbound: 38:47 (including dwell times)
    - Total running time: 1:17:15
    - Planned cycle time: 1:20:30
- **Planned service levels**
    - The Project has design criteria for transit vehicles (revenue cars) as follows: "The vehicle interior shall accommodate the peak passenger demand (P_{15}) with passenger loadings not to exceed a comfort load standard ($L_{Comfort}$), except for periods of limited duration not to exceed ten minutes when a design load standard (L_{Design}) shall be acceptable".[16] However, the values for the peak passenger demand, P_{15} and passenger comfort load standard, $L_{Comfort}$ are not available to PMOC at this time. The L_{Design} value is revealed as 140 standees and 50 seated.[17]
    - The criteria goes on to state:" Vehicles shall provide the maximum number of seats available to passengers, including the provision of tip-up seats in standee / multi-purpose areas. A minimum of 25% of the design load (AW2) passengers shall be provided with seats (fixed + tip-ups)."[18]
    - Two-car trains[19]
    - Train capacity: 336 passengers
        - 100 seated
        - 236 standing
    - Peak: 3.5 minute headway[19]
    - Off-Peak: 6 minute headway[20]
    - Trains required for planned peak service: 23
    - Total cars required for planned peak service: 46
- **Train Control**
    - The Project signaling system has not yet been specified, but the City states in the Operations Design Criteria what is envisioned as:

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[14] TCRP Report 100. (Page 5-27)
[15] HHCTCP Model Assumptions, September 11, 2008.
[16] HHCTCP Design Criteria – Operations, Revision July 1, 2008(Page 2-3)
[17] HHCTCP Draft Chapter 17, Revenue Vehicle Design Criteria, August 1, 2008 (Page 18)
[18] Ibid. (Page 6)
[19] Email to PMOC from James Dunn, PB. October 6, 2008.
[20] HHCTC Environmental Impact Statement, August 1, 2008. (Table 2-5)

"A Train Control System sufficient to ensure safe train movement while maximizing line capacity shall be provided on all main tracks and yard selected tracks as determined in final design. Train operations shall normally be completely automatic, allowing for safe operations without requiring onboard manual operation or supervision. The TCS shall consist of ATO, ATP and ATS."[21]

This automated operational objective would translate into a "cab-control" or "moving-block" signal train control methodology.

- Given the lack of data on the revenue vehicle and complementary train control equipment specifications, PMOC has not performed an independent train control requirements analysis.

- **Traction Power**
  - The City has yet to develop specific requirements. The various reports and design criteria documentation provide guidelines but the detailed requirements and power load analyses are yet to be documented, if conducted at all. A major reason for the lack of data appears to be the uncertainty until recently of the revenue vehicle to be used; at one point it looked as if it might be anything from a standard LRV through an AGT vehicle. The City now has determined the vehicle to be a mini metro type, effectively equivalent to a heavy rail vehicle with automatic operating controls (attribute of an AGT system).
  - What does appear in the design criteria are both solid guidelines and others that are circumspect in that there is circular referencing that does not bring closure on specifics:
    - **"Chapter 17, Section 12.4, TRACTION ELECTRIFICATION SYSTEM CHARACTERISTICS** – The basic third rail contact power limitations under which the revenue vehicles shall operate in revenue service are detailed in Chapter 12--Traction Electrification. All vehicle propulsion and auxiliary equipment shall be designed for operation at these voltages without damage, failure of the equipment to function, or reduction in required service life. All vehicles shall provide automatic forced reduced performance further limiting the vehicle maximum line current under low voltage conditions as further defined in Section 12.8.2."[22]
    - **"Chapter 17, Section 12.8.1, VEHICLE PERFORMANCE – Supply Voltage** – All vehicle equipment shall be designed to operate satisfactorily over the power system supply range identified in Section 12.4." A circular reference without specific data for analysis."[23]
    - **"Chapter 17, Section 12.8.1, VEHICLE PERFORMANCE – Maximum Line Current Voltage** – The maximum line draw per vehicle shall not exceed 1,350 amperes (propulsion plus auxiliaries)."[24]

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[21] HHCTCP Design Criteria – Operations,, Revision July 1, 2008 Section 2.2 1.5 (Page 2-3)
[22] HHCTCP Draft Chapter 17, Revenue Vehicle Design Criteria, August 1, 2008 (Page 5)
[23] Ibid. (Page 18)
[24] Ibid. (Page 19)

- The specific data may not be present or simulations run with emphasis on traction power compatibility with revenue operations (normal service through emergency situations) intent for the desired type of vehicle, but that is not entirely unexpected at the pre-PE Phase level of planning and design. The City has indicated, and the criteria documentation has shown, that the intent is "to provide sufficient interface information to allow revenue vehicle and other Project systems design development during the PE phase, and develop estimates of capital, operating, and maintenance costs"[25].

Given the lack of data on the revenue vehicle and auxiliary equipment power consumption specifications, PMOC has not performed an independent traction power requirements analysis.

4.3 Capacity Analysis

TCRP 100 outlines procedures for transit capacity and levels of service analysis that typically use easy-to-obtain data sets as input variables. In case project specific information is not available, Report 100 provides default values for consideration and these are empirically derived from similar system data. Central to the capacity analysis is the peak 15-minute period during the AM weekday period, or the "peak-of-the-peak", when all systems while endure its maximum regular utilization. This section summarizes the transit demand forecasts and evaluates the planned peak service capacity and tests the City's dwell time and running time estimates and generates analysis of cycle time and vehicle requirement. Finally, the peak line and person capacity of the Project is calculated following *TCRP 100* methodologies.

4.3.1 Forecast Design Year Peak Period Passengers

The forecast ridership for the Project is 88,000 daily weekday passengers by year 2030. The EIS ridership forecast also estimates the number of passengers boarding and alighting for each station and direction during the morning (approximately 6:30 – 8:30 am) two-hour peak period. Although the data was modeled for the afternoon peak period, the morning two-hour peak period is considered the maximum utilization period based on the heavily home-based work trip patterned corridors such as the Project corridor represents.

Typically passenger loadings are not uniformly distributed throughout the peak period. An adjustment called the "peak hour factor" (PHF) is routinely used to estimate passenger volumes during the "peak-of-the-peak" 15-minute time period. The City has not provided the PHF for the Project, so a standard default value was used. *TCRP 100* recommends a heavy rail[26] peak hour factor (PHF) of 0.80. The derivation of the peak-of-the-peak 15-minute ridership estimate from the two hour peak forecasts entails estimating the average 15-minute peak boardings, by in this case dividing the two-hour interval into eight typical 15-minute slots then dividing the average 15-minute load by the 0.80 PHF. The net effect of this adjustment is to add 25% more riders to the peak-of-the-peak above the average 15-minute peak ridership so as to reflect the non-uniform passenger arrival to the stations. This factoring does not change the overall ridership forecast but

[25] Ibid. (Page 4)
[26] TCRP Report 100. (Page 5-68)

assigns how this same ridership will reasonably use the corridor. Table 4-1 shows the forecast two-hour morning peak and calculated 15-minute peak-of-the-peak passenger activity.

Table 4-1. 2030 Station Passenger AM Peak Ridership Forecast

Eastbound	*2 hour peak*		*15 minute peak*		
Station	**Ons**	**Offs**	**Ons**	**Offs**	**Line Volume**
East Kapolei	2370	0	370	0	370
UH West Oahu	2570	10	402	2	770
Hoopili	520	40	81	6	845
West Loch	1550	140	242	22	1066
Waipahu Transit Cntr	680	100	106	16	1156
Leeward CC	110	240	17	38	1136
Pearl Highlands	3860	250	603	39	1700
Pearlridge	950	560	148	88	1761
Aloha Stadium	340	310	53	48	1766
Ala Lilikoi	880	690	138	108	1795
Middle Street	280	560	44	88	1752
Kalihi	560	630	88	98	1741
Kapalama	90	440	14	69	1686
Iwilei	180	520	28	81	1633
Chinatown	90	300	14	47	1600
Downtown	290	2540	45	397	1248
Civic Center	100	980	16	153	1111
Kakaako	50	700	8	109	1009
Ala Moana Cntr	0	6460	0	1009	0

Westbound	*2 hour peak*		*15 minute peak*		
Station	**Ons**	**Offs**	**Ons**	**Offs**	**Line Volume**
Ala Moana Cntr	1340	0	209	0	209
Kakaako	140	30	22	5	227
Civic Center	180	150	28	23	231
Downtown	310	230	48	36	244
Chinatown	80	70	13	11	245
Iwilei	280	120	44	19	270
Kapalama	40	150	6	23	253
Kalihi	160	270	25	42	236
Middle Street	140	180	22	28	230
Ala Lilikoi	170	430	27	67	189
Aloha Stadium	90	150	14	23	180
Pearlridge	230	330	36	52	164
Pearl Highlands	700	180	109	28	245
Leeward CC	30	350	5	55	195
Waipahu Transit Cntr	170	190	27	30	192
West Loch	90	360	14	56	150
Hoopili	20	220	3	34	119
UH West Oahu	0	410	0	64	55
East Kapolei	0	350	0	55	0

The morning peak direction is eastward. Ons and offs and the line volume for the 15-minute peak-of-the-peak at each station in the peak direction is shown in Figure 4-1.

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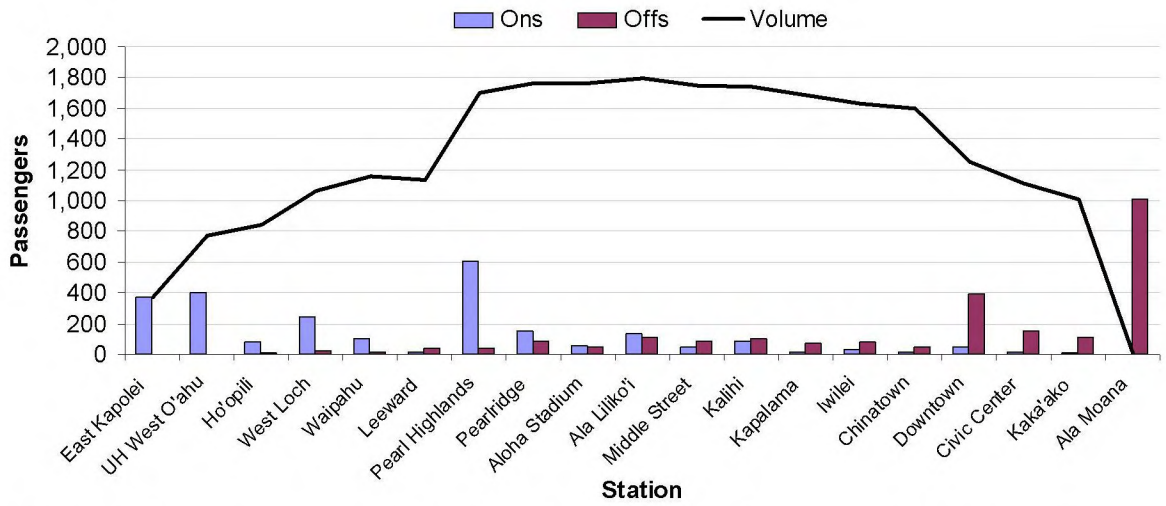
Figure 4-1. Eastbound Passenger Activity and Line Volume (Peak 15 minutes)



Ala Lilikoi is the eastward peak load point of the line. 1,795 passengers are forecast to be traveling east on the line between the Ala Lilikoi and Middle Street stations during the morning 15-minute peak-of-the-peak. Among intermediate stations, Pearl Highlands has the highest level of morning peak passenger activity, with 603 passengers forecast to board the line during the peak 15 minutes of weekday operation. Boardings and alightings are approximately equal from Pearl Highlands eastward to the Downtown station where almost 400 passengers are forecast to alight. East of Downtown station, the majority of morning peak passengers are alighting. More than 40% of the eastbound peak period passengers are forecast to alight at the eastern terminal of Ala Moana.

4.3.2 Planned Peak Person Capacity

As shown in Section 4.2.2, the Project planned peak service will operate two-car trains every 3.5 minutes with a maximum passenger load of 336 passengers per train. The person capacity reflects the number of trains in a period of time multiplied by the passenger capacity of each train. Therefore, the person capacity in the peak 15-minute period is equal to 1,440 standing and seated passengers.

Equation 1: 15-Minute Person Capacity

$$15MinutePersonCapacity = \frac{15Minutes}{3.5Minutes/Train} \times 336Pass/Train = 1440$$

The planned *seated* person capacity is 100 seats per two car train. The service would offer 429 seats to passengers in the peak 15-minute interval.

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Equation 2: 15-Minute Seated Capacity

$$15MinuteSeatedPersonCapacity = \frac{15Minutes}{3.5Minutes/Train} \times 100Seats/Train = 429$$

The 336 passenger load assumes a loading standard of 3.2 ft^2 of standing space for each of the 236 standing passengers. This level of crowding is characterized as "reasonable" by TCRP 100.[27]

Higher levels of crowding could be sustained but are not recommended. For instance, a loading standard of 2.15 ft^2 of standing space per standing passenger could be operated. However, it is not considered reasonable for system design and service reliability to load the network to such crush loads in view of patron perception of discomfort. *TCRP 100* describes the 2.15 ft^2/standee condition as "an uncomfortable near-crush load for North Americans with frequent body contact and inconvenience with packages and briefcases. Moving to and from doorways is extremely difficult."[27] Should the City plan for this level of crowding, the standing capacity would increase to 350 standees for a two-car train. The person capacity of the corridor would increase accordingly to 1,928 passengers in the peak 15 minutes.

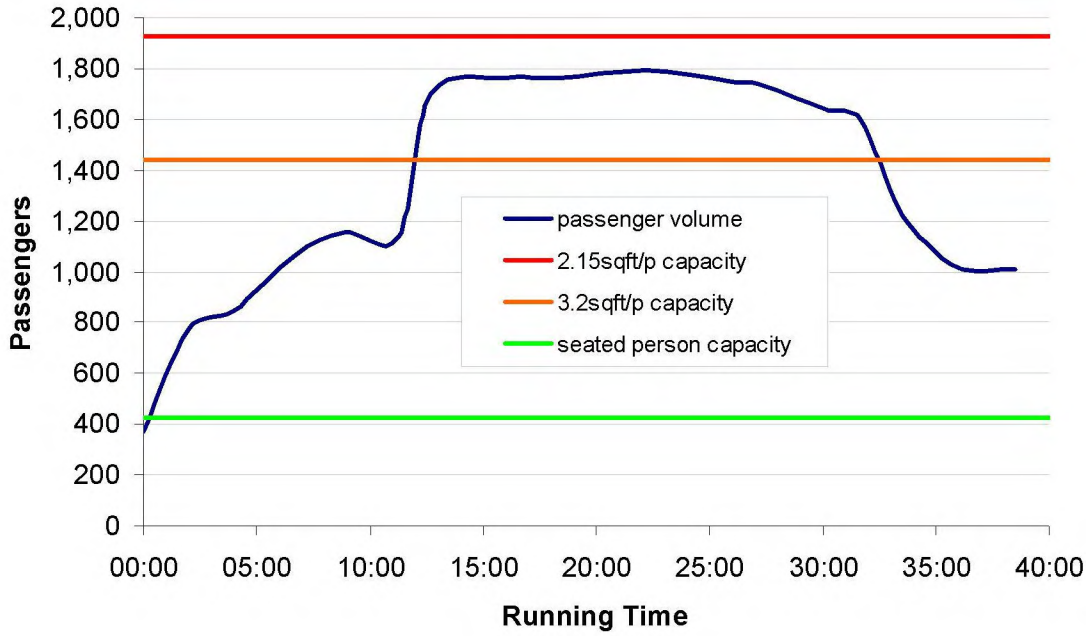
Equation 3: Near-Crush Loaded 15-Minute Capacity

$$NearCrushLoaded15MinutePersonCapacity =$$
$$\frac{15Minutes}{3.5Minutes/Train} \times 450Passengers/Train = 1928Passengers/15Minutes$$

Figure 4-2 illustrates the relationships between the forecast peak 15-minute passenger volume and the planned seated, 3.2 ft^2/standee, and 2.15 ft^2/standee capacities. As shown in Figure 4-2, passengers will be standing for the length of the line during the peak of peak. The level of crowding will exceed the "reasonable" 3.2 ft^2/p crowding standard for more than half the trip (approximately 20 minutes). The forecast crowding would approach, but not exceed, the "near-crush" loading standard of 2.15 ft^2/standee.

[27] Ibid. (Page 5-27)

Figure 4-2. Eastbound AM Peak-of-the-peak 15-Minute Passenger Volume



Holding train lengths constant, a shorter headway would be necessary to maintain a minimum 3.2 ft^2 per standee crowding level. The minimum required headway is a function of the passenger volume at the peak load point. Section 4.3.1 determined eastbound at Ala Lilikoi to be the peak load point of the route with a passenger volume of 1,795 through the 15-minute morning peak-of-the-peak. A headway of 2.8-minutes would be required to ensure at least 3.2 ft^2 per standee in the peak-of-the-peak.

Equation 4: Minimum Headway (3.2 ft^2 per standee)

$$MinimumHeadway = 15Minutes \times \frac{336Passengers/Train}{1{,}795Passengers} = 2.80Minutes$$

Alternatively, if the train length is increased to three-car trains, the passenger capacity per train would be 504. Substituting 504 passengers into Equation 4 calculates a minimum headway of 4.2 minutes to ensure at least 3.2 ft^2 per standee in the peak-of-the-peak.

The peak hour factor does not increase the overall ridership forecast. Any passengers that are added to the 15-minute peak-of-the-peak forecast are subtracted from the non-peak-of-the-peak forecast. Figure 4-3 shows that the average passenger volume of a non-peak-of-the-peak 15-minute time period does not exceed the 3.2 ft^2/p crowding standard with the planned 3.5-minute headway. Therefore, a 2.8-minute headway would only be necessary for two-car train operations during the peak-of-the-peak period. The planned 3.5-minute headway service would suffice for the remainder of the morning peak period.

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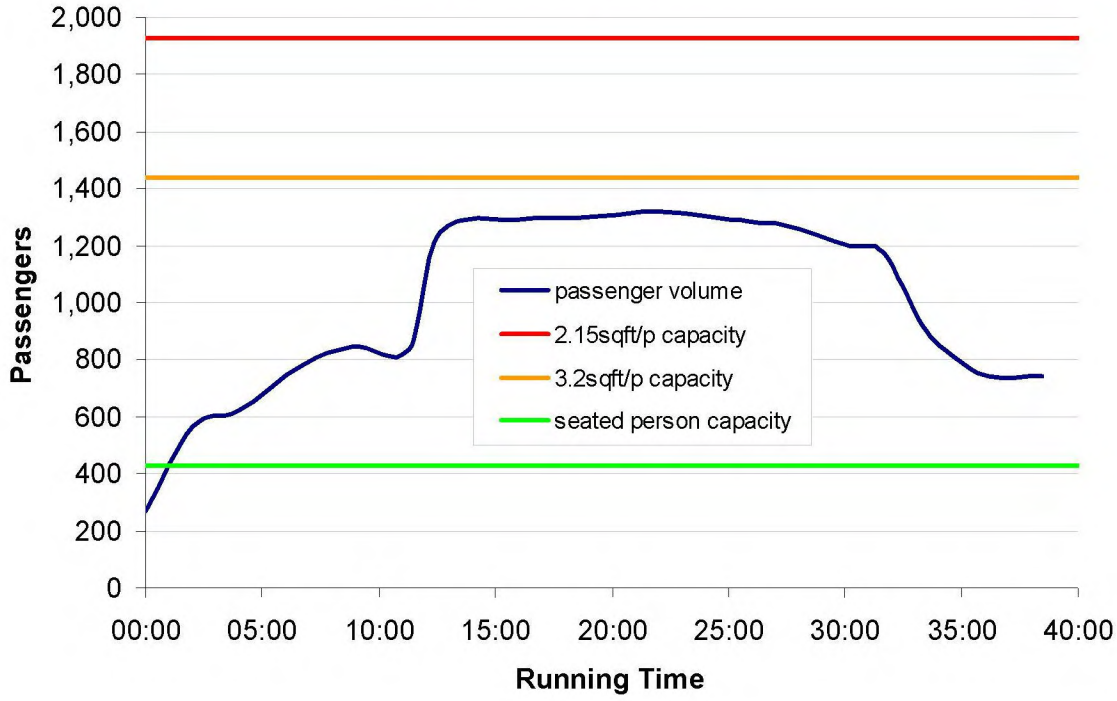
Figure 4-3. Eastbound AM Non Peak-of-the-peak 15-Minute Passenger Volume and Two-Car Train Operations



4.3.3 Dwell and Running Time Analysis

Station dwell times and station-to-station running times determine the minimum system train requirements. After adjusting dwell and running times, new train requirements are calculated for both the planned 3.5-minute headway and the necessary 2.8-minute headway as previously discussed.

4.3.4 Dwell Time

The City estimated a constant 20 second dwell time at each station. Empirical information from *TCRP 100* suggests a 20 second dwell time, especially at heavily loaded platforms, is substantially lower than actual North American practice. A more empirical prediction of dwell time can be developed using the ridership forecasts. TCRP Report 13 models dwell time as a function of passenger activity and an overhead value. Passenger activity is derived from the number of passengers boarding and alighting[28]. The constant overhead value represents the additional dwell time necessary for door operations and time spent standing in the station waiting for signal (or automated command) clearance to proceed.

[28] Parkinson, Tom and Fisher, Ian. Rail Transit Capacity (TCRP Report 13). Transportation Research Board, Washington DC. 1996. (Page 48)

Methodology

TCRP Report 13 estimated a nested pair of linear regression equations to model dwell time. First, the passenger activity time is modeled as a function of passengers boarding and alighting. Next, the total time a vehicle will spend dwelling at a station is modeled as a function of the passenger activity time and a constant term. Using natural logarithms, the functional form of this model is shown in Equation 5 and Equation 6. The estimators for the model are shown in Table 4-2. This regression model was calibrated using data from North American level boarding heavy-rail systems, including systems using automatically controlled doors.

Equation 5: TCRP Passenger Activity Time Regression Model

$$Ln(\text{passenger activity time}) = \text{activityConstant} + B*\text{boarding} + A*\text{Alighting} + B2*(\text{Boarding})^2 + A2*(\text{Alighting})^2$$

Equation 6: TCRP Dwell Time Regression Model

$$Ln(\text{dwell time}) = \text{dwell Constant} + T * (\text{activity time from above equation})$$

Table 4-2. TCRP Dwell Time Regression Model Estimators

Passenger Activity Time Estimators	
activityConstant	1.514
B	0.0987
A	0.0776
B2	-0.00159
A2	-0.000985
Dwell Time Estimators	
dwellConstant	3.168
T	0.0254

Source: TCRP Report 13, pp 48

Ridership forecasts for the peak-of-the-peak 15-minute time period are used to estimate the maximum dwell time. Table 4-1 presents the resulting station 15-minute level passenger activity (ons and offs). The passenger activity by station for each train through the peak-of-the-peak is calculated by dividing the passenger activity for the 15-minute peak-of-the-peak by the number of trains scheduled for the peak 15-minute period.

Noted here are the station design criteria for passenger stations, criteria which include these objectives:

- "Station platforms shall be sized to accommodate site specific patronage projections. The minimum area (excluding elevator, escalator, stair queuing space, and the 24-inch platform safety edge strip) should accommodate the peak 15-minute entraining load at 10sq.ft/person or the peak 15-minute de-training and entraining loads at 7sq.ft/person.
- The minimum width of a center platform is 30'-0".

- The minimum width of a side platform is 12'-0" where the vertical circulation elements (stairways, escalators and elevators) are located outside the limits of the platform.
- In no case shall the clear distance between the edge of the platform and any obstruction be less than 8'-0".
- The length of the boarding platforms shall be 300 feet."[29]

Passengers may board and alight the train at each station in parallel across all the available doors. All Project stations will have a single platform so passenger activity would be limited to one side of the car. The vehicle specification calls for two or three double-stream doors on each side of the car[30]. To generate the most constrained dwell time estimates, two double-stream doors per side are assumed for this analysis: Passenger activity per two car train would be distributed across four doors, or eight passenger streams.

Unless a station platform is especially crowded, waiting passengers do not tend to disperse themselves evenly across the platform. So, when the train arrives, the activity at each door is not identical. To account for the uneven distribution of passenger activity, a door ratio multiplier is used to predict the passenger activity at the peak door. A door ratio value of 1.2, or an increase of 20% over the average door, is recommended for heavy rail systems[31].

Planned 3.5-Minute Headways

Table 4-3 shows the forecast station dwell time for the morning peak train. The forecast station dwell times consistently exceed the City's assumption of 20 seconds. The Pearl Highlands station has the highest level of passenger activity and a 41-second forecast dwell time. This dwell forecast is almost twice the value assumed by the City. In the Westbound off peak direction, the dwell times are also estimated to be longer than 20 seconds for all stations, even though the passenger activity is light.

[29] HHCTCP Design Criteria – Architectural, Draft June 30, 2008 (Pages 30-31)
[30] HHCTCP Design Criteria – Revenue Vehicle. August 1, 2008. Draft (Page 5)
[31] TCRP Report 13 (Page 82)

Table 4-3. Peak Train Dwell Time Estimates (3.5-Minute Headway)

Eastbound	Overall		Peak Door			Forecast Dwell Time
Station	Ons	Offs	Ons	Offs	Onboard	
East Kapolei	86	0	13	0	86	33
UH West Oahu	94	0	15	1	180	35
Hoopili	19	1	3	1	197	28
West Loch	57	5	9	1	249	31
Waipahu Transit Cntr	25	4	4	1	270	28
Leeward CC	4	9	1	2	265	28
Pearl Highlands	141	9	22	2	397	41
Pearlridge	35	20	6	4	411	31
Aloha Stadium	12	11	2	2	412	28
Ala Lilikoi	32	25	5	4	419	30
Middle Street	10	20	2	4	409	29
Kalihi	20	23	4	4	406	30
Kapalama	3	16	1	3	393	28
Iwilei	7	19	1	3	381	28
Chinatown	3	11	1	2	373	28
Downtown	11	93	2	14	291	33
Civic Center	4	36	1	6	259	29
Kakaako	2	26	1	4	236	28
Ala Moana Cntr	0	236	0	36	0	40
					Total (excluding first and last stations)	8:32

Westbound	Overall		Peak Door			Forecast Dwell Time
Station	Ons	Offs	Ons	Offs	Onboard	
Ala Moana Cntr	49	0	8	0	49	30
Kakaako	5	1	1	1	53	27
Civic Center	7	5	1	1	54	27
Downtown	11	8	2	2	57	28
Chinatown	3	3	1	1	57	27
Iwilei	10	4	2	1	63	28
Kapalama	1	5	1	1	59	27
Kalihi	6	10	1	2	55	28
Middle Street	5	7	1	1	54	27
Ala Lilikoi	6	16	1	3	44	28
Aloha Stadium	3	5	1	1	42	27
Pearlridge	8	12	2	2	38	28
Pearl Highlands	26	7	4	1	57	28
Leeward CC	1	13	1	2	46	28
Waipahu Transit Cntr	6	7	1	2	45	28
West Loch	3	13	1	2	35	28
Hoopili	1	8	1	2	28	28
UH West Oahu	0	15	0	3	13	27
East Kapolei	0	13	0	2	0	27
					Total (excluding first and last stations)	7:48

Sensitivity Analysis

The forecast dwell times in Table 4-3 assume a 3.5-minute headway of two cars and two usable double-wide doors per car. However, Section 4.3.1 determined that the forecast demand requires two car trains at a 2.8-minute headway. A 2.8-minute headway would reduce the passenger activity on each train, hence reducing the dwell time. Morning peak trips that are not through the peak-of-the-peak will also have less passenger activity. Furthermore, increasing the number of doors per side from two to three will reduce passenger activity per door by 50%. Table 4-4 summarizes the total dwell time in each direction for each combination of passenger activity (peak or non-peak), headway (3.5 or 2.8 minutes), and doors per side (two or three). The total dwell time of each scenario is compared to the overall results reported in Table 4-3. For non-peak-of-the-peak round trips the total forecast dwell time is reduced by 18 seconds. For all activity levels and headways, the marginal benefit of a third usable double-wide door is between 19 and 23 seconds for the overall trip.

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Table 4-4. Dwell Time Sensitivity Analysis

Peak-of-the-peak	Doors per Side	Total Dwell Eastbound	Total Dwell Westbound	Reduction from Peak, 2 doors, 3.5 min hdwy
3.5 headway	2	8:32	7:48	-
	3	8:12	7:45	0:23
2.8 headway	2	8:20	7:47	0:13
	3	8:02	7:44	0:34
Non Peak-of-the-peak	**Doors per Side**	**Total Dwell Eastbound**	**Total Dwell Westbound**	**Reduction from Peak, 2 doors, 3.5 min hdwy**
3.5 headway	2	8:16	7:46	0:18
	3	8:00	7:43	0:37

4.3.5 Terminal Time

The City supplied data does not address the turnback (or looping at the ends of the line) so PMOC has no documentation to review and assess. *TCRP 100* provides a methodology to undertake such an analysis, including a formula to calculate the maximum time available per track for terminal layover.[32] The Project consists of entirely double-tracked exclusive right of way. In the absence of detailed design and because this corridor is all new construction and there does not appear to be any structural constraints in placing crossovers near the terminal stations, the turn-backs at either terminal end could be presumed to be optimally designed with double crossovers in front of or immediately behind the side platform configured terminals, or in both locations, so as to ensure a platform is accessible for an in-bound train within the 2.8 or 3.5 minutes of window to maintain headways and avoid limiting the line capacity. Nonetheless, during peak periods such limited layover times can be difficult to maintain. In the Report 100, several strategies are outlined which other systems utilize to improve the terminal time turnback. Given the proposed speed restrictions for approaching stations, including terminal stations and the planned operating characteristics of the mini metro transit vehicle, as identified for the Project, the PMOC can only opine that the City must rigorously address this issue early and be prepared to be realistic in finalizing operating schemes and designs so as to effect accurate and pragmatic conclusions.

4.3.6 Running Time

The City modeled station-to-station running times with an acceleration assumption of 3.00 mphps and average of 2.2 mphps. The City deceleration assumption is 0.89 mphps. Maximum speed of the vehicle is 55 mph. Lacking the ability to replicate the City's calculations, the PMOC assumes that the simulation was conducted with appropriate speed limitations due to curvature, grade, and track quality. With these assumptions, the City's station-to-station running times are used without modification.

The City's total running time estimate, however, changes in response to the forecast increases in dwell times. Table 4-5 compares the running times with the City dwell time assumption and the

[32] TCRP Report 100 (Pages 5-15 through 5-17)

PMOC forecast dwell times. In total, the PMOC estimated dwell times increase the running time by three minutes in the eastbound direction and two minutes in the westbound direction during the morning peak. This PMOC identified impact is discussed at Section 4.3.8 of this chapter (see below).

Table 4-5. Running Time Estimates (Peak 15 Minutes)

Eastbound	Station-to-Station Running Time	Dwell Time City	Dwell Time PMOC	Westbound	Station-to-Station Running Time	Dwell Time City	Dwell Time PMOC
East Kapolei	-	-	-	Ala Moana Cntr	-	-	-
UH West Oahu	1:39	20	35	Kakaako	1:45	20	27
Hoopili	1:40	20	28	Civic Center	1:12	20	27
West Loch	2:23	20	31	Downtown	0:56	20	28
Waipahu	1:52	20	28	Chinatown	1:22	20	27
Leeward CC	2:02	20	28	Iwilei	1:03	20	28
Pearl Highlands	1:04	20	41	Kapalama	1:08	20	27
Pearlridge	3:02	20	31	Kalihini	1:19	20	28
Aloha Stadium	2:03	20	28	Middle Street	1:03	20	27
Ala Lilikoi	3:26	20	30	Ala Lilikoi	3:18	20	28
Middle Street	3:18	20	29	Aloha Stadium	3:30	20	27
Kalihini	1:03	20	30	Pearlridge	2:05	20	28
Kapalama	1:17	20	28	Pearl Highlands	3:02	20	28
Iwilei	1:06	20	28	Leeward CC	1:04	20	28
Chinatown	1:04	20	28	Waipahu	2:02	20	28
Downtown	1:22	20	33	West Loch	1:53	20	28
Civic Center	0:56	20	29	Hoopili	2:26	20	28
Kakaako	1:12	20	28	UH West Oahu	1:40	20	27
Ala Moana Cntr	1:59	-	-	East Kapolei	1:59	-	-
	32:28	5:40	8:32		32:47	5:40	7:48
Total Running Time		**38:08**	**41:00**	**Total Running Time**		**38:27**	**40:35**

4.3.7 Cycle Time

Cycle time is the sum of the round trip running time and layover time, and a multiple of the headway. The City's planned round trip cycle time for the 3.5-minute peak headway is 1:20:30 allowing for 3:55 of layover time. The vehicle design criteria[33] specifies a minimum layover time of two minutes at each terminal, or a total of 4 minutes built into the cycle time. (Also refer to Section 4.3.5, as regards terminal turnback time). Consequently, the planned cycle time would be inadequate to accommodate the increased running time and the specified turn time.

The sum of the forecast eastbound and westbound running times in the peak-of-the-peak with a 3.5-minute headway and cars equipped with two double-wide doors per side (Table 4-4) is 1:21:35. This exceeds the planned cycle time of 1:20:30 by more than one minute. To allow for at least two minutes of turn time at both terminals, the new cycle time would be 1:27:30. Under

[33] HHCTCP Design Criteria – Revenue Vehicle, August 1, 2008. Draft (Page 19)

this circumstance 25 trains would be required to maintain a 3.5-minute headway with this cycle time (Table 4-6). This represents a two train/four car increase to the City's current plan.

Table 4-6. Cycle Time Comparison

Service Level	Peak-of-the-peak	Round Trip Time	Headway	Peak Trains	Peak Cars	Cycle Time	Layover Time
City Plan	-	1:16:35	3.5	23	46	1:20:30	03:55
PMOC Estimates	Y	1:21:35	3.5	25	50	1:27:30	05:55
	Y	1:21:22	2.8	31	62	1:26:48	05:26
	N	1:21:17	3.5	25	50	1:27:30	06:13

To determine the running times for scenarios with 2.8-minute headways and non-peak-of-the-peak, the forecast dwell times in Table 4-4 are replaced with the appropriate value from Table 4-3:

- The PMOC calculates that a 2.8-minute headway would require a 1:26:48 cycle time with a total of 31 trains. Presuming a satisfactorily designed terminal station track configuration at each end such a schedule would allow for a total of 5:26 layover time (meeting the criteria for at least 2 minutes) and require eight more trains and sixteen more cars than have been proposed.

- Running times in the non-peak-of-the-peak would require a 1:27:30 cycle time with a total of 25 trains to maintain a 3.5-minute headway. The reduced dwell time in the non-peak-of-the peak results in slightly more layover time than the forecast running time in the peak-of-the-peak with 3.5-minute headways (6:13 vs. 5:55).

- Increasing the number of doors would not result in a vehicle savings. The dwell time sensitivity analysis in Section 4.3.4 concluded that a third double-wide door per side would reduce the dwell time by at most 26 seconds. That is an insufficient reduction in running time to reduce the cycle time / vehicle requirements.

4.3.8 Forecast Vehicle Requirements

Section 4.3.1 concluded that, during the morning peak, a 3.5-minute headway is sufficient except in the peak-of-the-peak. At that time, a headway of 2.8-minutes is required to meet the forecast demand. In other words, it is only necessary to maintain 2.8-minute headways for a portion of the two hour peak period. Vehicle requirements depend on how long the service is being operated at each frequency. PMOC analysis assumed a 15-minute peak-of-the-peak, but there will be a transition period between the baseline and peak-of-the-peak passenger demand which will require headways shorter than 3.5 minutes. Operating trains at 2.8-minute headways for 30 minutes in the morning peak should cover the peak-of-the-peak 15 minutes as well as any transition period. To derive the fleet requirements, a weighted average of the trains required to maintain each headway is calculated in Table 4-7. A 2.8-minute headway requires 31 trains for a full cycle while a 3.5-minute headway requires 25 trains. Operating a 2.8-minute headway for 30 minutes and a 3.5-minute headway otherwise would require 27 trains. This represents an overall increase of four trains / eight cars over the City's planned vehicle requirements.

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Table 4-7. Forecast Vehicle Requirements

Headway (min)	Cycle Time	Duration (h:mm)	Percent of Cycle	Train Requirements Full Cycle	Train Requirements Partial
2.8	1:26:48	0:30	35%	31	11
3.5	1:27:30	0:56	65%	25	16
			Total	**Trains**	**27**
				Cars	**54**

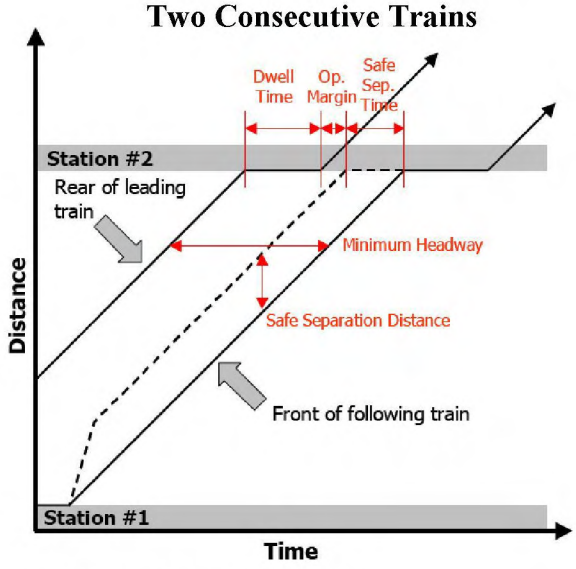
4.4 Maximum Line Capacity

Line capacity is a function of track configuration, passenger activity, station characteristics, vehicle characteristics (performance and length), and the minimum following distance between trains. The Project consists of entirely double-tracked exclusive right of way. In the absence of detailed design and because this corridor is all new construction, the turn-backs at either terminal end are presumed to be optimally designed with double crossovers in front of or immediately behind the side platform configured terminals so as to ensure a platform is accessible within the 2.8 or 3.5 minutes of window to maintain headways and avoid limiting the line capacity. Consequently, the line capacity is presumed here to be limited solely by the passenger activity, station characteristics, vehicle characteristics, and the minimum following distance between trains. This presumption is not to infer that any of the other points raised are to be overlooked during additional planning and design by the City, rather it is made given the exclusive guideway and track configuration that can be designed most appropriately to effect the cycle times required with the correct train availability and functioning automatic train control and supervision.

Figure 4-4 illustrates how dwell time, operating margin, and safe separation time combine to limit the minimum headway.

- Dwell time, as modeled in Section 4.3.1, is influenced by the number of passengers boarding, alighting, and onboard as well as the train and platform configuration.
- Operating margin is literally a margin for error and random events in daily operations such as a briefcase caught in a door or a hitch in train performance. The estimate of operating margin represents the time for the train to clear the station and depends on platform and train length. *TCRP 100* recommends a default value of 20 seconds for operating margin[34].
- Safe separation time is a function of the minimum following distance, train length,

Figure 4-4. Distance-Time Plot of Two Consecutive Trains



NOTE: Acceleration and braking curves omitted for clarity.

[34] TCRP Report 100. (Page 5-67)

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and vehicle speed.

The minimum sustainable headway is equal to the sum of these three components.

The minimum achievable headway on any simple double track line is established at the station with the longest dwell time or the station with the most severe speed restriction below the optimal station approach speed. This is called the "critical station". The longest dwell time during the peak-of-the-peak (41 seconds) is forecast at Pearl Highlands eastbound (Table 4-3). The City documentation on civil elements and the data utilized in the train modeling identifies the lowest speed restriction across the entire corridor as 25 mph and, therefore, would not reduce the optimal approach speed to stations, including the terminal stations. The Project signaling system has not yet been specified, but it is expected that the automated operation would rely on a "cab-control" or "moving-block" signal train control methodology.

TCRP provides a safe separation distance calculator to estimate minimum train separation time as a function of: station length; train approach speed to the station; maximum line speed; train's mechanical characteristics; type of signal control; and the grades at the critical station[35]. The formula to calculate the minimum headway is shown in Equation 7: Minimum Train Separation Formula. Variable descriptions and values are shown in Table 4-8.

Equation 7: Minimum Train Separation Formula

$$H(s) = \sqrt{\frac{2(L+D)}{a_s(1-0.1G_x)}} + \frac{L}{v_a} + \left(\frac{100}{K} + B\right)\left(\frac{v_a}{2d_s(1+0.1G)}\right) + \frac{a_s(1-0.1G)t_{os}^2}{2v_a}\left(1-\frac{v_a}{v_{\max}}\right) + t_{os} + t_{jl} + t_{br}$$

Table 4-8. Minimum Train Separation Calculation Input Variables

Term	Units	Description	Source	Value
L	meters	length of the longest train	City	36.6
D	meters	distance—front of train to exit block	TCRP Default	10
K	constant	% service braking rate	TCRP Default	75
B *cab control signaling*		train detection uncertainty constant	TCRP Default	1.2
B *moving block signaling*		train detection uncertainty constant	TCRP Default	1
t_{os}	seconds	overspeed governor operating time	TCRP Default	3
t_{jl}	seconds	time lost to braking jerk limitation	TCRP Default	0.5
a_s	m/s^2	service acceleration rate	City	1.34
d_s	m/s^2	service deceleration rate	City	0.89
t_{br}	seconds	brake system reaction time	TCRP Default	1.5
v_{max}	km/h	maximum line velocity	City	88
P_e	meters	Positioning error (moving block only)	TCRP Default	6.25
v_l	%	% of normal line voltage	TCRP Default	90
G	%	Grade into headway critical station	City	-3.12

[35] TCRP A-8 Rail Transit Capacity, Transport Consulting Limited, 111-1141 West 7th Avenue, Vancouver BC Canada.1996.

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The minimum train separation is calculated for both cab-control and moving-block signaling in Table 4-9. The optimum approach speed with either signal control type is lower than all speed restrictions on the corridor. Consequently, approach speed limits do not restrict the minimum achievable headway on the proposed Project. Pearl Highlands would be the critical station because the 41-second dwell time forecast at this station is the longest on the network. The minimum train separation at Pearl Highlands would be 33 seconds for cab-control and 23 seconds for moving-block.

Table 4-9. Signal Type Capacity Constraints

	Cab-control	Moving-block
Minimum train separation (sec)	33	24
Optimal approach speed (mph)	11	12

The minimum sustainable headway is equal to the sum of the dwell time, operating margin, and the minimum train separation at the critical station. Dwell time and operating margin are independent of the signaling system. The PMOC estimates the minimum sustainable headway with a cab-control signaling system would be 94 seconds and 85 seconds with a moving-block signaling system eastbound at Pearl Highlands Station.

Table 4-10. Minimum Sustainable Headway (seconds)

	Cab Control	Moving Block
Dwell Time	41	
Operating Margin	20	
Safe Separation	33	24
Total	94	85

Therefore, with either signaling type (cab-control or moving-block) a 2.8-minute headway is well within the capability of the planned corridor. In fact, the peak headway could be reduced by almost 50% in response to increased ridership if sufficient cars (above what has already been estimated by PMOC as needed) were available for operation.

4.5 Maximum Person Capacity

Person capacity is calculated from the line capacity and the car capacity. Section 4.4 found that the Project's minimum sustainable headway for two car trains is 94 or 85 seconds with cab-control or moving-block signaling, respectively. Each two-car train could carry up to 336 passengers with a loading standard of 3.2 ft^2 of standing space. Following TCRP guidelines, the person capacity calculation is adjusted downward by a peak hour factor to accommodate real world variability in passenger loadings, i.e., patrons will generally adjust the arrivals to better ensure either a seat (optimal for many) or a less crowded car, thus the partial mitigation in the consistency of the peak-within-the-peak demand. Depending on the signaling type, the maximum person capacity would be either 10,294 or 11,384 passengers per hour.

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Table 4-11. Maximum Person Capacity

	Cab Control	Moving Block
Minimum Headway	94	85
Trains per Hour	38.3	42.4
Passengers per Train	336	
Peak Hour Factor	0.8	
Maximum Passengers per Hour	10,294	11,384

4.6 Maximum Person Capacity

Person capacity is calculated from the vehicle capacity and the car capacity. Section 0 found that the Project's minimum sustainable headway for two car trains is 94 or 85 seconds with cab-control or moving-block signaling, respectively. Each two-car train could carry up to 336 passengers with a loading standard of 3.2 ft^2 of standing space. Following TCRP guidelines, the person capacity calculation is adjusted downward by a peak hour factor to accommodate real world variability in passenger loadings. Depending on the signaling type, the maximum person capacity would be either 10,294 or 11,384 passengers per hour.

Table 4-12. Maximum Person Capacity

	Cab Control	Moving Block
Minimum Headway	94	85
Trains per Hour	38.3	42.4
Passengers per Train	336	
Peak Hour Factor	0.8	
Maximum Passengers per Hour	10,294	11,384

4.7 Conclusion

(1) The planned frequency of 3.5 minutes with 2 car trains is insufficient to serve the 2030 peak-of-the-peak passenger demand. An increase of frequency to 2.8-minute headways or an increase in train capacity is necessary to maintain a design loading standard presented by the Project criteria documentation of 3.2 ft^2 of standing space per standee.

(2) The dwell time assumption of 20 seconds is too short. An estimated dwell time based on the forecast passenger activity is more appropriate ranging between 27 and 41 seconds at each station for a total of 16:20 of dwell time for the peak-of-the-peak train compared with the City's allowance of 11:20.

(3) Together, the end-to-end running time and peak fleet size do not provide sufficient recovery time at terminal stations for trains to reliably turn for their next trip.

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(4) The current project scope has a vehicle fleet size of approximately 60 vehicles (with six spares). Operating a 2.8-minute headway through the peak of the morning peak and a 3.5-minute headway otherwise would require 27 trains to maintain. This represents an increase of four trains / eight cars over the proposed service level, thus suggesting a project budget to support a fleet size of up to 68 vehicles, less spares.

(5) With either signaling type (cab-control or moving-block) a 2.8-minute headway is well within the capability of the planned corridor.

(6) The current ridership projections for the project are 5,745 passengers per hour. Depending on the signaling type, the maximum person capacity is either 10,294 or 11,384 passengers per hour, thus would support the anticipated ridership projection.

4.8 Recommendations

(1) The Project has substantial documentation for this point in its planning and design, the completion of Alternatives Analysis. PMOC does recommend that the City undertake more detailed demand forecasting for the corridor and build into the rail component of the modeled network capacity constraints that closely resemble, if not altogether mirror, North American rail transit experience. Certainly these constraints need to reflect policies and standards planned by the City for the Project, yet PMOC highly recommends rigorous scrutiny by the City of the parameters used by the modelers.

(2) PMOC recommends the use by the City of the *TCRP 100* as a guidance tool in setting capacity constraints for demand forecasting, and assessing viability and functionality of the Project.

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5.0 SUBTASK 32E: PROJECT DELIVERY METHOD REVIEW

5.1 Methodology

The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #32: Project Scope, Definition and Capacity Review Procedures,* dated March 29, 2007 to assess and evaluate the grantee's technical approach for delivering the proposed Project within the constraints of their existing or proposed statutory or organizational procurement authority and in the context of their project strategies, risk analysis, and procurement planning. The PMOC also assessed and evaluated whether the grantee's project delivery method and contracting packaging strategy as defined and implemented in the Project Management Plan (PMP) minimizes project risks and provides the greatest likelihood of implementation success. Specifically, this section of the Spot Report provides an overview of the contracting methodology to be employed during the design, construction, and procurement phases of the project.

To support the Project Delivery Method Review, the PMOC reviewed the files, reports and documents identified in Appendix B.

5.2 Review

This section refers only to the First Project as described in Section 1.0 of this Spot Report. The First Project has been divided into five (5) segments as shown in Figure 5-1. The City intends to implement the First Project in two phases. Phase I includes the West Oahu and Farrington segments and is scheduled to begin incrementally staged revenue operations by the end of 2012. Phase II includes the Kamehameha, Salt Lake, and City Center segments and is scheduled to begin incrementally staged revenue operation in late 2016. Full revenue service along the full corridor is anticipated to occur in late 2018. The City intends to utilize a combination of traditional and alternative contract delivery methods to implement the First Project as described below.

Figure 5-1. Construction Segments

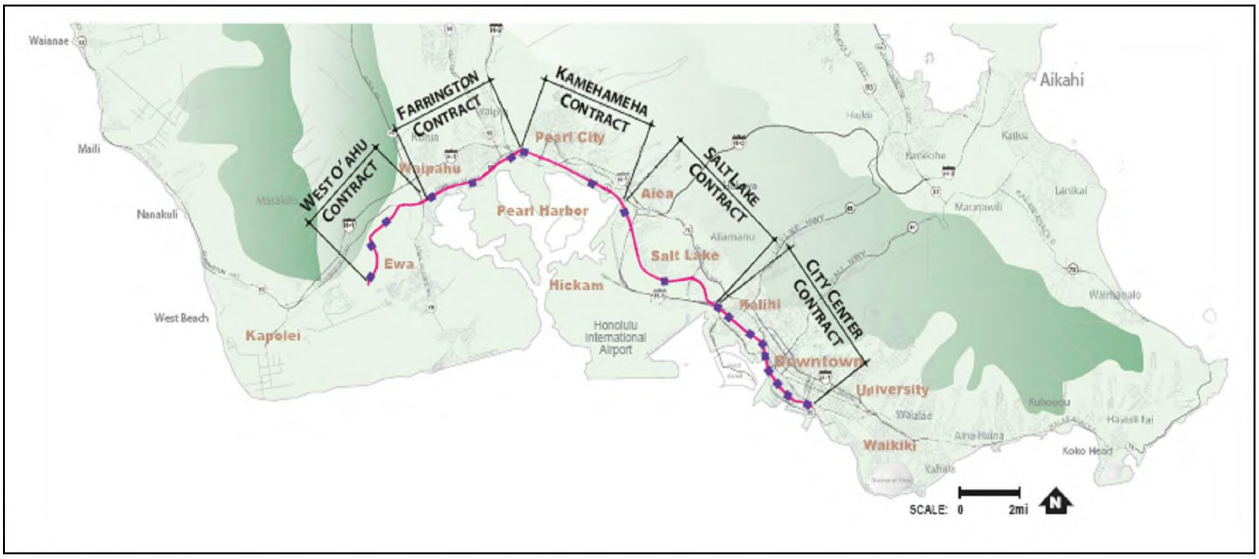

Table 5-1 presents the ***City's*** target dates for key milestones of this New Starts Project as identified in their Master Project Schedule.

Table 5-1. Target Dates for Key Milestones per Master Project Schedule (MPS)

Milestone	Target Date
Issue LONP for Farrington Station Group FD	16-Oct-08
Approval to Enter PE	31-Dec-08
Issue LONP for RFP Part 2 for DB Guideway/MSF/Systems	04-Jan-09
Record of Decision	26-Aug-09
Approval to Enter Final Design (Phase I and II)	26-Dec-09
Issue LONP for MSF Construction	17-Sep-09
Issue LONP for Phase I Guideway FD	29-Nov-09
Issue LONP for Phase I Guideway Construction	27-Dec-09
Issue LONP for Systems and Vehicles	24-Feb-10
Request FFGA	25-Jun-10
Execute FFGA	20-Feb-11
Revenue Operations Date (all segments)	18-Dec-18

It should be noted that all certain milestones associated with Letters of No Prejudice (LONP) must be modified to be compliant with the requirements of federally sponsored projects. A LONP cannot be considered until a Record of Decision has been issued.

The scope of each Standard Cost Category (SCC) element pertinent to the Project is discussed in the following sections.

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5.2.1 Consultant Services

SCC 80.01 – Preliminary Engineering
The City has contracted with Parsons Brinckerhoff to serve as the General Engineering Consultant (GEC) in completing PE/EIS efforts for the Project. The period of performance of the contract is August 2007 to March 2010. The scope of work for this contract includes PE for all Project components of Phases I and II. For those items that will be constructed utilizing Design-Build (DB) methodology, the GEC is required to prepare contract documents that could be included in a two-step Best Value procurement package.

SCC 80.02 – Final Design
The City intends to award approximately 11 EDC contracts to complete Final Design of those elements identified in Table 5-2, although this strategy may be redefined during PE. Management of these contracts would be performed by the City with support from the Project Management Support Consultant (PMC) and the General Construction Management consultant (GCM). The scope of work for these Final Design contracts would include Final Design of those Project components that are to be constructed utilizing Design-Bid-Build (DBB) methodology, as identified in Table 5-2.

It should be noted that the City anticipates issuing the first Notice to Proceed (NTP) in August 2009 immediately following receipt of the Record of Decision and approval to enter Final Design. This rapid sequence is aggressive and likely not tenable.

Final Design of Phase I line segments, the Maintenance and Storage Facility (MSF), and systems components will be completed by the selected DB contractor.

SCC 80.03 – Project Management for Design and Construction
A contract was awarded to InfraConsult LLC in April 2007 to serve as the City's PMC. The scope of work includes providing in-house project management services and functions as an extension of the City's staff. In this role InfraConsult provides professional, technical, and managerial support services to initiate and complete the PE and the Environmental Impact Statement (EIS) phase of the Project. The period of performance of the contract is April 2007 to October 2009. However, the City has indicated that an amendment will be issued to extend the contract to coincide with the end date of the Preliminary Engineering contract in March 2010. City also indicated that, should it not be successful in staffing of in-house positions, PMC contract may be extended further.

The City intends to award a second PMC contract that would extend from PE through the start of revenue operations. The scope of the second PMC contract will include: assisting the City with specialized support during design and construction; assisting the City with oversight of design, construction, manufacturing, precasting, installation, testing, and commissioning; and assisting the City with high-level management support including financial and political issues. In general, the PMC contract will serve as a staff augmentation contract for the City. As discussed in Section 3.0, the City's proposed staffing should be sufficient to manage the multiple design and construction contracts while maintaining the overall project schedule. However, this aspect will need to be review once the Project is in PE and the delivery methodology is refined.

SCC 80.04 – Construction Administration & Management

The overall responsibility for construction management will be assigned to the GCM, with oversight by the RTD Chief of Construction. The GCM will be procured during the PE phase. The GCM will provide services during Final Design and the numerous construction phases, including oversight of the EDC efforts, resident engineering, office engineering, and construction inspection. The GCM will be responsible for performing Quality Assurance inspections of all EDC and Contractor activities, reviewing all contract document submittals including shop drawings and specifications, reviewing contractor invoices, reviewing requests for information, reviewing requests for change, conducting inspections, value engineering, and reviewing change order estimates.

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Table 5-2. Consultant Contract Packaging

SCC	Description	Contract Package	NTP	Contract End	Notes
80.01	PE/EIS	Project-wide	Aug-07	Mar-10	NTP given to PB in August 2007 for EIS
80.02	Final Design	West Oahu/ Farrington Guideway/Utilities Contract (Phase I)[1]	Dec-09	Mar-12	Final Design to be completed by DB contract team
		Maintenance Facility and Storage Yard[1]	Mar-10	Apr-14	Final Design to be completed by DB contract team
		Systems[1]	Apr-10	Dec-18	Final Design to be completed by DB contract team
		Kamehameha Utility & Guideway Design	Apr-10	Aug-11	
		Salt Lake Utility & Guideway Design	Dec-09	Apr-11	
		City Center Utility & Guideway Design	Oct-10	Jan-12	
		West Oahu Station Group	Aug-10	Dec-11	3 stations
		Farrington Station Group	Aug-09	Feb-11	3 stations
		Kamehameha Station Group	Oct-11	Jan-13	2 stations
		Pearl Highlands Station/ Multi-Level Parking Facility	Not yet Defined	Not yet Defined	1 station
		Salt Lake Station Group	Apr-12	Jul-13	4 stations
		City Center Station Group	Mar-10	Jun-11	3 stations
		Kakaako Station Group	Mar-10	Jun-11	3 stations
		H1/H2 Ramps at Pearl Highlands	Not yet Defined	Not yet Defined	Draft Contract Packaging Plan refers to H2 and H1 ramps separately. It is unclear whether one design contract will include both ramps.
80.03	Project Management for Design and Construction (1st Contract)	Project-wide	Apr-07	Oct-09	Contract awarded to InfraConsult in April 2007
	Project Management for Design and Construction (2nd Contract)		Aug-09	Dec-18	Second PMC contract to be awarded
80.04	Construction Administration & Management	Project-wide	Aug-09	Dec-18	

[1]Contract will be Design-Build. All others will be Qualifications Based Selection (QBS).

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5.2.2 Construction and Major Material and Equipment Procurement

A Design/Build (DB) contract delivery method is planned for the Phase I guideway (West Oahu and Farrington segments). Design-Bid-Build (DBB) is planned for the Phase II guideway (Kamehameha, Salt Lake, and City Center segments). Vehicles and systems elements are to be included in one separate DB contract package.

Following integrated testing, revenue service along the Farrington segment of Phase I is scheduled to begin at the end of 2012 and revenue service along the Kamehameha segment of Phase II is planned to begin in 2016. Full revenue service along the full corridor is anticipated to occur in late 2018.

SCC 10 – Guideway and Track Elements

The Project is divided into five (5) line segments: West Oahu, Farrington, Kamehameha, Salt Lake, and City Center. The City intends to combine the two western line segments (West Oahu and Farrington) into one DB contract under Phase I. The City will utilize a two-step Request for Proposals (RFP), or Best Value, contract procurement process. Under this single DB contract, the City intends to complete all utility relocations, guideway construction, and trackwork for these two line segments. Station and systems work will be completed under separate contracts as discussed below. Part 1 of the RFP is scheduled for issuance in early 2009. DB construction is planned to begin in late 2009, after the ROD is issued, and would extend into 2013.

The three remaining line segments (Kamehameha, Salt Lake, and City Center) will be constructed using the DBB delivery method. The three line segment contracts will each include guideway construction and trackwork. The City anticipates awarding the first of these DBB line segment contracts for Phase II in late 2012.

As expected at this development point of the Project, elevated guideway substructure and superstructure details have not been finalized. However, it is anticipated that the foundations generally will consist of drilled piers and pier caps. The elevated guideway will consist of a viaduct supported by columns and bent caps. The current configuration of the viaduct superstructure is a precast segmental trapezoidal box girder proportioned to support two trackways and sound barriers. Erection of the approximately 10-foot long precast concrete segments would occur with the assistance of a long steel truss called an erection gantry. The gantry would travel along the guideway alignment suspending and post-tensioning all the 10-foot segments needed for a 150-foot span in a single stage process. The girder section will be designed to span 150 feet and would be simply supported. For spans longer than 150 feet, particularly where the highway crosses over highway interchanges, other construction methods are being considered including balanced cantilever or possibly cast-in-place viaducts.

SCC 20 – Stations, Stops, Terminals, Intermodal

The City intends to utilize the DBB delivery method for all Phase I and II stations, resulting in a total of six (6) contract packages. Two of those packages would be prepared to support Phase I. The remaining four (4) station construction packages would be awarded in Phase II beginning in late 2014.

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There are (19) aerial Stations: 13 with side platform with mezzanines; five (5) with side platform without mezzanines; and one center platform with mezzanine. ~~Eighteen of the nineteen elevated stations are cast-in-place concrete dual side platform configurations. One station is currently planned to include a center platform. Each elevated station includes a mezzanine below the guideway for access between the eastbound and westbound platforms.~~

The City intends to issue a separate DB contract to furnish / install / test / commission all elevator and escalator equipment.

SCC 30 – Support Facilities: Yards, Shops, Administration Buildings

The Maintenance and Storage Facility (MSF) contract delivery method will be DB. The City is considering two locations for the MSF: the Navy Drum Site and a site near the University of Hawaii West Oahu Campus. The City's preference is the Navy Drum Site from an operational standpoint as it is located near the midpoint of the alignment. The current issue is timing for acquiring access to the Navy Drum Site to complete the geotechnical exploration program. The site will be environmentally clean when it is turned over to the City.

The Navy Drum Site topography is very steep and will require an extensive amount of cut and fill. Until detailed geotechnical and survey data can be collected and analyzed, the extent of this earthwork cannot be accurately quantified. If access is not granted to the Navy Drum Site in sufficient time to complete the preliminary geotechnical exploration efforts, the City will proceed with locating the MSF on the West Oahu site.

The MSF contract will include design and construction of the maintenance shop, the storage yard, all trackwork, the Operations Control Center, and the administration facilities. The current cost estimate is based on a Cost Estimating Relationship (CER) and is not specific to either proposed location. The City intends to issue Part 1 of the RFP in the spring of 2009, with NTP scheduled for June 2009. Construction would start in December 2009, and the facility would be fully functional by late 2012.

The City intends to include procurement of all running and third rail materials within the MSF Contract. The MSF contractor would thereby be responsible for procurement, shipping, and storage of the rail until the respective line segment contractors can begin installation. It is anticipated that the line segment contractors would be responsible for transportation of the rail to the specific line segments from the storage point at the MSF.

SCC 40 – Sitework & Special Conditions

The Phase I DB line segment contractor will be responsible for relocation of all utilities within the contract limits. Under Phase II, the City anticipates awarding three separate Advanced Utility Relocation contracts using the DBB project delivery method starting in early 2011. To do so, the City will likely request a Letter of No Prejudice.

Execution of utility relocation agreements between the City and the respective utility owners is scheduled to begin in 2009.

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SCC 50 – Systems and SCC 70 – Vehicles

The City has indicated that the technology for the revenue vehicles will ~~likely~~ consist of a heavy rail ~~Light Metro or Light Rail Rapid Transit heavy rail~~ vehicle with steel wheels running on steel rail at standard gauge. The vehicles will be electrically powered by means of a third rail. As expected, specific details on the vehicle design criteria were not fully developed at the time of this Spot Report.

The City is considering a DB (Best Value) approach for procurement of approximately 60 revenue vehicles to support Segments I and II and the systems components. At the time of this Spot Report, the City was preparing documentation to issue a two-part RFP that would include design / manufacture / testing of revenue vehicles as well as design / supply / installation / testing of the traction power, signal system, train control, and communications systems for the entire First Project alignment. The City believes that this would reduce their risk in integrating new revenue vehicle technology with third-party systems components. The City held a workshop on August 22, 2008 to solicit input and feedback from the contracting and manufacturing community on this approach.

The City anticipates issuance of Part 1 of the RFP for the Revenue Vehicle and Systems Components during the 1st Quarter of 2009. Part 2 of the RFP would be issued during the 2nd Quarter of 2009. Award of a contract would occur in April 2010.

Phase I revenue vehicle design / manufacture / delivery would then begin along with systems design. Delivery of revenue vehicles would be scheduled to support the start of revenue service along a portion of the Phase I segment in late 2012. It is uncertain at this time how many vehicles would be procured to support Phase I. However, during the September 2008 Risk Assessment Workshop, the City indicated that initial revenue service may be provided with the first four (4) vehicles once accepted. Service would possibly increase as additional vehicles are delivered and accepted.

Manufacture and delivery of vehicles for Phase II would begin in 2013. Phase II systems design / supply / installation / testing would begin in 2013 under the same DB contract for Phase I.

The City intends to award a separate DBB contract the installation of all owner furnished fare collection equipment. A potential NTP for this contract has not yet been identified but can be during PE without impacting the Project schedule.

SCC 60 – Right-of-Way

Phase I right-of-way (ROW) certification is scheduled to begin with entry into PE. Phase I ROW acquisition is scheduled to be completed by late 2011. Phase II ROW acquisition is scheduled to begin in 2011.

Table 5-3 summarizes the methodology that the City is considering for each Standard Cost Category (SCC) element.

Figure 5-1 presents the Linear (or "Horseblanket") Schedule for the Project dated September 22, 2008. It should be noted that, although many of the dates identified are no longer valid, this is

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good representation of the delivery methodology, proposed timing, and coordination for the discrete contract packages that the City is considering. The PMOC is uncertain whether this figure will be updated and distributed by the City to correspond with future revisions of the Master Project Schedule.

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Table 5-3. Construction and Equipment Contract Packaging

SCC	Description	Contract Package	Contract Type	NTP	Contract End	Notes
10	Guideway and Track Elements	West Oahu and Farrington Guideway and Utilities Contract	DB	Dec-09	Mar-12	Includes installation of running/third rail
		Kamehameha Contract	DBB	Sep-11	Jun-15	Includes installation of running/third rail
		Salt Lake Contract	DBB	Aug-08	Dec-15	
		City Center Contract	DBB	Mar-13	Aug-16	
20	Stations	West Oahu Station Group	DBB	Jan-12	Apr-14	3 stations; includes park-and-ride lot
		Farrington Station Group	DBB	Mar-11	Apr-14	3 stations; includes park-and-ride lot
		Kamehameha Station Group	DBB	Feb-15	Feb-17	2 stations; includes park-and-ride lot
		Salt Lake Station Group	DBB	Jun-15	Nov-18	4 stations includes park-and-ride lot
		City Center Station Group	DBB	Jul-15	Mar-18	3 stations includes park-and-ride lot
		Kakaako Station Group	DBB	Sep-15	Jun-19	3 stations; includes park-and-ride lot
		Elevators and Escalators (SCC 20.07)	DB	Apr-12	May-19	Procure, install, test, and commission
30	Support Facilities	Maintenance Facility and Storage Yard (SCC 30.01 and 30.03)	DB	Mar-10	Apr-14	Includes procurement of rail for full alignment; two sites under consideration
40	Sitework and Special Conditions	Kamehameha Utility and H1 Ramps Relocation (SCC 40.02)	DBB	Jun-11	Apr-12	
		Salt Lake Utility Relocation (SCC 40.02)	DBB	Feb-11	Jun-13	
		City Center Utility Relocation (SCC 40.02)	DBB	Nov-11	Oct-13	
50	Systems	Train Control and Signaling (SCC 50.01)	DB	Apr-10	Dec-18	To be packaged with revenue vehicles procurement
		Traction Power Supply (SCC 50.03)				
		Traction Power Distribution (SCC 50.04)				
		Communications (SCC 50.05)				
		Central Control (SCC 50.07)				
		Fare Equipment (SCC 50.06)	DBB	Not yet defined	Not yet defined	Install owner furnished equipment
70.02	Vehicles	Heavy Rail Vehicles	DB	Apr-10	Dec-18	To be packaged with systems components

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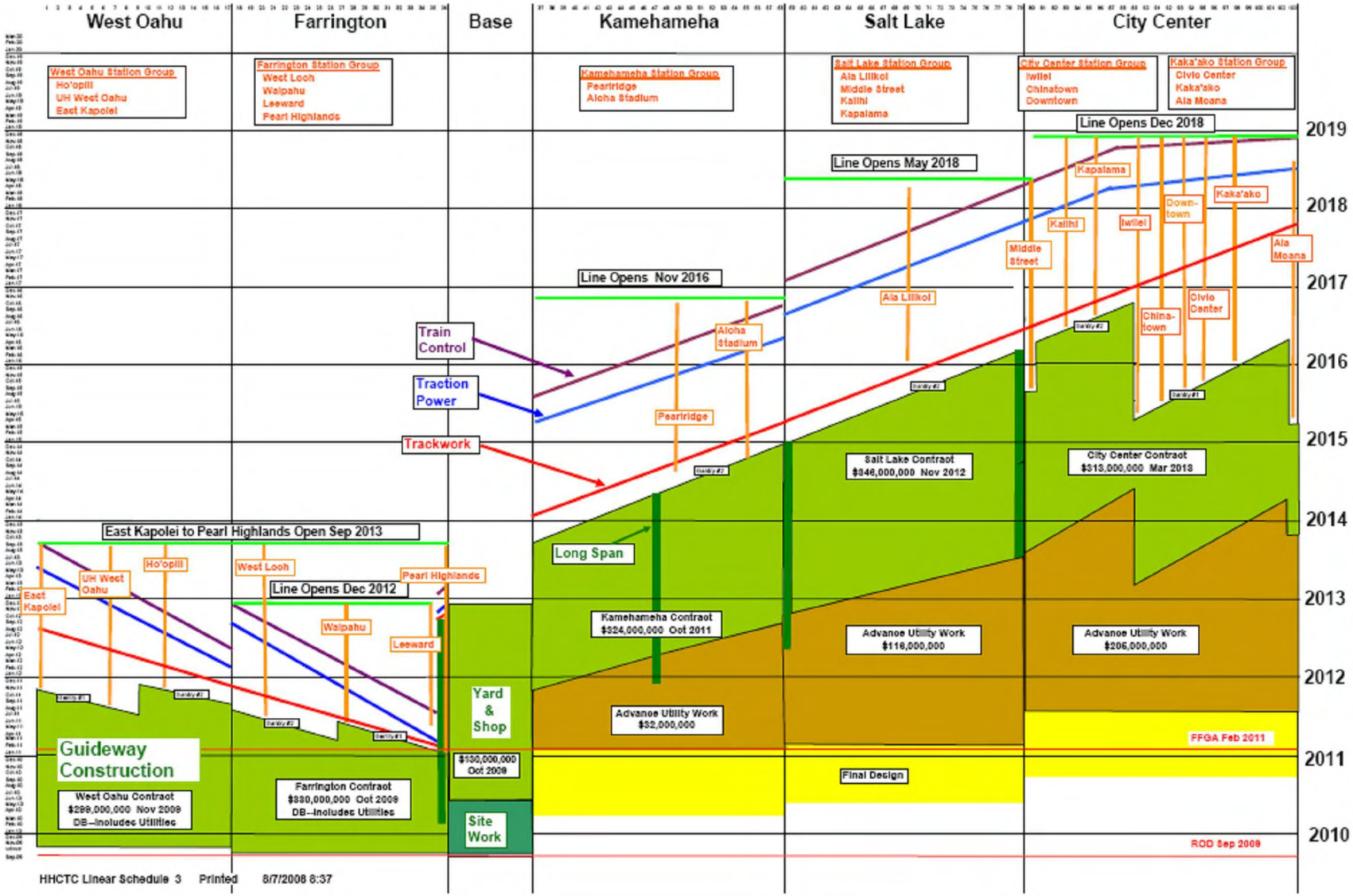
Figure 5-1 . Linear Schedule ("Horse Blanket" Diagram)



5.3 Findings

The following sections provide the PMOC findings for each SCC. These findings were utilized in development of the PG-40A and B products, as included within this Spot Report.

General

The contract delivery methodology proposed by the City could be successfully executed. The City does have the statutory authority to award the contract types currently under consideration. However, the PMOC does have some general concerns as they relate to the overall Project implementation:

- The PMOC is concerned that the multiple delivery methods being considered for Phase I and Phase II, particularly guideway construction, may not be the most cost-effective means to deliver the Project. Time is the key driver for using a DB contract delivery method for Phase I. However, the PMOC believes that this may not be a prudent approach to minimize cost. Construction on the underdeveloped west end of the project will be much simpler than the congested Central Business District east portion of the project. If the design is fully developed for the entire corridor first, and the construction estimating considers the entire alignment relative to constructability, more detailed and more accurate cost estimates can be prepared for the guideway elements.

  The City cannot presume that the unit costs associated with work for the DB segments under Phase I will equate to the unit costs for the DBB segments under Phase II. Further, given that the spread of bidding for Phase I and II will occur over a period of four to five years, the City must ensure they have adequate contingency to account for construction market changes relative to labor, material, and equipment.

  ~~In addition, PMOC believes that if the DB contracting remains for Phase I, the RFP should specifically call for a Schedule of Values that breaks down the bidder pricing so as to permit project estimators to better evaluate and adopt/adapt the results in their estimating for Phase II line segment contract packages.~~

  The PMOC understands that if the DB contracting remains for Phase I, the RFP will call for a Schedule of Values that breaks down the bidder pricing so as to permit project estimators to better evaluate and adopt/adapt the results in their estimating for Phase II line segment contract packages.

- According to the State of Hawaii's Department of Business, Economic Development & Tourism "E. Construction" Newsletter for the 3rd Quarter of 2008,

  > *"The dollar value of private building authorizations and government contracts awarded both decreased in the second quarter of 2008 compared with the same quarter last year".*

  However, this is in contrast to another statement in the newsletter that stated:

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"…construction jobs continued to grow, although the pace of growth has slowed from the previous two years".

The PMOC shares the City's concern that there may not be sufficient labor to support the Project without significant increases in unit costs to offset any importation and subsistence of labor to the island. The estimated construction value of this project is approximately $3.1 billion in year of expenditure dollars. This work is to be completed over eight to nine years, resulting in an average value of $360 million per year, with a peak estimated at $690 million in 2012. This construction period has been targeted by the City to coincide with its cash flow projections. The estimated value of construction for the State of Hawaii for the past three years has averaged $7.1 billion according to the Department of Business, Economic Development & Tourism website. This peak year for the Project would represent 10% of the entire construction value for the State of Hawaii.

- The PMOC shares the City's concern that the availability of major materials (fuel, cement, steel, copper, lumber, etc.) may be an issue for the Project and the bids may reflect such uncertainty. The concern is two-fold. First, the global construction market is driving an increase in material costs. Second, the limitation of available materials for an island market may impact cost and schedule. There is a significant cost and time component associated with shipping materials to Hawaii. The PMOC is not confident that the cost estimate properly reflects such concerns.

- The PMOC shares the City's concern regarding the availability of construction equipment available to support the Project schedule. There will be numerous contracts being simultaneously executed over the course of the Project. The increase in equipment needs, particularly during the peak years, may result in higher than anticipated unit costs and schedule issues.

  Additionally, erection of the approximately 10-foot long precast concrete segments would likely occur with the assistance of an erection gantry. With this assumed construction technique, it is a real possibility that the DB contractor will appear to prospective Phase II DBB contractors to have a significant competitive advantage during the Phase II bidding since the Phase I DB contractor has made an investment in necessary equipment. Such an assessment by prospective DBB bidders could result in other prospective contractors deciding not to submit bids for Phase II, thereby adversely impacting the competitive bid environment. A similar event occurred in another system's construction contracting for long span girders after the "standard" girders contract had been awarded. Prospective bidders believed the investment already made on casting yard, casting equipment, and rigs to haul the spans degraded the competitive bidding environment. Therefore, the PMOC is concerned that the City may receive a single bid from the Phase I line segment DB contractor for the DBB segments that is significantly higher due to lack of competition. The PMOC cannot quantify this potential impact but acknowledges a significant amount of uncertainty and risk.

- Inclement weather impacts are not of particular concern, and the schedule reflects this. However, there is little float in the overall schedule to recover from the significant impacts associated with potential tropical storms or hurricanes that may hit the island and/or shipping lanes.

At this phase of the Project, the PMOC cannot provide a detailed opinion on the constructability of the proposed design. Although the base guideway elements are constructible, it cannot be definitively ascertained if they will be constructible throughout all portions of the corridor. However, the PMOC does believe that the conceptual plans have been advanced sufficiently for this phase (pre-PE). The PMOC does have some concerns as they relate to design and construction of key elements that should be further investigated if the Project advances to PE.

SCC 10 – Guideway and Track Elements

- The City has access to an extensive amount of geotechnical data from previous investigation programs. The GEC has effectively compiled and utilized this information to establish geotechnical criteria. At this time, the City is uncertain whether they will prepare and issue a Geotechnical Baseline Report.

  From a review of the geotechnical data provided by the City, it is clear that the subsurface conditions are highly variable along the 20-mile corridor. Specific concerns include undulating stratigraphy, high water tables, and numerous environmental surface restrictions. Production rates for foundation installation should be conservative given the variability of the subsurface conditions and the access restrictions, particularly within the Phase II segments. The PMOC is concerned that the cost estimate may not adequately reflect fluctuations in production rates and the probability of encountering unforeseen underground conditions.

- Site access will be of particular concern for both guideway and station construction. The amount of traffic and pedestrian congestion and close proximity of business and residential properties, particularly along Phase II, will severely restrict the contractors' access, material delivery, and installation. This could result in schedule pressure and increased costs due to loss of contractor productivity. In addition, the City will require the contractors to identify the laydown, or staging, areas for each individual contract. The PMOC recommends the City identify and secure as much land as reasonably possible to support contractor staging/storage areas.

- The PMOC cannot determine the adequacy of General Conditions for any of the DB or DBB contracts at this time. The City is still in the process of developing draft contract documents.

- Final Design of the Phase I line segments and systems components will be performed concurrently by two separate DB contractors. There is concern that the necessary coordination between the DB contractor for the Phase I line segment and the DB system contract can be achieved adequately to prevent delays or cost impacts.

- There may be duplication of design efforts. The typical viaduct superstructure sections of the line segments will generally be uniform throughout the full corridor. By having the DB contractor develop the line segment design for Phase I and an EDC complete the line segment design for Phase II, the City may not realize any potential cost savings from a more efficient Phase II design.

- The schedule for contracting the DBB work is very tight and potentially unattainable due to contractor workload. In addition, the schedule has insufficient time to recover from contract document amendments during the bidding process, poor bids, protested bids, real estate acquisition delays, and delays associated with access or permits.

SCC 20 – Stations, Stops, Terminals, Intermodal

- Site access will be of particular concern as discussed above.

- Material and equipment staging/storage areas have not been identified. The PMOC recognizes more definitive information will evolve during the PE phase.

- Station security measures have not been clearly defined, and therefore are not detailed in present criteria or design progress at this phase of the Project. The PMOC recognizes more definitive information will evolve during the PE phase.

- ~~The City should assess the implications of placing the mezzanine above the platform and whether it would result in a lowering of the transitway profile thus providing some cost savings.~~

SCC 30 – Support Facilities: Yards, Shops, Administration Buildings

- The PMOC shares the City's concern that the uncertainty with the MSF location has not been adequately captured in the cost estimate. There will be numerous impacts if the Navy Drum Site cannot be acquired including rail alignment, construction staging (i.e. rail storage), and operational constraints. This should be addressed early in PE.

- The scope for the Administration Building and Operations Control Center has not been defined. The PMOC recognizes that this can be more definitively addressed during PE. However, it is typical in AA for a grantee to provide a conceptual design for such a critical facility and its functions. This also provides a "Basis for Design" document for the estimators and subsequent scopes of work for PE phase.

SCC 40 – Sitework and Special Conditions

- The City has not finalized any utility agreements. There is a significant number of underground and above ground utilities requiring adjustment or relocation that have considerable associated costs and schedule risks that the City plans to manage. The PMOC recognizes more definitive information will evolve during the PE phase.

- The City has not incorporated detailed utility adjustment and relocation activities in the Master Project Schedule. While it is understood that the Project is in the pre-PE phase, the City intends to issue Part 1of the RFP for the Phase I line segment in early

2009. Regardless of when an RFP is issued, it is critical that the City have a reasonable understanding of all utility impacts beforehand. The PMOC recognizes more definitive information will evolve during the PE phase. This effort should be a primary focus early in PE.

SCC 50 – Systems and SCC 70 – Revenue Vehicles

- Understandably, the scope and criteria for the systems components and revenue vehicles have not been fully defined as the Project remains in the AA/Planning phase. These SCC categories should be addressed immediately in PE given the accelerated nature of Phase I and the critical impact any decisions on vehicle and systems technology will have on the overall Project configuration.

- It appears there will be a de-mobilization required by the systems DB contractor between Phase I (line segment and MSF) and the subsequent Phase II line segments. However, it is unclear what amount of lag time will be required before the systems contractor can re-mobilize to complete the remaining Phase II segments. It is expected that the bids will reflect this uncertainty.

SCC 60 – Right-of-Way

- The ROW schedule, as defined in the PMP, has not been sufficiently developed. The PMOC recognizes more definitive information will evolve during the PE phase.

- The PMOC has concerns with the technical capacity (resource availability) of the City's ROW Department to maintain schedule.

- The PMOC has concerns with several significant areas including temporary construction easements, the "economic remainders" (particularly for properties along Dillingham), and visual/aesthetic impacts of the guideway and stations to adjacent property owners. The City may discover the necessity to acquire more partial or full takes and/or temporary or permanent construction easements than initially planned, thus impacting the project budget and schedule.

5.4 Conclusion

Each of the concerns above has been taken into consideration in development of the PG-40A and B sections of this Spot Report.

At this juncture of the development of the Project, and as relates to the Project Delivery Method (PG-32E) assessment, the PMOC concludes that the Project is ready to enter the PE Phase.

5.5 Recommendations

To bring the project up to a satisfactory level of consideration, the PMOC recommends that FTA require the City to address each of the relevant findings in this section of the Spot Report, and adequately respond to each. Alternatively, the City should show reasonable cause in not agreeing with a finding(s) and, either, provide a rationale disagreement with the finding(s) or what course

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of action it intends to take, and when, during the early stages of the PE Phase. This course of action should be outlined in the PDP. The PMOC believes this FTA requirement will protect the Federal interests should PE Phase funding be approved and enable the City to embark on PE efforts with a far more definitive scope of work and overall budget and schedule.

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6.0 SUBTASK 33A: PARAMETRIC PROJECT COST ESTIMATE REVIEW

6.1 Methodology

The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #33: Characterization of Grantee Project Cost Estimate and Escalation,* dated March 29, 2007 to assess and evaluate the grantee's cost estimate. Specifically, the PMOC completed a review of the project cost estimate to ensure it was:

- Mechanically correct and complete
- free of any material inaccuracies or incomplete data
- Consistent with relevant, identifiable industry or engineering practices
- Uniformly applied by the grantee's cost estimators and consistent in its method of calculation
- Consistent with the project scope outlined in the appropriate NEPA documents

The PMOC then assessed the integration and traceability of the estimate into the defined scope of the project for the purposes of "baselining" the project estimate as the costs, scope issues and project become more fully defined and developed through progression of project definition. Using the data developed from this analysis, the PMOC made adjustments to the grantee cost estimate for use in the PG-40 Risk Assessment.

The PMOC also reviewed and evaluated the general uniformity in the grantee's escalation of costs from the base year, to the YOE dollars, the escalation factors used to estimate YOE dollars and the soundness of the economic forecasts and escalation factors.

The focus of this evaluation is the City's 2008 Standard Cost Category (SCC) Estimate, referred to within this Spot Report as the *2008 SCC Estimate.* The City's *Main Worksheet – Build Alternative* from the *SCC Worksheet* is included as Appendix C. This estimate was prepared by their General Engineering Consultant (GEC) and their subconsultants. However, much of the information used to evaluate this estimate is contained in other supporting project documentation made available to the PMOC including those items identified in Appendix B.

6.2 Review

The PMOC reviewed the City's *2008 SCC Estimate* that correlates to the scope and values included in the Administrative Draft Environmental Impact Statement (DEIS). The PMOC Cost Estimate Review consists of two primary functions. The first is a review and evaluation of project scope inclusively, as identified in the DEIS. The second is a characterization of the mechanical and fundamental soundness of the cost estimate. The PMOC review also includes an evaluation of the cost estimate source data and its use in the *2008 SCC Estimate*, particularly with regard to Public Utility Relocation Units developed from the *1992 Original Estimate*. The cost elements were also reviewed for accuracy and applicability to the project.

The Association for the Advancement of Cost Engineering (AACE) published a recommended practice titled *Cost Estimate Classification System*. Along with the Level of Project Definition, the recommended practice establishes the expected Accuracy Range for five estimate classifications (Table 6-1). An estimate's quality can be measured by its overall accuracy range.

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Table 6-1. Cost Estimate Classification System

	Primary Characteristic	Secondary Characteristic			
Cost Estimate Class	**Level of Project Definition (%of Completion)**	**Purpose of Estimate**	**Estimating Methodology**	**Expected Accuracy Range***	**Expected Accuracy Range in Percent**
Class 5	0% to 2%	Screening or Feasibility	Stochastic or Judgment	40 to 20	+400% to –100%
Class 4	1% to 15%	Concept Study or Feasibility	Primarily Stochastic	3 to 12	+160% to –60%
Class 3	10% to 40%	Budget Authorization, or Control	Mixed, but Primarily Stochastic	2 to 6	+60% to –30%
Class 2	30% to 70%	Control or Bid/Tender	Primarily Deterministic	1 to 3	+30% to –15%
Class 1	50% to 100%	Check Estimate or Bid/Tender	Deterministic	1	+10% to –5%

*Note: If the range index value of "1" represents +10/-5%, then an index of value of 10 represents +100/-50%.

The PMOC believes the City's *2008 SCC Estimate* and supporting documentation is an AACE "Class 4" estimate due to its mostly parametric nature. It is understood that the project documents (drawings) may be more advanced than this classification would normally indicate. However, the estimate is based on earlier "adjusted/escalated" information, and thus from an overall viewpoint, it is still a study or feasibility type of estimate. Certain portions of the estimate may exceed this "Class 4" classification but will not significantly change the percentages of an expected accuracy range as noted in the above table.

The City has not yet developed a detailed bottoms-up cost estimate as the project remains in the early Planning/DEIS phase and has informally requested to be allowed to advance to PE where it is assumed a more detailed estimate will be prepared, as is customary. The PMOC did not use an Microsoft (MS) Excel spreadsheet Data Reduction Table to distribute the project costs because the City's estimate was developed using Timberline cost estimating software. Thus, nearly all of the estimate line items are based on Cost Estimating Relationships (CER). Those that are not are included as Lump Sum allowances. The estimate also includes Lump Sum allowance line items for Allocated and Unallocated Contingencies. Understandably, as the project progresses and scope refines with greater detail, a Data Reduction Table can be prepared for more intensive Risk Assessment analysis purposes.

6.2.1 Review of Construction Costs

The PMOC team reviewed the *2008 SCC Estimate* and supporting data provided by the City, which included information regarding civil, architectural, track work, utilities, vehicles, and systems components. The estimate is well organized and appears to support the scope described in the DEIS. The level of development of the estimate is very limited and depends heavily on

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Allowance, Lump Sums, and CERs. The cost estimate quantity unit measures are predominately Rail-Feet, Track-Feet, or Square Feet. The cost estimate quantities were parametrically derived within the Timberline cost estimating software. The cost estimate contains a significant amount of unit pricing from similar transit projects across the US mainland. These prices were adjusted to reflect the Hawaii market and applied to the respective quantity unit measure.

Additionally, the GEC transferred and incorporated cost from the *2007 MK Utility Estimate* for Private Utility Relocations/Removals. However, a 15.0% reduction was taken for an "assumed" franchise sharing with the utility and a 10.0% reduction was included for utility relocation design as this was stated to have been included in the units in the methodology.

Unit costs are standard throughout the estimate and did not take into consideration varying conditions along the alignment. The cost estimate does not account for unforeseen ground conditions or related unusual geotechnical conditions. Some consideration was given structurally to account for variability in grades, structure height, or spans and known geotechnical conditions.

There were some quantity and mechanical errors that were discovered in this review. These are reported in each of the SCC section of this report. Additional cost related issues or risks that were identified as concerns in other sections of this Spot Report are noted below.

6.2.2 Review of General Condition Costs

The GEC generated detailed assemblies for the *2006 Parametric Estimate*. This estimate included the contractor's overhead and profit (General Conditions) in the unit costs as variable percentages dependent upon the individual assembly and estimator's judgment as follows:

- 0.5% to 6.0% for Maintenance of Traffic
- 6.0% to 10.0% for Mobilization/Demobilization
- 0.5% to 4.0% for Minor Utilities

All CER items in the *2008 SCC Estimate* include contractor indirect costs, overhead & profit, and allocated design & construction contingencies, although no specific breakdown of these components is available. However, these General Conditions components from the *2006 Parametric Estimate* are not fully traceable to the *2008 SCC Estimate*. The *2008 SCC Estimate* does not include a separate category or line item(s) for indirect cost and likewise does not contain supporting documentation explaining the inclusion of indirect costs within the direct cost line items. Some of the information typically contained in a General Conditions estimate includes:

- Detailed Construction Schedule
- Contracting and delivery strategy (i.e. Design/Build, CM-at-Risk, Multiple Prime, Fast-track, etc.)
- Necessary equipment lists and durations
- Contract requirements for Quality Control/Assurance, Scheduling, Traffic Control, Liquated Damages, Assignment of Risks.
- More detailed information on actual construction required

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The PMOC recognizes a detailed line item estimate for General Conditions is not feasible this early in the project. However, it is recommended that the City conduct a review and evaluation of all elements typically associated with General Conditions so these items can further developed in PE and adequately incorporated into the cost estimate.

6.2.3 Review of Quantities

The *2008 SCC Cost Estimate* appears to support the scope described in the DEIS. This cost estimate included both summary sheets and detailed backup in MS Excel for each SCC. The cost estimate criteria document describing the methodology used in developing the estimate was provided and is incorporated into the project estimates. The methodology does not, in any detail, address other assumptions made in developing the estimate, the schedule, and documentation of productivity or unit costs, indirect costs or overhead and profit.

The detailed estimate sheets were reviewed for the individual line items each SCC. Quantity spot checks were not performed on line items or quantities in the *2006 Parametric Estimate* as these are not directly traceable back to the conceptual drawings but were generated by GECs Timberline software in their parametric estimating approach. The PMOC crosschecked the transfer from the detail sheets to the *2008 SCC Estimate* summary sheets of the estimate and found the mechanical accuracy of the estimate is excellent and no math-type discrepancies were identified at this level.

It was determined that the estimated length of the alignment of 101,740 Route Feet matches the stationing indicated on the preliminary drawings. This value is critical as the developed parametric units utilize this quantity (divided into segments) for many calculations.

Due to the style of estimate that was prepared – a parametric estimate – an in-depth review and analysis or correlation of project quantities was not developed by the PMOC, as would normally occur in projects in later stages of development and as required by PG-33 (Subtask 33B). The drawings are considered planning documents as they were developed to support the DEIS. Quantities are basically alignment lengths, structure counts, major utilities identified, and other similar broad-style or all-encompassing quantities.

6.2.4 Review of Cost Estimate Escalation

Escalation factors are of great concern, given the recent financial events impacting the United States' and global economies. The 2008 SCC Estimate includes the following escalation rates:

- 4.85% for FY2009
- 3.55% for FY2010
- 2.90% for FY2011
- 2.80% thru FY2019

These percentages add a value of approximately $997 million to the SCC Base Year Project Costs, including contingency (escalation portion) and finance costs.

The Engineering News Record (ENR) Construction Cost indices indicate an average escalation of 4.7% for the past five years and 4.0% for the past 15 years. ~~The City provided the PMOC with a document listing an expected inflation rate of 2.8% for Hawaii.~~

It is the PMOC's opinion these percentages are trending low. The PMOC believes the City should institute a more conservative and realistic approach of applying substantially higher escalation rates to the *2008 SCC Estimate* as a result of the instabilities and downtrends recently experienced in the United States market and historical data provided by ENR. For purposes of adjusting the cost estimate as input into the Cost Risk Model, the PMOC utilized a rate of 4.85% in 2009, 4.25% for 2010 through 2015, and 2.8% for 2016 through 2019.

6.2.5 Review of Risks

From the PMOC Risk Identification List presented and discussed in the September 2008 Risk Assessment Workshop, as well as subsequent risks found in the PMOC review, many major risks were identified and are listed in the separate SCCs. However, the following risks apply to multiple SCCs and are listed here for brevity:

- Governance Risks exist that are beyond the control of the project
- Design is more advanced than the estimate (once estimate is developed based on more detailed plans, uncertainty with corresponding line items can be reduced)
- Soft costs are based on percentages of construction costs
- Project Development Plan is yet to be developed
- Volatile bidding market
- A perceived shortage of skilled and unskilled labor may exist
- General Conditions have not yet been developed
- Change orders for construction will occur
- Working in a confined and congested area and delivery of materials to the site
- Excise Tax may not be adequately included for all cost items in the estimate
- Recent unrest in the United States and Global Financial markets as well as the threat of a worldwide recession will bring substantial risks to this project in the near term and long term as well.

6.2.6 Review of Standard Cost Categories

Table 6-2 provides a summary of the 2008 SCC Estimate in both base year and year-of-expenditure (YOE) dollars including allocated and unallocated contingency amounts.

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Table 6-2. 2008 SCC Estimate

SCC	Description	Project Estimate			
		Base Year		YOE	
		Total	Contingency	Total	Contingency
10	**Guideway & Track Elements (Route Miles)**	**1,261,224,594**	**226,489,688**	**1,549,289,729**	**278,220,191**
10.01	Guideway: At-grade exclusive right-of-way	0	0	0	0
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	0	0	0	0
10.03	Guideway: At-grade in mixed traffic	0	0	0	0
10.04	Guideway: Aerial structure	1,103,789,580	196,943,292	1,355,896,379	241,925,365
10.05	Guideway: Built-up fill	0	0	0	0
10.06	Guideway: Underground cut & cover	0	0	0	0
10.07	Guideway: Underground tunnel	0	0	0	0
10.08	Guideway: Retained cut or fill	6,631,081	1,244,479	8,145,627	1,528,720
10.09	Track: Direct fixation	139,213,885	26,126,771	171,010,495	32,094,155
10.10	Track: Embedded	0	0	0	0
10.11	Track: Ballasted	0	0	0	0
10.12	Track: Special (switches, turnouts)	11,590,048	2,175,146	14,237,228	2,671,952
10.13	Track: Vibration and noise dampening	0		0	
20	**Stations, Stops, Terminals, Intermodals**	**262,975,504**	**49,353,559**	**338,165,718**	**63,464,777**
20.01	At-grade station, stop, shelter, mall, terminal, platform	0	0	0	0
20.02	Aerial station, stop, shelter, mall, terminal, platform	199,467,259	37,434,738	256,499,133	48,138,115
20.03	Underground station, stop, shelter, mall, terminal, platform	0	0	0	0
20.04	Other stations, landings, terminals: Intermodal, ferry, trolley, etc.	0	0	0	0
20.05	Joint development	0	0	0	0
20.06	Automobile parking multi-story structure	0	0	0	0
20.07	Elevators, escalators	63,508,245	11,918,821	81,666,585	15,326,662
30	**Support Facilities: Yards, Shops, Admin. Bldgs.**	**117,190,233**	**21,993,513**	**133,868,487**	**25,123,581**
30.01	Administration Building: Office, sales, storage, revenue counting	20,075,571	3,767,655	22,932,682	4,303,859
30.02	Light Maintenance Facility	0	0	0	0
30.03	Heavy Maintenance Facility	97,114,662	18,225,858	110,935,805	20,819,722
30.04	Storage or Maintenance of Way Building	0	0	0	0
30.05	Yard and Yard Track	0	0	0	0
40	**Sitework & Special Conditions**	**643,868,033**	**144,662,152**	**753,546,133**	**169,304,267**
40.01	Demolition, Clearing, Earthwork	31,210,292	7,627,681	36,526,732	8,926,999
40.02	Site Utilities, Utility Relocation	363,610,903	88,865,174	425,549,299	104,002,691
40.03	Haz. mat'l, contam'd soil removal/mitigation, ground water treatments	12,476,369	3,049,179	14,601,625	3,568,584
40.04	Environmental mitigation, e.g. wetlands, historic/archeologic, parks	12,730,112	3,111,193	14,898,591	3,641,161
40.05	Site structures including retaining walls, sound walls	0	0	0	0
40.06	Pedestrian / bike access and accommodation, landscaping	0	0	0	0
40.07	Automobile, bus, van accessways including roads, parking lots	223,840,357	42,008,925	261,969,887	49,164,831
40.08	Temporary Facilities and other indirect costs during construction	0	0	0	0
50	**Systems**	**235,555,047**	**44,207,464**	**302,549,444**	**56,780,544**
50.01	Train control and signals	39,131,195	7,343,892	50,260,529	9,432,574
50.02	Traffic signals and crossing protection	28,875,760	5,419,218	37,088,338	6,960,502
50.03	Traction power supply: substations	50,687,225	9,512,654	65,103,219	12,218,155
50.04	Traction power distribution: catenary and third rail	77,772,372	14,595,821	99,891,674	18,747,030
50.05	Communications	23,635,131	4,435,690	30,357,217	5,697,248
50.06	Fare collection system and equipment	4,763,385	893,962	6,118,143	1,148,214
50.07	Central Control	10,689,979	2,006,227	13,730,324	2,576,820
CONSTRUCTION SUBTOTAL (10 - 50)		**2,520,813,411**	**486,706,376**	**3,077,419,511**	**592,893,360**
60	**ROW, Land, Existing Improvements**	**137,662,191**	**45,887,397**	**160,122,543**	**53,374,181**
60.01	Purchase or lease of real estate	135,163,482	45,054,494	157,216,156	52,405,385
60.02	Relocation of existing households and businesses	2,498,709	832,903	2,906,387	968,796
70	**Vehicles**	**266,143,610**	**51,511,667**	**329,618,886**	**63,797,204**
70.01	Light Rail	0	0	0	0
70.02	Heavy Rail	236,412,673	45,757,292	292,797,118	56,670,410
70.03	Commuter Rail	0	0	0	0
70.04	Bus	0	0	0	0
70.05	Other	0	0	0	0
70.06	Non-revenue vehicles	6,089,670	1,178,646	7,542,057	1,459,753
70.07	Spare parts	23,641,267	4,575,729	29,279,711	5,667,041
80	**Professaonal Services**	**756,244,023**	**146,011,914**	**936,956,318**	**180,902,964**
80.01	Preliminary Engineering	75,624,402	14,601,191	93,695,632	18,090,296
80.02	Final Design	113,436,603	21,901,787	140,543,448	27,135,444
80.03	Project Management for Design and Construction	138,644,738	26,768,851	171,775,325	33,165,543
80.04	Construction Administration & Management	252,081,341	48,670,638	312,318,773	60,300,988
80.05	Professional Liability and other Non-Construction Insurance	37,812,201	7,300,596	46,847,816	9,045,149
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	37,812,201	7,300,596	46,847,816	9,045,149
80.07	Surveys, Testing, Investigation, Inspection	12,604,067	2,433,532	15,615,939	3,015,050
80.08	Start up	88,228,469	17,034,723	109,311,570	21,105,345
SUBTOTAL (10 - 80)		**3,680,863,235**	**730,117,354**	**4,504,117,258**	**890,967,709**
90	**Unallocated Contingency**	**220,851,835**	**220,851,835**	**270,246,065**	**270,246,065**
SUBTOTAL (10 - 90)		**3,901,715,070**	**950,969,189**	**4,774,363,323**	**1,161,213,774**
100	**Finance Charges**	**359,651,000**	**0**	**484,070,859**	**0**
TOTAL PROJECT COST (10 - 100)		**4,261,366,070**	**950,969,189**	**5,258,434,182**	**1,161,213,774**

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(1) SCC 10 – Guideway and Track Elements

Table 6-3. SCC 10 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
10.04	Guideway: Aerial Structure			1,355,896		1,355,896
10.08	Guideway: Retained Cut or Fill			8,146		8,146
10.09	Track: Direct Fixation			171,010		71,010
10.12	Track: Special			14,237		14,237
	Total			**1,549,290**		**1,549,290**

Note: All values are in YOE $ x1000.

Quantity Review

Since this is a parametric style estimate, the only quantity checked was overall length for the guideways, and it is accurate.

Unit Measure Pricing Review

The PMOC review of unit prices contained in the assemblies finds that many of the unit prices are in the high range for these SCC 10 elements, but the generated quantities appear reasonable. The material prices for various types of track work, although given as a lump sum unit price, are trending high as compared to industry standard pricing but this may be a result of the entire alignment essentially being elevated and located in roadway right-of-way (ROW). Since the track work length is known and the design is standard (but expensive), the costs for materials and labor are expected to be well understood by the project staff. Overall the trackwork portion of the estimate is reasonable.

In the current estimate for this SCC, the costs are distributed with the CER items representing 100% of the estimate. A review of SCC line items resulted in the following observations:

- *SCC 10.04 Guideway: Aerial Structure ($1,355,896,000 in YOE)*
- *SCC 10.08 Guideway: Retained Cut or Fill ($8,146,000 in YOE)*
- *SCC 10.09 Track: Direct Fixation ($171,000,000 in YOE)*
- *SCC 10.12 Track: Special (Switches and Turnouts) ($14,237,000 in YOE)*
  No discrepancies were identified.

Contingency Review (Allocated and Latent)

Table 6-3 includes only Allocated Contingency and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 10 is $278.22 million (YOE), which represents 21.89% contingency.

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(2) *SCC 20 – Stations, Stops, Terminals, Intermodal Facilities*

Table 6-4. SCC 20 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
20.02	Aerial Stations			256,499		256,499
20.03	Underground Stations					0
20.07	Elevators/Escalators			81,667		81,667
	Total			**338,166**		**338,166**

Note: All values are in YOE $ x1000.

Quantity Review

Since this is a parametric style estimate, the only quantity checked was the overall count of the stations, which is accurate. It was noted during the September 2008 Risk Assessment Workshop that the count of elevators and escalators is likely conservative but is being reviewed by the GEC. Changes will be reflected in the plans and estimate once the study is completed.

Unit Measure Pricing Review

As expected, the DEIS documents are not developed well enough for a bottoms-up estimate to be generated for the stations other than to generate broad generic line items thru the parametric process. The PMOC noted that these station assembly costs are higher than average for most typical elevated stations; however, the scope is not clearly defined and the prices are not that unreasonable given the geographic location of the project.

In the current estimate for this SCC, the costs are distributed with the CER representing 100% of the estimate. A review of line items resulted in the following observations:

- *SCC 20.01 Aerial Stations ($256,499,000 in YOE)*
  No discrepancies were identified.

- *SCC 20.03 Underground Stations ($0 in YOE)*
  Leeward Community College Station is the only proposed at-grade or slightly depressed station. However, the *2008 SCC Estimate* utilized the aerial stations CER for this station.

- *SCC 20.07 Escalators/Elevators ($81,667,000 in YOE)*
  No discrepancies were identified.

Contingency Review (Allocated and Latent)

Table 6-4 includes only Allocated Contingency and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 20 is $63.465 million (YOE), which represents 23.10% contingency.

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(3) SCC 30 – Support Facilities: Yards, Shops & Admin. Building

Table 6-5. SCC 30 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
30.01	Administration Building			22,933		22,933
30.04	Heavy Maintenance Facility			110,936		110,936
30.05	Yard and Yard Track					0
	Total			**133,868**		**133,868**

Note: All values are in YOE $ x1000.

Quantity Review

The project scope for support facilities is based upon a square foot requirement for the buildings and a parametric estimate to generate quantities.

Unit Measure Pricing Review

In the current City's estimate for this SCC, the costs are distributed with the CER items representing 100%. A review of line items resulted in the following observations:

- *SCC 30.01 Administration Building ($22,933,000 in YOE)*
  No discrepancies were identified.

- *SCC 30.04 Heavy Maintenance Facility ($110,936,000 in YOE)*
  No discrepancies were identified.

- *SCC 30.05 Yard and Yard Track ($0 in YOE)*
  No cost was contained within this SCC as it was included in SCC 30.04.

Contingency Review (Allocated and Latent)

Table 6-5 includes only Allocated Contingency and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 30 in YOE is $25.124 million, which represents 23.10% contingency.

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(4) SCC 40 – Sitework & Special Conditions

Table 6-6. SCC 40 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
40.01	Demolition, Clearing, Earthwork			36,527		36,527
40.02	Site Utilities, Utility Relocation			425,549		425,549
40.03	Haz Matl ,Contamination				14,602	14,602
40.04	Environmental Mitigation				14,899	14,899
40.05	Site Structures, including retaining walls					0
40.06	Pedestrian/ bike access					0
40.07	Automobile, bus, van access ways			261,970		261,970
40.08	Temporary Facilities and other indirect costs during construction					0
	Total			**724,046**	**29,501**	**753,546**

Note: All values are in YOE $ x1000.

Quantity Review

Since this is a parametric style estimate, the only quantity checked for this SCC was the overall length, which is accurate.

Unit Measure Pricing Review

In the current City estimate for this SCC, the costs are distributed with the CER items ($724.0 million) representing 96.1% of the estimate and Lump Sum or Allowance items ($29.5 million) representing 3.9% of the estimate. A review of line items resulted in the following observations:

- *SCC 40.01 Demolition ($36,527,000 in YOE)*
  No discrepancies were identified.

- *SCC 40.02 Site Utilities, Utility Relocation ($425,549,000 in YOE)*
  The *2006 Parametric Estimate*, and by default the *2008 SCC Estimate*, are supported in part by the original cost estimate for the 1992 Honolulu Rapid Transit Development Project System Procurement Contract (& Methodology) dated August 30, 1991, referred to as the *1992 Original Estimate* in this report. The *1992 Original Estimate* was jointly prepared by Kaiser Engineers and Lea & Elliot Engineers to assist the City and County of Honolulu with verification of vendor/contractor bids for the initial procurement that was eventually abandoned.

  A more recent utility estimate, referred to as the *2007 MK Utility Estimate*, was incorporated into the *2008 SCC Estimate* to provide values for the Private and Public Utility Relocation and Removal. The PMOC believes the two unit prices developed in the *2007 MK Utility Estimate* for relocation and removal of utilities has been

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calculated incorrectly from the *1992 Original Estimate*, and that the value of the estimate is understated for this element of work.

The *2007 MK Utility Estimate* recommended the GEC use only two unit prices from the *1992 Original Estimate,* a cost per route foot (RF) for "reinstallation of public utilities requiring relocations" and a cost to "remove public utilities". The *2007 MK Utility Estimate* noted that the *1992 Original Estimate* included an overall cost of $6.15 million (2007 dollars) for utility reinstallation and $4.09 million (2007 dollars) for removal for 81,740 route feet (1992 quantity) of the alignment. This translates to a rounded unit cost of $75 per Route Foot (RF) utility reinstallation and $50 per RF for removal in 2007 dollars. The GEC used higher base year rates in the *2008 SCC Estimate* of $91.42 per RF for utility reinstallation and $56.22 per RF for removal after adjusting for escalation and traffic control. However, the *1992 Original Estimate* has a total value for utility relocations of $29.37 million. If this value is escalated (using 3.9% average) to 2007 dollars, it results in an estimated cost of $52 million, substantially greater that the amount included in the *2008 SCC Estimate*. In the PMOC's opinion, the 2008 SCC Estimate does not adequately capture the cost for public utilities for this approximate 20-mile alignment with 80% of it in a densely populated and highly congested area.

In addition, the Project staff indicated during the September 2008 Risk Assessment Workshop that the *1992 Original Estimate* was based on essentially complete plans. However, the basis of estimate from the *1992 Original Estimate* clearly states the estimate was "conceptual". This estimate was based on 20 bents per segment, was developed based on a representative utility relocation cost per bent, and was extrapolated across each segment.

One final issue is that the Project staff stated in the September 2008 Risk Assessment Workshop that the Project would assume the costs for all utility relocations, public and private. However, the *2007 MK Utility Estimate*, which was used to prepare the *2008 SCC Estimate*, was reduced by 15% to account for "suspected franchise agreements" with the utility owners. Thus an inconsistency exists as the Project staff noted in the September 2008 Risk Assessment Workshop that the Private Utilities would be 100% funded by the Project "in order to maintain control and schedule". In the PMOC's opinion, this should be added back into the estimate, as addressed in Section 6.3.1.

- *SCC 40.03 Hazardous Materials ($14,602,000 in YOE)*
  No discrepancies were identified.

- *SCC 40.04 Environmental Mitigations ($14,899,000 in YOE)*
  No discrepancies were identified.

- *SCC 40.05 Site Structures including retaining walls, sound walls ($0 in YOE)*
  No cost included in the budget for this SCC.

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- *SCC 40.06 Pedestrian/bike access, accommodation, landscape ($0 in YOE)*
  No cost included in the budget for this SCC.

- *SCC 40.07 Automobile, bus, van access ways, including roads, parking lots ($261,970,000 in YOE)*
  No discrepancies were identified.

Contingency Review (Allocated and Latent)
Table 6-6 includes only Allocated Contingency and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 40 is $25.124 million (YOE), which represents 28.98% contingency.

(5) SCC 50 – Systems

Table 6-7. SCC 50 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
50.01	Train Control and Signals			50,261		50,261
50.02	Traffic Signals and Crossing Protection			37,088		37,088
50.03	Traction Power Supply – Substations			65,103		65,103
50.04	Traction Power Distribution – Catenary			99,892		99,892
50.05	Communications			30,357		30,357
50.06	Fare Collection System & Equip.			6,118		6,118
50.07	Central Control			13,730		13,730
	Total			**302,549**		**302,549**

Note: All values are in YOE $ x1000.

Quantity Review
For the systems, since this is a parametric style estimate, the only quantity checked was overall length, which is accurate. It was noted that the final line segment quantity did not match the stationing, but it was assumed this was due to a longer length being necessary to account for tail tracks or other elements that were not specifically identified.

It was also noted that some of the parametric quantities for the systems elements contained in the CERs had less than whole numbers. In some cases, the aggregate sum of the various line sections did not equal whole numbers. This possible discrepancy was brought to the Project staff's attention at the September 2008 Risk Assessment Workshop. They indicated that it was likely an anomaly of the software used to develop the CERs and would be reviewed to ensure consistency in the estimate preparation. It should be noted that these discrepancies were minor and would no significant effect on the cost estimate at this stage.

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Unit Measure Pricing Review

In the current City estimate for this SCC, the costs are distributed with the CER items ($302.6 million) representing 100% of the estimate. A review of line items resulted in the following observations:

- *SCC 50.01 Train Control and Signals ($50,261,000 YOE)*
- *SCC 50.02 Traffic Signals and Crossing Protection ($37,088,000 YOE)*
- *SCC 50.03 Systems: Traction Power: Substations ($65,103,000 in YOE)*
- *SCC 50.04 Traction Power: Third Rail ($99,892,000 in YOE)*
- *SCC 50.05 Communications ($30,357,000 in YOE)*
- *SCC 50.06 Fare Collection ($6,118,000 in YOE)*
- *SCC 50.07 Systems: Central Control ($13,730,000 in YOE)*

  The estimate provides no extensive detail for each of these line items due to the parametric style of estimate. While the PMOC cannot determine whether each of these SCC line items is complete or consistent with future requirements, the PMOC has determined the amount of detail provided sufficiently describes the scope of work for a rough order of magnitude cost estimate developed in the planning phase. The PMOC recognizes a significant number of cost and schedule risks exist for each portion of the work as the scope definition is limited and still evolving.

Contingency Review (Allocated and Latent)

Table 6-7 includes only Allocated Contingency and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 50 is $56.781 million (YOE), which represents 23.10% contingency.

(6) SCC 60 – Right-of-Way

Table 6-8. SCC 60 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
60.01	Purchase or lease of real estate			157,216		157,216
60.02	Relocation of existing households & businesses			2,906		2,906
	Total			**160,123**		**160,123**

Note: All values are in YOE $ x1000.

Quantity Review

Since this is a parametric style estimate, the real estate quantity was not checked as the design is not advanced sufficiently and is subject to vary greatly as the project advances forward.

Unit Measure Pricing Review

The costs are distributed with the CER items ($160.1 million) representing 100% of the estimate. A review of line items resulted in the following observations:

- *SCC 60.01 Purchase or lease of real estate ($157,216,000 in YOE)*

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The City has indicated that the basis of cost for real estate is the City or County tax assessment value. These are updated bi-annually, and a large risk likely exists for acquiring the parcels. The City also stated the cost estimate does not include costs for temporary or permanent easements.

- *SCC 60.02 Relocation of existing households and businesses ($2,906,000 in YOE)*
  No discrepancies were identified.

Contingency Review (Allocated and Latent)
Table 6-8 includes only Allocated Contingency and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 60 is $53.374 million (YOE), which represents 50.00% contingency.

(7) SCC 70 – Vehicles

Table 6-9. SCC 70 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
70.02	Heavy Rail				292,797	292,797
70.05	Other				0	0
70.06	Non-revenue Vehicles				7,542	7,542
70.07	Spare Parts				29,280	29,280
	Total				**329,619**	**329,619**

Note: All values are in YOE $ x1000.

Quantity Review
The *2008 SCC Estimate* includes the procurement of 60 heavy rail vehicles. However, as noted in Section 4.0 – Subtask 32A: Project Capacity Review, the PMOC believes the capacity of the proposed system is insufficient to accommodate the 2030 forecast ridership. The PMOC estimates that the City will require an additional eight (8) vehicles to support the requisite level of service, bringing the total number of vehicles required to 68.

Unit Measure Pricing Review
In the current City estimate for this SCC, the costs are distributed with the Lump Sum or Allowance items ($329.6 million) representing 100% of the estimate for this portion of the work. A review of line items resulted in the following observations:

- *SCC 70.02 Heavy Rail ($292,797,000 in YOE)*
  No discrepancies were identified.

- *SCC 70.06 Non-revenue vehicles ($7,542,000 in YOE)*
  No discrepancies were identified.

- *SCC 70.07 Spare Parts ($29,280,000 in YOE)*
  No discrepancies were identified.

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Contingency Review (Allocated and Latent)
Table 6-9 includes only Allocated Contingency and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 70 in YOE is $63.797 million, which represents 24.00% contingency.

(8) SCC 80 – Professional Services

Table 6-10. SCC 80 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
80.01	Preliminary Engineering			93,696		93,696
80.02	Final Design			140,543		140,543
80.03	Project Management for Design & construction			171,775		171,775
80.04	Construction Administration & Management			312,319		312,319
80.05	Insurance			46,848		46,848
80.06	Legal, Permits, review Fees			46,848		46,848
80.07	Surveys, Testing, Investigation, Inspection			15,616		15,616
80.08	Agency Force Account Work			109,312		109,312
	Total			**936,956**		**936,956**

Note: All values are in YOE $ x1000.

Quantity Review
Since this is a parametric style estimate, the quantity was not checked as these professional and administrative type costs are based on a percentage and not on the basis of a staffing or work plan. It is anticipated that once the project is advanced to PE that staffing plans will be developed to improve the accuracy of these estimates.

Unit Measure Pricing Review
Professional Services is one of the largest cost categories in the *2008 SCC Estimate*. The values are calculated on a percentage basis of the construction values. If the base cost increases or decreases, then so do the soft costs, as these are a function of the total project cost in the parametric style of estimating.

In the current Project estimate for this SCC, the costs are distributed with the CER items ($937.0 million) representing 100% of the estimate. A review of line items resulted in the following observations:

- *SCC 80.01 Preliminary Engineering – 3.0% of SCC 10-50 ($93,696,000 in YOE)*
- *SCC 80.02 Final Design – 4.5% of SCC 10-50 ($140,543,000 in YOE)*
- *SCC 80.03 Project Management for Design and Construction – 5.5% of SCC 10-50 ($171,775,000 in YOE)*
- *SCC 80.04 Construction Administration and Management – 10.0% of SCC 10-50 ($312,319,000 in YOE)*

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- *SCC 80.05 Insurance – 1.5% of SCC 10-50 ($46,848,000 in YOE)*
- *SCC 80.06 Legal Permits: Review fees by other agencies, cities etc – 1.5% of SCC 10-50 ($46,848,000 in YOE)*
- *SCC 80.07 Surveys, Testing, Investigation, Inspection – 0.5% of SCC 10-50 ($15,616,000 in YOE)*
- *SCC 80.08 Start-up – 3.5% of SCC 10-50 ($109,312,000 in YOE)*
  No discrepancies were identified.

Contingency Review (Allocated and Latent)
Table 6-10 includes only Allocated Contingency, and no Latent Contingency was identified for this work element. The value for Allocated Contingency for SCC 80 is $180.903 million (YOE), which represents 23.93% contingency.

(9) SCC 90 – Contingency

Table 6-11. SCC 90 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
90	Unallocated Contingency				270,246	270,246
	Total				**270,246**	**270,246**

Note: All values are in YOE $ x1000.

Quantity Review
A quantity review was not applicable for this SCC.

Unit Measure Pricing Review
In the current Project estimate, the costs for SCC 90 are distributed with the Lump Sum or Allowance items ($270.2 million) representing 100% of the estimate for this portion of the work. A review of line items resulted in the following observations:
- *SCC 90.00 Contingency ($270,246,000 in YOE)*
  No discrepancies were identified.

Contingency Review (Allocated and Latent)
This section addresses contingencies included in the direct cost line items and all Unallocated Contingency.
- *Design and Construction Contingency Factors*
  A review of the *2008 SCC Estimate* reveals an unallocated contingency level of 6.00% ($270,246,000 YOE) and an allocated contingency level of 24.74% ($890,968,000 in YOE) of the subtotal cost of SCC 10 to 80. Each of the individual SCC elements as shown in the various tables above (SCC 10 to 80) includes the corresponding allocated contingency values. It is shown here to identify the aggregate value in one convenient spot but is not included in the SCC 90 table above.

- *Latent Contingency*

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The PMOC could not identify any Latent Contingency in the *2008 SCC Estimate*, and this issue was discussed at the September 2008 Risk Assessment Workshop. The Project the staff noted the estimate did not contain any latent contingency. With that being said, the parametric style of estimating does not lend itself to finding latent contingency in a review analysis due to the lack of detail and the use of software to develop quantities. Additionally since the current drawings and the estimate are not coordinated, and effectively there is not a set of documents identified as the basis of estimate, then a check cannot be made to see if latent contingency exists from a quantity standpoint either.

(10) SCC 100 Finance Charges

Table 6-12. SCC 100 YOE Estimate

SCC	Description	Cost Estimate Classification				Total
		Plan Quantity	Estimate Quantity	CER	LS	
100	Finance Cost				484,071	484,071
	Total				**484,071**	**484,071**

Note: All values are in YOE $ x1000.

Quantity Review
Not Applicable for Finance Costs

Unit Measure Pricing Review
In the current City estimate for this SCC, the costs are distributed with the Lump Sum or Allowance items ($484.1 million) representing 100% of the estimate for this portion of the work.

The allowance for Finance Charges is to reflect the cost of borrowing to match the cash flow requirements for construction progress payments versus the anticipated flow of funding from the contributing agencies.

Contingency Review (Allocated and Latent)
No Allocated Contingency is included for this work element and no Latent Contingency was identified during either the September 2008 Risk Assessment Workshop or the subsequent review of the furnished project documents.

6.3 PMOC Adjustments to Base Cost Estimate

The PMOC made adjustments to the project's direct costs due to omissions in scope or to under valuation of certain cost items. The PMOC has identified adjustments to the Base Cost Estimate (BCE) that can be categorized as Line Item Adjustments, Excise Tax Adjustments, or Escalation Adjustments. The input for the Cost Risk Model (Section 8.0) and basis for the evaluation of project cost contingency (Section 9.0) is the Adjusted BCE, which is the BCE net of contingencies and finance costs and includes the PMOC adjustments discussed below. Table 6-15 provides a summary of the Cost Risk Model Input including PMOC Adjustments.

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6.3.1 Line Item Adjustment

The PMOC has identified Line Item Adjustments for the following SCCs:

SCC 20 – Stations, Stops, Terminals, Intermodals
Leeward Community College Station is the only proposed at-grade or slightly depressed station. However, the *2008 SCC Estimate* utilized the aerial stations CER for this station. This issue was discussed at September 2008 Risk Assessment Workshop, and the project staff noted they would send a revised estimate to address this discrepancy. The project staff issued a memo dated September 19, 2008 stating that the costs would likely be slightly higher for a depressed station (retained fill) versus a typical elevated station. The *2008 SCC Estimate* was unchanged. Therefore, the PMOC extracted the proportionate cost for the Leeward CC Station from SCC 20.02 – Aerial Station and included it in SCC 20.03 – Underground Station. The purpose of this adjustment was to allow for a different Beta Risk Factor for each element of the project.

SCC 40 – Sitework & Special Conditions
As discussed in Section 6.2.6 (4), an adjustment to SCC 40.02 – Site Utilities, Utility Relocation is warranted for both public and private utilities as follows:.

- Public Utility Adjustment
  - 2008 Adjustment $61,473,918
  - YOE Adjustment $71,945,540

- Private Utility Adjustment
  - 2008 Adjustment $40,576,487
  - YOE Adjustment $47,488,388

The result of these adjustments is shown in Table 6-15.

SCC 70 – Vehicles
The *2008 SCC Estimate* includes the procurement of 60 heavy rail vehicles. However, as noted in Section 4.0 – Subtask 32A: Project Capacity Review, the PMOC believes the capacity of the proposed system is insufficient to accommodate the 2030 forecast ridership. The PMOC estimates that the City will require an additional eight (8) vehicles to support the requisite level of service, bringing the total number of vehicles required to 68. The result of this adjustment is shown in Table 6-15.

SCC 80 – Professional Services
Since all SCC 80 costs are percentages of the base construction costs and effectively based on CERs, Line Item Adjustments are necessary for consistency. These adjustments were based on the increase in value as a result of other adjustments made. The result of these adjustments is shown in Table 6-15.

6.3.2 Excise Tax Adjustment

The PMOC noted in its review of the *1992 Original Estimate* a Hawaii Excise Tax was added to the bottom line or gross value of the budget at the then current rate of 4.167% against the entire

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project value. The *2008 Support Spreadsheet* (detail) shows that only a portion of the entire base year budget (approximately $1.765 billion) was assessed using the Excise Tax at the current rate of 4.710%. However, it is difficult to determine how the *2008 SCC Estimate* addressed the excise tax as it is now "buried" in the SCC line items of this summary spreadsheet and the detailed *2008 SCC Support Spreadsheet* does not include the MS Excel formulas.

The Excise Tax is a business tax that is different than a sales tax and likely applies to almost all exchanges, including construction, professional fees and other soft costs, materials, labor, real estate, and construction contracts. Additionally, there is a separate Hawaii Use Tax, which may be compounding and may add to the Excise Tax under certain situations that can occur with certain contracting strategies. The PMOC believes the Excise Tax should be assessed against the project gross values unless it can be proven that the City is exempted. To develop a rough order of magnitude cost, the PMOC developed Table 6-13.

Table 6-13. Excise Tax Calculation

Line	Description	Amount
1	**TOTAL Project Estimate (Base Year)**	**4,261,366,070**
2	Base Year Excise Tax Amount included in 2008 SCC Estimate	83,135,242
3	Escalation Factor [Line 5 / Line 1]	1.234
4	YOE Excise Tax Amount included in 2008 SCC Estimate [Line 2 x Line 3]	102,587,103
5	**TOTAL Project Estimate (YOE)**	**5,258,434,182**
6	Finance Cost (YOE)	(484,070,859)
7	Contingency (YOE)	(1,161,213,774)
8	Excise Tax included in 2008 SCC Estimate	(102,587,103)
9	PMOC Line Item Adjustment	193,579,831
10	PMOC Escalation Adjustment	194,568,633
11	**SUBTOTAL [Sum of Lines 5 thru 10]**	**3,898,710,910**
12	Excise Tax Rate	4.710%
13	Total Value of Excise Tax	183,629,284
14	**TOTAL Excise Tax Adjustment [Line 13 - Line 4]**	**81,042,181**

Therefore, the PMOC concludes that the Project estimate has a shortfall of approximately $81.0 million (YOE) for the excise tax issue. The City has indicated that they are seeking exemption from this Excise (and/or Use Tax) pending legislative action. However, until such exemption is granted, the Project estimate should reflect the full cost exposure for this tax.

There may be risk in the way the Cost Estimate is organized because each segment of the Project (Stations, Parts of Stations, Utility relocations, Line Segments, Track, etc) is presented in its totality. In most areas it is useful and appropriate. Each such element can be seen as a separate "entity". However, there is the risk that one element will overlap a portion of another (leading to a 'double' count) or that site work may be missed in a 'grey' area between two elements (leading to an under count). The coordination method used to avoid this inherent risk should be specified and explained.

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6.3.3 Escalation Adjustment

As noted in Section 6.2.4, the Engineering News Record (ENR) Construction Cost indices indicate an average escalation of 4.7% for the past five years and 4.0% for the past 15 years. The City's SCC worksheet utilized the following expected inflation rates:

- 4.85% for 2009
- 3.55% for 2010
- 2.90% for 2011
- 2.80% for 2012 through 2019

The resulting values were compared to obtain an Escalation Adjustment factor for each SCC as shown in Table 6-14.

Table 6-14. Escalation Factors

SCC	YOE Base Cost (City Escalation)	YOE Base Cost (PMOC Escalation)	Value of Adjustment	Factor
10	1,549,289,729	1,635,052,242	85,762,514	1.055
20	338,165,718	360,459,209	22,293,491	1.066
30	133,868,487	136,627,771	2,759,284	1.021
40	753,546,133	778,443,497	24,897,363	1.033
50	302,549,444	322,433,621	19,884,177	1.066
60	160,122,543	164,937,575	4,815,032	1.030
70	329,618,886	350,243,159	20,624,273	1.063
80	936,956,318	986,957,614	50,001,296	1.053
90	270,246,065	284,108,267	13,862,202	1.051
100	484,070,859	484,070,859	-	1.000
TOTAL	**5,258,434,182**	**5,503,333,815**	**244,899,633**	

6.3.4 Adjustment Summary

The City's BCE of $5.258 billion (YOE) includes $890.97 million in allocated contingency, $270.25 million in unallocated contingency, and $484.07 million in finance charges. This equates to 32% contingency, and its adequacy is addressed in Section 9.0. The BCE appears to also have some latent contingency, but the amount cannot be easily quantified at this stage of the project because the SCC line items are based primarily on CERs. To condition the BCE, the PMOC identified the following adjustments:

- Line Item Adjustments – $193.58 million (YOE)
- Excise Tax Adjustment – $81.04 million (YOE)
- Escalation Adjustment – $198.70 million (YOE), based on a rate of 4.85% in 2009, 4.25% for 2010 through 2015, and 2.8% for 2016 through 2019

The input for the Cost Risk Model (Section 8.0) and basis for the evaluation of project cost contingency (Section 9.0) is the Adjusted BCE. To develop the Adjusted BCE, the following steps were taken:

- Start with City's BCE (YOE) – $5,258,434,182
- Strip YOE allocated and unallocated contingency – $1,161,213,774

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- Deduct YOE financing costs – $484,070,859
- Apply PMOC YOE adjustments as outlined above – $473,324,630
- Result is an Adjusted BCE (YOE) of $4.086 billion

Table 6-15. PMOC Adjustments and Cost Risk Model Input

		Risk Assessment Model Input					
		YOE	PMOC Adjustments				Adjusted
SCC	Description	w/o Contingency	Line Item	Excise Tax	Escalation	Total	Total
10	**Guideway & Track Elements (Route Miles)**	**1,271,069,538**	**0**	**27,299,654**	**71,872,551**	**99,172,205**	**1,370,241,743**
10.01	Guideway: At-grade exclusive right-of-way	0	0	0	0	0	0
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	0	0	0	0	0	0
10.03	Guideway: At-grade in mixed traffic	0	0	0	0	0	0
10.04	Guideway: Aerial structure	1,113,971,014	0	23,925,538	62,989,425	86,914,963	1,200,885,977
10.05	Guideway: Built-up fill	0	0	0	0	0	0
10.06	Guideway: Underground cut & cover	0	0	0	0	0	0
10.07	Guideway: Underground tunnel	0	0	0	0	0	0
10.08	Guideway: Retained cut or fill	6,616,908	0	142,116	374,153	516,269	7,133,177
10.09	Track: Direct fixation	138,916,339	0	2,983,604	7,855,016	10,838,620	149,754,959
10.10	Track: Embedded	0	0	0	0	0	0
10.11	Track: Ballasted	0	0	0	0	0	0
10.12	Track: Special (switches, turnouts)	11,565,276	0	248,396	653,958	902,353	12,467,630
10.13	Track: Vibration and noise dampening	0	0	0	0	0	0
20	**Stations, Stops, Terminals, Intermodals**	**274,700,941**	**0**	**5,899,945**	**18,498,544**	**24,398,489**	**299,099,430**
20.01	At-grade station, stop, shelter, mall, terminal, platform	0	9,184,426	197,260	618,485	10,000,171	10,000,171
20.02	Aerial station, stop, shelter, mall, terminal, platform	208,361,018	(9,184,426)	4,277,856	13,412,684	8,506,114	216,867,132
20.03	Underground station, stop, shelter, mall, terminal, platform	0	0	0	0	0	0
20.04	Other stations, landings, terminals: Intermodal, ferry, trolley, etc.	0	0	0	0	0	0
20.05	Joint development	0	0	0	0	0	0
20.06	Automobile parking multi-story structure	0	0	0	0	0	0
20.07	Elevators, escalators	66,339,923	0	1,424,829	4,467,374	5,892,204	72,232,126
30	**Support Facilities: Yards, Shops, Admin. Bldgs.**	**108,744,906**	**0**	**2,335,591**	**2,289,580**	**4,625,171**	**113,370,077**
30.01	Administration Building: Office, sales, storage, revenue counting	18,628,822	0	400,104	392,222	792,327	19,421,149
30.02	Light Maintenance Facility	0	0			0	0
30.03	Heavy Maintenance Facility	90,116,083	0	1,935,486	1,897,358	3,832,845	93,948,928
30.04	Storage or Maintenance of Way Building	0	0		0	0	0
30.05	Yard and Yard Track	0	0		0	0	0
40	**Sitework & Special Conditions**	**584,241,866**	**119,433,926**	**15,113,340**	**23,748,983**	**158,296,248**	**742,538,115**
40.01	Demolition, Clearing, Earthwork	27,599,732	0	592,779	931,488	1,524,267	29,123,999
40.02	Site Utilities, Utility Relocation	321,546,608	119,433,926	9,471,249	14,883,046	143,788,221	465,334,828
40.03	Haz. mat'l, contam'd soil removal/mitigation, ground water treatments	11,033,041	0	236,964	372,364	609,328	11,642,370
40.04	Environmental mitigation, e.g. wetlands, historic/archeologic, parks	11,257,430	0	241,784	379,937	621,721	11,879,151
40.05	Site structures including retaining walls, sound walls	0	0			0	0
40.06	Pedestrian / bike access and accommodation, landscaping	0	0			0	0
40.07	Automobile, bus, van accessways including roads, parking lots	212,805,055	0	4,570,564	7,182,148	11,752,712	224,557,767
40.08	Temporary Facilities and other indirect costs during construction	0	0	0	0	0	0
50	**Systems**	**245,768,900**	**0**	**5,278,551**	**16,499,359**	**21,777,911**	**267,546,811**
50.01	Train control and signals	40,827,955	0	876,891	2,740,929	3,617,820	44,445,775
50.02	Traffic signals and crossing protection	30,127,836	0	647,077	2,022,591	2,669,668	32,797,503
50.03	Traction power supply: substations	52,885,063	0	1,135,850	3,550,367	4,686,216	57,571,279
50.04	Traction power distribution: catenary and third rail	81,144,644	0	1,742,801	5,447,535	7,190,335	88,334,979
50.05	Communications	24,659,969	0	529,639	1,655,513	2,185,153	26,845,122
50.06	Fare collection system and equipment	4,969,929	0	106,743	333,649	440,392	5,410,321
50.07	Central Control	11,153,505	0	239,552	748,775	988,327	12,141,832
CONSTRUCTION SUBTOTAL (10 - 50)		**2,484,526,151**	**119,433,926**	**55,927,081**	**132,909,017**	**308,270,024**	**2,792,796,175**
60	**ROW, Land, Existing Improvements**	**106,748,362**	**0**	**2,292,710**	**3,278,965**	**5,571,675**	**112,320,037**
60.01	Purchase or lease of real estate	104,810,770	0	2,251,095	3,219,449	5,470,543	110,281,314
60.02	Relocation of existing households and businesses	1,937,592	0	41,615	59,517	101,132	2,038,723
70	**Vehicles**	**265,821,682**	**33,412,366**	**5,709,239**	**19,080,319**	**58,201,925**	**324,023,607**
70.01	Light Rail	0	0	0	0	0	0
70.02	Heavy Rail	236,126,707	30,374,879	5,071,459	16,992,341	52,438,679	288,565,387
70.03	Commuter Rail	0	0	0	0	0	0
70.04	Bus	0	0	0	0	0	0
70.05	Other	0	0	0	0	0	0
70.06	Non-revenue vehicles	6,082,304	3,037,488	130,634	388,744	3,556,866	9,639,169
70.07	Spare parts	23,612,671	0	507,146	1,699,234	2,206,380	25,819,051
80	**Professaonal Services**	**756,053,354**	**40,733,537**	**17,113,152**	**43,434,317**	**101,281,006**	**857,334,360**
80.01	Preliminary Engineering	75,605,336	4,585,389	1,722,313	4,371,344	10,679,045	86,284,381
80.02	Final Design	113,408,003	6,878,083	2,583,469	6,557,015	16,018,568	129,426,571
80.03	Project Management for Design and Construction	138,609,782	8,406,546	3,157,573	8,014,130	19,578,249	158,188,031
80.04	Construction Administration & Management	252,017,785	15,284,629	5,741,042	14,571,145	35,596,817	287,614,601
80.05	Professional Liability and other Non-Construction Insurance	37,802,667	2,292,694	861,156	2,185,672	5,339,522	43,142,190
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	37,802,667	2,292,694	861,156	2,185,672	5,339,522	43,142,190
80.07	Surveys, Testing, Investigation, Inspection	12,600,889	764,231	287,052	728,557	1,779,841	14,380,730
80.08	Start up	88,206,225	229,269	1,899,391	4,820,781	6,949,442	95,155,667
SUBTOTAL (10 - 80)		**3,613,149,549**	**193,579,830**	**81,042,181**	**198,702,619**	**473,324,630**	**4,086,474,178**
90	**Unallocated Contingency**	**0**	**0**	**0**	**0**	**0**	**0**
SUBTOTAL (10 - 90)		**3,613,149,549**	**193,579,830**	**81,042,181**	**198,702,619**	**473,324,630**	**4,086,474,178**
100	**Finance Charges**	**484,070,859**	**0**	**0**	**0**	**0**	**484,070,859**
TOTAL PROJECT COST (10 - 100)		**4,097,220,408**	**193,579,830**	**81,042,181**	**198,702,619**	**473,324,630**	**4,570,545,038**

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6.4 Conclusion

In general, the PMOC has found that the current available cost estimate is reasonable and acceptable for a project in the Pre-PE phase. The following specific observations are provided and should be addressed once the Project is advanced to PE.

(1) The PMOC's review of the City's project cost estimate concludes the estimate is not mechanically correct in some instances but is essentially consistent with the project scope identified in the DEIS, although it is not entirely free of inaccuracies.

(2) The PMOC has characterized the project cost data as an AACE "Class 4" estimate due to its mostly parametric nature. The PMOC derived the data elements based on a professional judgment from other projects.

(3) As noted herein, the PMOC identified a ~~significant~~ risk associated with the cost estimate General Conditions based on a lack of definition.

(4) The PMOC found a ~~significant~~ understatement of costs with regards to the Excise Tax value included in the Estimate.

(5) The PMOC found a shortfall in the value calculated for the Public Utility relocations as a result of not including all costs from the base *1992 Original Estimate*.

(6) The Project staff noted in the September 2008 Risk Assessment Workshop that the Private Utilities would be fully funded by Project. However, the *2007 MK Utility Estimate* that was used to prepare the *2008 SCC Estimate* was reduced by 15% to account for "suspected franchise agreements" with the utility owners.

(7) The PMOC found the percentages used by the City for escalation in their *2008 SCC Estimate* are too conservative.

6.5 Recommendations

(1) The PMOC recommends that the City prepare a detailed bottoms-up estimate during early PE. In addition, they should perform quality assurance checks to verify scope inclusivity and that SCC categories are escalated in accordance with the Master Project Schedule. The cost estimate and Basis of Estimate should provide more justification and backup documentation supporting the quantification and assumptions for the "soft costs" and related General Conditions for the project.

(2) The PMOC recommends the City develop a separate cost estimate (or detail assembly) for the General Excise Tax and/or Use Tax. The City should follow the current excise tax requirements for calculation of the value ~~It is recommended~~

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~~that an approach similar to that used for the 1992 Original Estimate be used that assesses these taxes against the entire contract value.~~

(3) The PMOC recommends the City recalculate the parametric values for the unit costs they have included for Relocation and Removal of the Public Utilities in their 2008 SCC Estimate and adjust their budget accordingly.

(4) The PMOC recommends the City investigate the suspect parametric quantities in the Systems Estimate (SCC 50) that do not sum to a whole number.

(5) The PMOC recommends the City increase their estimate to include the 15% reduction removed from the Private Utility SCCs as a result of the franchise sharing agreement as this is in direct contradiction to their contracting strategy as explained in the September 2008 Risk Assessment Workshop.

(6) The PMOC recommends the City recalculate the values for soft costs once the above adjustments are made to their estimate.

(7) The PMOC recommends the City reconsider the values utilized for escalation to develop the Year of Expenditure costs for their 2008 SCC Estimate, and to incorporate the likelihood that escalation will be high for the next several years as a result of the recent global financial crisis.

7.0 SUBTASK 34A: PROJECT SCHEDULE REVIEW

7.1 Methodology

The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #34: Project Schedule Review procedures,* dated March 29, 2007 to assess and evaluate the City's project schedule.

Jacobs has developed and refined a standard Technical Schedule Review (TSR) report format based on senior program management experience, the evolution of scheduling software packages, and program experience on other federal programs. The TSR provides a standard reporting format for various types of schedules such as design schedules, construction schedules and Master Integrated Program Schedules. In addition, the TSR reviews the contractual requirements set by the project sponsor and evaluates the overall program user(s) conformance of schedule management execution.

The review of the Project schedule addresses seven subcategories as identified in the PG-34 (Subtask 34A):

- Schedule
- Technical Review
- Resource Loading
- Project Calendars
- Interfaces
- Project Critical Path
- Critical Areas of Concern

The TSR categories characterize each element in the project/program schedule, from schedule development, performance measurement, through post project archive record documentation. Jacobs tailored the TSR format to better synchronize with the PG-34A. The result is a combination of the PG-34 plus additional review categories contained in the "Technical Review" subcategory, listed above. The schedule review will evaluate the efficiency and effectiveness of the project sponsor's project implementation during any phase of the project life cycle. According to the PG-34, the schedule review will also:

> *"...evaluate the completeness, consistency, and adequacy of the project sponsor schedule and make recommendations to the project sponsor on redirecting or reprioritizing its efforts to correct the inadequately defined areas."*

The schedule review also validates the inclusivity of the Project scope and characterizes individual project elements within the current Project phase. It also validates the program management's readiness to enter and implement the next major program phase, the PE phase. The report findings result in a compilation of tabular and graphical reports and conclude with a list of PMOC recommendations for Project sponsor action.

The PMOC used the meeting notes, files, reports and documents identified in Appendix B to support the Schedule Review.

7.2 Review and Analysis of Project Schedule

7.2.1 Schedule Review

The City submitted a proposed construction schedule titled "HHCTP As of August 25.xer" in early August 2008. The PMOC conducted a preliminary schedule review and produced a list of comments to the City during the September 2008 Risk Assessment Workshop. The City incorporated most of the PMOC comments in a revised schedule, titled "CITY.PRX", on September 20, 2008. The PMOC schedule review is based on the revised MPS file "CITY.PRX". The schedule technical data and summary dates are included in the Table 7-1 and Table 7-2, and the Summary Schedule is shown as Figure 7-1.

Table 7-1. Schedule Summary

Schedule Item	MPS
Number of activities	202
Number of activities in longest path	16
Started activities	0
Completed activities	0
Number of relationships	322
Percent complete	0 %
Number of hammocks	1
Number of early constraints	3
Number of late constraints	2
Number of mandatory constraints	1
Data date	September 15, 2008
Start date	September 15, 2008
Imposed finish date	N/A
Latest calculated early finish	December 18, 2018

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Table 7-2. Summary Schedule Dates

Description	Start Date	Finish Date
Preliminary Engineering		
PE Request thru FTA Approval	15SEP08	31DEC08
PE thru ROD	31DEC08	28AUG09
Design Build Procurement		
MSF (thru issuance of NTP)	16SEP08	01MAR10
Guideway (thru issuance of NTP)	16SEP08	17JAN10
Systems (thru issuance of NTP)	16SEP08	24APR10
Final Design		
Final Design (FD) Request thru FTA Approval	24APR09	05JAN09
Full Funding Grant Agreement (FFGA)		
Application thru Approval	24APR09	26FEB11
Construction		
Start	20DEC09	
Vehicle (Design/Manufact./Deliver/Test/Commission)	25APR10	18DEC18
System (Design/Manufact./Install/Test/Commission)	25APR10	18DEC18
Open Farrington Section		15DEC12
Open East Kapolei Pearl Highlands		16APR14
Open to Aloha Stadium		26MAR17
Open to Ala Moana Center		18DEC18

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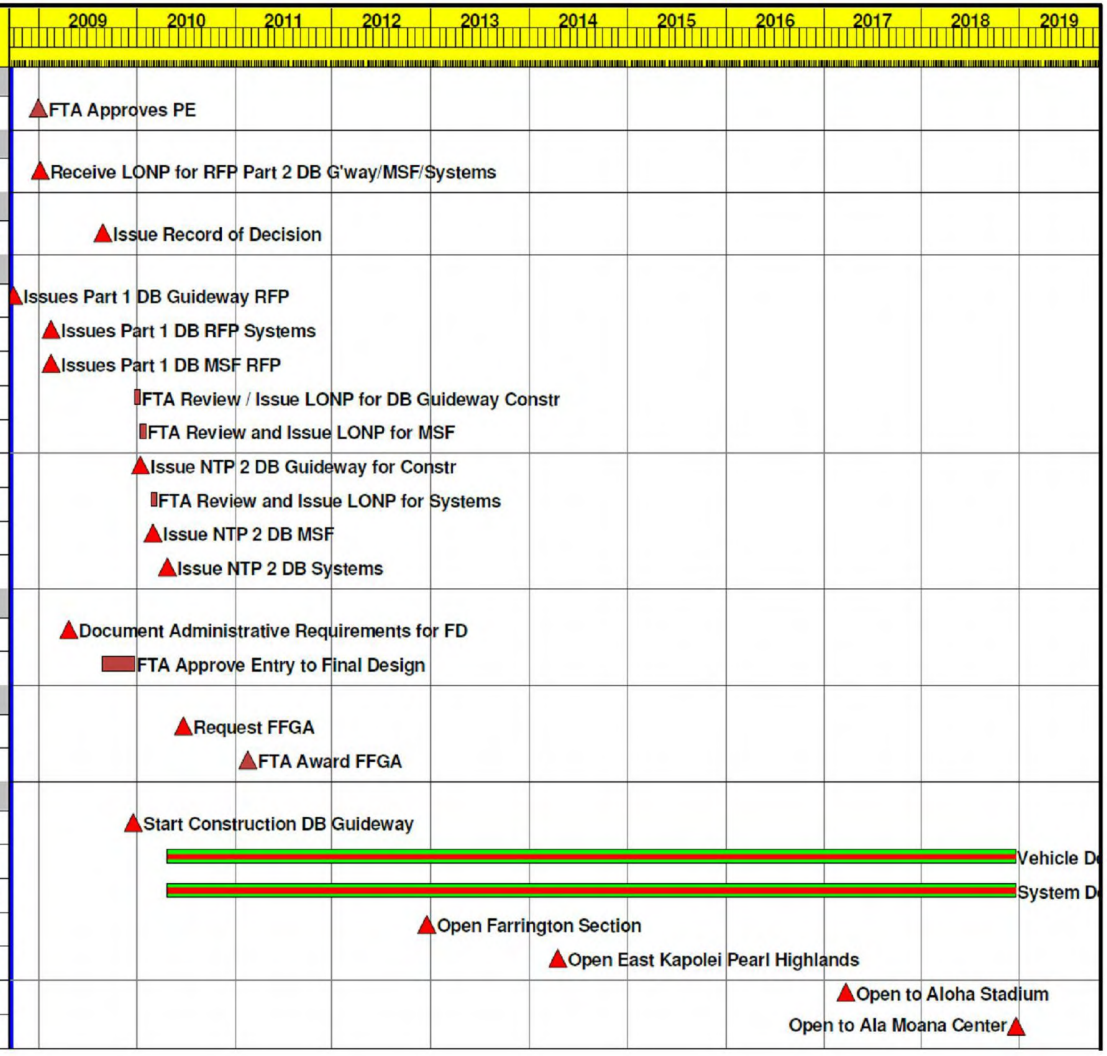
Figure 7-1. Summary Schedule

Activity Description	Orig Dur	Early Start	Early Finish
READINESS FOR PELIMINARY ENGINEERING			
FTA Approves PE	0	31DEC08	
ADVANCED CONCEPTUAL ENGINEERING			
Receive LONP for RFP Part 2 DB	0	05JAN09	
EIS & PRELIMINARY ENGINEERING			
Issue Record of Decision	0		28AUG09
DB PROCUREMENT			
Issues Part 1 DB Guideway RFP	0	30SEP08	
Issues Part 1 DB RFP Systems	0	13FEB09*	
Issues Part 1 DB MSF RFP	0	13FEB09*	
FTA Review / Issue LONP for DB Guideway Constr	21	27DEC09	16JAN10
FTA Review and Issue LONP for MSF	21	15JAN10	04FEB10
Issue NTP 2 DB Guideway for Constr	0	17JAN10	
FTA Review and Issue LONP for Systems	21	24FEB10	16MAR10
Issue NTP 2 DB MSF	0	01MAR10	
Issue NTP 2 DB Systems	0	25APR10	
READINESS FOR FINAL DESIGN			
Document Administrative Requirements for FD	0	25APR09	
FTA Approve Entry to Final Design	120	29AUG09	26DEC09
FULL FUNDING GRANT AGREEMENT			
Request FFGA	0	25JUN10	
FTA Award FFGA	0	20FEB11	
CONSTRUCTION & RELATED ACTIVITIES			
Start Construction DB Guideway	0	20DEC09	
Vehicle Design/Manufacture/Test/Commission	3,160	25APR10	18DEC18
System Design/Manufacture/Instal/Test/Commission	3,160	25APR10	18DEC18
Open Farrington Section	0	15DEC12*	
Open East Kapolei Pearl Highlands	0		16APR14
Open to Aloha Stadium	0		26MAR17
Open to Ala Moana Center	0		18DEC18



The following section includes schedule review categories as listed in the PG-34. In accordance to the PG-34 Subtask 34A, the following eighteen (18) categories address the PMOC's opinions noting exceptions and recommendations. Categories 12 thru 18 relate to the schedule review of "sound engineering practices".

(1) The structure of the schedule and its soundness in terms of identified activities, durations, sequencing, and float.

The schedule structure refers to the integrity of the elemental components that make-up a schedule: Work Breakdown Structure (WBS), activities, activity elements, activity relationships, activity float and criticality.

Work Breakdown Structure

Work Breakdown Structure (WBS) is a sorting and organization of project-specific information (budget, cost and schedule) usually determined by the owner. A WBS is defined by activity code or WBS fields in the scheduling software. A MPS that is comprised of multiple subprojects must contain a standardized WBS or activity code structure. Many times WBS or activity code fields are established by the owner and supplied to the schedule users, especially if multiple consultants or contractors are sharing the same program wide WBS. Summary activity grouping such as "hammocking" is frequently used for upwards Level-1 reporting and provides an easy way to sort large groupings of activities in schedules containing hundreds or thousands of activities.

The primary function of the WBS is to clearly identify and illustrate the major areas of work for the Project. It also distinguishes multiple projects (contracts) within a MPS. Such areas of work include but are not limited to:

- Environmental Mitigation
- Right of Way Acquisition and Relocation
- Utility Relocations
- Planning / PE / Final Design / Construction / Startup & Testing / Closeout
- Individual Contract or Project Packaging
- Geographical Areas or Areas by Responsibility
- Procurement for Professional Services
- Material and Equipment Procurement

Each of these categories will be addressed and refined as the Project continues into the PE and Final Design phases.

The following verifications were used to review and evaluate the WBS:

- Verification that the project scope is adequately represented by a sufficient amount of detailed tasks (schedule activities). Major activities and summary level items include rights-of-way; third party coordination (utilities, businesses, communities, related agencies, and related stakeholders), contract packaging strategies, work in place, material procurements, materials in and out of the project (debris and soil hauling, muck, etc.).

- Verification of contract packaging strategies, traceability of schedule organization and structure utilizing activity coding and filtering capability for reporting.

The MPS contains one hammock activity for "New Starts Preliminary Engineering". The MPS can be summarized by the activity code structure. The activity code structure contains the following categories for sorting purposes:

- AREA
  - General
  - West Oahu
  - Farrington
  - West Oahu/Farrington
  - Maintenance Storage Facility
  - Kamehameha
  - Salt Lake
  - City Center
  - Guideway
  - Systems

- ITEM NAME
  - Guideway
  - System
  - MSF
  - Station

- STEP
  - Readiness for Preliminary Engineering
  - Advanced Conceptual Engineering
  - EIS & Preliminary Engineering
  - DB procurement
  - Readiness for Final Design
  - Construction & related Activities
  - Construction

The activity code library in the scheduling software is incomplete, but the schedule does have enough of the code structure completed to produce a meaningful WBS. The current MPS can be summarized by major work element or contract as illustrated in Figure 7-2 though more sorting and summary capability remains to be completed.

The MPS activity detail is sufficient to determine the type of work that is being performed; however, it does not provide the detail to determine all of the specific elements of work or specific locations of work. Likewise the interdependencies among various work areas are summary in nature.

Figure 7-2. WBS

Activity Description	Orig Dur	Early Start	Early Finish
READINESS FOR PELIMINARY ENGINEERING			
+			
	106	16SEP08	30DEC08
ADVANCED CONCEPTUAL ENGINEERING			
+			
	137	16SEP08	30JAN09
EIS & PRELIMINARY ENGINEERING			
+			
	467	16SEP08	26DEC09
DB PROCUREMENT			
+ Maintenance Storage Facility			
	531	16SEP08	28FEB10
+ Guideway			
	488	16SEP08	16JAN10
+ Systems			
	586	16SEP08	24APR10
READINESS FOR FINAL DESIGN			
+			
	467	16SEP08	26DEC09
FULL FUNDING GRANT AGREEMENT			
+			
	674	24APR09	26FEB11
CONSTRUCTION & RELATED ACTIVITIES			
+ General			
	3,746	16SEP08	18DEC18
+ West Oahu			
	1,979	15NOV08	16APR14
+ Farrington			
	2,033	16SEP08	10APR14
+ West Oahu/Farrington			
	1,218	15NOV08	16MAR12
+ Maintenance Storage Facility			
	1,971	15NOV08	08APR14
+ Kamehameha			
	3,054	15NOV08	26MAR17
+ Salt Lake			
	3,652	15NOV08	14NOV18
+ City Center			
	3,615	15NOV08	08OCT18

Activities

Each schedule activity, at a minimum consists of the following elements:

- Activity Identification (ACT ID) Number
- Activity Description
- Activity Type – Explains what kind of activity it is (work task, milestone, hammock, etc.)
- Activity Duration
- Activity Predecessor and Successor
- Some activities contain constraint dates (see Schedule Run Report)

The MPS contains 202 activities, 34 of which are milestones. The MPS contains one hammock activity. The activity descriptions are clear and adequately describe the work task. The small amount of activities addresses scope inclusivity on a summary level for a project of such large scope and magnitude.

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Durations

The City provided a Basis of Schedule at the request of the PMOC in order to support the general schedule assumptions. The Basis of Schedule explains the schedule structure, WBS and activity categories, and addresses major assumptions for the aerial bridge structures noting the optimization of two gantry equipment systems. It also explains assumptions for guideway aerial structure activity durations. The major assumptions are listed below:

- 1 crew will install 2 (bent) piers / week,
- Install 2 spans (300 linear foot) / 2 Gantry / week
- Install 1 span (150 linear feet) / 1 Gantry / week
- Installation of 400 Route Feet/ week (Area specific)
- Installation of 300 Route Feet / week (Area specific)

The MPS activities are very summary in nature and therefore generally contain large durations. Sixty-eight (68) of the 202 schedule activities (33% of the total activities) contain a duration greater than 100 days.

Table 7-3. Activity Duration Count

Milestone (0)	1 to 50	51 to 100	100 to 500	500 to 1000	1000 +	Total
34	78	21				133
			44	11	13	68
						201

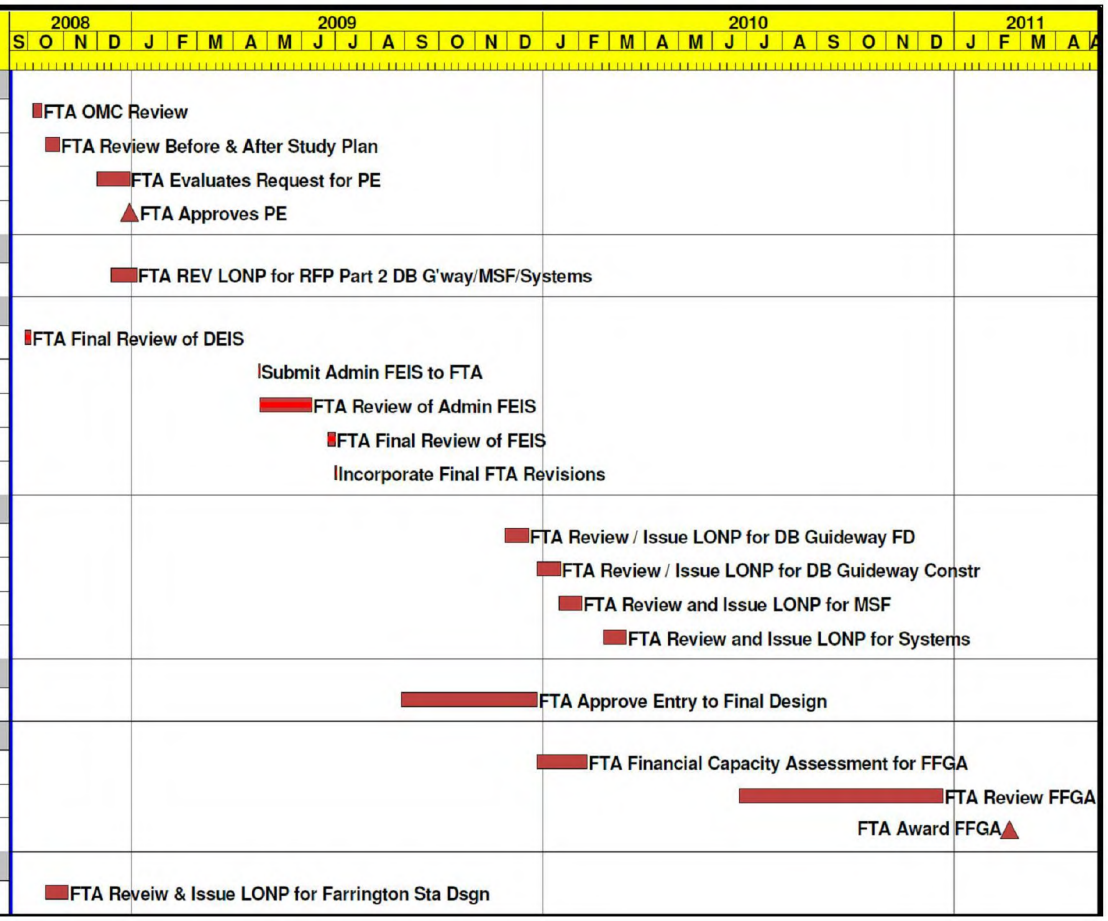
The MPS contains two activities with a duration of 3,160 days. One activity represents rail vehicle procurement/delivery/testing and one activity represents systems integration. The City intends to coordinate systems design and performance specifications with the vehicles as the system will function automatically without train operators. Both activities have zero total float and appear on the critical path.

Figure 7-3 presents those activities associated with FTA review periods. The durations for each activity were estimated by the City. The PMOC and the FTA reviewed these activities and provided a suggested duration ranges for each activity.

The PMOC has determined that some activity durations are still insufficient and some activity durations are excessive. In some cases, the activities are too summary in nature and their durations cannot be adequately evaluated. For instance, the vehicles and system integration technology scopes are not definitive. The PG-40B section addresses each activity duration and criticality index through a Monte Carlo simulation. This simulation accounts for the most probable critical path and generates a probability curve for different project completion scenarios accounting for the variances in activity durations.

Figure 7-3. FTA Participation Activities

Activity Description	Orig Dur	Early Start	Early Finish
READINESS FOR PELIMINARY ENGINEERING			
FTA OMC Review	7	06OCT08	12OCT08
FTA Review Before & After Study Plan	14	16OCT08	29OCT08
FTA Evaluates Request for PE	30	01DEC08	30DEC08
FTA Approves PE	0	31DEC08	
ADVANCED CONCEPTUAL ENGINEERING			
FTA REV LONP for RFP Part 2 DB	21	15DEC08	04JAN09
EIS & PRELIMINARY ENGINEERING			
FTA Final Review of DEIS	5	29SEP08	03OCT08
Submit Admin FEIS to FTA	1	24APR09	24APR09
FTA Review of Admin FEIS	46	25APR09	09JUN09
FTA Final Review of FEIS	5	24JUN09	30JUN09
Incorporate Final FTA Revisions	2	01JUL09	02JUL09
DB PROCUREMENT			
FTA Review / Issue LONP for DB Guideway FD	21	29NOV09	19DEC09
FTA Review / Issue LONP for DB Guideway Constr	21	27DEC09	16JAN10
FTA Review and Issue LONP for MSF	21	15JAN10	04FEB10
FTA Review and Issue LONP for Systems	21	24FEB10	16MAR10
READINESS FOR FINAL DESIGN			
FTA Approve Entry to Final Design	120	29AUG09	26DEC09
FULL FUNDING GRANT AGREEMENT			
FTA Financial Capacity Assessment for FFGA	45	27DEC09	09FEB10
FTA Review FFGA	180	25JUN10	21DEC10
FTA Award FFGA	0	20FEB11	
CONSTRUCTION & RELATED ACTIVITIES			
FTA Reveiw & Issue LONP for Farrington Sta Dsgn	21	16OCT08	05NOV08



Sequencing
The PMOC generated a Schedule Run Report (see schedule review category (18) "Mechanical correctness and completeness" for discussion). The Schedule Run Report verifies the absence of "open-ended" activities (missing relationship links), which is a fundamental soundness check. A critical path is partially discernible and the schedule activities flow in a logical and time-scaled descending manner.

Float
The CPM network contains 201 task activities and 1 hammock activity. Many activities and logic paths exhibit positive float. Of the 201 task activities, 48 activities contain a total float greater than 99 days, as summarized in the Table 7-4.

Table 7-4. Activity Total Float Count

< than 1	1 to 19	20 to 49	50 to 99	100 to 500	500 to 1000	1000 +	Total
35	60	33	25				153
				35	4	9	48
							201

The MPS does not contain an excessive amount of float and the critical path is discernible. The MPS also includes a reasonable amount of "near critical paths" for activities containing float less than 20 days.

PMOC Finding
The PMOC has determined the MPS structure is fundamentally sound but recommends detail on the specific elements, locations of work, and interdependencies among work areas be expanded and incorporated into the MPS. MPS revisions are needed but can be addressed during the PE phase.

(2) The reasonability of logic with respect to physical construction constraints.

The MPS was developed with some consideration of physical construction constraints such as construction of the aerial guideway structure, and the relocation, adjustment and installation of utilities in the narrow street limits of the alignment. More detail related to traffic control, material storage and handling, working adjacent to waterways, and operational adjacencies to third party businesses is needed and will understandably evolve as more project scope and definition is refined during the PE and Final Design phases.

The Project Development Plan, Project Execution Plan, and Risk Mitigation and Monitoring Plans are good management techniques and tools to support the schedule work plan related to physical construction constraints. A greater level of activity detail and activity duration calculations will be necessary to account for "constraining elements" that inherently adversely impact construction staging and material installation.

PMOC Finding
The MPS remains under development as the Project transitions from the planning phase to the PE phase. The MPS does not completely address physical construction constraints as it is understandably too premature to provide a detailed construction schedule. MPS revisions are needed but can be addressed during the PE phase.

(3) The sequencing is consistent with expected contractor crewing requirements and adequate for efficient or expected contracting methods or packaging strategies.

The MPS and the Basis of Schedule address the proposed design and construction packaging strategy. The WBS also separately identifies construction activity by project segment, which illustrates the sequencing among construction segment procurement and installation. Construction contractor crewing requirements are based on the optimization of two gantry erection systems for construction of the aerial guideway structure. The sequencing will generally proceed in an easterly direction starting at the Farrington/West Oahu segment. The Project consists of five Revenue Operation Dates related to the incremental construction and operational turnover of the five project alignment segments. The schedule WBS is organized and clearly segregated by the Project segments. Optimization of aerial guideway structure gantry equipment seems very intuitive and a very reasonable means and methods approach as most of the project alignment is aerial. The contract procurement process is addressed in detail in schedule review category (15) below.

PMOC Finding
The MPS remains under development as the Project transitions from the planning phase to the PE phase. The MPS does not completely address the construction phase requirements of this PG-34A review category as it is understandably too premature. The MPS does adequately address the City's contract packaging strategies but does not completely address contractor crewing requirements. MPS revisions are needed but can be addressed during the PE phase.

(4) The work area segmentation connected with the planned right-of-way acquisition provides sufficient work area(s) for efficient use of limited resources.

The MPS contains a minimal amount of detail to identify ROW acquisitions and their logical connectivity to the work activity tasks identified in the current MPS. The City is currently developing a ROW Schedule based on 205 partial and full takes currently identified along the proposed alignment. The MPS does contain summary ROW activities separated by project segment, though a significant amount of detail will be needed to better represent the interface of ROW parcels and the sequencing of acquiring temporary and permanent access prior to respective construction work on each parcel.

Since ROW acquisition is critical to the start of a significant portion of work along the alignment, there may be a considerable amount of schedule risk if real estate acquisition activities are delayed. Moreover, the potential for businesses relocations are high schedule risk factors as well as they require lengthy and unpredictable duration efforts.

PMOC Finding
The PMOC has determined the MPS addresses summary right-of-way acquisition tasks but requires a significant amount of more detail. MPS revisions are needed but can be addressed during the PE phase.

(5) Work efforts of similar nature that occur concurrently are identified and reasonably sequenced in the schedule to assure similar work activities can be accomplished with efficient crew sizing.

This category predominately focuses on the construction phase and the optimization of equipment and labor forces for similar and consecutively executed work elements. The aerial guideway structure by far is the best opportunity to optimize economies of scale and related efficiencies with crew sizing. The Basis of Schedule includes logical assumptions for crew sizing and optimization related to pier, bent and aerial structure installation. The MPS construction activities do not address this category in elaborate detail because the Project is in the planning phase.

Moreover, the construction activities are too summary in nature to adequately review and evaluate this category. The MPS is not resource loaded so resource "smoothing", "squeezing", "crunching" and related resource utilization and concurrency analysis cannot be conducted and evaluated.

PMOC Finding
The MPS remains under development as the Project transitions from the planning phase to the PE phase. The MPS does not completely address the construction phase requirements of this PG-34A review category as it is understandably too premature. MPS revisions are needed but can be addressed during the PE phase.

(6) Work durations can be validated from many different perspectives - from the program level; from the contract level; design periods; procurement cycles; time for civil and systems contracts; and finally to the detailed activity durations for performing the work.

PMOC Finding
The MPS remains under development as the project transitions from the planning phase to the PE phase. The MPS does not completely address the construction phase requirements of this PG-34A review category as it is understandably too premature. MPS revisions are needed but can be addressed during the PE phase.

(7) Consistency with the project scope adopted in the Records of Decision (FTA and FAA).

PMOC Finding
The project is currently in the planning phase (pre-PE). The City anticipates that the Record of Decision would be issued around August 2009.

(8) It is logical and appropriately detailed with tasks.

The MPS is fundamentally sound presented in a logical manner through the use of an intuitive WBS and descriptive activity tasks and milestones. As a result of the PMOC's September 2008 request to revise the City's previous MPS, the MPS does now include more detail for the FTA New Starts process including the requirements for readiness to enter PE, EIS & PE, Design/Build contract procurement, Readiness to Enter Final Design, and the Full Funding Grant Agreement process. While the MPS contains more detail for the current planning phase and upcoming PE phase, the revised MPS contains fifty-six activities less than the first MPS the PMOC reviewed in September 2008. The amount of activities in the MPS seems very low considering the enormous scope of the Project with a budget of this magnitude.

PMOC Finding
The PMOC has determined the MPS is represented in a logical manner but lacks activity detail from PE to the startup and testing phases. MPS revisions are needed but can be addressed during the PE phase.

(9) That schedule detail beneath the 'hammock' or summary level is task based, reflecting work elements that are structured by project (i.e., Initial Segment), contract package, phase (e.g., PE, Final Design, Permits, ROW, etc.), tasks and milestones.

The detail below the summary levels generally does provide adequate detail to differentiate between major project segment and contracting areas. The MPS can be sorted by major project phase (PE / Design / Construction / Startup & Testing) and contains a minimal number of milestones for each project element. While the schedule's detail activities represent "task based" work by description and duration, the MPS does not contain resources and therefore does not provide quantification of necessary manpower and equipment resources needed to perform the activity task.

PMOC Finding
The PMOC recommends the City resource load the MPS during the Final Design phase and require all schedule users (design consultants and construction contractors) to provide resource loaded schedules.

(10) Basic Predecessors and Successors are identified for all material tasks.

The MPS does not contain enough detail to identify "material" tasks related to the construction phase. This information will become available as the Project and the MPS progresses during the PE and Final Design phases.

PMOC Finding
The MPS remains under development as the Project transitions from the planning phase to the PE phase. The MPS does not completely address the construction phase requirements of this PG-34A review category as it is understandably too premature. MPS revisions are needed but can be addressed during the PE phase.

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(11) More complex relationships have been developed and input in that tasks are assigned multiple predecessors and successors in order to define more complex task relationships-or schedule integration.

The MPS does not contain many complex or multiple activity relationships. Most of the MPS activities do not contain multiple predecessors or successors as the schedule is predominately linear in nature. The complexity is expected to increase during the PE phase as the Project scope and project documentation in general are refined.

PMOC Finding
The MPS remains under development as the Project transitions from the planning phase to the PE phase. The MPS does not completely address the requirements of this PG-34A review category as it is understandably too premature. MPS revisions are needed but can be addressed during the PE phase.

(12) Float at the critical interfaces, assumed progress rates are identifiable and adequate.

The CPM network contains many activities and logic paths that are exhibiting positive float. The MPS activities are very summary in nature and therefore generally contain large durations. As shown in Table 7-4, forty-eight (48) of the 202 schedule activities (24% of the total activities) contain a duration greater than 100 days.

The MPS does not contain an excessive amount of float and the critical path is partially discernible. The MPS also includes reasonable "near critical paths" for activities containing float of less than one day. Some areas of construction and integration are recognized in the MPS, though the level of detail does not allow for a strong judgment as to activities that have the potential to impact interface areas. For example, separate construction contract coordination for aerial structures, track work, systems and stations do not have detailed relationships and specific tasks identifying critical interface points.

PMOC Finding
The assumed progress rates are not identifiable. Therefore it is difficult to determine their adequacy. The Basis of Schedule does contain some assumptions for work production rates and those schedule activities are identifiable and adequate for this phase of the Project. The MPS remains under development as the Project transitions from the planning phase to the PE phase. The MPS does not completely address the construction phase requirements of this PG-34A review category as it is understandably too premature. MPS revisions are needed but can be addressed during the PE phase.

(13) Embedded contingencies are identified and assessed as adequate relative to project duration.

The MPS contains a minimal amount of activities and logic paths that exhibit positive total float. The positive total float could be considered "contingency" though the City and its consultant stated they have incorporated latent "embedded" contingency in the

activity original durations. The City stated that it \would provide their assumptions for assigning latent contingencies in the activity original durations in its Basis of Schedule. The City's Basis of Schedule submitted to the PMOC on September 23, 2008 does not contain this information.

PMOC Finding

The PMOC has determined some latent contingency exists in many activity durations though has no substantiation or assumptions provided by the City. The City should provide better documentation and substantiation of their activity durations and address the incorporation of latent contingency for all activity durations. MPS revisions are needed but can be addressed during the PE phase.

(14) Schedule contains a full range of activities starting with FTA initiating approvals (DEIS, FEIS, LONP, FFGA), procurement and performance of civil/facilities and systems Final Design, right-of-way acquisition, utility/agency agreements, utility relocation, civil and systems contract procurement, civil and systems construction, agency operations and maintenance mobilization, and integrated pre-revenue testing.

At the request of the PMOC, the City revised and re-submitted their MPS to correct mechanical and fundamental soundness issues. Most of the PMOC's comments were related to the Planning and PE work tasks and required FTA New Starts tasks. The following WBS categories were added to the MPS:

- Readiness for PE
- Advanced Conceptual Engineering
- EIS & Preliminary Engineering
- Readiness for Final Design
- Full Funding Grant Agreement

The MPS revision included more activities to describe the City's request for several Letters of No Prejudice (LONP) for design and construction of the Maintenance Storage Facility, Guideway, Systems, and the Farrington station contracts as illustrated in Figure 7-4.

The MPS revision included more activities to describe the real estate acquisition for each construction contracting segment of the Project as illustrated in Figure 7-5.

The MPS, however, does not include enough detail for utility related tasks (see Figure 7-6). Such tasks include utility agreements, utility coordination and planning, underground utility exploration, relocation, abandonment and installation. The PMOC has identified utilities, in general, as a high risk project element containing significant cost and schedule implications. A significant amount of expanded detail is needed to address the congested utility corridors needing adjustment prior to construction.

The MPS contains one summary activity representing systems integration (train control, traction power, communication and signaling, startup and testing). This activity has a duration of 3,160 days and lacks activity relationships and project element/contract

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interface. Considering this is a starter system extra time and attention will be needed during the testing and startup and operational commissioning of the Project and will require a significant amount of schedule detail as the MPS development continues in the PE phase.

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Figure 7-4. LONP Activities

Activity Description	Orig Dur	Early Start	Early Finish
ADVANCED CONCEPTUAL ENGINEERING			
Prep LONP Request Part 2 DB G'way/MSF/Systems	30	16SEP08	15OCT08
Req LONP for RFP Part 2 DB G'way/MSF/Systems	0	15DEC08	
FTA REV LONP for RFP Part 2 DB	21	15DEC08	04JAN09
Receive LONP for RFP Part 2 DB	0	05JAN09	
DB PROCUREMENT			
Prepare the LONP Request for Systems	30	17SEP09	16OCT09
Prepare the LONP Request for MSF	30	17SEP09	16OCT09
Prepare LONP Request for DB Guideway FD	30	30OCT09	28NOV09
Prepare LONP Request for DB Guideway Constr	30	27NOV09	26DEC09
FTA Review / Issue LONP for DB Guideway FD	21	29NOV09	19DEC09
FTA Review / Issue LONP for DB Guideway Constr	21	27DEC09	16JAN10
FTA Review and Issue LONP for MSF	21	15JAN10	04FEB10
FTA Review and Issue LONP for Systems	21	24FEB10	16MAR10
CONSTRUCTION & RELATED ACTIVITIES			
Prepare LONP Request for Farrington Sta Design	30	16SEP08	15OCT08
FTA Reveiw & Issue LONP for Farrington Sta Dsgn	21	16OCT08	05NOV08

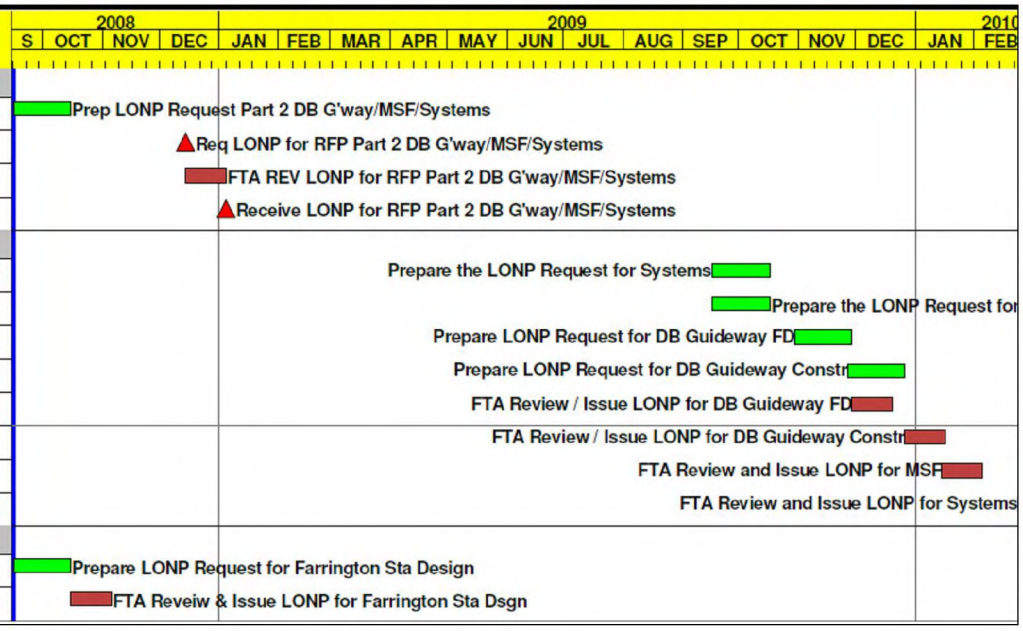


Figure 7-5. Real Estate Activities

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish
CONSTRUCTION & RELATED ACTIVITIES				
I100	Identify ROW Requirements	60	16SEP08	14NOV08
I110	Identify ROW Parcels	0	15NOV08	
I200	ROW West Oahu Station	200	15NOV08	02JUN09
I410	ROW & Relocation Farrington Stations	365	15NOV08	14NOV09
I440	ROW Relo for West Oahu/Farrington Guideway	200	15NOV08	02JUN09
I500	ROW for MSF	180	15NOV08	13MAY09
I600	ROW for Kamehaha Guideway	365	15NOV08	14NOV09
I650	ROW & Relocation for Kamehameha Station	365	15NOV08	14NOV09
I700	ROW & Relocation for Salt Lake Guideway	365	15NOV08	14NOV09
I750	ROW & Relocation for Salt Lake Stations	365	15NOV08	14NOV09
I800	ROW & Relocation for City Center Guideway	365	15NOV08	14NOV09
I850	ROW & Relocation for Kaka'ako Stations	365	15NOV08	14NOV09
I880	ROW & Relocation for City Center Stations	365	15NOV08	14NOV09

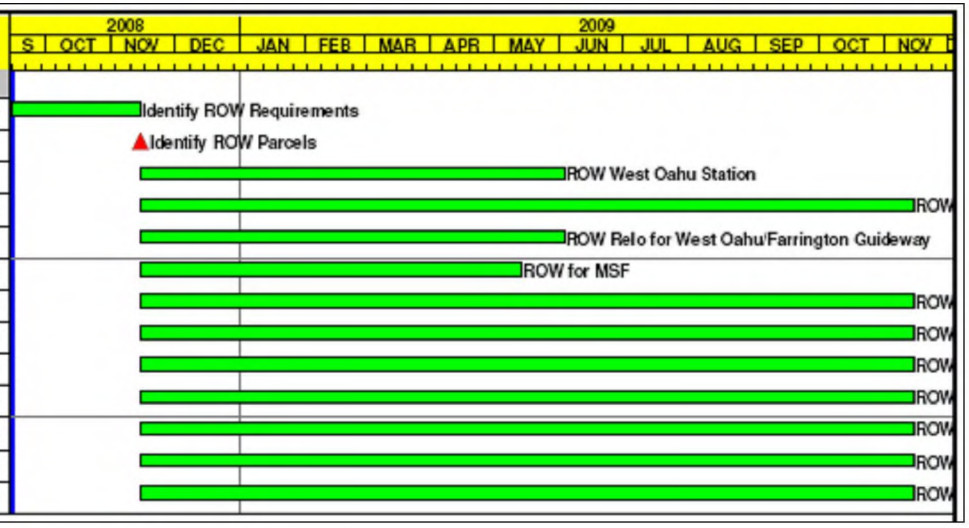
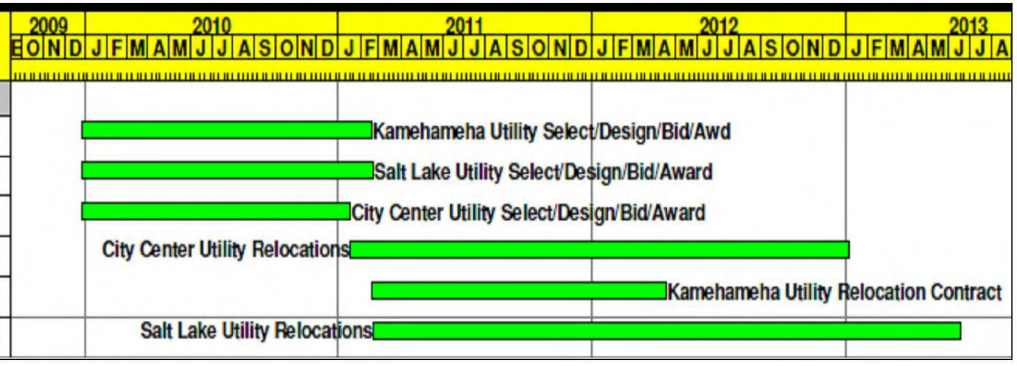


Figure 7-6. Utility Activities

Activity Description	Orig Dur	Early Start	Early Finish
CONSTRUCTION & RELATED ACTIVITIES			
Kamehameha Utility Select/Design/Bid/Awd	418	27DEC09	17FEB11
Salt Lake Utility Select/Design/Bid/Award	420	27DEC09	19FEB11
City Center Utility Select/Design/Bid/Award	386	27DEC09	16JAN11
City Center Utility Relocations	720	17JAN11	05JAN13
Kamehameha Utility Relocation Contract	425	18FEB11	17APR12
Salt Lake Utility Relocations	850	20FEB11	18JUN13



PMOC Finding

The MPS remains under development as the Project transitions from the planning phase to the PE phase. The MPS does not completely address the construction phase requirements of this PG-34A review category as it is understandably too premature. MPS revisions are needed but can be addressed during the PE phase.

(15) Contract procurement processes and durations are adequate and complete.

Figure 7-7 presents all Project Design-Build (DB) contracts. The first operable segment, with a ROD of December 15, 2012, is located at the west end of the Project within the West Oahu/Farrington segments. The City's strategy to use a DB contracting method is based primarily on time savings as they wish to achieve a Minimal Operable Segment as soon as possible. The DB contracts within this segment include construction of the aerial guideway structure and systems. The Maintenance and Storage Facility is also a DB contract as the facility is needed when the first segment becomes operational.

The DB contract procurement method is divided into two parts: Part 1 and Part 2. The City stated Part 1 was similar to a Request for Qualifications process and Part 2 represents the final proposal submission and review process.

The contract procurement delivery method for all project stations and the remaining project segments (Kamehameha, Salt Lake and City Center) guideway construction is DBB as shown in Figure 7-8. However, the contract procurement schedule activities are summarized and do not contain detailed logic strings.

The durations allotted for the contract procurements seem fair and reasonable for the DB two-part process though the PMOC recommends the City provide more justification in the Basis of Schedule for the original duration calculation. The PMOC also recommends the MPS contain a Base or a Resource calendar specifically for Board Meetings requiring contract award or related special actions.

The durations allotted for the station DBB contract procurement contracts cannot be individually evaluated because the summary activities do not provide enough detail for each element within the procurement process (Select/Design/Bid/Award) as illustrated below. However, at the summary level, each contract procurement activity duration appears fair and reasonable.

Figure 7-7. Design-Build Procurement

Activity Description	Orig Dur	Early Start	Early Finish
DB PROCUREMENT			
Maintenance Storage Facility			
Prepare Part 1 DB RFP MSF	14	16SEP08	29SEP08
Prepare Part 2 DB RFP MSF	60	15NOV08	13JAN09
Issues Part 1 DB MSF RFP	0	13FEB09*	
Offerors Prepare DB MSF Response Part 1	45	13FEB09	29MAR09
Offerors Submit DB RFP Part 1 MSF	0	30MAR09	
Evaluate DB MSF Part 1 Submittals	21	30MAR09	19APR09
Submit Part 2 DB RFP MSF to City Council	0	20APR09	
Council Review RFP Specs MSF	30	20APR09	19MAY09
Issues Part 2 DB MSF RFP	0	20MAY09	
Offerors Prepare DB MSF Response Part 2	120	20MAY09	16SEP09
Offerors Submit DB Part 2 MSF	0	17SEP09	
Guideway			
Prepare Part 1 DB RFP Guideway	14	16SEP08	29SEP08
Prepare Part 2 DB RFP Guideway	60	16SEP08	14NOV08
Issues Part 1 DB Guideway RFP	0	30SEP08	
Offerors Prepare DB Guideway Response	45	30SEP08	13NOV08
Offerors Submit DB RFP Part 1 Guideway	0	14NOV08	
Evaluate DB Guideway Part 1 Submittals	21	14NOV08	04DEC08
Submit Part 2 DB RFP Guideway to City Council	0	15NOV08	
Council Review RFP Specs for Guideway	60	15NOV08	13JAN09
Issues Part 2 DB Guideway RFP	0	23JAN09*	
Offerors Prepare DB Part 2 G'way Response & VE	120	23JAN09	22MAY09
Issues PE Addendum Part 2 DB Guideway RFP	0		13FEB09
Offerors Submit DB Part 2 Guideway	0	23MAY09	
Evaluate Offerors Part 2 Submittals (Summary)	160	23MAY09	29OCT09
Select Award & Execute DB Guideway	45	30OCT09	13DEC09
Issue NTP 1 DB Guideway for FD	0	20DEC09	
Systems			
Prepare Part 2 DB RFP Systems	60	16SEP08	14NOV08
Prepare Part 1 DB RFP Systems	14	16SEP08	29SEP08
Issues Part 1 DB RFP Systems	0	13FEB09*	
Offerors Prepare DB Systems Response Part 1	45	13FEB09	29MAR09
Offerors Submit DB RFP Part 1 Systems	0	30MAR09	
Evaluate DB Systems Part 1 Submittals	21	30MAR09	19APR09
Submit Part 2 DB RFP Systems to City Council	0	20APR09	
City Council Review RFP Specs for Systems	30	20APR09	19MAY09
Issues Part 2 DB Systems RFP	0	20MAY09	
Offerors Prepare DB Part 2 Systems Response	120	20MAY09	16SEP09
Issues PE Addendum Part 2 DB Systems RFP	30	19JUN09	18JUL09
Prepare the LONP Request for Systems	30	17SEP09	16OCT09
Offerors Submit DB Part 2 Systems	0	17SEP09	
Evaluate Offerors Part 2 Systems Submittals	160	17SEP09	23FEB10
FTA Review and Issue LONP for Systems	21	24FEB10	16MAR10
Buy America Pre Award Audit	30	24FEB10	25MAR10
Select Award & Execute DB Systems	60	24FEB10	24APR10
Issue NTP 2 DB Systems	0	25APR10	

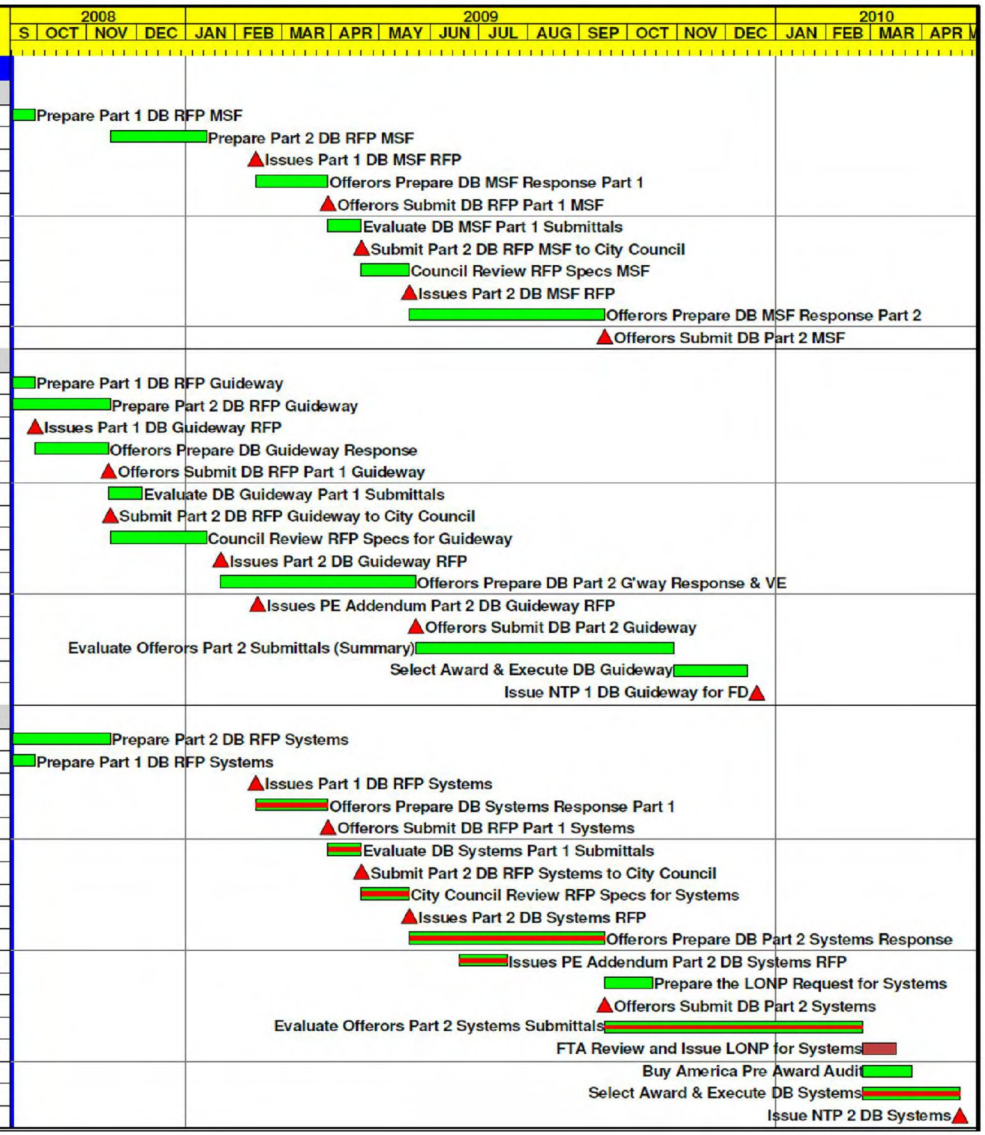
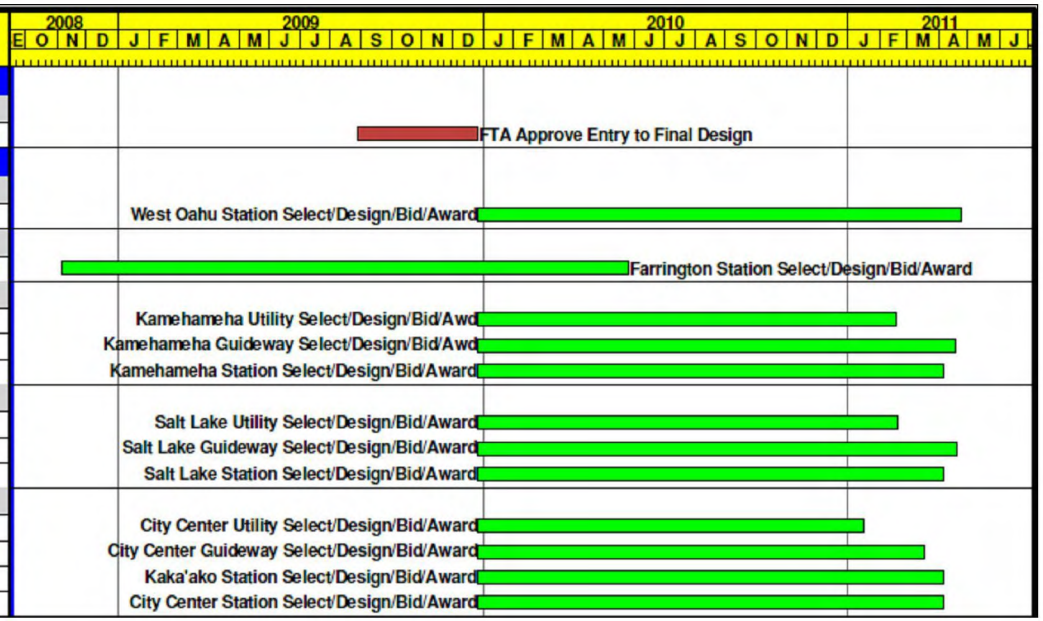


Figure 7-8. Design-Bid-Build Procurement

Activity Description	Orig Dur	Early Start	Early Finish
READINESS FOR FINAL DESIGN			
FTA Approve Entry to Final Design	120	29AUG09	26DEC09
CONSTRUCTION & RELATED ACTIVITIES			
West Oahu			
West Oahu Station Select/Design/Bid/Award	482	27DEC09	22APR11
Farrington			
Farrington Station Select/Design/Bid/Award	567	06NOV08	26MAY10
Kamehameha			
Kamehameha Utility Select/Design/Bid/Awd	418	27DEC09	17FEB11
Kamehameha Guideway Select/Design/Bid/Awd	478	27DEC09	18APR11
Kamehameha Station Select/Design/Bid/Award	466	27DEC09	06APR11
Salt Lake			
Salt Lake Utility Select/Design/Bid/Award	420	27DEC09	19FEB11
Salt Lake Guideway Select/Design/Bid/Award	480	27DEC09	20APR11
Salt Lake Station Select/Design/Bid/Award	466	27DEC09	06APR11
City Center			
City Center Utility Select/Design/Bid/Award	386	27DEC09	16JAN11
City Center Guideway Select/Design/Bid/Award	446	27DEC09	17MAR11
Kaka'ako Station Select/Design/Bid/Award	466	27DEC09	06APR11
City Center Station Select/Design/Bid/Award	466	27DEC09	06APR11



PMOC Finding
The PMOC has determined that the MPS adequately addresses contract procurement processes and the activity durations for the DB contracts but more detail is needed for the station contracts. MPS revisions are needed but can be addressed during the PE phase.

(16) Lead times and durations for equipment and material manufacturing and delivery are adequate and complete.

The MPS does not contain activity detail describing equipment and material procurement except for one activity representing vehicle procurement and one activity representing Systems Integration as described in item number (14) above.

Table 7-5 below identifies all of the Project contracts that require schedule activities identifying the equipment and material procurement process.

Table 7-5. Equipment and Material Procurement Activities

Category	Shop drawings, approvals, material acquisitions	Fabrication	Shipping, Delivery & Storage
Communication & OCC	Not identified	Not identified	Not identified
Fare Collection	Not identified	Not identified	Not identified
Track work	Not identified	Not identified	Not identified
Traction Power	Not identified	Not identified	Not identified
Train Control	Not identified	Not identified	Not identified
Vehicle Procurement	3,160 days for all items related to procurement.		

The procurement process logic string typically contains a minimum of the following activities:

Shop Drawings → Submit for Review and Approval → Mtrl. Acquisition/ Fabrication/Inspect. → Shipping and Delivery → Storage (if necessary) → (ready for installation)

The PMOC recommends a similar logic string be incorporated into each project segment and contract as these are critical to project execution, contain moderate to high risks, and most likely will impact the critical path sometime during the Project.

PMOC Finding
The MPS remains under development as the Project transitions from the planning phase to the PE phase. The MPS does not completely address the construction phase requirements of this PG-34A review category as it is understandably too premature. MPS revisions are required but can be addressed during the PE phase.

(17) Construction work sequencing follows a typical expected work sequence for the mode such as acquire right-of-way; relocate utilities; construct roadway improvements, under-drains, duct banks and catenary pole foundations; construct station platforms and finishes; install track work; install systems components, communications, signals,

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traction electrification and fare collection. However, sequencing consistent with expected contractor crewing requirements may be inadequate for efficient contracting methods.

Most of the elements described in the category are not represented in the proposed construction phase of the MPS primarily because the MPS remains in development and is preliminary in nature. However, each element above should be represented in the MPS at least in summary. Other sections of this report focus on the importance of providing more detail for right-of-way and utility work as they are aligned with early and critical elements of the MPS.

PMOC Finding
The PMOC has determined the MPS does not adequately address the elements in this category and will require a significant amount of expanded detail. MPS revisions are needed but can be addressed during the PE phase.

(18) Mechanical correctness and completeness.

The Schedule Run Report generated by Primavera scheduling software indicates the number of activities in the MPS, the overall percent complete, data date, start date and projected completion date of the schedule, all activities containing constraint dates, activities with "open-ends" having no successor and or predecessor relationship connections, and out-of-sequence progressing. Typically open-ended activities include the first start activity, the last finish activity, and sometimes finish milestone activities. Generally open-ended activities are caused by an oversight where an activity is missing a predecessor or successor. This usually occurs during schedule development and when activity relationships are revised during routine progress updating. Caution should be used during schedule progress updating because a minor oversight can create an unintentional open-ended activity. It only takes one incorrect logic connection, or open-ended activity, to severely undermine the integrity of a schedule. Routine maintenance procedures include the review of open-ended activities to ensure they are properly used and connected to the appropriate relationship chains.

The out-of-sequence progressing is an important indicator because it indicates errors, omissions and other potential problems that can distort milestone dates and general progress information thus affecting the schedule as a whole. Proper activity progress updating and review will prevent out-of-sequence progressing problems. In addition, keeping open-ended activities to a minimal amount is conducive to "good housekeeping" practices and overall a more manageable task during schedule updating. For this reason, many schedule specifications require only the start and end activities can be open-ended.

The critical path can be easily distorted by the excessive use of constraint dates, out-of-sequence progressing, open-ended activities and other improper progress update procedures. A common oversight is the misinterpretation of a schedule's true critical path. Sometimes a schedule calculation caused by the excessive or improper use of constraint dates may adversely impact the critical path software calculation. Consistent

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monitoring of the critical path during progress updates and variance reporting is crucial and reconciled by evaluating the Schedule Run Report.

The following verifications were used to review and evaluate the fundamental soundness:

- Verification of reasonable logic and activity relationships using the Precedence Diagram Method for predecessors and successors
- Schedule Run Report
- Verification that activity constraints are properly identified and used
- Verification that activity relationships are not "open-ended"
- Verification that activities do not contain "out-of-sequence progressing"
- Verification that activity original durations are adequate and justified by basis of schedule assumptions and by resource utilization assumptions
- Characterization of the nature of the project schedule compared to its respective Program

The PMOC generated a Schedule Run Report of the "*CITY.PRX*" MPS. The Schedule Run Report contains sections for constraint listing, open end listing, out-of-sequence progress listing, and schedule statistics (see Figure 7-9).

Figure 7-9. Schedule Run Report

```
Primavera Scheduling and Leveling Calculations -- Scheduling Report Page: 1

 This Primavera software is registered to JACOBS.
 Start of schedule for project CITY.

 User name CHARLES .

 Constraint listing -- Scheduling Report Page: 2

  Activity   Date           Constraint
 ---------- ------- ---------------------------
 A170               Start Milestone
 A190               Start Milestone
 D220               Start Milestone
 E100       16SEP08 Early Start Constraint
 E200               Hammock Activity
 E300               Finish Milestone
 F240               Start Milestone
 F270               Start Milestone
 I110               Start Milestone
 I140               Start Milestone
 I160               Start Milestone
 I160       15DEC12 Mandatory Start Constraint
 I165               Finish Milestone
 I165       20APR14 Late Finish Constraint
 I170               Finish Milestone
 I170       31MAR17 Late Finish Constraint
 I999               Finish Milestone
 N180       31OCT08 Expected Finish Constraint
 N250               Start Milestone
 N270               Start Milestone
 P120               Start Milestone
 P140               Start Milestone
 P160               Start Milestone
 P180               Start Milestone
 P180       23JAN09 Start-On Constraint
 P190               Finish Milestone
 P210               Start Milestone
 P240               Start Milestone
 P290               Start Milestone
 P320               Start Milestone
 P320       13FEB09 Early Start Constraint
 P340               Start Milestone
 P360               Start Milestone
 P380               Start Milestone
 P420               Start Milestone
 P470               Start Milestone
 P620               Start Milestone
 P620       13FEB09 Early Start Constraint
 P640               Start Milestone
 P660               Start Milestone
 P680               Start Milestone
 P700               Start Milestone
 P750               Start Milestone
```

```
Open end listing -- Scheduling Report Page: 3
----------------
Activity          1  has no predecessors
                                          Activity I999       has no successors


Scheduling Statistics for Project CITY:
Schedule calculation mode - Retained logic
Schedule calculation mode - Contiguous activities
Float calculation mode    - Use finish dates
SS relationships          - Use early start of predecessor


       Schedule run on Tue Sep 23 19:14:28 2008
                 Run Number  1426.

      Number of activities..................      202
      Number of activities in longest path..       16
      Started activities....................        0
      Completed activities..................        0
      Number of relationships...............      322
      Percent complete......................      0.0
      Number of hammocks ...................        1
      Number of expected finish activities..        1
      Number of early constraints...........        3
      Number of late  constraints...........        2
      Number of mandatory constraints.......        1
      Number of start-on constraints........        1

      Data date.............................  15SEP08
      Start date............................  15SEP08
      Imposed finish date...................
      Latest calculated early finish........  18DEC18
```

Constraint Dates
The report constraint listing indicates the frequent use of constraint dates, many of which are start milestone constraints. Although the PMOC has determined that the constraint dates have been properly applied and used throughout the MPS, we recommend minimizing the amount of constraint dates used on the MPS to avoid it becoming a maintenance issue that that may inadvertently affect the critical path calculations as the MPS increases in size in future project phases.

Open-Ended Activities
The initial MPS the City submitted to the PMOC, "HHCTP As of August 25.xer" had severe fundamental soundness issues due to the number of open-ended activities. This was the major reason the PMOC requested the City to revise and resubmit the MPS. The revised MPS "City.PRX" Schedule Run Report, listed above, indicates two (2) open-ended activities, the start and completion activities. Therefore no more issues remain with open-ended activities.

Out-of-Sequence Progressing
The Schedule Run Report indicates there are no progressed activities, and therefore, out-of-sequence progressing is non-existent.

PMOC Finding
The PMOC has determined the MPS does not contain fatal flaws or missing activity relationships that undermine the scheduling software calculations. According to the results of the Schedule Run Report, the MPS is mechanically correct. MPS revisions are needed but can be addressed during the PE phase.

7.3 Technical Review

The fundamental element that supports the integrity of a schedule is the internal schedule calendar structure, including the default settings and calculations utilized with the scheduling software. Before a manager can interpret the schedule information generated from schedule reports, a check must be performed to ensure the information in the schedule is fundamentally correct and contains logical activity relationship connections. A fundamental soundness check must be performed after every schedule update to ensure that the information and logic contained in the schedule is correct and properly represent actual work performed. Once the fundamental check is performed, the schedule can be updated and generated reports can be interpreted with confidence.

7.3.1 Requirements, Conformance and Standardization

Requirements refer to the specification and contractual requirements specifically related to the Project. ***Conformance*** refers to the assurance that all parties abide by the contractual specifications and requirements. ***Standardization*** refers to the approach of requiring all scheduling parties to use the same input and output forms so that all reporting information is consistent and "standardized". The requirements and standards are typically set by the owner during the PE and Final Design phases when the project management control systems are completely defined and tailored for the program. Report standardization is crucial for upwards

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and downwards reporting. The data input and output must be standardized, organized and sorted in a consistent and thorough manner so they can be summarized and tailored for the appropriate reporting audiences.

This review element also includes a detailed review and evaluation of the project management control system to determine how efficiently and effectively the procedures are being implemented by the program team. Schedule contractual conformance by all parties is not only a necessity but is paramount to the ongoing avoidance and mitigation of contract modifications, change orders and claims. Contractual conformance commitment by all parties amplified from the top down is essential for a projects successful planning and timely execution.

The following verifications were used to review and evaluate the requirements, conformance and standardization:

- Verification that the project sponsor has established the technical capacity and capability and program management tools (hardware, software and procedures) to develop and maintain a Master Integrated Schedule in order to orchestrate project execution for all phases of the project
- A verification that the project sponsor has developed a CPM schedule specification and standard reporting templates and procedures for the program
- A verification that all parties are executing schedule management in accordance with the project specifications and related contractual requirements

The City began MPS development in early 2007. The Project is currently in the Planning (pre-PE) phase and project CPM schedule specifications and contractual requirements are understandably not yet developed. The PMP does describe, in detail, the various types of schedules to be developed and maintained throughout the Project's life cycle, including:

- Master Project Schedule
- Master Summary Schedule
- Planning Schedule
- ROW Schedule
- Design Schedule(s)
- Construction Schedule(s)
- Startup & Testing Schedule(s)

During the technical capacity and capability assessment, the PMOC determined the City and its PMC were not developing and maintaining the required schedules in accordance with their PMP requirements. While the City's GEC is using a very detailed EIS/PE Planning Schedule, the PMOC discovered that the MPS, Master Summary Schedule and ROW Schedule were not completely developed. The PMOC emphasized the need to develop a baseline MPS in order to better communicate the "project plan" and the necessity to frequently update the "plan" to better measure work progress. The MPS has not been updated (progress status), which therefore, means the City has not utilized the MPS as a baseline to measure work performance against.

<u>PMOC Finding</u>

The PMOC recommends that the City define a consistent WBS, reporting format and update frequency for the current MPS and carry the "standards" over to the design consultants,

construction contractors and vendors to ensure schedule reporting standardization as the Project continues. The PMOC also recommends the City complete ROW Schedule development and enhance the incorporation of the GEC EIS/PE detailed schedule into the MPS. The City should also baseline the MPS and commence monthly progress status update reporting. MPS revisions are needed but can be addressed during the PE phase.

7.3.2 Software Settings

The most powerful schedule management tool is the scheduling software being used. This tool, like all tools, must be used properly. The predominate scheduling software programs such as Open Plan, MS Project and Primavera, all have various program calculation settings allowing the scheduler flexibility with schedule develop, progress, and alternative scenario evaluation. The schedule software contains calculation settings that apply to cost and resource loading, critical path, predecessor and successor logic connectivity, percent complete, cost and resource utilization, and actual work performed. Many, if not all of these settings are crucial for progress update and critical path calculation.

CPM schedule specifications and related contractual requirements seldom address or completely specify which scheduling software setting conditions are required for a given project or program. This oversight may lead to intentional software setting manipulation resulting in favor of the end user. The architect/engineer should incorporate a CPM schedule specification that addresses scheduling software settings when the specifications are developed during the Final Design phase.

Special attention is needed to ensure that schedule calculations accurately generate and not distort schedule calculation data. The scheduling software calculation settings should be monitored to ensure they are consistently used and not randomly changed or manipulated, especially on large programs that require multiple design and or construction schedules.

The following verifications were used to review and evaluate the scheduling software settings:

- Verification that scheduling software settings are properly established by contractual requirements, consistently used, and reviewed by the owner.

The Project sponsor has not yet developed a CPM schedule specification for the program and has not yet established standardized schedule software settings. The current Project schedule does, however, contain the default settings and is acceptable at this time.

The PMOC reviewed the schedule and determined all settings are in compliance to the specification requirements and are consistently used for the schedule update files reviewed by the PMOC. Though the PMOC does not believe the software calculation settings have been manipulated with intent to generate false or unreliable outcomes, the PMOC emphasized that the Project sponsor should establish procedures to review and verify that all required schedule calculation settings are consistently used.

<u>PMOC Finding</u>
The PMOC has determined the MPS is adequately using scheduling software setting in accordance to industry "standard of care" practices. The PMOC recommends the City address

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schedule software settings in the contractual specifications and requirements when applicable during the design and construction phases.

7.3.3 Performance Measurement and Monitoring (Progress Updates)

Work performance measuring is the key to a successful and accurate progress schedule update. Most important is the accuracy of the progress information logged and entered into the schedule ensuring that logical relationships are revised and maintained. Schedule updating is the process of determining the current status of each activity and the overall Project as a whole. Schedule updating first requires an adequate method of measuring and documenting work performance typically managed by field personnel. The information is then recorded by actual start and finish dates, percent complete, resource utilization and unexpected events or field conditions are noted as well. This information is crucial because the schedule software calculation that generates the Project milestone and completion dates relies on work performance measurements and maintenance of logical activity relationships.

The following verifications were used to review and evaluate the progress updates:

- Verification that schedule updates among all parties are performed frequently and conform to the project specifications, requirements and PMP guidelines
- Verification that performance measurement techniques and reporting is adequately implemented and incorporated into the schedule updates. Such examples include earned value, trending, forecasting and activity pacing.
- Verification of Activity Pacing during progress. This is the comparison of original durations versus actual durations to verify the reasonableness of trending and forecasting techniques based on historical work performance measured through earned value analysis
- Verification of dispute avoidance and resolution (mitigation) techniques are a part of the schedule progress update reporting process
- Verification that change management techniques are used to track the schedule update process

The MPS is very dynamic as the scope, schedule and budget continue to be developed and refined as the Project enters the PE phase. The MPS has not been baselined and schedule updates have not been performed. Actual dates and percent complete information is not evident and should be entered for historical purposes.

The MPS has not been updated (progress status), which therefore, means the City has not utilized the MPS as a baseline to measure work performance against. The PMOC recommends the City accurately record progress information in the MPS as this information will provide a valuable historical database for future projects and assist with trending and forecasting analysis.

<u>PMOC Finding</u>
The City should baseline the MPS and commence monthly progress update reporting during the PE phase.

7.3.4 Resource Loading

Cost and resource loading includes the planned utilization of material, labor and equipment resources required to perform the work. The resource library may contain material, labor and or equipment resources a basis for determining and quantifying activity original durations and remaining durations as work is performed, measured and progressed in the schedule, typically interfaced with earned value management. When resources are assigned to an activity, the quantity complete and units per time period of the driving resources determine the activity's duration. In addition the activity resources can be "leveled", "smoothed", "squeezed" or "crunched" as resource utilization, analysis and management decisions are evaluated for remaining work to be performed.

The resource library also may contain budget and cost information. The cost loaded information is generated and submitted with monthly progress updates to support monthly payment requests by the designer and or the construction contractors. An adequately resourced schedule combined with earned value management (backward looking) and trending analysis (forward looking) are prudent schedule control methods especially during the project schedule update process, regardless of the Project phase.

The following verifications were used to review and evaluate the resource utilization:

- Verification of resource planning and utilization for materials, labor, equipment, and third party impacts
- Verification of budget and cost management planning techniques associates with activities or activity groupings related to major program/project components

As shown in Figure 7-10, the MPS resource library contains one resource named "COST". This resource is intended to populate the schedule activities with a budget amount. Some activities have the "COST" resource assigned but none of the activities contain a budget amount. No other resources are used in the MPS.

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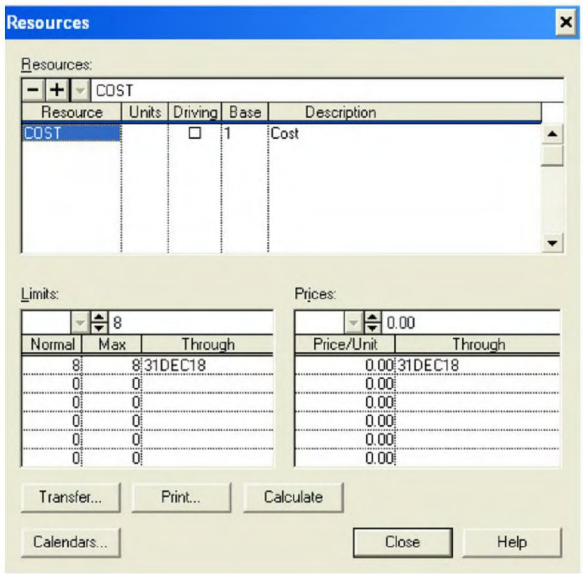
Figure 7-10. Resource Library



PMOC Finding

The PMOC has determined the MPS does not contain a resource library that is cost or resource loaded. The PMOC understands that resource utilization is not prudent at this time as the MPS remains under development and refinement but advocates resource utilization immediately thereafter. The PMOC recommends the City require resource utilization in the various project schedule specifications and related contractual requirements for the design and construction phases. The resource assignments will greatly assist with activity duration calculations, and claim avoidance and mitigation reviews.

7.3.5 Project Calendars

The scheduling software calendar library dictates the number of work periods and non-work periods, usually measured in units of hours or days. The calendar(s) also can be used to incorporate non-work periods such as holidays, weather days, or other seasonal restriction periods such as the installation of temperature sensitive materials. The utilization of multiple calendars is not only practical and necessary during schedule development, but also should be monitored frequently and reviewed to track historical information.

The following verifications were used to review and evaluate the calendar(s):

- Verification of the proper use of a calendar library that adequately addresses the regional weather conditions, imposed seasonal or holiday restrictions, and or temperature sensitive installation of materials, material or subcontractor restrictions, allowances to calculate periods of inefficiencies, etc.

The MPS global structure was reviewed to verify the calendar utilization. As shown in Figure 7-11, the MPS utilizes three (3) Base Calendars and one (1) Resource Calendar for the "Cost" Resource. Base Calendar 1 is 7 work days per week, Base Calendar 2 is 5 work days per week

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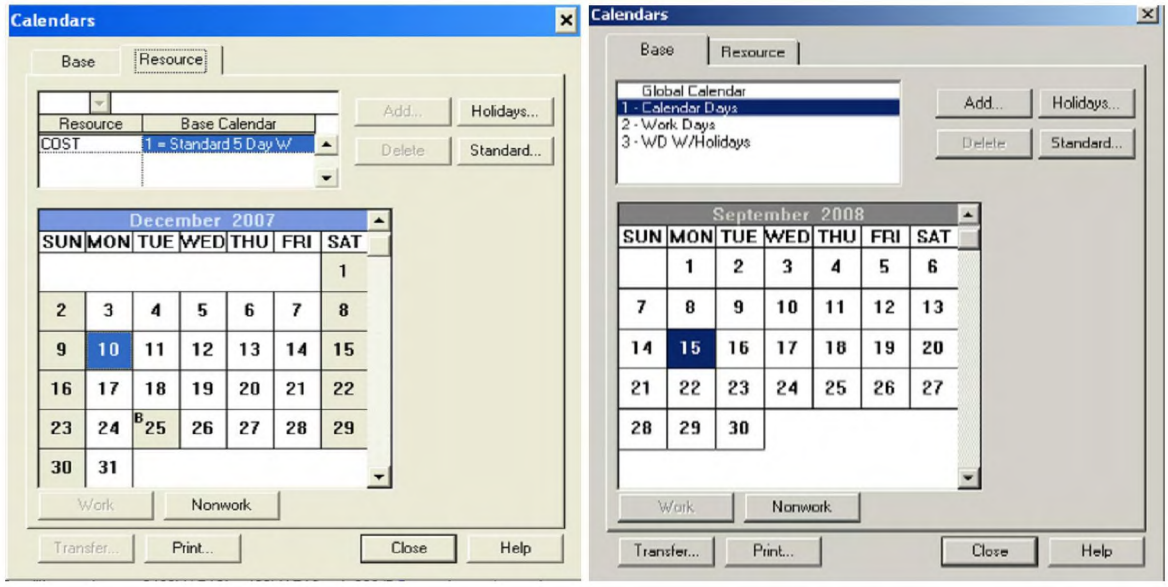
without holidays and Base Calendar 3 is 5 work days per week with holidays. Base Calendar 3 does not include all holidays and requires correction.

Figure 7-11. Calendar Library



The calendar library does not contain anticipated inclement weather days. These periods of non-work performance can be addressed in many ways such as in increased activity durations or accounted for in separate calendars. The City did state they incorporated latent contingency into the activity original durations, not the calendars, to account for inclement weather. They also stated Hawaii in general, does not encounter a significant amount of severe weather or undergo significant weather seasons that negatively impact construction work activity.

PMOC Finding
The MPS calendar library adequately addresses this review category.

7.3.6 Interfaces

Program schedule interfacing includes the connectivity of granular activity detail traceable through Level 1 summary and hammock activities. It also includes contract packaging strategy and third party tasks directly impacting the Project. Scope and work interface must be coordinated between existing facilities and systems and within the design and construction itself. Schedule interface planning will be more crucial and evident as the master program schedule increases in detail during the PE, design and construction phases.

The following verifications were used to review and evaluate the interfaces:

- Verification that the contract packaging strategy is reflected in the schedule
- Verification that existing facilities and operable systems are coordinated and reflected in the schedule

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The MPS is not in enough detail to completely address this category as the current Project phase is planning. The MPS Basis of Schedule addresses the proposed design and construction packaging strategy. The MPS WBS also separately identifies construction activity by project segment, which illustrates the sequencing among construction segment procurement and installation.

The Project is a rail starter system and therefore does not connect with an existing operable segment or facility. The system will interface with multi-modal transit centers facilities connecting to bus operations.

PMOC Finding
The PMOC has determined the MPS does not adequately address proposed construction work interfaces but does adequately address the proposed contracting strategies. MPS revisions are needed but can be addressed during the PE phase.

7.3.7 Project Critical Path

Once a schedule is determined to be fundamentally and mechanically sound, the critical path can be reviewed and evaluated for schedule reasonableness. The critical path analysis determines the existence of a discernible critical path, the activities on the critical path, and whether schedule milestones and completion dates are realistic and achievable.

The following verifications were used to review and evaluate the critical path:

- Verification that a discernible critical path is properly generated and is not impacted by non-related activity constraints or other means of oversight or manipulation
- Verification of criticality indexing, and identification of near critical activity strings or fragnets
- Verification that the project schedule intermediate and completion milestone dates fall within a reasonable time range

The Project MPS utilizes a critical path calculation method by identifying critical activities either by identifying critical activities according to their total float or by using the software setting "Longest Path". The "Longest Path" critical path calculation is the truest indication of a project's critical path because it discriminates near-critical activities from the most critical activities. Two critical path bar charts are presented in Figure 7-12 (calculated by the "Longest Path") and Figure 7-13 (calculated by "Total Float Less Than 1").

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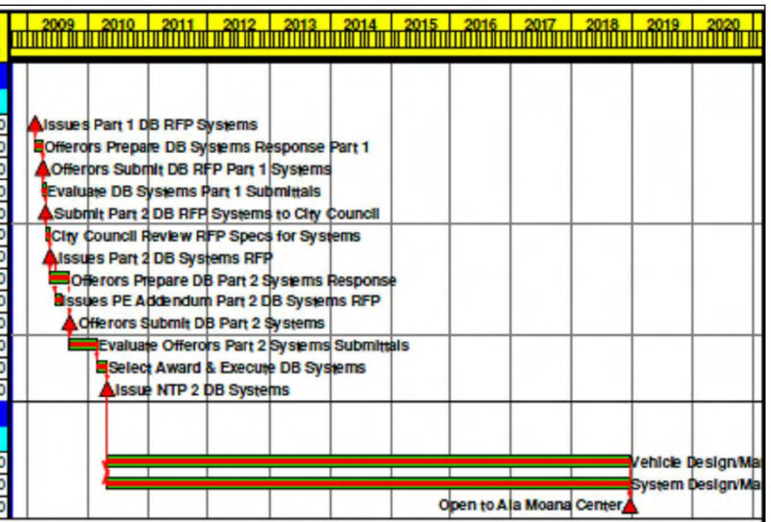
Figure 7-12. Longest Path

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish	Total Float
DB PROCUREMENT					
Systems					
P320	Issues Part 1 DB RFP Systems	0	13FEB09*		0
P330	Offerors Prepare DB Systems Response Part 1	45	13FEB09	29MAR09	0
P340	Offerors Submit DB RFP Part 1 Systems	0	30MAR09		0
P350	Evaluate DB Systems Part 1 Submittals	21	30MAR09	19APR09	0
P360	Submit Part 2 DB RFP Systems to City Council	0	20APR09		0
P370	City Council Review RFP Specs for Systems	30	20APR09	19MAY09	0
P380	Issues Part 2 DB Systems RFP	0	20MAY09		0
P390	Offerors Prepare DB Part 2 Systems Response	120	20MAY09	16SEP09	0
P400	Issues PE Addendum Part 2 DB Systems RFP	30	19JUN09	18JUL09	0
P420	Offerors Submit DB Part 2 Systems	0	17SEP09		0
P430	Evaluate Offerors Part 2 Systems Submittals	160	17SEP09	23FEB10	0
P460	Select Award & Execute DB Systems	60	24FEB10	24APR10	0
P470	Issue NTP 2 DB Systems	0	25APR10		0
CONSTRUCTION & RELATED ACTIVITIES					
General					
I145	Vehicle Design/Manufacture/Test/Commission	3,160	25APR10	18DEC18	0
I150	System Design/Manufacture/Install/Test/Commission	3,160	25APR10	18DEC18	0
I999	Open to Ala Moana Center	0		18DEC18	0



Start Date 15SEP08
Finish Date 18DEC18
Data Date 15SEP08
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Early Bar
Progress Bar
Critical Activity

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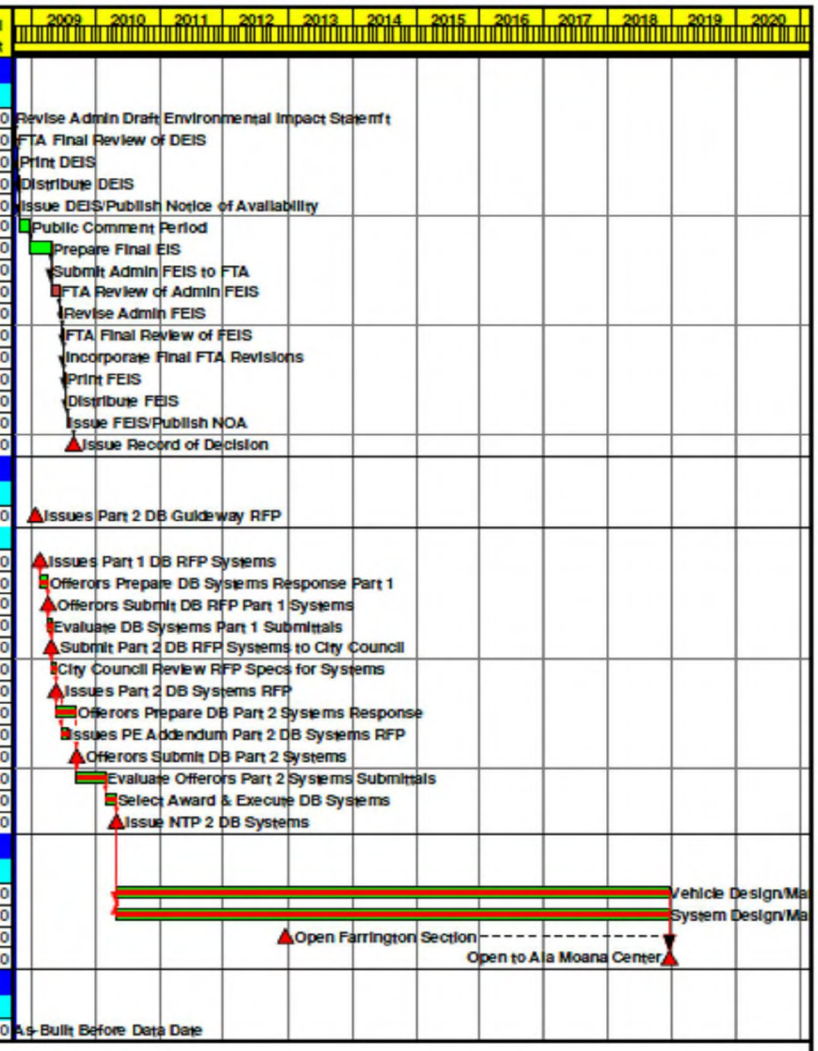
Figure 7-13. Total Float Less Than 1

Activity ID	Activity Description	Orig Dur	Early Start	Early Finish	Total Float
EIS & PRELIMINARY ENGINEERING					
E100	Revise Admin Draft Environmental Impact Statemt	9	16SEP08*	26SEP08	0
E110	FTA Final Review of DEIS	5	29SEP08	03OCT08	0
E120	Print DEIS	6	08OCT08	15OCT08	0
E130	Distribute DEIS	7	16OCT08	24OCT08	0
E140	Issue DEIS/Publish Notice of Availability	1	24OCT08	24OCT08	0
E150	Public Comment Period	44	24OCT08	24DEC08	0
E170	Prepare Final EIS	121	24DEC08	23APR09	0
E220	Submit Admin FEIS to FTA	1	24APR09	24APR09	0
E230	FTA Review of Admin FEIS	46	25APR09	09JUN09	0
E240	Revise Admin FEIS	10	10JUN09	23JUN09	0
E250	FTA Final Review of FEIS	5	24JUN09	30JUN09	0
E260	Incorporate Final FTA Revisions	2	01JUL09	02JUL09	0
E270	Print FEIS	4	03JUL09	08JUL09	0
E280	Distribute FEIS	5	09JUL09	15JUL09	0
E290	Issue FEIS/Publish NOA	1	17JUL09	17JUL09	0
E300	Issue Record of Decision	0		28AUG09	0
DB PROCUREMENT					
Guideway					
P180	Issues Part 2 DB Guideway RFP	0	23JAN09*		0
Systems					
P320	Issues Part 1 DB RFP Systems	0	13FEB09*		0
P330	Offerors Prepare DB Systems Response Part 1	45	13FEB09	29MAR09	0
P340	Offerors Submit DB RFP Part 1 Systems	0	30MAR09		0
P350	Evaluate DB Systems Part 1 Submittals	21	30MAR09	19APR09	0
P360	Submit Part 2 DB RFP Systems to City Council	0	20APR09		0
P370	City Council Review RFP Specs for Systems	30	20APR09	19MAY09	0
P380	Issues Part 2 DB Systems RFP	0	20MAY09		0
P390	Offerors Prepare DB Part 2 Systems Response	120	20MAY09	16SEP09	0
P400	Issues PE Addendum Part 2 DB Systems RFP	30	19JUN09	18JUL09	0
P420	Offerors Submit DB Part 2 Systems	0	17SEP09		0
P430	Evaluate Offerors Part 2 Systems Submittals	160	17SEP09	23FEB10	0
P460	Select Award & Execute DB Systems	60	24FEB10	24APR10	0
P470	Issue NTP 2 DB Systems	0	25APR10		0
CONSTRUCTION & RELATED ACTIVITIES					
General					
I145	Vehicle Design/Manufacture/Test/Commission	3,160	25APR10	18DEC18	0
I150	System Design/Manufacture/Instal/Test/Commission	3,160	25APR10	18DEC18	0
I160	Open Farrington Section	0	15DEC12*		0
I999	Open to Ala Moana Center	0		18DEC18	0
1	As-Built Before Data Date	1	15SEP08	15SEP08	0



Start Date 15SEP08
Finish Date 18DEC18
Data Date 15SEP08
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Early Bar
Progress Bar
Critical Activity

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The longest path bar chart begins on February 13, 2009 due to the artificial constraint date imposed on Activity ID P320 "Issues Part 1 DB RFP Systems". The critical path is non-existent from the Data Date of September 15, 2008 to the start of this activity, an example of how a constraint date can negatively impact the critical path calculation. One method to by-pass the longest path calculation is to identify the critical path by activity total float as illustrated in the second bar chart.

The MPS generates a discernible critical path which extends through a logical sequence of activities from the current planning phase up to the start of construction. The critical path that extends through the construction activities is too summarized and lacks a detail chain of activities. Because of this, the construction phase critical path extends through two activities, with excessive original durations, both related to vehicle procurement. Vehicle procurement includes design, manufacturing and inspection, delivery, inspection and testing. The construction phase critical path lacks detail and is too summarized. The PMOC has reservations about the Project's true critical path during the construction phase and cannot conduct a detailed analysis based on the lack of detail.

PMOC Finding
The PMOC recommends the City expand the construction activities in order to better generate a detailed critical path. In addition, the use of constraint dates should be minimized so critical path calculations are not distorted. MPS revisions are needed but can be addressed during the PE phase.

7.3.8 Critical Areas of Concern

The critical areas of concern include project elements that contain a high level of uncertainty especially early in the project developments phases of PE and Final Design. Historically these areas include:

- Environmental and Wetland Mitigation
- Right of Way Acquisition and Relocation
- Utility Relocations
- Long Lead Material and Equipment procurement
- Third Party Agreements
- Tunneling
- Non-conventional construction methods
- Operational Adjacencies

Interestingly enough, many of the common items listed above have been identified by the PMOC as major areas of concern for the Project. They are:

- ROW Acquisitions
- Utilities – Agreements, exploration, adjustment, abandonment and or relocation
- Construction Material Procurements
- Vehicle Procurement
- Systems Integration / Startup and Testing – Not identified in the MPS

The PMOC recognizes more definitive information will evolve during the PE phase.

Real Estate Acquisition and Management (ROW)
The first draft of the Project Real Estate and Acquisition Management Plan (RAMP) has been reviewed and accepted by the PMOC (BAH) earlier this year. The City is currently identifying the partial and full takes, and the temporary easement associated with the Project rail alignment. To date the City has identified 205 partial and full takes along the First Project alignment. The ROW department and PMC staff are developing a detailed ROW Schedule. This schedule will be included in the MPS in summary form. The current MPC includes very summary level activities for ROW but requires more detail to better identify critical path and near critical path activities related to early phased ROW acquisitions.

This report assigns a high risk to ROW acquisition because the PMOC continually witnesses adverse real estate impacts to schedules and budgets from other transit agencies across the nation. The PMOC expects the City to greatly expand the ROW acquisition detail in the MPS before Entry into PE as the ROW department finalizes schedule development.

Utilities
A significant amount of above ground utilities must be adjusted or relocated prior to the construction of a considerable portion of the 18 miles aerial guideway structure. Likewise, underground utilities must be explored and possibly adjusted to avoid conflict with the aerial guideway structures' drilled piers and related foundations associated with the rail alignment.

There is a schedule risk, which may be significant, arising from the fact that the utility relocation plans have not been completely developed both from a design and contractual point of view. The coordination effort will be great due to the number of utility companies that must work concurrently and at times in the same area. In addition, the time period for these relocations is aggressive, large scale, and uncommon for the island. The utility relocations and adjustments will definitely impact businesses, pedestrian and vehicular traffic, and construction traffic along the corridor. The utility company and third party resource available to accomplish the utility relocations and adjustments are also a considerable PMOC concern.

Construction Material Procurements
The MPS does not contain any activity detail for construction material procurement and or long-lead equipment procurements except for minimal representation for procurement of the rail vehicles. Understandably, most of these material procurement schedule activities can be incorporated into the MPS when the scope and design are refined during the PE and Final Design phases. The PMOC believes the most important material procurement items relate to the potential fabrication and storage sites for the aerial guideway structure, and supporting layout sites for construction related materials and equipment storage.

Vehicle Procurement
The MPS contains one activity that represents vehicle procurement. This activity, ACT ID I145 "Vehicle Design/Manufacture/Test/Commission", has a duration of 3,160 days with no assumptions or duration justification included in the Basis of schedule. Moreover, the MPS does not contain multiple activity relationships or work contracting interfaces with the vehicle procurement, systems integration or maintenance storage facility.

The current MPS has multiple Revenue Operation Dates associated with the incremental delivery of operable segments:

- ROD 1 – Farrington Segment (December 15, 2012)
- ROD 2 – East Kapolei to Pearl Highlands (April 16, 2014)
- ROD 3 – Open to Aloha Stadium (March 26, 2017)
- ROD 4 – Open to Ala Moana Center (December 18, 2018)

The coordination of vehicle procurement, delivery, inspection, burn-in, and operator training is a critical component to the incremental segment RODs. The MPS identifies vehicle procurement as the critical path though the critical path is too vague and summary in nature. A significant amount of detail is needed to better represent the true relationships between vehicle procurement and other major elements of the Project.

Systems Integration

The MPS does not contain any activities describing systems integration for train control, traction power, communications and signaling, startup and testing, and operational interfacing. Considering that the Project is a starter system, extra time and attention are needed for debugging, problem solving, and facility/operations/maintenance training is anticipated during the startup and testing phase. The MPS severely lacks these crucial project elements and requires attention. Systems Integration is a major area of concern because of inherent first time problems encountered with a starter system. In addition, the scope includes an automatic train control system that does not use train operators, a non-traditional technology. The MPS requires a considerable amount of detail to represent the many systems integration interfaces with the incremental turnover of project minimal operable segments and related coordination with the maintenance service facility.

PMOC Finding

While the PMOC cannot address all of the review requirements of this PG-34A topic "Critical Areas of Concern" based on the current MPS, the MPS is sufficient in detail to support the PMOC's determination that the City has demonstrated the schedule review requirements necessary to enter the PE phase. MPS revisions are required but can be addressed during the PE phase.

7.4 Conclusion

The City's Master Project Schedule, "CITY.PRX", dated September 20, 2008, lacks detail for the PMOC to completely address all of PG-34 requirements, many of which are construction phase specific. The PMOC has determined the need to revise the current MPS but acknowledges the next MPS revision can be addressed early in the PE phase.

It is the PMOC's professional opinion that the Master Project Schedule is sufficient in detail to support the PMOC's determination that the City has demonstrated the schedule review requirements necessary to enter the PE phase.

7.5 Recommendations

7.5.1 Approval to Enter PE Phase

No specific recommendations necessary for conditional approval to enter PE have been identified.

7.5.2 Early PE Phase

The PMOC recommends the following comments be addressed and incorporated into the Master Project Schedule no later than the first sixty (60) days of the PE phase:

(1) The MPS requires more activity detail for the following critical project components:
- Utilities – exploration, adjustment, abandonment and or relocation
- Real Estate Acquisitions – identification, appraisals
- Systems Integration – traction power, signals and communications, train control
- Startup and Testing
- Operational Commissioning and Training
- Vehicle Procurement – procurement, design, manufacturing, delivery, testing
- Construction Material Procurements

(2) The MPS should utilize multiple schedule calendars (a feature of the scheduling software) for various types of work related to the PE, final design, procurement and construction of varying types of work, especially during the construction phase. The additional calendars can be assigned to special activities and events such as City board meetings for special actions and contract awards, public outreach meetings, FTA review periods and FTA (federal) holidays, overnight or off-peak weekends or hours for material handling and installation that impact traffic and the public in general, etc.

(3) The WBS should be modified to crossover with the Project budget and cost breakdown structure once developed and implemented.

(4) The Activity Code Structure should be expanded and completed.

(5) The Basis of Estimate should include activity duration assumptions and identification of latent contingency within each activity duration.

(6) The MPS should include all Third Party Agreements development and execution.

(7) Schedule activities for the City's staffing plan should be inserted including all efforts associated with recruiting, training, and transitioning between the PMC and the City key management staff positions.

(8) The number of constraint dates and should be reduced, and the use of mandatory constraint dates should be avoided.

(9) The City should baseline the MPS and commence monthly progress status update reporting.

7.5.3 Approval to Enter Final Design Phase

The PMOC recommends the following comments be addressed and incorporated into the Master Project Schedule prior to entrance into the final design phase:

(1) The City should define a consistent WBS, reporting format, and update frequency for the current MPS. These "standards" should be applied to the design consultants, construction contractors, and vendors to ensure schedule reporting standardization as the Project continues.

(2) The City should address schedule software settings in the contractual specifications and requirements when applicable during the design and construction phases.

(3) The utilization of manpower and equipment resource loading and budget/cost loading should be addressed.

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8.0 SUBTASK 40A: ASSESSMENT OF PROJECT COST RISK

8.1 Methodology

The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #40: Risk Management Products and Procedures,* dated March 29, 2007 complete a cost risk analysis of the Project.

As part of the PMOC task to provide concentrated oversight efforts and deliver products with regard to assessing risks for the Project, this section outlines the steps taken to prepare the Risk Management products under Subtasks 40A of the PG-40. The PMOC in its findings will describe the project, provide FTA with a well-grounded professional opinion as to the reliability of the scope, cost, and schedule of the City's LPA, describe uncertainties, and make a statement of the potential cost range (lower/upper bound).

The PMOC evaluated the City's Base Cost Estimate (BCE) to determine what programmatic risks it poses to FTA's accomplishment of its core accountabilities to simulate mitigation scenarios and maximize the application and effectiveness of the City's contingency.

The PMOC established a programmatic "management baseline" for evaluating the reliability of the City BCE given the various elements of uncertainty associated with the effectiveness and efficiency of the City's project implementation. The PMOC identified, assessed, and evaluated the uncertainties in the project scope, schedule and cost estimate based upon the PMOC review and analysis of City's data under PG-32, 33 and 34.

Based upon this analysis, the PMOC translated those data findings and related information into Level 1 probability distributions of the project cost estimate as developed through an empirically established, random variable model. The PMOC also applied theoretical decision concepts, such as expected value of perfect information and expected value of imperfect information, to simulate the effects of grantee mitigation throughout the project implementation. This grantee mitigation is based on the premise that risk mitigation is a sequential process assuming the following risks are mitigated in the following sequence:

- Requirements Risks
- Design Risks
- Market Risks
- Early Construction Risks (composed of Geotechnical/Utility risks/ right-of-entry)
- Mid-Range Construction Risks (associated with coordination of contractors)
- Start-Up or Substantial Completion of Construction Risks

This Program Management model is to be fully scalable in terms of BCE/SCC/WBS/contract packaging levels depending upon the project phase and FTA direction. The model uses program level, prior experience, and project-specific data supplied by FTA and the grantee to estimate the impact of totally effective mitigation by the grantee for various project milestones. The procedure consists of sequentially reducing, adjusting and conditioning grantee and third-party cost and schedule data, in combination with prior programmatic experience to empirically estimate parameters for the assumed distributions, and then modifying these parameters as

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necessary to simulate the variance reduction/mitigation potential for the specified project milestones or phases.

The PMOC identified all allocated and unallocated contingencies and escalation that represent costs most likely not to be incurred in the most optimistic scenario. Where the PMOC developed information using other risk assessment products to identify scope, cost or schedule elements with a high degree of likelihood (in excess of 90%) of required grantee cost estimate adjustment, the "unadjusted base" cost shall be modified accordingly to produce an "adjusted base" cost. The result is the Adjusted BCE, which is net of all contingency and finance costs.

The Adjusted BCE becomes the input for the 10th percentile of the assumed distribution, considered as the cost estimate for the ***most optimistic scenario*** (stripped of all contingency). The costs are presumed to follow a lognormal distribution, and the 90th percentile of the distribution is determined by the product of the 10th percentile value times a factor of β or Beta Risk Factor (BRF). The 90th percentile is equal to a value that represents a 90% likelihood that the actual project cost at completion will be equal to or less than this number. The mean and variance of the empirical distribution are fully determined using the assumed distribution, the 10th percentile and the parameter BRF.

A fully dependent, or perfectly correlated, distribution assumes positive correlation between the cost elements (correlation coefficient of 1.0); while the independent distribution assumes the cost elements are not correlated (correlation coefficient of 0.0). The BCE/SCC/Budget elements are developed and summed, assuming a "first order approximation" that comes in at a step-off of 1/3rd of the total difference in variance between the fully independent and fully dependent scenarios.

FTA program experience has shown that the 1/3rd step-off between the best- and worst-case scenarios is an appropriate statistical estimate for the total project cost estimate. This follows the guidance provided by PG-40 and accommodates the development of a picture of risks that will, under normal circumstances and strong risk-informed project management by the Grantee, capture the risk reducing impacts as detailed engineering, construction/procurement bidding and actual contracts performance proceeds.

The empirical parameter BRF can vary by project element and through project implementation, and is estimated in conformance with the criteria summarized in Table 8-1.

Variances between the grantee BCE were evaluated using various BRFs to simulate the expected value of totally effective mitigation and these targets represent data inputs for scheduled and triggered mitigation requirements to be developed in the near future, but mitigation plans are not part of the PMOC scope of work under this task order.

Table 8-1. Range of Beta Risk Factor (BRF)

BRF Value or Range *	Description	Notes
Above 2.5	Implies increasing uncertainty associated with project requirements.	Design risks cannot be greater than 2.5 and may reflect a need to increase the adjusted base rather than for a higher BRF.
2.5	All requirement risks have been mitigated.	
…	Implies increasing mitigation of design risk.	
…	Implies increasing uncertainty associated with project design.	
2.0	All design risks have been mitigated.	Market risk cannot be greater than 2.0 and may reflect a need to increase the adjusted base rather than force a higher BRF.
…	Implies increasing mitigation of market/bidding risk or availability of increasingly reliable market data short of a project specific firm price.	Transitioning through 1.9, 1.85, 1.8, etc. reflects the increasing availability of reliable market pricing data on the high end to more specific pricing data on the lower end.
…	Implies increasing uncertainty associated with market risks;	
1.75	All market risks inclusive of bidding risk have been mitigated through availability of a firm price/quote.	
…	Implies increasing mitigation of early construction risk	
…	Implies increasing uncertainty associated with geotechnical/utility/claim risks/ROW right-of-entry (early construction risks).	
1.5-1.35	All early construction risks composed of geotechnical/utility/major claims, usually associated with 20% complete, have been mitigated.	The reason for the allowable variation of 1.5-1.35 is to reflect that certain element-specific mitigation (such as guideway or systems require 1.5 for fully mitigated, where as simple bus pads require only 1.35 for fully mitigated).
…	Implies increasing mitigation in the areas of normal change order activity.	
1.35-1.20	All mid-construction risks inclusive of major claims, delays, impacts, etc., usually associated with 75% complete, have been mitigated.	The reason for the allowable variation is the same.
1.05-1.15	All start-up / substantial completion of construction risks, usually associated with 90% complete, have been mitigated.	The reason for the allowable variation is the same.
…	Implies increasing mitigation in the areas of start-up and pre-revenue operations activity.	
1.0	Implies there is no risk or uncertainty of any kind associated with this item and represents the perfectly mitigated state of the project scope item, or the expected value of perfect mitigation.	

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8.2 Risk Identification for SCC/Baseline Cost Estimate Units

The PMOC team reviewed the capacity, delivery methodology, cost, and schedule documents supplied from the City as part of the assigned tasks under PG-32A, 32E, 33A, and 34A. The results and findings of these reviews are contained in other sections of this PMOC Spot Report.

A summary of the Cost Risk Model Input (Adjusted BCE) is presented in Table 6-15. These PMOC adjustments include deducting the estimated contingencies (creating the "unadjusted base"); estimating the "adjusted base" as a result of the cost, schedule and scope risk review; and evaluating the variance of the estimate under the most optimistic and the worst-case scenarios.

The City's BCE of $5.258 billion (YOE) includes $890.97 million in allocated contingency, $270.25 million in unallocated contingency, and $484.07 million in finance charges. The BCE appears to also have some latent contingency, but the amount cannot be easily quantified at this stage of the project because the SCC line items are based primarily on Cost Estimating Relationships. To condition the BCE, the PMOC identified adjustments as discussed in detail in Section 6.0. The result is an Adjusted BCE of $4.086 billion (Table 6-15).

It should be noted that the Cost Risk Model does not perform any analysis with regard to finance costs. The City's estimated finance costs are stripped to develop the Adjusted BCE so no compounding occurs. However, once the Cost Risk Model results are determined, the finance costs must be added back.

The project baseline cost estimate was characterized based on the type of estimate and the extent of detail to support the data. The costs for each project element were categorized as unit cost quantities, lump sums and Cost Estimating Relationships (CER). The baseline estimate costs were also categorized based on the extent of details and the type of risk associated with each cost element:

- Requirements Risk
- Market Risk
- Design Risk
- Construction Risk

This categorization of the baseline estimate provides support for the development of estimate adjustments and the evaluation of project risks as reflected through the BRF.

The findings of the cost, schedule and scope reviews and the potential cost impacts identified during these reviews are reflected in the risk assessment model by means of adjustments (as may be warranted) and the BRF applied to each SCC. These adjustments result in forecasts for the most likely value of the total project cost in specific phases of the Project. The Project is currently at the "End of AA" and near "Entry to PE" phase. Therefore, the Level 1 project baseline has been set to Q3/2008, which corresponds to the current phase of the project in terms of planning/design and grantee cost estimating/budgeting.

Since the Draft Environmental Impact Statement was only recently published, much of the technical data regarding the project scope, schedule, and cost estimates are open to further

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development. Therefore, it should be emphasized that all risks are currently categorized as "Requirements Risks" (i.e. minimum BRF of 2.5) as a result of the stage of the project. This is a normal state at this stage of project planning and early design. Nonetheless, as the product of the AA Phase, the Project as presented appears in adequate condition for federal consideration of funding further analyses and progression into the PE Phase. In cases where the BRF exceeded the minimum value per PG-40 for specific SCCs, prior program experience was utilized to develop the appropriate BRF at the pre-PE phase.

The basis of each associated Beta Risk Factor (as summarized in Table 8-2) is detailed below. A Risk Register summarizing these findings is included as Appendix D.

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Table 8-2. Honolulu Project Beta Risk Factors

SCC	Decription	Pre PE	Entry to FD	FFGA	50% Const	90% Const
10	**Guideways & Track**					
10.01	Guideway: At-grade exclusive right-of-way	1.01	1.01	1.01	1.01	1.01
10.02	Guideway: At-grade semi-exclusive (allows cross-traffic)	1.01	1.01	1.01	1.01	1.01
10.03	Guideway: At-grade in mixed traffic	1.01	1.01	1.01	1.01	1.01
10.04	Guideway: Aerial structure	3.00	2.50	1.75	1.35	1.15
10.05	Guideway: Built-up fill	1.01	1.01	1.01	1.01	1.01
10.06	Guideway: Underground cut & cover	1.01	1.01	1.01	1.01	1.01
10.07	Guideway: Underground tunnel	1.01	1.01	1.01	1.01	1.01
10.08	Guideway: Retained cut or fill	3.00	2.50	1.75	1.35	1.15
10.09	Track: Direct fixation	2.50	2.50	1.75	1.35	1.15
10.10	Track: Embedded	1.01	1.01	1.01	1.01	1.01
10.11	Track: Ballasted	1.01	1.01	1.01	1.01	1.01
10.12	Track: Special (switches, turnouts)	3.00	2.50	1.75	1.35	1.15
10.13	Track: Vibration and noise dampening	1.01	1.01	1.01	1.01	1.01
20	**Stations, Stops**					
20.01	At-grade station, stop, shelter, mall, terminal, platform	1.01	1.01	1.75	1.35	1.01
20.02	Aerial station, stop, shelter, mall, terminal, platform	3.00	2.50	1.75	1.35	1.15
20.03	Underground station, stop, shelter, mall, terminal, platform	4.00	2.50	1.75	1.35	1.15
20.04	Other stations, landings, terminals: Intermodal, ferry, trolley, etc.	1.01	1.01	1.01	1.01	1.01
20.05	Joint development	1.01	1.01	1.01	1.01	1.01
20.06	Automobile parking multi-story structure	1.01	1.01	1.01	1.01	1.01
20.07	Elevators, escalators	2.50	2.50	1.75	1.35	1.15
30	**Support Facilities**					
30.01	Administration Building: Office, sales, storage, revenue counting	3.50	2.50	1.75	1.35	1.15
30.02	Light Maintenance Facility	1.01	1.01	1.01	1.01	1.01
30.03	Heavy Maintenance Facility	3.50	2.50	1.75	1.35	1.15
30.04	Storage or Maintenance of Way Building	1.01	1.01	1.01	1.01	1.01
30.05	Yard and Yard Track	1.01	1.01	1.01	1.01	1.01
40	**Sitework**					
40.01	Demolition, Clearing, Earthwork	3.00	2.50	1.75	1.35	1.15
40.02	Site Utilities, Utility Relocation	3.00	2.50	1.75	1.35	1.15
40.03	Haz. Mat'l, contam'd soil removal/mitigation, ground water treatments	3.50	2.50	1.75	1.35	1.15
40.04	Environmental mitigation, e.g. wetlands, historical/archeologic, parks	3.50	2.50	1.75	1.35	1.15
40.05	Site structures including retaining walls, sound walls	1.01	1.01	1.01	1.01	1.01
40.06	Pedestrian / bike access and accommodation, landscaping	1.01	1.01	1.01	1.01	1.01
40.07	Automobile, bus, van accessways including roads, parking lots	3.00	2.50	1.75	1.35	1.15
40.08	Temporary Facilities and other indirect costs during construction	1.01	1.01	1.01	1.01	1.01
50	**Systems**					
50.01	Train control and signals	3.50	2.00	1.75	1.35	1.15
50.02	Traffic signals and crossing protection	3.00	2.00	1.75	1.35	1.15
50.03	Traction power supply: substations	3.50	2.00	1.75	1.35	1.15
50.04	Traction power distribution: catenary and third rail	3.50	2.00	1.75	1.35	1.15
50.05	Communications	3.50	2.00	1.75	1.35	1.15
50.06	Fare collection system and equipment	3.00	2.00	1.75	1.35	1.15
50.07	Central Control	3.50	2.00	1.75	1.35	1.15
60	**Right-of-Way**					
60.01	Purchase or lease of real estate	3.00	2.00	1.75	1.35	1.15
60.02	Relocation of existing households and businesses	3.00	2.00	1.75	1.35	1.15
70	**Vehicles**					
70.01	Light Rail	1.01	1.01	1.01	1.01	1.01
70.02	Heavy Rail	3.00	2.00	1.75	1.35	1.15
70.03	Commuter Rail	1.01	1.01	1.01	1.01	1.01
70.04	Bus	1.01	1.01	1.01	1.01	1.01
70.05	Other	1.01	1.01	1.01	1.01	1.01
70.06	Non-revenue vehicles	2.50	2.00	1.75	1.35	1.15
70.07	Spare parts	3.00	2.00	1.75	1.35	1.15
80	**Professional Services**					
80.01	Preliminary Engineering	2.00	2.00	1.75	1.35	1.15
80.02	Final Design	3.00	2.00	1.75	1.35	1.15
80.03	Project Management for Design and Construction	3.00	2.00	1.75	1.35	1.15
80.04	Construction Administration & Management	3.50	2.00	1.75	1.35	1.15
80.05	Insurance	3.00	2.00	1.75	1.35	1.15
80.06	Legal; Permits; Review Fees by other agencies, cities, etc.	3.00	2.00	1.75	1.35	1.15
80.07	Surveys, Testing, Investigation, Inspection	3.00	2.00	1.75	1.35	1.15
80.08	Agency Force Account Work	3.00	2.00	1.75	1.35	1.15

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8.2.1 SCC 10 – Guideway and Track

The system is, effectively, all aerial in nature except for one station. The AA Phase planning and design has concluded that the elevated guideway would be located primarily within existing thoroughfare right-of-way, built using segmental construction for the most part, with aerial stations built and many having concourses below. The primary elements of work under this SCC include guideway and track, and miscellaneous special trackwork. The following BRF for Q3/2008 have been applied in the associated risk categories:

Requirements Risk

- SCC 10.04 – Guideway and Track Elements ***[BRF = 3.0]***
  - The design is incomplete and ~~significant~~ requirements risks still exist.
  - Coordination of the guideway/structures and vehicles has not occurred.
  - The interface and coordination with the Hawaii Department of Transportation will be onerous and a MOU has yet to be executed. Also, the City must address all FHWA requirements.
  - Geotechnical information is incomplete.
  - ROW takes are not completely known, and the alignment can change.
  - An operating plan has not been developed, which could affect the guideway configuration.
  - The location of MSF is not certain, potentially affecting the line section contractors' costs.
- SCC 10.08 – Guideway: Retained Cut or Fill ***[BRF = 3.0]***
  - The design is incomplete and ~~significant~~ requirements risks still exist.
- SCC 10.09 – Track: Direct Fixation ***[BRF = 2.5]***
  - With regard to the vehicle and consist maximum weight and dynamic load considerations, the car is assumed to be Heavy Rail, though some specifics and its capacity (and train length) are yet to be defined.
- SCC 10.12 – Track: Special (switches, turnouts, etc.) ***[BRF = 3.0]***
  - The design and operating plan not sufficiently developed to establish track configuration; additional design must be performed to identify specifics.

Design Risk

- SCC 10.04 – Guideway and Track Elements
  - With regard to gantry approach for curves, the construction methods will ultimately be determined by contractors; however, estimators need to work with constructability professionals to account for techniques available and factor likely costs.
  - Aerial structures design development cannot be refined until additional geotechnical data are available; supplemental boring program with approximately 750-foot spacing will aid analysis. Pilot holes may also be required where complex strata or utilities are unclear.
  - ROW alignments and track geometry not fully defined or captured in current estimate. Also, final consideration cannot be determined until the revenue vehicle and actual decisions on ROW can be determined.

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- The design is incomplete. Decisions are pending regarding rights-of-way, at least one station's vertical profile, the parking garage and its roadway access, and the possible MSF site.

Construction Risk

- SCC 10.04 – Guideway and Track Elements
  - Construction inefficiencies adjacent to waterways must be addressed. A technical paper should be prepared relative to constructability, permitting and maintenance of navigation rights.
  - Construction inefficiencies & liabilities over live traffic (street & highways) must be addressed. A technical paper should be prepared and included in contract documents addressing Maintenance of Traffic (MOT); however, it may be necessary in some locations for the City to prescribe MOT to effect satisfactory community and/or business response and not have disruptions of work.
  - Construction access (material handling and installation) inefficiencies must be addressed. A technical paper should be prepared relative to constructability, permitting, safety for the traveling public (vehicular and pedestrian) and MOT.
  - Plinth pads and rail are to be constructed by line section prime contractor. The qualification of the contractor (likely a subcontractor) should be combined with robust quality inspections and testing rather than prescribed means & methods to ensure proper control of track geometry.
  - Precast yard locations must be identified, which is a contractor responsibility.
  - Laydown areas have not been identified. The City should identify locations where it currently owns the land, leaving final decisions with the contractor. Availability of public lands should be included in the contract documents.
- SCC 10.09 – Track: Direct Fixation
  - Plinth pads and rail are to be constructed by line section prime contractor. The qualification of the contractor (likely a subcontractor) should be combined with robust quality inspections and testing rather than prescribed means & methods to ensure proper control of track geometry.
- SCC 10.12 – Track: Special (switches, turnouts, etc.)
  - Procurement by MSF contractor and installation by line segment contractor (location of MSF will impact cost) – Estimating must carefully and comprehensively incorporate material handling, security and quality.

8.2.2 SCC-20 – Stations, Stops

The design of the station facilities is at the AA Phase level of detail. As planned, stations are aerial with the exception of one (Leeward Community College Station) and would be accessed from grade via stairs, elevators and/or escalators, with concourses provided as necessary below the station platform(s). One station will be at or near at-grade. The following BRFs for Q3/2008 have been applied in the associated risk categories:

Requirements Risk

- SCC 20.02 – Aerial Station, Stop, Shelter, Mall, Terminal, Platform ***[BRF = 3.0]***
  - Stations have large lump sum allowances in the assembly cost developed.

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- Costs for the at-grade/depressed station (Leeward Community College) have been included in the aerial station SCC and is priced as an aerial station in the estimate. A PMOC adjustment has been made to remove the approximate cost from this SCC.
- Parking Structure costs are not included in SCC 20.06 as is customarily done.
- Security Measures are not clearly identified.

- SCC 20.03 – Underground Station ***[BRF = 4.0]***
  - No cost is assigned for the at-grade section. The Leeward Station, whose costs are included in SCC 20.02, includes a retaining wall on one side and possibly an underpass. A PMOC adjustment has been made to this SCC.
- SCC 20.07 – Elevators, Escalators ***[BRF =2.5]***
  - Scope, requirements and quantity are not defined.
  - PMOC cannot identify vertical circulation requirements on station-by-station basis. Required details must be developed.

Design Risk

- SCC 20.02 – Aerial Station, Stop, Shelter, Mall, Terminal, Platform
  - Drawings reflect integration between station supports and segmental guideway, but guideway and stations are to be constructed under two separate contracts – Guideway Superstructure Study – Summary Report; p. 16; Fig. 11 and 13.
  - A large lump sum amount is shown for station canopy with no detail to support cost. A breakdown of the cost estimate must be provided.
  - Security Measures are not clearly defined. The cost estimate does not reflect the progression of this element.

Construction Risk

- SCC 20.02 – Aerial Station, Stop, Shelter, Mall, Terminal, Platform
  - Laydown areas have not been identified. The City should identify locations where it currently owns the land, leaving final decisions with the contractor. The availability of public lands should be included in the contract documents.

8.2.3 SCC 30 – Support Facilities

The support facilities include a heavy/light maintenance and storage facility as well as yard and storage track facilities (with some storage track at each end of the system). The risks associated with this SCC are, again, primarily requirements risks, with one design risk identified even after requirements risks are mitigated. The design of the MSF is quite generic, and certain requirements risks exist because much information on design functions and features that has yet been determined, and many of these are dependent on the ultimate contract used to acquire vehicles and systems (planned as either a design-build or a comprehensive furnish-install contract). Typically these types of decisions occur later in the design process. The following BRFs for Q3/2008 have been applied in the associated risk categories:

Requirements Risk

- SCC 30.01 – Admin Bldg: Office, Sales, Storage, Revenue Counting ***[BRF =3.5]***
  - Scope is not defined. Functional definition and requirements must be developed.

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- SCC 30.03 – Heavy Maintenance Facility ***[BRF =3.5]***
  - Vehicle Basis of Design and functional sizing have not been fully developed, which could affect the MSF configuration.
  - Two locations for the MSF are being considered. Schedule impacts are possible if the Navy Drum Site acquisition is delayed.
  - The scope of earthwork for the Navy Drum Site is unknown.

Design Risk

- SCC 30.05 – Yard & Yard Track
  - No cost was contained within this SCC as it was included in SCC 30.04. However, there is an impact on the rail alignment along Navy Drum location if property is not acquired. Additional analysis and design are needed.

8.2.4 SCC 40 – Sitework

Sitework design is largely encountered at the station locations (for access/egress), under the guideway and at the MSF. The site work planning done to date has heavily utilized information from the earlier attempts by the City to implement a rail project. This information, together with AA Phase planning to build a predominately elevated guideway and station mostly within existing public thoroughfare rights-of-way leads the City to conclude that its site work and utilities efforts will be limited and relatively inexpensive. The PMOC does not totally disagree but does question the realism of the current viability of alignment (and ROW) information from 1990s, the existing extent of public, military and private utilities conflicts and several other areas where uncertainties appear to exist. The following BRFs for Q3/2008 have been applied in the associated risk categories:

Requirements Risk

- SCC 40.01 – Demolition/Clearing And Earthwork ***[BRF = 3.0]***
  - The scope is not fully defined. The estimate is based on route foot cost (parametric).
  - Landscaping is a Lump Sum item with minimum definition of scope. Pricing is based upon derived cost from the *1992 Original Estimate* and is not properly separated into SCC 40.06 as is customarily done.
- SCC 40.02 – Site Utilities, Utility Relocation ***[BRF = 3.0]***
  - Utility Agreements are not in place with private or public owners, including the military.
  - The *2008 SCC Estimate* is partially based on 1992 bid for 60% of the current east end of alignment. It takes into account escalation and reflects some activity since that time through site survey. However, there is a need for sufficient exploratory work to ensure stability of old ducts, pipes, etc.
  - Schedule of relocations has not been developed.
  - Hazardous Materials is a Lump Sum item, with minimum definition of scope.
  - Environmental Mitigations are a Lump Sum item, with minimum definition of scope.
- SCC 40.03 – Hazardous Materials ***[BRF = 3.5]***
  - Hazardous Materials is a Lump Sum item, with minimum definition of scope.

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- SCC 40.04 – Environmental Mitigations ***[BRF = 3.5]***
  - Environmental Mitigations are a Lump Sum item, with minimum definition of scope.
- SCC 40.07 – Automobile, Bus, Van Accessways ***[BRF = 3.0]***
  - Pedestrian/Bike Accessways are a Lump Sum item, with minimum definition of scope.

Construction Risk

- SCC 40.02 – Site Utilities, Utility Relocation
  - Schedule of relocations are not developed. It requires development through integrated design, geotechnical data and exploratory work with key areas where issues may be present.

8.2.5 SCC 50 – Systems

The elements of work under this SCC include train control and signals, traffic signals and crossing protection, traction power and distribution, fare collection, central control and communications for the Project. Because of the revenue passenger vehicle the City is proposing (a Heavy Rail vehicle similar to those currently used in activity center applications and typically delivered as part of a design-build or comprehensive furnish-install type of procurement with all requisite systems elements included from same contractor), this SCC review takes the vehicle and potential procurement mechanism into consideration. The following BRFs for Q3/2008 have been applied in the associated risk categories:

Requirements Risk

- SCC 50.01 – Train Control And Signals ***[BRF = 3.5]***
  - Scope is not fully defined.
  - Specific vehicle technology has not been defined.
  - Operations Plan has not been developed.
  - The responsible entity for state safety oversight in Hawaii has not been determined.
- SCC 50.02 – Traffic Signals And Crossing Protection ***[BRF = 3.0]***
  - Scope is not fully defined
  - ~~Significant~~ Adjustments to and relocations of existing traffic signals will be required.
- SCC 50.03 – Traction Power Supply: Substations ***[BRF = 3.5]***
  - Scope is not fully defined
  - ROW takes are not defined for substation pads. The cost estimate does address substation as currently scoped. Relocations or reductions in numbers may occur.
- SCC 50.04 – Traction Power Distribution: Catenary And Third Rail ***[BRF = 3.5]***
  - Scope is not fully defined.
- SCC 50.05 – Communications ***[BRF = 3.5]***
  - Scope is not fully defined.
- SCC 50.06 – Fare Collection Systems And Equipment ***[BRF = 3.0]***
  - Scope is not fully defined.
  - Technology has not been selected.

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- This SCC item is not adequately identified in the Master Project Schedule.
- SCC 50.07 – Central Control ***[BRF = 3.5]***
  - Scope is not defined.

Construction Risk

- SCC 50.01 – Train Control And Signals
  - Likely mobilization/de-mobilization will be required between initial DB segment and subsequent segments will add costs to Project.

8.2.6 SCC 60 – Right-of-Way

The right-of-way planning done to date has heavily utilized information from the earlier (1990s) attempt by the City to implement a rail project. This information, together with AA Phase planning to keep the guideway and most of each station within existing public thoroughfare rights-of-way leads the City to conclude that its ROW program will be limited and relatively inexpensive. PMOC does not totally disagree but does question the realism of not encroaching on private properties, the extent of adversely impacted residences and businesses, the current viability of ROW information from 1990s, and several other areas where uncertainties appear to exist. In the instances of access to, over and/or through, and from such existing ROW as that owned by HDOT and other non-City entities, PMOC considers these as high-risk land or air rights acquisition areas. The following BRFs for Q3/2008 have been applied in the associated risk categories:

Requirements Risk

- SCC 60.01 – Purchase Or Lease Real Estate ***[BRF = 3.0]***
  - Basis of Estimate is not clearly defined.
  - Potential negative court judgments can occur.
  - ROW schedule has not been developed for 205 property acquisitions that have been identified to date.
  - Resource technical capacity of the ROW Department to maintain schedule is a concern. Other than having authority and relative experience, staffing requirements and accountability with project requirements are unclear.
  - ROW acquisitions may require "economic remainder" judgments or full takes, particularly along Dillingham Boulevard.
  - Temporary and permanent easements scope is unknown. The PMOC recognizes that this is typically more definitively addressed during PE.
  - Schedule of property acquisitions is necessary to assess potential impacts to construction and design.
  - Coordination with HDOT will be necessary. No MOU has been executed. The PMOC recognizes that this MOU can be more definitively addressed during PE.
- SCC 60.02 – Relocation Of Existing Households And Businesses ***[BRF = 3.0]***
  - Schedule for property acquisition is necessary for assessment of potential impacts to construction and design.
  - ROW schedule is not yet developed for the estimated 205 takes. The PMOC recognizes that this can be more definitively addressed during PE.

- Resource technical capacity of the ROW Department to maintain schedule is a concern.

8.2.7 SCC 70 – Vehicles

The risk for this cost item is mainly attributable to the acquisition of what the City and its design team are calling a "light metro" vehicle for revenue operations. Heavy Rail Vehicles (SCC 70.02) is used in this review as the features of the City desired vehicles would tend to be more aligned thereto. The proposed vehicle acquisition risk is relatively high, as such vehicles for use in the urban rail transit manner being proposed are not currently in production or scheduled for delivery. Most such vehicle applications are in activity center (e.g., airports) use and not in mainline services. Furthermore, most current applications have been procured together with all requisite systems components (communications, signals, power and power distribution, etc.) and not as vehicle-only procurements. The City is leaning toward a similar procurement for its vehicles. The following BRFs for Q3/2008 have been applied in the associated risk categories:

<u>Requirements Risk</u>

- SCC 70.02 – Heavy Rail (Vehicles) ***[BRF = 3.0]***
  - Technical specifications for rail vehicles have not been fully defined.
  - Quantity of vehicles is insufficient based on transit capacity analysis. PMOC has made an adjustment to BCE.
- SCC 70.06 – Non-Revenue Vehicles ***[BRF = 2.5]***
  - No basis is shown for needs or type of equipment.
- SCC 70.07 – Spare Parts ***[BRF = 3.0]***
  - No basis is shown yet for needs, type or method of procurement.

<u>Market Risk</u>

- SCC 70.02 – Heavy Rail (Vehicles)
  - Combining the Vehicles and Systems into a single contract may lower the number of potential bids that can be received and could limit competition for future procurements.

8.2.8 SCC 80 – Professional Services

The City's cost estimate includes a general budget for most of the items contained in this category, though the GEC contract does provide a reasonable breakdown of work to be performed and the first PMC contract is intended only to provide personnel until the City hires staff through the PE Phase. Professional Services include Preliminary and Final Design, Project Management for Design and Construction, Construction Administration and Management, Insurance, Legal/Permits, Surveys/Testing and Inspection and Agency Force Account Work. Because of the stage of the project, the risks associated with this SCC include only requirements risks at this time. The following BRFs for Q3/2008 have been applied in the associated risk categories:

<u>Requirements Risk</u>

- SCC 80.01 – Preliminary Engineering ***[BRF = 2.0]***

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- Professional service costs are not based on staffing plans or detailed estimates.
- GEC contract includes an undefined/un-scoped $1 million extra work allowance for PE.
- GEC contract for PE does not clearly define NTP #3.
- ~~GEC contract is $85 million but SCC estimate includes $75 million for PE.~~
- There are limited or no performance metrics relative to all participants for control of budget and adherence to schedule.
- There is no scope definition or identification of permits required or third party approvals.
- PMOC made adjustments to certain line items within SCC 10-70. The SCC 80 costs required adjustments once the SCC 10-70 adjustments were included in the project budget as the SCC80 values are calculated on a percentage basis and thus dependent on the adjusted values.

- SCC 80.02 – Final Design ***[BRF = 3.0]***
  - No Basis of Estimate is developed. Costs are based on a percentage of construction value.
  - Final Design cost growth is likely until PE scope, schedule and budget are more developed.
- SCC 80.03 – Project Management For Design And Construction ***[BRF = 3.0]***
  - No Basis of Estimate is developed. Costs are based on a percentage of construction value.
  - No staffing plan is shown for City or consultants.
  - Initial PMC Contract includes an undefined/un-scoped $1 million extra work allowance.
  - Identification of performance metrics relative to all participants should be developed to ensure control of budget and adherence to schedule.
- SCC 80.04 – Construction Administration & Management ***[BRF = 3.0]***
  - No Basis of Estimate is developed. Costs are based on a percentage of construction value.
- SCC 80.05 – Insurance ***[BRF = 3.0]***
  - Insurance methodology is not yet defined.
  - No Basis of Estimate is developed. Costs are based on a percentage of construction value.
- SCC 80.06 – Legal: Permits, Review Fees By Other Agencies, Cities, Etc. ***[BRF = 3.0]***
  - No Basis of Estimate is developed. Costs are based on a percentage of construction value.
  - No scope definition or identification of permits required, third party approvals, etc. is provided.
  - Un-anticipated litigation may add cost to the Project (e.g., protests from adversary groups, community groups, adjacent landowners, and other affected parties).
- SCC 80.07 – Surveys, Testing, Investigation, Inspection ***[BRF = 3.0]***
  - No Basis of Estimate is developed. Costs are based on a percentage of construction value.
- SCC 80.08 – Start-Up ***[BRF = 3.0]***

- No Basis of Estimate is developed. Costs are based on a percentage of construction value.

8.2.9 Miscellaneous Areas of Risk Applicable to Multiple SCCs

There are a number of project elements, including grantee authorities, roles and responsibilities, where a substantial amount of uncertainties with respect to execution of the Project exist today and will have potential adverse impact on the project. As with specific SCC categories of work, these elements and consequent areas of uncertainty are not unexpected at this early (i.e., pre-PE Phase) stage of a project being planned. Nonetheless, each has risk consequences, and until and unless the issues are satisfactorily resolved, they should be taken into consideration with respect to the ultimate estimate of total costs for the project, and therefore the baseline project budget. Following are those elements and relative uncertainties:

Requirements Risks

- Governance, MOUs, Legislative and City Actions – The Project is not clear on who the final decision maker or entity relative to technology, capital financing and the operations and maintenance of the bus and rail system. ~~Furthermore, in the event a transit authority is legislated, its governance, financing, etc. are unknown~~. As there are at least several MOUs that should be developed, it is uncertain what force they will have and who will be the ultimate arbiter in event of disagreements.
- Design is more advanced than cost estimate – Current (Q3/2008) estimate may not capture all design elements (scope is not traceable to estimate).
- Soft costs are only calculated as a percentage of construction value (no basis or staffing plans) – For example, PE scope of work is exceptionally detailed but no staffing plan is provided for the City or its consultants. Additionally, it appears that the City has had difficulties in hiring necessary staff, which may be an indication of non-competitive salaries, fringe benefits, moving allowances, etc. It also appears that retention of consultant staff may be an issue.
- Identification of performance metrics relative to all participants – control of budget and adherence to schedule – Currently the project documentation with respect to project control lacks real metrics to monitor performance in cost or time, except by broad, end-product oriented deliverables and due dates. In real terms, such lack of performance metrics and the mechanism (e.g., "earned value" techniques) to measure them portends inability to effectively and timely monitor trends and avoid budgetary or schedule problems.
- Coordination/Approvals of both design concepts and construction staging by HDOT and the City is an area of concern. This is one of the areas where MOUs can be useful. Failure to bring the HDOT and City agencies into the project management scoping and Project Development Plan will miss the opportunity to inform these entities about the timing and coordination issues and the negative impact delays can cause.
- The Chief Procurement Officer of the City/County government has been identified as having the authority for contract approval authority.
- The designer is developing the estimates with no independent oversight and without having experienced estimating staff within the City staff reviewing and assessing the

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consultant's work. Estimating should be overseen and assessed by some other entity who is not the designer.

- No identifiable configuration management/change control mechanism is in place, though it is adequately addressed in the PMP.
- Contract packaging must be refined – The City has identified an initial packaging and delivery method. However, they acknowledged that it requires refinements, particularly as the packages could unwittingly lead to lessened competition.

Design Risks

- Schedule for contracting DBB work is very tight ~~and potentially unattainable~~ due to workload, insufficient time to recover from poor bids, etc. The City shows more concern over DB schedule and contracting issues than those of DBB. Both have ~~serious~~ issues and planning must provide reasoned, practical contingency in schedules and staffing must be planned to handle.

Market Risks

- Steel, concrete, rail, aggregate, fuel and all construction materials may increase in price due to volatile and unpredictable market conditions. Current estimates and projected inflationary factors must more definitively reflect actual industry and materials cost increases of the recent past.
- A volatile bidding market can be accommodated in yet-to-be seen robust risk-informed estimating.
- The availability of skilled and unskilled labor will require more detailed analysis of the local labor market as it relates to the overall construction being planned in Oahu and the remainder of the State.
- General Conditions and Basis for General Conditions have not yet been developed.

Construction Risks

- Delays due to weather can be reflected in a refined Integrated Master Project Schedule, which should be monitored and assessed.
- Change Orders during construction (varies from 3% ~ 12%) can be accommodated in robust risk-informed estimating.

8.3 Cost Risk Model Results

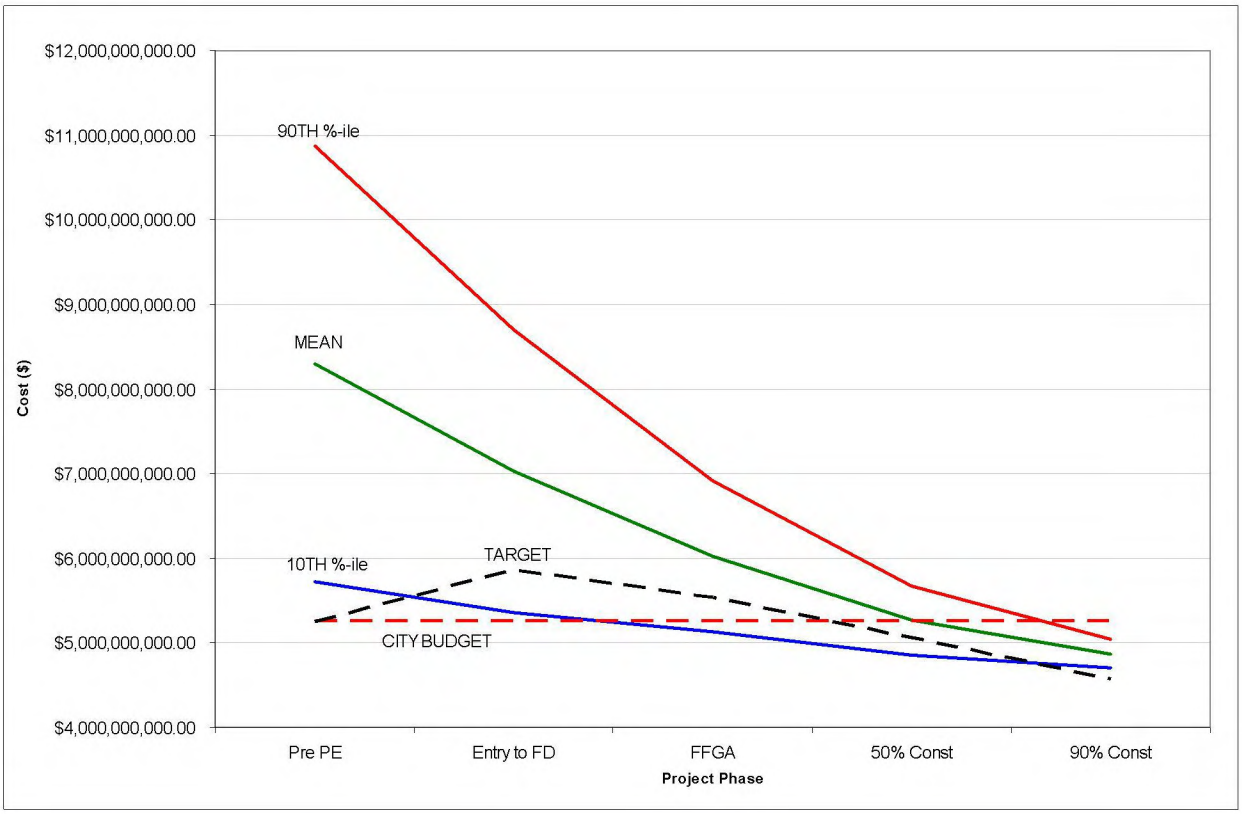
Using the Adjusted BCE values for each SCC and the BRFs identified above, the Cost Risk Model was used to calculate the possible optimistic (10%), median (50%), and pessimistic (90%) project costs. This Level 1 statistical risk analysis results in a most optimistic total project cost of $5.24 billion at this Pre-PE phase (or the baseline phase of the project). After adding back the finance costs of $484.07 million, the statistically most optimistic Total Project Cost becomes $5.72 billion at this early project stage of development. The most pessimistic estimate for the total project cost at this pre-PE phase is $10.39 billion. After adding back the finance costs of $484.07 million, the statistically most pessimistic Total Project Cost becomes $10.87 billion.

The Level 1 statistical risk analysis was used to forecast the total project cost at the following Project phases:

- Baseline – Entry into PE (Q3/2008)
- Entry into Final Design (Q4/2009)
- FFGA Award (Q1/2011)
- 50% Construction (Q2/2014)
- 90% Construction (Q4/2017)

In this risk-informed dynamic analysis, the BRF values for the different project phases were applied in accordance with PG-40 and in part through FTA program experience with other projects and the identified risks that could cause cost escalation. Figure 8-1 depicts how the values of the 10th, 50th (mean), and 90th percentiles of the total project cost change during the life of the project. These values (i.e., projected costs) drop as the requirements, design, and market risks are eliminated from the project through the advancement of the design analysis, engineering applications and the availability of firm bids. The City budget is shown as $5.258 billion.

Figure 8-1. Plot of Cost Risk Model Project Forecasts and Target Values



As shown in Figure 8-1, with totally effective mitigation it is possible for the Project to be implemented within the current budget. At the pre-PE phase of project development, where detailed design analyses and engineering conclusions have yet to be accomplished, nor have bids been received to actualize market conditions of prices, a significantly wide range typically exists between best and worst case scenarios for a project cost. The primary method for mitigation of risks and narrowing the statistical range of potential final cost is through investigations and analyses with risk-informed design and engineering development. Secondary mitigation is the

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amount of additional contingency that must be funded based on the expected risks, as discussed in Section 9.0.

There is a period of time in the project life cycle where the risks can be mitigated. However, after a certain point the risks cannot be mitigated and, therefore, must be paid for through the project contingency. This point is identified as the project "Break Point". The FTA program experience shows that the break point for a project is around the 20% construction phase where most of the design and market risks have been substantially mitigated or eliminated.

The primary mitigation method is chiefly design development and is the preferred method to achieve project cost targets. Secondary mitigation is the amount of additional contingency that must be funded based on the expected risks. The percentage of coverage needed varies by project phase. Mitigation coverage requirements recommended in PG-40 are shown in Table 8-3. The Target Value is determined from the Cost Risk Model as the required budget at each phase for the corresponding Level of Confidence as defined by PG-40 (i.e. Level of Confidence for "Entry into Final Design" is 30%, which corresponds to $5.855 billion from Cost Risk Model). The required capacity (minimum contingency) is then calculated as the difference between the Target Value (shown as the dashed black line in Figure 8-1) and the Adjusted BCE of $4.086 billion (as summarized in Table 8-3).

Table 8-3. Required Mitigation Capacity

Project Phase	Coverage Target	Target Value	Required Capacity
Baseline – Entry into PE	10%	$5,238,502,255	$1,152,028,077
Entry into Final Design	30%	$5,855,611,169	$1,769,136,991
FFGA Award	50%	$5,536,295,323	$1,449,821,145
50% Construction	80%	$5,048,720,300	$962,246,122
90% Construction	90%	$4,561,857,430	$475,383,252

Based on this analysis, the Project should include $1.152 billion in total contingency, or 28.2% of the Adjusted BCE, at the pre-PE phase. When considering all adjustments, escalation, contingency, and financing costs, the result is an estimated Total Project Cost of $5.72 billion based solely on the Cost Risk Model. It should be noted that the Cost Risk Model indicates that the required contingency may increase during the next phase of the Project but eventually would decrease. This is the result of the remaining risks and their impacts on the overall budget at the various stages of the project.

8.4 Conclusion

The Level 1 risk analysis results in a most-optimistic total project cost of $5.24 billion at the Pre-PE phase (or the baseline phase of the project). After adding back the finance costs of $484.07 million, the Total Project Cost becomes $5.72 billion. The most pessimistic estimate for the total project cost is $10.39 billion. After adding back the finance costs of $484.07 million, the Total Project Cost becomes $10.87 billion.

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This analysis must be supported by an assessment of the contingency per PG-35 to confirm the adequacy of the total Project budget, as is done in Section 9.0, following. In addition, the estimate must undergo significant refinement once the project advances into the PE phase.

8.5 Recommendations

With this Adjusted BCE and the Beta Risk Factors applied in the Cost Risk Model, using both more static statistical and more dynamic risk-informed analyses, the end result is a Pre-PE phase budget that Jacobs believes is sufficient and, therefore, recommends a Total Project Budget of $5.72 billion at this time. However, this analysis must be supported by an assessment of the contingency per PG-35 to confirm the adequacy of the total Project budget as discussed in Section 9.0.

It is recognized that estimate will undergo significant refinement once the project advances into the PE phase. Over the course of the Project, the Cost Risk Model indicates that it is possible for the Project to be implemented within the current budget with totally effective. The primary mitigation method is chiefly design development and is the preferred method to achieve project cost targets. Secondary mitigation is the amount of additional contingency that must be funded based on the expected risks, as discussed in Section 9.0.

It should be noted that the Schedule Risk Assessment, as discussed in Section 10.0, indicates that there is an 85% probability of achieving ROD by October 23, 2019, which is a delay of approximately 10 months from the City's plan. Although a delay in the Project schedule would typically correlate to increased costs, the overall impact cannot be determined at this time because the primary cost drivers resulting from schedule delays are "soft costs". Since these "soft costs" are only a percentage of the construction value of the Project, their impact cannot be assessed until a staffing plan or more detailed estimate is developed.

9.0 SUBTASK 35A: PROJECT COST CONTINGENCY BASELINE REVIEW

9.1 Methodology

The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #35: Project Contingency and Third Party Profit Review Procedures,* dated March 29, 2007 to assess and evaluate the City's cost contingency. Per PG-35, the PMOC shall fully identify, describe, and analyze the adequacy of the City's cost contingencies. For PG-35A products, this means three steps:

(1) Forward Pass –The working target for total contingency (defined as the aggregate of allocated and unallocated cost contingency, net of allowances and financing) is determined at key milestones:

- Entry into Preliminary Engineering = 30%
- Entry into Final Design = 20%
- Award of an FFGA = 15%
- 90-100% bid = 10%
- 50% construction complete = 5%

(2) Backward Pass – The PMOC developed estimates of the minimum amount of total cost contingency that is reasonably expected to be necessary at that point in time for the Project to be completed within budget and on time. The following parameters were used per PG-35.

- At the Revenue Operations Date (ROD), the demand for total cost contingency has been reduced to a minimum requirement for scope changes or clarifications and schedule delays or changes. The PMOC identified a working target for this point as 3% total contingency based on prior experience.
- At "substantially complete" (90-100% bid), the project is typically exposed to cost changes in the range of 12%.
- Continuing with the "backwards pass", the PMOC developed an estimate of minimum contingency based upon the City's technical capacity, project delivery method, and Project Management Plan for the same milestones that were developed as part of the forward pass.

(3) Cost Risk Model – Based on the results of the Cost Risk Model, the percentage of coverage needed varies by project phase. The Target Value is determined from the Cost Risk Model as the required budget at each phase for the corresponding Level of Confidence as defined by PG-40 (i.e. Level of Confidence for "Entry into Final Design" is 30%). The required capacity (minimum contingency) is then calculated as the difference between the Target Value and the Adjusted BCE.

The PMOC then reconciles the various sets of data to develop recommended contingency minimums for the key project milestones.

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9.2 Review of Project Cost Contingency

The PMOC team used the *2008 SCC Estimate* dated September 3, 2008 to complete the contingency analysis. The estimate is summarized by FTA Standard Cost Category (SCC) in Table 6-2.

The Base Year (2008 dollars) and Year-of-Expenditure (YOE) contingencies for the Project are shown in Table 6-2. For the purposes of this analysis, the allocated contingency for each SCC category was individually escalated using the inflation factors by cost category from the SCC workbook to YOE. The PMOC used the same inflation factors identified by the City within the SCC Workbook for escalation of the individual line items in developing their YOE estimates. The unallocated contingency was escalated as well from Base Year to YOE using the same methodology. The charts and tables in this report are based on YOE and the City's ROD of 2018.

As noted in Section 6.0, the PMOC made adjustments to the Project's direct costs due to omissions in scope or under valuation of certain cost items. In addition, the PMOC attempted to identify latent contingencies included in the direct cost estimate. However, given that the estimate is based solely on Cost Estimating Relationships, latent contingency amounts were not readily identified. The PMOC adjustments summed to $473.2 million (YOE), as shown in Table 6-15.

9.3 Analysis of Project Cost Contingency

9.3.1 Forward Pass

The Project contingency dollar amounts were reviewed by the PMOC. The minimum values calculated based on the PG-35 guideline percentages are shown in Table 9-1. From these values, minimum contingency hold points were determined for the Project by multiplying the guideline percent recommended and the construction cost in YOE dollars (excluding contingency or financing cost).

Table 9-1. PG-35 Contingency Percentages and Calculated Hold Points

Project Milestone	FTA Guideline Percentage	Calculated Hold Point
Entry to PE	30%	$1,225,942,254
Entry to FD	20%	$817,294,836
FFGA Award	15%	$612,971,127
90-100% Bid	10%	$408,647,418
50% Construction	8.0%	$326,917,934
75% Construction	6.0%	$245,188,451
90% Construction	4.0%	$163,458,967
Revenue Operations Date	3.0%	$122,594,225

The City's *2008 SCC Estimate* includes $890.0 million (YOE) in allocated contingency and $270.3 million (YOE) in unallocated contingency, for a total of $1.161 billion. This is 32.1% of

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the City's Base Cost Estimate (BCE) in YOE dollars and 28.4% of the Adjusted BCE in YOE dollars.

At Entry into PE, the estimated contingency should be roughly 30% of the Project's Adjusted BCE. This results in an estimated contingency of $1.226 billion based on the Adjusted BCE of $4.086 billion.

When considering all adjustments, escalation, contingency, and financing costs, the result is an estimated Total Project Cost of $5.80 billion based solely on FTA guideline contingency percentages.

9.3.2 Backward Pass

The following is a summary of the "backward pass" process used for this Spot Report:

(1) The PMOC estimated approximately 3.0% (approximately $120,000,000) of the construction YOE dollars should be available for claims during project closeout.

(2) The total duration for the project from Entry into PE through project closeout was calculated at 130 months (March 2009 to January 2020) with contingencies needed for 26 months of delay (20% per PG-35).

(3) Extended overhead for the various contractors was estimated at $2,900,000 per month. Program support costs for the City are estimated at $5,900,000 per month.

(4) 90% Construction was calculated as 15 months of construction overhead at $3 million per month + 15 months of soft cost at $6 million per month + Remaining Change Orders at 1%.

(5) 50% Construction was calculated as 6% of YOE dollars. This estimate is considered reasonable because all final design, right-of-way acquisition, vehicle/systems procurement, utility relocation, and the majority of geotechnical differing site conditions risks will have passed.

(6) 20% Construction was calculated as 10% of YOE dollars. This estimate is considered reasonable because all final design, right-of-way acquisition, and utility relocation risk will have passed, but construction phasing and systems risks remain.

(7) The design period was not used during this analysis as it was determined that any delays occurring prior to the start of construction would have a cost comprised of contract escalation for the number of months the project was delayed prior to the start of construction.

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Table 9-2. Backward Pass Values

Project Timeframe	Backward Pass Value	Notes
20% Construction	$410,000,000	Calculated Target 10% YOE (rounded)
50% Construction	$240,000,000	Calculated Target 6% YOE (rounded)
75% Construction	$200,000,000	Calculated Median
90% Construction	$170,000,000	15 Months of Construction overhead at $3M/month + 15 Months of Soft Cost at $6M/month + Remaining Change Orders of 1%
Revenue Operations Date	$120,000,000	Approximately 3% for claims
Total	**$1,140,000,000**	

The total result is $1.14 billion contingency, or 27.9% of the Adjusted BCE. When considering all adjustments, escalation, contingency, and financing costs, the result is an estimated Total Project Cost of $5.71 billion based solely on the Cost Risk Model.

9.3.3 Contingency Calculation Using Cost Risk Model (PG-40A)

Based on the Cost Risk Model analysis discussed in Section 8.0 , the Project should include $1.152 billion in total contingency, or 28.2% of the Adjusted BCE, at the pre-PE phase. When considering all adjustments, escalation, contingency, and financing costs, the result is an estimated Total Project Cost of $5.72 billion based solely on the Cost Risk Model. It should be noted that the Cost Risk Model indicates that the required contingency may increase during the next phase of the Project but eventually would decrease. This is the result of the remaining risks and their impacts on the overall budget at the various stages of the project.

9.4 Conclusion

The purpose of this section of the Spot Report is to provide an analysis of the project contingency requirements using various methods. The estimation of the required cost contingency needs to recognize the mitigation capacity available at each phase of project development throughout the life of project. The recommended contingency in the BCE must be adequate to support the project through project close-out. In this Spot Report, a contingency amount is recommended for inclusion in the BCE at the current phase of the project. Management of contingency will be accomplished using a Project Execution Plan with project-specific strategies to be developed at a later phase. The Project Execution Plan is to be built upon an analysis of contingencies and planning of contingency replenishment.

Table 9-3 summarizes the results of the contingency analyses performed for this Project.

Table 9-3. Contingency Analysis Summary

Analysis Method	Resulting Percentage of Adjusted BCE	Calculated Contingency (YOE)	Calculated Total Project Cost (YOE)
Forward Pass	30.0%	$1,226,000,000	$5,796,456,038
Cost Risk Model	28.2%	$1,152,000,000	$5,722,573,115
Backward Pass	27.9%	$1,140,000,000	$5,710,545,038

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9.5 Recommendations

Based on these analyses, the PMOC recommends a minimum contingency of $1.226 billion (YOE), which is 30% of the Adjusted BCE amount of $4.086 billion (YOE). ***This results in a Total Project Budget of $5.80 billion (YOE), which is an increase of $538.0 million (YOE) or 10.1% of the City's current budget.*** ~~This equates to an 11% Level of Confidence in the Cost Risk Model after deducting the finance costs.~~

10.0 SUBTASK 35C: PROJECT SCHEDULE CONTINGENCY REVIEW & SUBTASK 40B: ASSESSMENT OF PROJECT SCHEDULE RISK

10.1 Methodology

The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #35: Project Contingency and Third Party Profit Review Procedures,* dated March 29, 2007 to assess and evaluate the City's schedule contingency. The PMOC followed the requirements outlined in the *FTA Project Management Oversight Operating Guidance (PG) #40: Risk Management Products and Procedures,* dated March 29, 2007 complete a schedule risk analysis of the Project.

The role of the PG-40B product is to establish a programmatic management baseline for evaluating the reliability of the grantee project schedule and its components given the various elements of uncertainty associated with the effectiveness and efficiency of the grantee's project schedule for project implementation. The PMOC identified, assessed and evaluated the uncertainties in the project schedule using a Monte Carlo simulation model was used that is fully scalable in terms of BCE/SCC/WBS/Contract packaging levels depending upon the project phase. Input for the model was based on observational data, professional judgment, and intermediate analysis. The result was probability distributions of the project schedule. The PMOC then identified and analyze the adequacy of the City's schedule contingencies per the requirements of PG-35C.

10.2 Review and Analysis of Project Schedule Contingency

10.2.1 Project Schedule Characteristics

The City submitted a proposed construction schedule titled "HHCTP As of August 25.xer" in early August 2008. The PMOC conducted a preliminary schedule review and produced a list of comments to the City during the Risk Assessment workshop site visit on September 11, 2008. The City incorporated the PMOC comments in a revised schedule, titled "CITY.PRX", on September 20, 2008. The PMOC prepared a PG 34 Subtask 34A Draft Project Schedule Review Spot Report on the Master Project Schedule. The City's MPS Schedule file, "CITY.PRX" was used to support the Schedule Review, the PG-35C Schedule Contingency Review, and the PG-40B Assessment of Project Schedule Risk. The technical schedule data is included in Table 10-1.

Table 10-1. Technical Schedule Data

Master Project Schedule *"CITY.PRX"*	
Number of activities	202
Number of activities in longest path	16
Started activities	0
Completed activities	0
Number of relationships	322
Percent complete	0 %
Number of Hammocks	1
Number of early constraints	3
Number of late constraints	2
Number of mandatory constraints	1
Data date	15SEP08
Start date	15SEP08
Imposed finish date	N/A
Latest calculated early finish	18DEC18

In order to assess the schedule progress and the timing of cost contingency reductions, the schedule needs milestones established at the completion of activities which posed risks to the project. These milestones are either associated with project phase (PE, final design, or construction) or related to one of the five project segment Revenue Operation Dates. The City plans to incrementally open individual project segments in an easterly direction. While these milestones are critical to the City, the PMOC is most concerned with cost and schedule impacts to the final project completion date (ROD). The PMOC used the incremental ROD dates as critical measuring points for the evaluation of schedule contingency.

Based on the "*CITY.PRX*" schedule, the milestone completion dates shown in Table 10-2 were indicated.

Table 10-2. Schedule Summary Dates

Description	Finish Date
Entry into PE	31DEC08
Entry into Final Design	05JAN09
FFGA Award	26FEB11
Construction/ROD	
Vehicle (Design/Manufact./Deliver/Test/Commission)	18DEC18
System (Design/Manufact./Install/Test/Commission)	18DEC18
Open Farrington Section	15DEC12
Open East Kapolei Pearl Highlands	16APR14
Open to Aloha Stadium	26MAR17
Open to Ala Moana Center	18DEC18

10.2.2 Analysis

A quantified schedule risk analysis was performed on the *"CITY.PRX"* schedule. This technique provides a means to determine schedule risk as a function of risk associated with the activities that make up the schedule. The CPM schedule is comprised of a network or activities logically

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sequenced to identify the longest critical path, start to completion. The schedule risk assessment techniques takes the planning process another step further accounting for uncertainty by using a range of durations to complete each activity instead of a single point duration. It calculates the overall schedule duration by developing a probabilistic distribution for each activity's duration, then totals the durations on the longest critical path. These ranges are then combined to determine the overall schedule duration.

The activity duration probability distributions were aggregated using PertMaster, a simulation program that uses a Monte Carlo type probability algorithm. The Monte Carlo sampling technique method is described below:

- Activity durations are randomly selected from an appropriate frequency distribution
- Project length and critical path data are calculated based on the sampled durations
- The procedure is repeated several thousand times (simulation runs) using a computer and a record is kept of the critical path data generated
- An average project duration and standard deviation are calculated based on the simulated data
- The probability of meeting a certain date is then calculated

The computer simulation gives a more reliable estimate since it takes into account the effect of near-critical paths. For each activity, a record is kept of the proportion of simulation runs in which the activity is critical. This proportion is called the "Criticality Index". For instance, if an activity was critical in 3,000 simulation runs out of 10,000 total simulation runs, the Criticality Index = 0.3.

Before running the PertMaster program, the PMOC assigned three durations to each schedule activity in the *"CITY.PRX"* MPS schedule. The three durations for each activity represent the minimum (Best Case), most likely, and maximum (Worst Case). The PMOC reviewed the activity Original Durations (OD) in the MPS schedule (*CITY.PRX*) and made an objective determination of the adequacy of each activity Original Duration (OD). The PMOC used many of the schedule OD durations as the most-likely durations. However, in some cases the PMOC determined the OD was too aggressive. The duration assignments are based on PMOC experience and program understanding. The value ranges (differences in activity durations) reflect levels of uncertainty. Based on the three durations, a triangular distribution was assigned to each activity. The range of durations for each activity is shown in Figure 10-1.

The PMOC suggested activity duration ranges for the "Most Likely" category specific to the Master Schedule activities that represent FTA review periods are captured in Table 10-3. The PMOC suggests the City review these activity durations with the FTA for concurrence prior to entry into PE and on a frequent basis as the project evolves through the FFGA process. The PMOC increased most of the activity durations as they appear overly aggressive especially considering the Master Project Schedule calendar is 7 work days per week, not a normal 5 day work week.

Table 10-3. Most Likely Durations for FTA Review Activities

Activity ID	Activity Description	Original Duration	PMOC Suggested Duration
I405	FTA Review & Issue LONP for Farrington Sta	21	30
P730	FTA Review and Issue LONP for MSF	21	30
P260	FTA Review / Issue LONP for DB Guideway FD	21	30
P280	FTA Review / Issue LONP for DB Guideway	21	30
P440	FTA Review and Issue LONP for Systems	21	30
E110	FTA Final Review of DEIS	5	20
N200	FTA OMC Review	7	15
N220	FTA Review Before & After Study Plan	14	20
N260	FTA Evaluates Request for PE	30	60
A180	FTA REV LONP for RFP Part 2 DB	21	25
N270	FTA Approves PE	0	0
E220	Submit Admin FEIS to FTA	1	1
E230	FTA Review of Admin	46	60
E250	FTA Final Review of FEIS	5	20
E260	Incorporate Final FTA Revisions	2	15
D240	FTA Approve Entry to Final Design	120	150
F170	FTA Financial Capacity Assessment for FFGA	45	45
F250	FTA Review FFGA	180	180
F270	FTA Award FFGA	0	0

All durations are 7 work days per week.

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Figure 10-1. CPM Activity Duration Ranges

Honolulu High Capacity Transit Corridor
PMOC (Jacobs) Schedule File "35C1"

ID	Description	Orig Duration	Minimum Duration	Most Likely	Maximum Duration	Duration Function	Criticality Index
1	As-Built Before Data Date	1	1	1	1	Triangle(1;1;1)	100%
A100	Prep LONP Request Part 2 DB G'way/MSF/Systems	30	20	25	35	Triangle(20;25;35)	3%
A110	DB Guideway Plan & Permit Design Schedule	60	50	60	70	Triangle(50;60;70)	6%
A120	DB MSF Plan & Permit Design Schedule	60	50	60	70	Triangle(50;60;70)	0%
A130	Geotech & Other DB Guideway Tech Reports	90	80	90	105	Triangle(80;90;105)	41%
A140	Geotech & Other DB MSF Tech Reports	90	75	90	105	Triangle(75;90;105)	3%
A150	DB Guideway Project Documents	120	100	110	130	Triangle(100;110;130)	42%
A170	**Req LONP for RFP Part 2 DB G'way/MSF/Systems**	**0**					**41%**
A180	FTA REV LONP for RFP Part 2 DB G'way/MSF/Systems	21	15	25	35	Triangle(15;25;35)	41%
A190	**Receive LONP for RFP Part 2 DB G'way/MSF/Systems**	**0**					**41%**
A200	DB MSF Project Documents	17	12	20	35	Triangle(12;20;35)	32%
D080	Procure GCM Contractor	180	160	180	200	Triangle(160;180;200)	21%
D090	Complete 3rd Party Agreements for FD Phase	220	180	200	270	Triangle(180;200;270)	97%
D095	Update Travel Forecasts for FD Phase	10	8	10	15	Triangle(8;10;15)	76%
D110	Update PMP Basic Requirements for FD	30	15	25	35	Triangle(15;25;35)	81%
D120	Submit PE Value Engineering Report	30	20	25	35	Triangle(20;25;35)	82%
D130	Produce Procurement Plans for FD Phase	30	20	25	35	Triangle(20;25;35)	82%
D140	Update New Starts Submittal	30	20	30	35	Triangle(20;30;35)	82%
D150	Update PMP Plans for FD	45	30	40	50	Triangle(30;40;50)	87%
D160	Update PMP Project Proceedures for FD	60	35	50	65	Triangle(35;50;65)	90%
D170	Complete PE Project Definition/Scope	90	65	85	95	Triangle(65;85;95)	98%
D180	Complete PE Project Cost/Schedule & Financl Plan	90	65	85	95	Triangle(65;85;95)	98%
D190	Complete PE Project Development Requirements	90	65	85	95	Triangle(65;85;95)	97%
D215	Before & After Study Milestone 2 Report	90	65	85	95	Triangle(65;85;95)	97%
D220	**Document Administrative Requirements for FD**	**0**					**100%**
D230	Conduct PE Phase Risk Assessment	120	90	135	160	Triangle(90;135;160)	100%
D240	FTA Approve Entry to Final Design	120	90	150	200	Triangle(90;150;200)	100%
E100	Revise Admin Draft Environmental Impact Statem't	9	7	10	21	Triangle(7;10;21)	100%
E110	FTA Final Review of DEIS	5	5	20	35	Triangle(5;20;35)	100%
E120	Print DEIS	6	4	5	7	Triangle(4;5;7)	100%
E130	Distribute DEIS	7	5	5	8	Triangle(5;5;8)	100%
E140	Issue DEIS/Publish Notice of Availability	1	1	1	1	Triangle(1;1;1)	100%
E150	Public Comment Period	44	40	44	50	Triangle(40;44;50)	100%
E160	Hold Public Hearings	5	5	5	10	Triangle(5;5;10)	100%
E170	Prepare Final EIS	121	95	120	160	Triangle(95;120;160)	100%
E180	Preliminary Engineering DB Guideway	45	35	50	80	Triangle(35;50;80)	70%
E190	Preliminary Engineering MSF	120	105	120	160	Triangle(105;120;160)	86%
E200	*New Starts Preliminary Engineering*	*361*					*0%*
E210	PE Value Engineering for DBB	15	12	15	35	Triangle(12;15;35)	100%
E220	Submit Admin FEIS to FTA	1	1	1	1	Triangle(1;1;1)	100%
E230	FTA Review of Admin FEIS	46	40	60	90	Triangle(40;60;90)	100%
E240	Revise Admin FEIS	10	5	15	30	Triangle(5;15;30)	100%
E250	FTA Final Review of FEIS	5	5	20	40	Triangle(5;20;40)	100%
E260	Incorporate Final FTA Revisions	2	1	15	30	Triangle(1;15;30)	100%
E270	Print FEIS	4	3	4	5	Triangle(3;4;5)	100%
E280	Distribute FEIS	5	4	5	7	Triangle(4;5;7)	100%
E290	Issue FEIS/Publish NOA	1	1	1	1	Triangle(1;1;1)	100%
E300	**Issue Record of Decision**	**0**					**100%**
F100	Update 3rd Party Agreements for Constr Phase	90	65	85	110	Triangle(65;85;110)	0%
F110	Update Travel Forecasts at FFGA	10	6	10	15	Triangle(6;10;15)	36%
F120	Update PMP Basic Requirements for Constr	30	20	25	35	Triangle(20;25;35)	44%
F130	Submit FD Value Engineering Report	30	20	25	35	Triangle(20;25;35)	44%
F140	Update Procurement Plans for Constr Phase	30	20	25	35	Triangle(20;25;35)	44%
F150	Update PMP Plans for Constr	45	25	35	45	Triangle(25;35;45)	49%
F160	Update PMP Project Proceedures for Constr	60	30	50	65	Triangle(30;50;65)	55%

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Honolulu High Capacity Transit Corridor

PMOC (Jacobs) Schedule File "35C1"

ID	Description	Orig Duration	Minimum Duration	Most Likely	Maximum Duration	Duration Function	Criticality Index
F170	FTA Financial Capacity Assessment for FFGA	45	35	45	55	Triangle(35;45;55)	94%
F180	Update Risk Assessment for FFGA	30	20	30	35	Triangle(20;30;35)	44%
F190	Comp FD Project Definition/Scope	120	100	120	140	Triangle(100;120;140)	99%
F200	Comp FD Project Cost/Schedule & Financial Plan	120	100	120	140	Triangle(100;120;140)	99%
F210	Comp FD Project Development Requirements	120	100	120	140	Triangle(100;120;140)	99%
F215	Before & After Study Milestone 3 Report	90	80	90	120	Triangle(80;90;120)	98%
F220	FFGA Application	30	30	80	120	Triangle(30;80;120)	100%
F230	City Council Authorizing Resolution of FFGA	30	20	30	60	Triangle(20;30;60)	100%
F240	**Request FFGA**	**0**					**100%**
F250	FTA Review FFGA	180	100	180	230	Triangle(100;180;230)	100%
F260	Congressional Review	60	60	60	90	Triangle(60;60;90)	100%
F270	**FTA Award FFGA**	**0**					**100%**
F280	City Executes FFGA	7	7	7	15	Triangle(7;7;15)	100%
I100	Identify ROW Requirements	60	52	60	70	Triangle(52;60;70)	0%
I110	**Identify ROW Parcels**	**0**					**0%**
I120	General Construction Manager Contract	3398	3000	3395	3400	Triangle(3000;3395;3400)	1%
I130	Program Management Support Contract	3398	3000	3395	3400	Triangle(3000;3395;3400)	2%
I140	**Start Construction DB Guideway**	**0**					**71%**
I145	Vehicle Design/Manufacture/Test/Commission	3160	2700	3160	3600	Triangle(2700;3160;3600)	18%
I150	System Design/Manufacture/Instal/Test/Commission	3160	2700	3160	3600	Triangle(2700;3160;3600)	37%
I160	**Open Farrington Section**	**0**					**100%**
I165	**Open East Kapolei Pearl Highlands**	**0**					**100%**
I170	**Open to Aloha Stadium**	**0**					**100%**
I175	Before & After Study Milestone 5 Report	120	105	120	125	Triangle(105;120;125)	1%
I200	ROW West Oahu Station	200	180	200	250	Triangle(180;200;250)	0%
I210	West Oahu Station Select/Design/Bid/Award	482	430	450	490	Triangle(430;450;490)	0%
I220	West Oahu Stations Construction	821	735	820	870	Triangle(735;820;870)	98%
I400	Prepare LONP Request for Farrington Sta Design	30	25	30	35	Triangle(25;30;35)	0%
I405	FTA Reveiw & Issue LONP for Farrington Sta Dsgn	21	18	30	45	Triangle(18;30;45)	0%
I410	ROW & Relocation Farrington Stations	365	325	365	400	Triangle(325;365;400)	0%
I420	Farrington Station Select/Design/Bid/Award	567	510	565	600	Triangle(510;565;600)	0%
I430	Farrington Stations Construction	1115	1000	1115	1250	Triangle(1000;1115;1250)	100%
I440	ROW Relo for West Oahu/Farrington Guideway	200	180	200	250	Triangle(180;200;250)	0%
I450	W790O/F Guideway DB Contract Design	790	710	790	820	Triangle(710;790;820)	49%
I460	WO/F Guideway DB Contract Sitework & Utilities	790	710	790	820	Triangle(710;790;820)	50%
I470	West Oahu/Farrington G'way DB Contract	790	710	790	820	Triangle(710;790;820)	100%
I500	ROW for MSF	180	160	180	250	Triangle(160;180;250)	0%
I510	MSF Design	1500	1350	1500	1700	Triangle(1350;1500;1700)	66%
I520	MSF DB Contract	1500	1350	1500	1700	Triangle(1350;1500;1700)	87%
I600	ROW for Kamehaha Guideway	365	325	365	400	Triangle(325;365;400)	0%
I610	Kamehameha Utility Select/Design/Bid/Awd	418	380	415	460	Triangle(380;415;460)	54%
I615	Kamehameha Guideway Select/Design/Bid/Awd	478	430	480	520	Triangle(430;480;520)	37%
I620	Kamehameha Utility Relocation Contract	425	375	425	460	Triangle(375;425;460)	54%
I630	Obtain Constr Funding Kamehameha G'way	210	190	210	230	Triangle(190;210;230)	100%
I635	Before & After Study Milestone 4 Report	90	80	90	105	Triangle(80;90;105)	99%
I640	Kamehameha G'way Constr Contract	1400	1260	1400	1540	Triangle(1260;1400;1540)	100%
I650	ROW & Relocation for Kamehameha Station	365	325	365	400	Triangle(325;365;400)	0%
I660	Kamehameha Station Select/Design/Bid/Award	466	400	465	520	Triangle(400;465;520)	0%
I665	Kamehameha Sitework	730	660	730	800	Triangle(660;730;800)	99%
I670	Kamehameha Stations Construction	730	660	730	800	Triangle(660;730;800)	100%
I700	ROW & Relocation for Salt Lake Guideway	365	325	365	400	Triangle(325;365;400)	0%
I710	Salt Lake Utility Select/Design/Bid/Award	420	380	420	450	Triangle(380;420;450)	22%
I715	Salt Lake Guideway Select/Design/Bid/Award	480	430	480	510	Triangle(430;480;510)	0%
I720	Salt Lake Utility Relocations	850	780	850	1000	Triangle(780;850;1000)	22%
I730	Obtain Constr Funding Salt Lake G'way	120	105	120	140	Triangle(105;120;140)	36%

Honolulu High Capacity Transit Corridor

PMOC (Jacobs) Schedule File "35C1"

ID	Description	Orig Duration	Minimum Duration	Most Likely	Maximum Duration	Duration Function	Criticality Index
I740	Salt Lake G'way Constr Contract	1200	1080	1200	1380	Triangle(1080;1200;1380)	58%
I750	ROW & Relocation for Salt Lake Stations	365	325	365	400	Triangle(325;365;400)	0%
I760	Salt Lake Station Select/Design/Bid/Award	466	420	465	500	Triangle(420;465;500)	0%
I765	Salt Lake Sitework	1250	1085	1250	1320	Triangle(1085;1250;1320)	28%
I770	Salt Lake Stations Construction	1250	1085	1250	1320	Triangle(1085;1250;1320)	58%
I800	ROW & Relocation for City Center Guideway	365	325	365	400	Triangle(325;365;400)	0%
I810	City Center Utility Select/Design/Bid/Award	386	345	385	410	Triangle(345;385;410)	3%
I815	City Center Guideway Select/Design/Bid/Award	446	400	445	500	Triangle(400;445;500)	0%
I820	City Center Utility Relocations	720	650	720	800	Triangle(650;720;800)	3%
I830	City Center G'way Constr Contract	1500	1350	1500	1620	Triangle(1350;1500;1620)	3%
I840	Obtain Constr Funding City Center G'way	210	190	210	270	Triangle(190;210;270)	0%
I850	ROW & Relocation for Kaka'ako Stations	365	325	365	440	Triangle(325;365;440)	0%
I860	Kaka'ako Station Select/Design/Bid/Award	466	420	465	510	Triangle(420;465;510)	0%
I870	Kaka'ako Stations Construction	1370	1230	1370	1430	Triangle(1230;1370;1430)	3%
I880	ROW & Relocation for City Center Stations	365	325	365	400	Triangle(325;365;400)	0%
I890	City Center Station Select/Design/Bid/Award	466	420	465	510	Triangle(420;465;510)	0%
I900	City Center Sitework	980	885	980	1030	Triangle(885;980;1030)	0%
I910	City Center Stations Construction	980	885	980	1030	Triangle(885;980;1030)	0%
I999	**Open to Ala Moana Center**	**0**					**100%**
N100	SCC Cost Work Sheets	7	4	7	12	Triangle(4;7;12)	95%
N110	Update PMP	20	15	20	25	Triangle(15;20;25)	98%
N120	Prepare Rev O&M Cost Methodology	20	15	20	30	Triangle(15;20;30)	98%
N130	PE Financial Plan FMOC Review	21	16	25	35	Triangle(16;25;35)	97%
N140	Making The Case Document	21	16	25	35	Triangle(16;25;35)	97%
N150	Prepare Request for PE	30	25	30	35	Triangle(25;30;35)	98%
N160	Prepare PDP Pre PE	30	25	40	45	Triangle(25;40;45)	100%
N170	Prepare Draft Before & After Study Plan	30	20	30	35	Triangle(20;30;35)	99%
N175	Before & After Data & Milestone 1 Report	75	55	75	85	Triangle(55;75;85)	100%
N180	Develop Pre PE Risk Assm't (JACOBS)	46	40	50	65	Triangle(40;50;65)	100%
N190	PMOC Review of PE PMP Update	7	5	13	20	Triangle(5;13;20)	98%
N200	FTA OMC Review	7	5	15	25	Triangle(5;15;25)	98%
N210	Prepare New Starts Templates & Certs	7	5	10	15	Triangle(5;10;15)	98%
N220	FTA Review Before & After Study Plan	14	14	20	30	Triangle(14;20;30)	99%
N230	Finalize Before & After Study Plan	7	5	7	12	Triangle(5;7;12)	99%
N240	Incorporate Jacobs Comments	30	20	25	35	Triangle(20;25;35)	100%
N250	**Submit Request for PE**	**0**					**100%**
N260	FTA Evaluates Request for PE	30	30	60	90	Triangle(30;60;90)	100%
N270	**FTA Approves PE**	**0**					**100%**
P100	Prepare Part 1 DB RFP Guideway	14	10	15	20	Triangle(10;15;20)	10%
P110	Prepare Part 2 DB RFP Guideway	60	50	60	65	Triangle(50;60;65)	67%
P120	**Issues Part 1 DB Guideway RFP**	**0**					**10%**
P130	Offerors Prepare DB Guideway Response	45	35	45	55	Triangle(35;45;55)	10%
P140	**Offerors Submit DB RFP Part 1 Guideway**	**0**					**10%**
P150	Evaluate DB Guideway Part 1 Submittals	21	15	20	28	Triangle(15;20;28)	10%
P160	**Submit Part 2 DB RFP Guideway to City Council**	**0**					**56%**
P170	Council Review RFP Specs for Guideway	60	50	60	90	Triangle(50;60;90)	56%
P180	**Issues Part 2 DB Guideway RFP**	**0**					**100%**
P190	**Issues PE Addendum Part 2 DB Guideway RFP**	**0**					**70%**
P200	Offerors Prepare DB Part 2 G'way Response & VE	120	90	110	140	Triangle(90;110;140)	71%
P210	**Offerors Submit DB Part 2 Guideway**	**0**					**71%**
P220	Evaluate Offerors Part 2 Submittals (Summary)	160	145	150	180	Triangle(145;150;180)	71%
P230	Select Award & Execute DB Guideway	45	30	45	50	Triangle(30;45;50)	71%
P240	**Issue NTP 1 DB Guideway for FD**	**0**					**71%**
P250	Prepare LONP Request for DB Guideway FD	30	25	30	35	Triangle(25;30;35)	71%
P260	FTA Review / Issue LONP for DB Guideway FD	21	15	30	45	Triangle(15;30;45)	71%

Honolulu High Capacity Transit Corridor

PMOC (Jacobs) Schedule File "35C1"

ID	Description	Orig Duration	Minimum Duration	Most Likely	Maximum Duration	Duration Function	Criticality Index
P270	Prepare LONP Request for DB Guideway Constr	30	25	30	35	Triangle(25;30;35)	100%
P280	FTA Review / Issue LONP for DB Guideway Constr	21	15	30	45	Triangle(15;30;45)	100%
P290	**Issue NTP 2 DB Guideway for Constr**	**0**					**100%**
P300	Prepare Part 2 DB RFP Systems	60	50	60	80	Triangle(50;60;80)	0%
P310	Prepare Part 1 DB RFP Systems	14	10	15	20	Triangle(10;15;20)	0%
P320	**Issues Part 1 DB RFP Systems**	**0**					**37%**
P330	Offerors Prepare DB Systems Response Part 1	45	35	45	55	Triangle(35;45;55)	37%
P340	**Offerors Submit DB RFP Part 1 Systems**	**0**					**37%**
P350	Evaluate DB Systems Part 1 Submittals	21	15	20	30	Triangle(15;20;30)	37%
P360	**Submit Part 2 DB RFP Systems to City Council**	**0**					**37%**
P370	City Council Review RFP Specs for Systems	30	20	30	60	Triangle(20;30;60)	37%
P380	**Issues Part 2 DB Systems RFP**	**0**					**37%**
P390	Offerors Prepare DB Part 2 Systems Response	120	105	120	140	Triangle(105;120;140)	26%
P400	Issues PE Addendum Part 2 DB Systems RFP	30	20	25	40	Triangle(20;25;40)	13%
P410	Prepare the LONP Request for Systems	30	20	25	40	Triangle(20;25;40)	0%
P420	**Offerors Submit DB Part 2 Systems**	**0**					**26%**
P430	Evaluate Offerors Part 2 Systems Submittals	160	135	150	190	Triangle(135;150;190)	37%
P440	FTA Review and Issue LONP for Systems	21	15	30	45	Triangle(15;30;45)	0%
P450	Buy America Pre Award Audit	30	22	25	35	Triangle(22;25;35)	0%
P460	Select Award & Execute DB Systems	60	45	60	70	Triangle(45;60;70)	37%
P470	**Issue NTP 2 DB Systems**	**0**					**37%**
P600	Prepare Part 1 DB RFP MSF	14	10	15	20	Triangle(10;15;20)	12%
P610	Prepare Part 2 DB RFP MSF	60	45	60	70	Triangle(45;60;70)	23%
P620	**Issues Part 1 DB MSF RFP**	**0**					**79%**
P630	Offerors Prepare DB MSF Response Part 1	45	40	45	60	Triangle(40;45;60)	79%
P640	**Offerors Submit DB RFP Part 1 MSF**	**0**					**79%**
P650	Evaluate DB MSF Part 1 Submittals	21	15	20	35	Triangle(15;20;35)	79%
P660	**Submit Part 2 DB RFP MSF to City Council**	**0**					**79%**
P670	Council Review RFP Specs MSF	30	25	30	35	Triangle(25;30;35)	79%
P680	**Issues Part 2 DB MSF RFP**	**0**					**87%**
P690	Offerors Prepare DB MSF Response Part 2	120	110	120	150	Triangle(110;120;150)	87%
P700	**Offerors Submit DB Part 2 MSF**	**0**					**87%**
P710	Prepare the LONP Request for MSF	30	25	30	35	Triangle(25;30;35)	36%
P720	Evaluate Offerors Part 2 MSF Submittals	120	100	115	140	Triangle(100;115;140)	87%
P730	FTA Review and Issue LONP for MSF	21	15	30	45	Triangle(15;30;45)	82%
P740	Select Award & Execute DB MSF	45	30	40	55	Triangle(30;40;55)	87%
P750	**Issue NTP 2 DB MSF**	**0**					**87%**

PertMaster Project Analytics	Company: Jacobs - FTA PMOC	Page 4 of 4	Sort: ID
	Manager:	Plan Finish: 18/Dec/18	Filter: None
	Planner: Charles Neathery		

Using the above probabilistic durations and triangular distribution, the schedule was recalculated 1000 times, selecting random durations for each task, to estimate the completion date/ROD. This analysis yields the results shown in Figure 10-2.

Figure 10-2. Finish Date Distribution

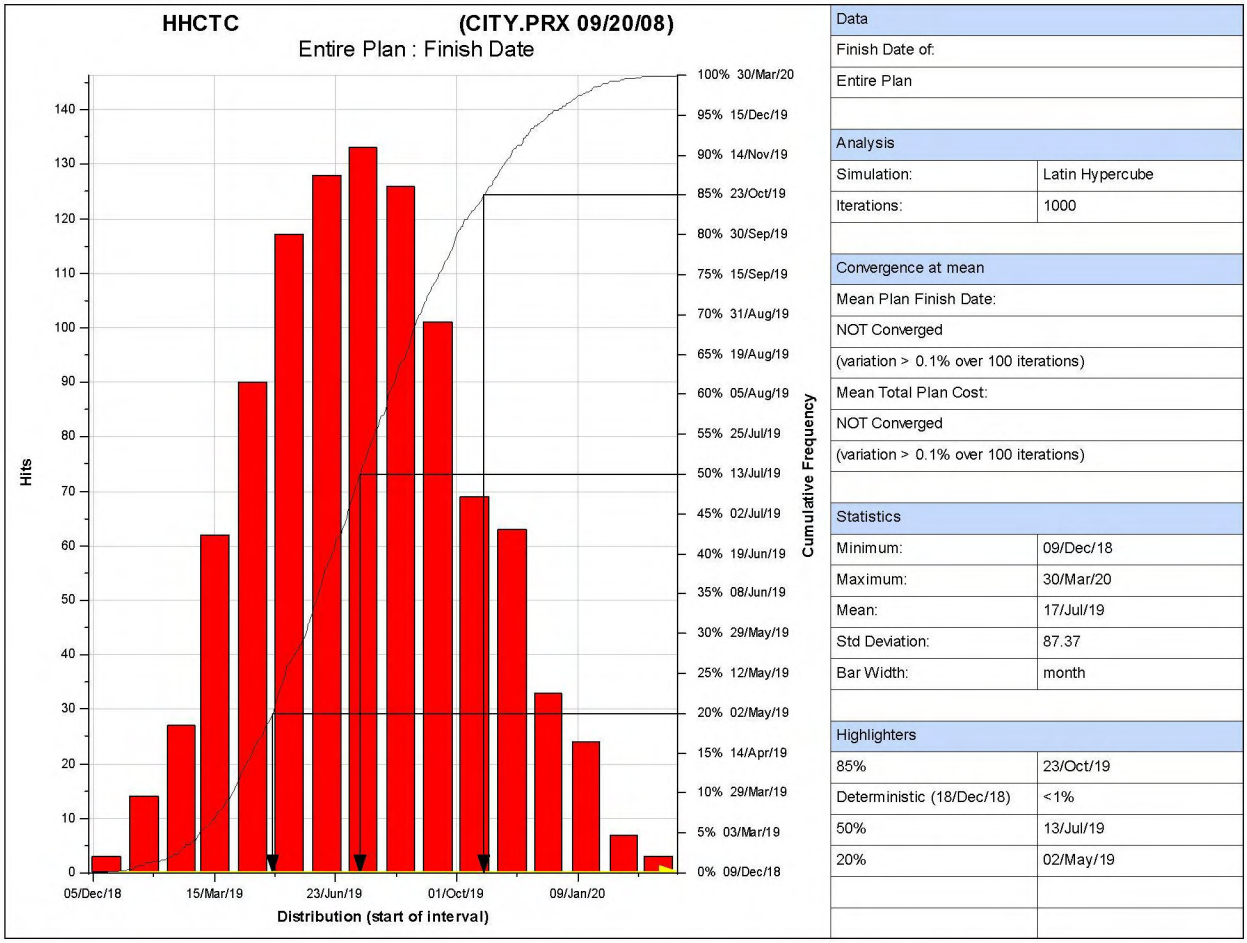

Figure 10-2 demonstrates that, based on the estimated range of activity durations, there is less than a 1% chance of achieving ROD by the project completion date/ROD of December 18, 2018 as calculated in the PMOC's "35C1.PRX" schedule developed, which is based on the City's "CITY.PRX" schedule. The analysis indicates there is an 85% probability of achieving ROD by October 23, 2019. The earliest calculated date for achieving ROD is December 5, 2018. The latest calculated date for achieving ROD is March 30, 2020.

The analysis also determined the "Criticality Index". The Criticality Index quantifies how often a task was on the critical path. It helps identify those tasks that are most likely to be critical. As the schedule is recalculated using the different durations, the critical path may change with each iteration; therefore, the critical path calculated in the update to the Baseline CPM schedule may not necessarily have the highest Criticality Index. Those activities with higher Critically Indexes are more likely to impact project completion.

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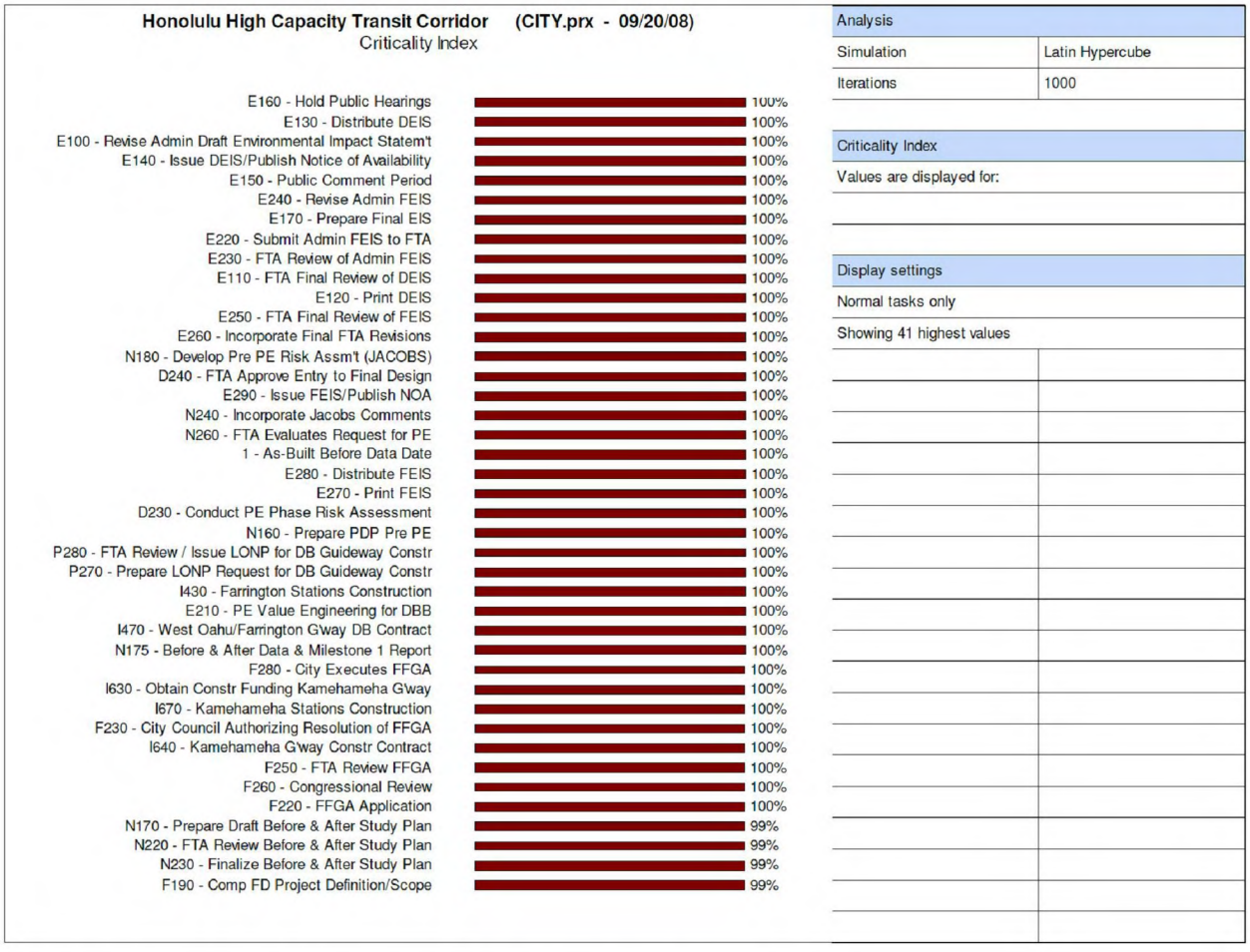
Figure 10-3 illustrates the activities criticality based on the percentage of time that the activity appeared on the critical path with each schedule iteration. The schedule contains a high amount of activities on the critical path calculations primarily because the schedule activities are linear, non concurrent, and are very summary in nature.

Figure 10-3. Criticality Index – Highest Values



10.2.3 Estimation of Project Schedule Mitigation Capacity

In addition to calculation of the ROD date, to assess the schedule mitigation capacity of the project, the schedule distribution was calculated for each of the schedule milestones described in Table 10-4. The distribution for these milestones was calculated in the same manner as for the ROD date. An optimistic date for achieving the milestone is the 20th percentile; high confidence of achievement is at the 85th percentile. Data are also shown for the median date (50th percentile) and the maximum date from the calculation. Table 10-4 shows a compilation of these dates. Figure 10-4 through Figure 10-10 illustrate the completion date probability distribution for each of the milestone activities.

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Table 10-4. Probability of Achievement Date of Schedule Milestones

Project Timeframe	Activity ID	Schedule Finish Date	Milestone Achievement Date – Percentile Rank			
			20th	50th	85th	Maximum
Entry into PE	N270	31DEC08	22JAN09	04FEB09	18FEB09	12MAR09
Entry into Final Design	D240	26DEC09	02APR10	01MAY10	07JUN10	12AUG10
FFGA Award	F270	26FEB11	12JUL11	25AUG11	15OCT11	17JAN12
Construction RODs						
Open Farrington Section	* I160	15DEC12	11NOV12	11NOV12	11NOV12	11NOV12
Open East Kapolei Pearl Highlands	I165	16APR14	01AUG14	11SEP14	04NOV14	09MAR15
Open to Aloha Stadium	I170	26MAR17	14AUG17	17OCT17	09JAN18	06JUL18
Open to Ala Moana Center	I999	18DEC18	02MAY19	13JUL19	23OCT19	30MAR20

*Mandatory constraint date in the City schedule distorted the triangular distribution of dates.

Figure 10-4. Activity N270 Finish Date Distribution

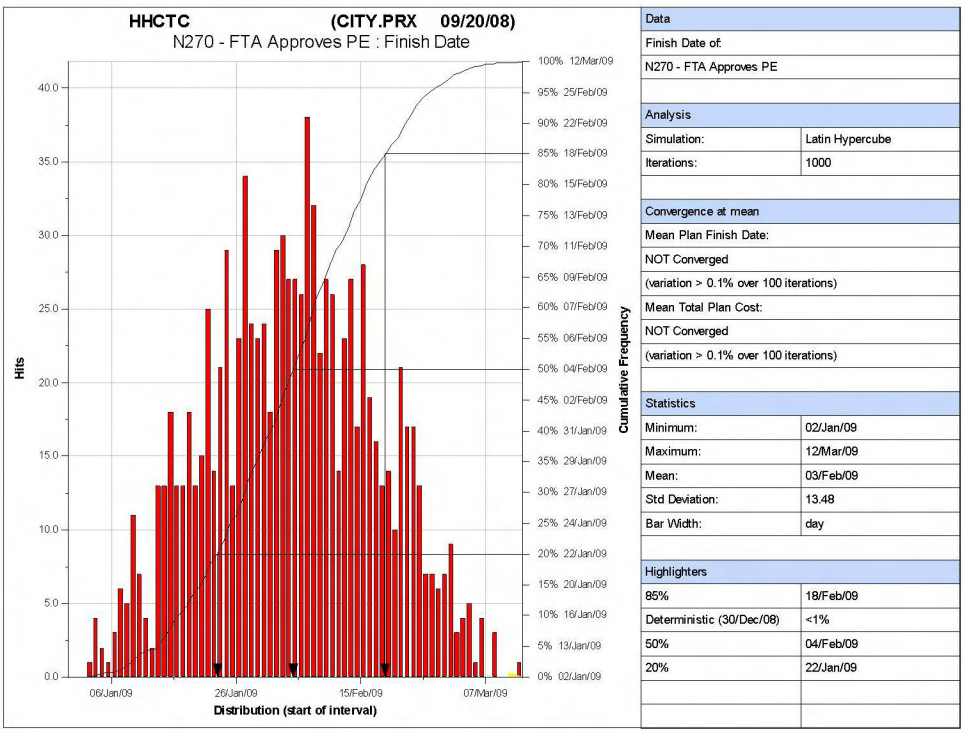

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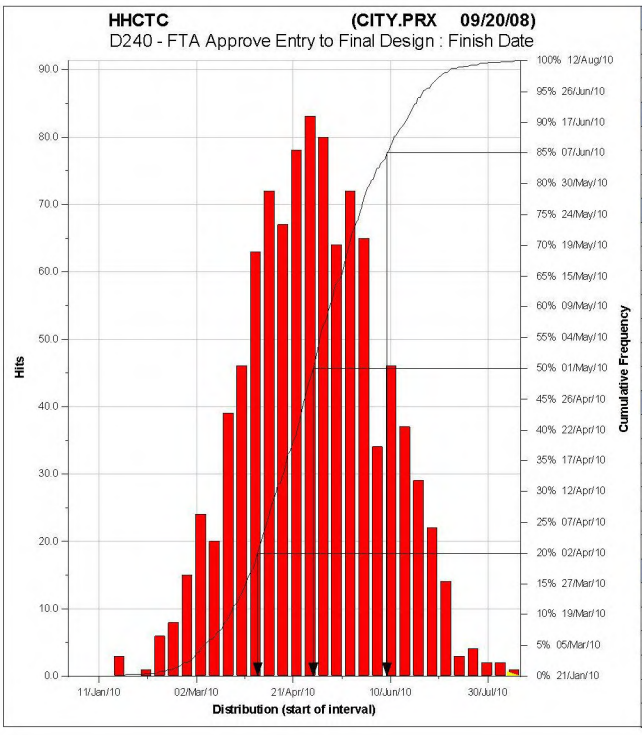
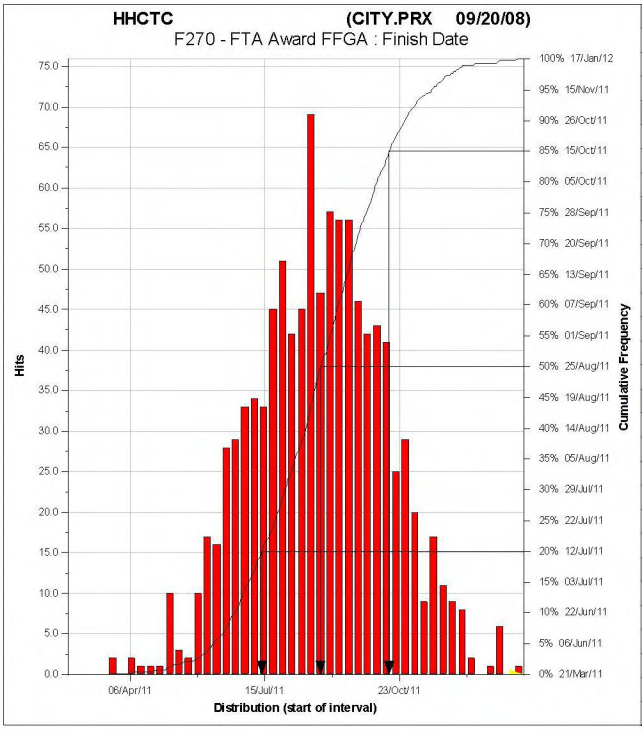
Figure 10-5. Activity D240 Finish Date Distribution



Data	
Finish Date of:	
D240 - FTA Approve Entry to Final Design	
Analysis	
Simulation:	Latin Hypercube
Iterations:	1000
Convergence at mean	
Mean Plan Finish Date:	
NOT Converged	
(variation > 0.1% over 100 iterations)	
Mean Total Plan Cost:	
NOT Converged	
(variation > 0.1% over 100 iterations)	
Statistics	
Minimum:	21/Jan/10
Maximum:	12/Aug/10
Mean:	01/May/10
Std Deviation:	34.07
Bar Width:	week
Highlighters	
85%	07/Jun/10
Deterministic (26/Dec/09)	<1%
50%	01/May/10
20%	02/Apr/10

Figure 10-6. Activity F270 Finish Date Distribution



Data	
Finish Date of:	
F270 - FTA Award FFGA	
Analysis	
Simulation:	Latin Hypercube
Iterations:	1000
Convergence at mean	
Mean Plan Finish Date:	
NOT Converged	
(variation > 0.1% over 100 iterations)	
Mean Total Plan Cost:	
NOT Converged	
(variation > 0.1% over 100 iterations)	
Statistics	
Minimum:	21/Mar/11
Maximum:	17/Jan/12
Mean:	24/Aug/11
Std Deviation:	49.21
Bar Width:	week
Highlighters	
85%	15/Oct/11
Deterministic (19/Feb/11)	<1%
50%	25/Aug/11
20%	12/Jul/11

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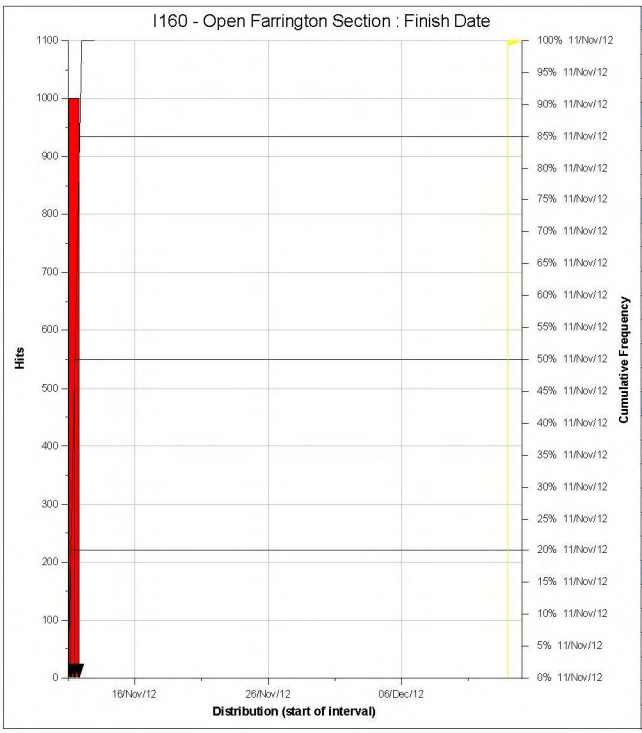
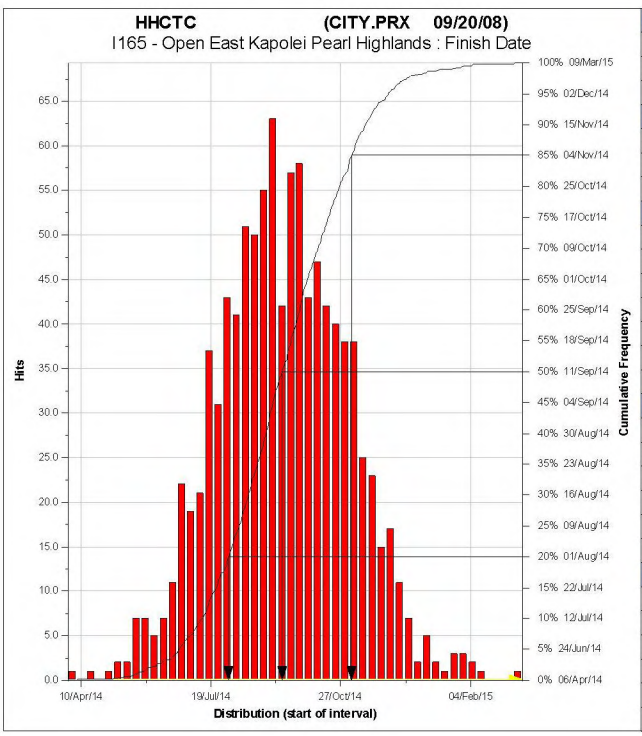
Figure 10-7. Activity I160 Finish Date Distribution



Data	
Finish Date of:	
I160 - Open Farrington Section	
Analysis	
Simulation:	Latin Hypercube
Iterations:	1000
Convergence at mean	
Mean Plan Finish Date:	
NOT Converged	
(variation > 0.1% over 100 iterations)	
Mean Total Plan Cost:	
NOT Converged	
(variation > 0.1% over 100 iterations)	
Statistics	
Minimum:	11/Nov/12
Maximum:	11/Nov/12
Mean:	11/Nov/12
Std Deviation:	0.000
Bar Width:	day
Highlighters	
85%	11/Nov/12
Deterministic (14/Dec/12)	100%
50%	11/Nov/12
20%	11/Nov/12

Figure 10-8. Activity I165 Finish Date Distribution



Data	
Finish Date of:	
I165 - Open East Kapolei Pearl Highlands	
Analysis	
Simulation:	Latin Hypercube
Iterations:	1000
Convergence at mean	
Mean Plan Finish Date:	
NOT Converged	
(variation > 0.1% over 100 iterations)	
Mean Total Plan Cost:	
NOT Converged	
(variation > 0.1% over 100 iterations)	
Statistics	
Minimum:	06/Apr/14
Maximum:	09/Mar/15
Mean:	12/Sep/14
Std Deviation:	49.85
Bar Width:	week
Highlighters	
85%	04/Nov/14
Deterministic (16/Apr/14)	<1%
50%	11/Sep/14
20%	01/Aug/14

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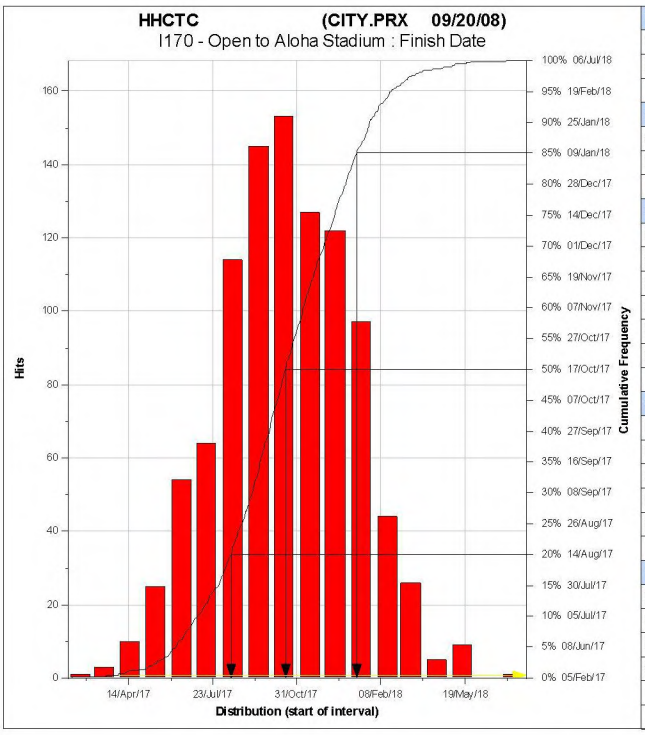
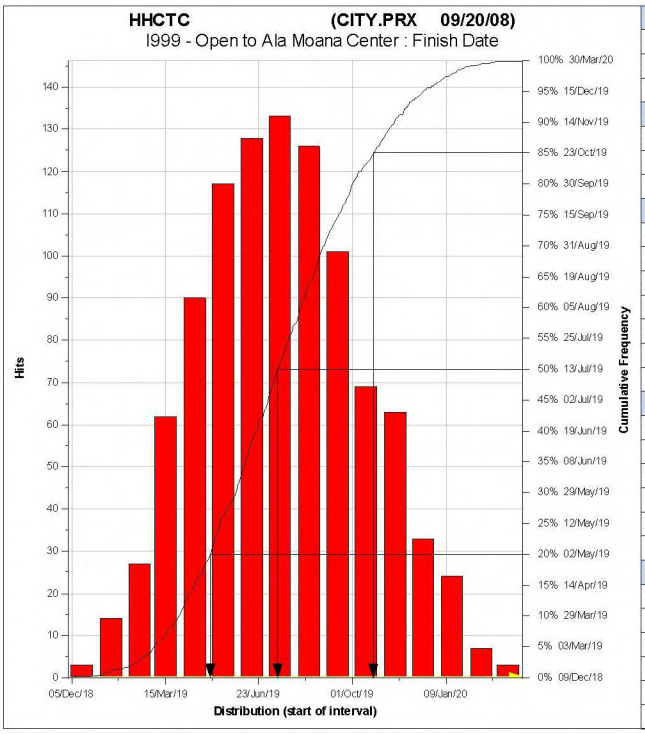
Figure 10-9. Activity I170 Finish Date Distribution



Data	
Finish Date of:	
I170 - Open to Aloha Stadium	
Analysis	
Simulation:	Latin Hypercube
Iterations:	1000
Convergence at mean	
Mean Plan Finish Date:	
NOT Converged	
(variation > 0.1% over 100 iterations)	
Mean Total Plan Cost:	
NOT Converged	
(variation > 0.1% over 100 iterations)	
Statistics	
Minimum:	05/Feb/17
Maximum:	06/Jul/18
Mean:	17/Oct/17
Std Deviation:	79.39
Bar Width:	month
Highlighters	
85%	09/Jan/18
Deterministic (26/Mar/17)	<1%
50%	17/Oct/17
20%	14/Aug/17

Figure 10-10. Activity I999 Finish Date Distribution



Data	
Finish Date of:	
I999 - Open to Ala Moana Center	
Analysis	
Simulation:	Latin Hypercube
Iterations:	1000
Convergence at mean	
Mean Plan Finish Date:	
NOT Converged	
(variation > 0.1% over 100 iterations)	
Mean Total Plan Cost:	
NOT Converged	
(variation > 0.1% over 100 iterations)	
Statistics	
Minimum:	09/Dec/18
Maximum:	30/Mar/20
Mean:	17/Jul/19
Std Deviation:	87.37
Bar Width:	month
Highlighters	
85%	23/Oct/19
Deterministic (18/Dec/18)	<1%
50%	13/Jul/19
20%	02/May/19

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10.2.4 Schedule Risk Summary

The PMOC has identified several schedule drivers that have the potential to delay the project completion date. These schedule drivers include:

(1) 100% Criticality Index:
- City DEIS activities
- City Request to Enter PE
- City Request to Enter Final Design
- LONP for Design/Build Guideway
- Kamehameha Stations Construction
- FFGA Application & Award Process

(2) 90% to 99% Criticality Index:
- Before & After Study Plan activities
- Document Revisions for Entry into Final Design (Plans, Cost & Schedule)

(3) 80% to 89% Criticality Index:
- Document Revisions for Entry into Final Design (PMP & value engineering)
- MSF PE Documents
- Procurement Process for MSF construction
- MSF Design and Construction (Design/Build contract)

(4) 70% to 79% Criticality Index:
- Procurement Process for MSF construction

This schedule risk assessment forecasts that the probability of achieving the proposed ROD of December 18, 2018 is less than 1%. The analysis indicates that there is an 85% probability of achieving the ROD by October 23, 2019.

Based on the current MPS, the PMOC recommends a project completion date (ROD), no earlier than November 14, 2019.

10.2.5 Schedule Risk Mitigation Plan

Based on the PMOC's review of the current MPS schedule and analysis using probabilistic modeling, there are several areas which should be pursued to increase the probability of achieving an early project completion date/ROD:

(1) City – Expedient development and submittal of New Starts documentation required of Request to Enter PE, Request to Enter Final Design, and subsequent FFGA Application.
(2) City – Expedient development and submittal of DEIS documents.
(3) City – Expedient development and submittal of LONP Requests.
(4) City – Expedient development and submittal of Before & After Study Plan.

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(5) City – Expedient contract document development and procurement of D/B contractors for the MSF and guideway.

These identified risks are solely based on the outcomes generated by PG-35C and PG-40C Products. A more detailed and formal risk identification metric is provided in Section 8.0.

10.3 Conclusion

The schedule risk analysis was based on the City's *"CITY.PRX"* schedule. The PMOC's schedule risk analysis, generated by the aggregation of activity duration probability distributions determined there is less than a 1% chance of achieving Revenue Operation Date (ROD) by the project completion date/ROD of December 18, 2018. The analysis indicates there is an 85% probability of achieving ROD by October 23, 2019. The earliest calculated date for achieving ROD is December 5, 2018. The latest calculated date for achieving ROD is March 30, 2020.

10.4 Recommendations

Based on the current MPS and the results of the schedule risk analysis and contingency analysis, the PMOC recommends a project completion date (ROD) no earlier than November 14, 2019.

10.4.1 Conditional Approval to Enter PE

The PMOC has determined there are no conditional requirements needed prior to the Entry into PE, though the PMOC has provided the following suggestions be incorporated into the Master Project Schedule during the next revision.

(1) Technical Schedule Review:
- Do not use mandatory constraints
- Reduce the amount of constraints used
- Increase the amount of activities in the longest critical path
- Do not use activity durations greater than 2 months

(2) Provide monthly schedule updates.

(3) Self perform PertMaster or similar Schedule Risk Analysis on the Master Project Schedule at least once per quarter. In addition, seek consultant, vendor and construction contractor input on critical schedule activity durations (Best Case, Worst Case, Most Likely) to support the Schedule Risk Analysis.

(4) Greatly expand the detail for Vehicle and Systems procurement, installation, testing and commissioning.

(5) Incorporate for schedule activity detail for early construction packages such as interagency agreements, early site-work packages, early utility adjustment packages, etc.

(6) Provide more backup documentation explaining the justification of activity original durations.

(7) Provide more activity detail for ROW acquisitions by contract segment.

(8) Seek FTA review and comment on schedule activities that indicate "FTA Review".

(9) Provide a summarized group of activities that are 100% complete for the past two years for a historical record.

(10) Allow more float contingency for construction contractor bid and award process for Design-Bid-Build and for Design-Build procurements to allow for bidding extensions, contract document addendums, etc.

(11) Provide more interim milestones within each contract segments. These milestones can be used as a means to support earned value measurement and general progress status reporting.

(12) The Master Project Schedule should be "baselined" early in the PE phase. The baseline should be used during subsequent monthly progress updates for variance reporting and to support the justification of recovery schedule efforts. Like wise, the City should incorporate schedule revisions to address any necessary means or methods of schedule recovery to account for any delays/schedule impacts realized to date.

10.4.2 During the Early PE Phase

The PMOC recommends the following comments, in addition to the Subtask 34A recommendations, be addressed and incorporated into the Master Project Schedule no later than the first sixty (60) days of the PE phase.

(1) The City MPS interim milestone activities representing the incremental Revenue Operation Dates should be consistently used and labeled as finish milestones. The City should evaluate the necessity of each milestone and how each milestone impacts the overall project. The milestones are:
- Open Farrington Section
- Open East Kapolei Pearl Highlands
- Open to Aloha Stadium
- Open to Ala Moana Center

(2) Develop and submit a schedule mitigation plan for at least three (3) months of schedule recovery for the following project milestones:
- Request to Enter Final Design
- FFGA Application, Review and Award Process
    - Open Farrington Section

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- Open East Kapolei Pearl Highlands
- Open to Aloha Stadium
- Open to Ala Moana Center

(3) Develop and submit a schedule mitigation plan for at least four (4) months of schedule recovery for the following project phases:
- Start-up and Testing (MSF)
- Start-up and Testing (Entire project alignment)

(4) Develop and submit a project contingency management procedure that identifies how and at what level the City senior management will control the contingency levels for the project.

(5) Evaluate the Vehicle/Systems procurement, Design/Build and Design/Bid/Build contracting strategies to determine if incentives can be included to increase the reliability of schedule performance for these vendors/contractors.

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11.0 CONCLUSION

The PMOC recognizes that components of this Project are further advanced than for a typical project in the pre-PE phase. The PMOC is of the opinion that the Project scope, schedule, and budget are sufficiently developed to allow the Project to advance into the PE phase. ***However, based on the cost risk and contingency analyses and presented within this Spot Report, the PMOC concludes that the Total Project Budget at this phase should be $5.80 billion (YOE) with a total contingency of $1.226 billion (YOE).*** ~~***This equates to an 11% Level of Confidence in the Cost Risk Model after deducting the finance costs and 30% total contingency of the Adjusted BCE.***~~

It is recognized that estimate will undergo significant refinement once the project advances into the PE phase. Over the course of the Project, the Cost Risk Model indicates that it is possible for the Project to be implemented within the current budget with totally effective. The primary mitigation method is chiefly design development and is the preferred method to achieve project cost targets. Secondary mitigation is the amount of additional contingency that must be funded based on the expected risks.

The Schedule Risk Assessment indicates there is an 85% probability of achieving ROD by October 23, 2019, which is a delay of approximately 10 months from the City's plan. The PMOC also recommends that the schedule be modified to reflect a higher probability of achieving the Revenue Operations Date. ***Based on the current MPS and the results of the schedule risk and contingency analyses, the PMOC recommends a project completion date (ROD) no earlier than July 2019, which corresponds to a 50% Level of Confidence at this time.***

The City should develop a Project Development Plan (PDP) to guide them in implementation of the PE phase. The PDP will provide the essential processes to be used, their anticipated costs and schedule, and various metrics to satisfactorily measure performance in attaining the planned delivery of products and completion. The major goal of the PDP, for both the City and the FTA, is to complete the Project within budget and on schedule by delivering the Project through each phase of its development and implementation with the project contingency (cost and time) within targets, completion criteria satisfied, risk mitigation scope accomplished, and mitigation capacity available. The PDP document is, therefore, the development of a distinct product called for by the PMP, which details recommendations for specific tasks and outcomes to advance this project through completion of PE and meeting the entry into the Final Design phase requirements of the FTA. Prior to advancing into Final Design, should the project be so considered, the City shall develop a Project Execution Plan pursuant to FTA requirements.

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APPENDICES

Appendix A: Evaluation Team

Team Member	Location	Role	Telephone	Email
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Appendix B: Documents Reviewed

Document	Date	Author
Basis of Capital Cost Escalation Rates	September 17, 2008	Parsons Brinckerhoff (PB)
Basis of Schedule.doc	September 20, 2008	City
Constr Sched Assumption Notes.pdf	August 28, 2008	City
Honolulu Linear Schedule 22 Sep 08.pdf	September 22, 2008	City
PMOC2 – Honolulu Linear Schedule 07 Aug 08.pdf	August 7, 2008	City
Revised Construction Schedule w Assumptions.pdf	August 28, 2008	City
Schedule Progress Submittal 7.pdf	September 2, 2008	City
Subsurface geology of Waikiki, Moiliili and Kakaako With Engineering Application, Masters Thesis submitted to the University of Hawaii	August 1976	C.J. Ferral
1992 Honolulu Rapid Transit Development Project System Procurement Contract & Methodology *[1992 Original Estimate]*	August 30, 1991	Kaiser Engineers / Lea & Elliot Engineers
Administrative Draft Environmental Impact Statement Honolulu High-Capacity Transit Corridor Project	August 1, 2008	City
Alternative Analysis Drawings	August 2008	PB
Bus Fleet Management Plan (BFMP), Rev. 0	April 4, 2008	City
Construction Workshop Frequently Asked Questions (FAQ)	June 12, 2008	City
Construction Workshop Presentation	June 12, 2008	City
CPM Schedule (CITY.pdf)	September 20, 2008	City
Current Geotechnical Investigation Program boring logs and boring location map		PB
DRAFT Design Criteria Section 1 – General Section 2 – Operations Section 3 – Environmental Section 4 – Track Alignment and Vehicle Clearances Section 5 – Trackwork Section 6 – Civil Section 7 – Traffic Section 8 – Utilities Section 9 – Structural Section 11 – Landscape Architecture Section 17 – Revenue Vehicle Section 18 – Maintenance and Storage Facilities Section 19 – Facility Mechanical Section 20 – Facilities Electrical Section 22 – Elevators and Escalators Architectural Corrosion Control Traction Power	August 1, 2008	PB
Email stating Salt Lake alternative running time, headway, and train consist details from James Dunn, PB	October 6, 2008	PB
Final Capital Costing Memorandum, dated *[October 2006 Memo]*	October 23, 2006	PB
Final Evaluation of Project Delivery Options	November 2, 2006	PB
Geotechnical and Geological Reconnaissance, Honolulu Rapid Transit System, Ewa and Honolulu, Hawaii	August 31, 2991	Geolabs-Hawaii
Geotechnical Engineering Exploration, North-South Road, Phase 1B, F.A.I. Project No. STP-8930(2), Ewa, Hawaii	February 8, 2007	Geolabs, Inc.

Document	Date	Author
Guideway Superstructure Study – Summary Report	May 22, 2008	PB
HHCTC Project Basis of Capital Cost Escalation Rates	September 17, 2008	PB
HHCTC Project Letter on cost of Leeward Community College Underground station	September 19, 2008	PB
HHCTCP Post Alternative Analysis Estimate Methodology	August 26, 2008	PB
Honolulu High-Capacity Transit Corridor Project, Steel Wheel Technology - Evaluation of Vehicle Types	June 12, 2008	PB
Honolulu Rapid Transit Development Project; System Design, Supply, Construction, and Operation & Maintenance; Geotechnical Engineering Exploration	March 1991	Geolabs-Hawaii
Honolulu Rapid Transit Program; Hotel Street Subway Design, Supply, and Construction; Geotechnical Basis for Proposal	July 1991	Dames & Moore
Honolulu Rapid Transit Program; Hotel Street Subway Design, Supply, and Construction; Geotechnical Engineering Exploration	July 1991	Dames & Moore
Honolulu Rapid Transit Program; Task 17.01– 40, Preliminary Geotechnical Exploration Report, King Street Subway Alignment Study	March 1992	Pacific Geotechnical Engineers, Inc.
Model Assumptions, ProjectSolve\Technical\Alignment Information	September 11, 2008	PB
Modified AA Estimate (assembly & parametric summary), filename "Baseline 30 w T2.xls" *[2008 SCC Support Spreadsheet]*	August 19, 2008	PB
PB Cost Estimate and Estimating Methodology *[2006 Parametric Estimate]*	June 30, 2006	PB
PMOC Monthly Monitoring Reports	October 2007 to April 2008	BAH
Procurement Methods / Project Delivery / Schedule Presentation	September 9, 2008	
Project Management Plan, Rev. 0	May 21, 2008	City
Project Orientation Presentation	September 9, 2008	
Proposed Construction Schedule, "HHCTP As of August 25.xer"	August 25, 2008	City
Quality Management Plan (QMP), Rev. 0	April 3, 2008	City
Real Estate and Acquisition Management Plan (RAMP), Rev. 0	May 22, 2008	City
Revised Master Project Schedule, "CITY.PRX"	September 20, 2008	City
Safety and Security Management Plan (SSMP) Rev 0	March 11, 2008	City
SCC New Starts estimate *[2008 SCC Estimate]*	September 3, 2008	PB
Spot Report #1 – Cost Validation Report (DRAFT)	May 2007	BAH
Spot Report #2 – PE Entry Readiness Report	October 2008	BAH
Structures Workshop Summary Report	January 7-10, 2008	PB
Systems Workshop Presentation	August 22, 2008	City
Takeoff Audit Report/HHCT/Modified AA Estimate (assembly examples)	September 9, 2008	PB
Technical Memorandum on Utility Relocations *[2007 MK Utility Estimate]*	May 14, 2007	MK
Transportation Technical Report	August 1, 2008	PB

Appendix C: SCC Worksheet

MAIN WORKSHEET-BUILD ALTERNATIVE (Rev.11, May 2, 2008)

City and County of Honolulu
Honolulu Rail Transit Project, East Kapolei to Ala Moana Center
Application for P.E.

Today's Date 09/11/08
Yr of Base Year $ 2nd Qtr FY 2008
Yr of Revenue Ops FY 2019

	Quantity		Base Year Dollars w/o Contingency (X000)	Base Year Dollars Allocated Contingency (X000)	Base Year Dollars TOTAL (X000)	Base Year Dollars Unit Cost (X000)	Base Year Dollars Percentage of Construction Cost	Base Year Dollars Percentage of Total Project Cost	YOE Dollars Total (X000)
10 GUIDEWAY & TRACK ELEMENTS (route miles)	**19.26**		1,034,735	226,490	**1,261,225**	**$ 65,490**	**50%**	**30%**	**1,549,290**
10.01 Guideway: At-grade exclusive right-of-way					0				0
10.02 Guideway: At-grade semi-exclusive (allows cross-traffic)					0				0
10.03 Guideway: At-grade in mixed traffic					0				0
10.04 Guideway: Aerial structure	18.91		906,846	196,943	1,103,790	$ 58,357			1,355,896
10.05 Guideway: Built-up fill					0				0
10.06 Guideway: Underground cut & cover					0				0
10.07 Guideway: Underground tunnel					0				0
10.08 Guideway: Retained cut or fill	0.34		5,387	1,244	6,631	$ 19,290			8,146
10.09 Track: Direct fixation			113,087	26,127	139,214				171,010
10.10 Track: Embedded					0				0
10.11 Track: Ballasted					0				0
10.12 Track: Special (switches, turnouts)			9,415	2,175	11,590				14,237
10.13 Track: Vibration and noise dampening					0				0
20 STATIONS, STOPS, TERMINALS, INTERMODAL (number)	**19**		213,622	49,354	**262,976**	**$ 13,841**	**10%**	**6%**	**338,166**
20.01 At-grade station, stop, shelter, mall, terminal, platform					0				0
20.02 Aerial station, stop, shelter, mall, terminal, platform	19		162,033	37,435	199,467	$ 10,498			256,499
20.03 Underground station, stop, shelter, mall, terminal, platform					0				0
20.04 Other stations, landings, terminals: Intermodal, ferry, trolley, etc.					0				0
20.05 Joint development					0				0
20.06 Automobile parking multi-story structure					0				0
20.07 Elevators, escalators			51,589	11,919	63,508				81,667
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS	19.26		95,197	21,994	**117,190**	**$ 6,085**	**5%**	**3%**	**133,868**
30.01 Administration Building: Office, sales, storage, revenue counting			16,308	3,768	20,076				22,933
30.02 Light Maintenance Facility					0				0
30.03 Heavy Maintenance Facility			78,889	18,226	97,115				110,936
30.04 Storage or Maintenance of Way Building					0				0
30.05 Yard and Yard Track					0				0
40 SITEWORK & SPECIAL CONDITIONS	19.26		499,206	144,662	**643,868**	**$ 33,434**	**26%**	**15%**	**753,546**
40.01 Demolition, Clearing, Earthwork			23,583	7,628	31,210				36,527
40.02 Site Utilities, Utility Relocation			274,746	88,865	363,611				425,549
40.03 Haz. mat'l, contam'd soil removal/mitigation, ground water treatments			9,427	3,049	12,476				14,602
40.04 Environmental mitigation, e.g. wetlands, historic/archeologic, parks			9,619	3,111	12,730				14,899
40.05 Site structures including retaining walls, sound walls					0				0
40.06 Pedestrian / bike access and accommodation, landscaping					0				0
40.07 Automobile, bus, van accessways including roads, parking lots			181,831	42,009	223,840				261,970
40.08 Temporary Facilities and other indirect costs during construction					0				0
50 SYSTEMS	19.26		191,348	44,207	**235,555**	**$ 12,231**	**9%**	**6%**	**302,549**
50.01 Train control and signals			31,787	7,344	39,131				50,261
50.02 Traffic signals and crossing protection			23,457	5,419	28,876				37,088
50.03 Traction power supply: substations			41,175	9,513	50,687				65,103
50.04 Traction power distribution: catenary and third rail			63,177	14,596	77,772				99,892
50.05 Communications			19,199	4,436	23,635				30,357
50.06 Fare collection system and equipment			3,869	894	4,763				6,118
50.07 Central Control			8,684	2,006	10,690				13,730
Construction Subtotal (10 - 50)	19.26		2,034,107	486,706	**2,520,813**	**$ 130,896**	**100%**	**59%**	**3,077,420**
60 ROW, LAND, EXISTING IMPROVEMENTS	19.26		91,775	45,887	**137,662**	**$ 7,148**		**3%**	**160,123**
60.01 Purchase or lease of real estate			90,109	45,054	135,163				157,216
60.02 Relocation of existing households and businesses			1,666	833	2,499				2,906
70 VEHICLES (number)	**60**		214,632	51,512	**266,144**	**$ 4,436**		**6%**	**329,619**
70.01 Light Rail					0				0
70.02 Heavy Rail	60		190,655	45,757	236,413	$ 3,940			292,797
70.03 Commuter Rail					0				0
70.04 Bus					0				0
70.05 Other					0				0
70.06 Non-revenue vehicles			4,911	1,179	6,090				7,542
70.07 Spare parts			19,066	4,576	23,641				29,280
80 PROFESSIONAL SERVICES (applies to Cats. 10-50)	19.26		610,232	146,012	**756,244**	**$ 39,269**	**30%**	**18%**	**936,956**
80.01 Preliminary Engineering			61,023	14,601	75,624				93,696
80.02 Final Design			91,535	21,902	113,437				140,543
80.03 Project Management for Design and Construction			111,876	26,769	138,645				171,775
80.04 Construction Administration & Management			203,411	48,671	252,081				312,319
80.05 Professional Liability and other Non-Construction Insurance			30,512	7,301	37,812				46,848
80.06 Legal; Permits; Review Fees by other agencies, cities, etc.			30,512	7,301	37,812				46,848
80.07 Surveys, Testing, Investigation, Inspection			10,171	2,434	12,604				15,616
80.08 Start up			71,194	17,035	88,228				109,312
Subtotal (10 - 80)	19.26		2,950,746	730,117	**3,680,863**	**$ 191,133**		**86%**	**4,504,117**
90 UNALLOCATED CONTINGENCY					**220,852**			**5%**	**270,246**
Subtotal (10 - 90)	19.26				**3,901,715**	**$ 202,601**		**92%**	**4,774,363**
100 FINANCE CHARGES					**359,651**			**8%**	**484,071**
Total Project Cost (10 - 100)	19.26				**4,261,366**	**$ 221,276**		**100%**	**5,258,434**
Allocated Contingency as % of Base Yr Dollars w/o Contingency					24.74%				
Unallocated Contingency as % of Base Yr Dollars w/o Contingency					7.48%				
Total Contingency as % of Base Yr Dollars w/o Contingency					32.23%				
Unallocated Contingency as % of Subtotal (10 - 80)					6.00%				
YOE Construction Cost per Mile (X000)									$159,798
YOE Total Project Cost per Mile Not Including Vehicles (X000)									$255,934
YOE Total Project Cost per Mile (X000)									$273,050

Appendix D: Risk Register

Risk Number	Description	Risk Category
SCC 10	**Guideway and Track**	
10.04-1	The design is incomplete and significant requirements risks still exist.	Requirements
10.04-2	Coordination of the guideway/structures and vehicles has not occurred.	Requirements
10.04-3	The interface and coordination with the Hawaii Department of Transportation will be onerous and a MOU has yet to be executed. Also, the City must address all FHWA requirements.	Requirements
10.04-4	Geotechnical information is incomplete.	Requirements
10.04-5	ROW takes are not completely known, and the alignment can change.	Requirements
10.04-6	An operating plan has not been developed, which could affect the guideway configuration.	Requirements
10.04-7	The location of MSF is not certain, potentially affecting the line section contractors' costs.	Requirements
10.04-8	With regard to gantry approach for curves, the construction methods will ultimately be determined by contractors; however, estimators need to work with constructability professionals to account for techniques available and factor likely costs.	Design
10.04-9	Aerial structures design development cannot be refined until additional geotechnical data are available; supplemental boring program with approximately 750-foot spacing will aid analysis. Pilot holes may also be required where complex strata or utilities are unclear.	Design
10.04-10	ROW alignments and track geometry not fully defined or captured in current estimate. Also, final consideration cannot be determined until the revenue vehicle and actual decisions on ROW can be determined.	Design
10.04-11	The design is incomplete. Decisions are pending regarding rights-of-way, at least one station's vertical profile, the parking garage and its roadway access, and the possible MSF site.	Design
10.04-12	Construction inefficiencies adjacent to waterways must be addressed. A technical paper should be prepared relative to constructability, permitting and maintenance of navigation rights.	Construction
10.04-13	Construction inefficiencies & liabilities over live traffic (street & highways) must be addressed. A technical paper should be prepared and included in contract documents addressing Maintenance of Traffic (MOT); however, it may be necessary in some locations for the City to prescribe MOT to effect satisfactory community and/or business response and not have disruptions of work.	Construction
10.04-14	Construction access (material handling and installation) inefficiencies must be addressed. A technical paper should be prepared relative to constructability, permitting, safety for the traveling public (vehicular and pedestrian) and MOT.	Construction
10.04-15	Plinth pads and rail are to be constructed by line section prime contractor. The qualification of the contractor (likely a subcontractor) should be combined with robust quality inspections and testing rather than prescribed means & methods to ensure proper control of track geometry.	Construction
10.04-16	Precast yard locations must be identified, which is a contractor responsibility.	Construction
10.04-17	Laydown areas have not been identified. The City should identify locations where it currently owns the land, leaving final decisions with the contractor. Availability of public lands should be included in the contract documents.	Construction
10.08-1	The design is incomplete and significant requirements risks still exist.	Requirements

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Risk Number	Description	Risk Category
10.09-1	With regard to the vehicle and consist maximum weight and dynamic load considerations, the car is assumed to be Heavy Rail, though some specifics and its capacity (and train length) are yet to be defined.	Requirements
10.09-2	Plinth pads and rail are to be constructed by line section prime contractor. The qualification of the contractor (likely a subcontractor) should be combined with robust quality inspections and testing rather than prescribed means & methods to ensure proper control of track geometry.	Construction
10.12-1	The design and operating plan not sufficiently developed to establish track configuration; additional design must be performed to identify specifics.	Requirements
10.12-2	Procurement by MSF contractor and installation by line segment contractor (location of MSF will impact cost) – Estimating must carefully and comprehensively incorporate material handling, security and quality.	Construction
SCC 20	**Stations, Stops**	
20.02-1	Stations have large lump sum allowances in the assembly cost developed.	Requirements
20.02-2	Costs for the at-grade/depressed station (Leeward Community College) have been included in the aerial station SCC and is priced as an aerial station in the estimate. A PMOC adjustment has been made to remove the approximate cost from this SCC.	Requirements
20.02-3	Parking Structure costs are not included in SCC 20.06 as is customarily done.	Requirements
20.02-4	Security Measures are not clearly identified.	Requirements
20.02-5	Drawings reflect integration between station supports and segmental guideway, but guideway and stations are to be constructed under two separate contracts – Guideway Superstructure Study – Summary Report; p. 16; Fig. 11 and 13.	Design
20.02-6	A large lump sum amount is shown for station canopy with no detail to support cost. A breakdown of the cost estimate must be provided.	Design
20.02-7	Security Measures are not clearly defined. The cost estimate does not reflect the progression of this element.	Design
20.02-8	Laydown areas have not been identified. The City should identify locations where it currently owns the land, leaving final decisions with the contractor. The availability of public lands should be included in the contract documents.	Construction
20.03-1	No cost is assigned for the at-grade section. The Leeward Station, whose costs are included in SCC 20.02, includes a retaining wall on one side and possibly an underpass. A PMOC adjustment has been made to this SCC.	Requirements
20.07-1	Scope, requirements and quantity are not defined.	Requirements
20.07-2	PMOC cannot identify vertical circulation requirements on station-by-station basis. Required details must be developed.	Requirements
SCC 30	**Support Facilities**	
30.01-1	Scope is not defined. Functional definition and requirements must be developed.	Requirements
30.03-1	Vehicle Basis of Design and functional sizing have not been fully developed, which could affect the MSF configuration.	Requirements
30.03-2	Two locations for the MSF are being considered. Schedule impacts are possible if the Navy Drum Site acquisition is delayed.	Requirements
30.03-3	The scope of earthwork for the Navy Drum Site is unknown.	Requirements

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Risk Number	Description	Risk Category
30.05-1	No cost was contained within this SCC as it was included in SCC 30.04. However, there is an impact on the rail alignment along Navy Drum location if property is not acquired. Additional analysis and design are needed.	Design
SCC 40	**Sitework**	
40.01-1	The scope is not fully defined. The estimate is based on route foot cost (parametric).	Requirements
40.01-2	Landscaping is a Lump Sum item with minimum definition of scope. Pricing is based upon derived cost from the *1992 Original Estimate* and is not properly separated into SCC 40.06 as is customarily done.	Requirements
40.02-1	Utility Agreements are not in place with private or public owners, including the military.	Requirements
40.02-2	The *2008 SCC Estimate* is partially based on 1992 bid for 60% of the current east end of alignment. It takes into account escalation and reflects some activity since that time through site survey. However, there is a need for sufficient exploratory work to ensure stability of old ducts, pipes, etc	Requirements
40.02-3	Schedule of relocations has not been developed.	Requirements
40.02-4	Hazardous Materials is a Lump Sum item, with minimum definition of scope.	Requirements
40.02-5	Environmental Mitigations are a Lump Sum item, with minimum definition of scope.	Requirements
40.02-6	Schedule of relocations are not developed. It requires development through integrated design, geotechnical data and exploratory work with key areas where issues may be present.	Construction
40.03-1	Hazardous Materials is a Lump Sum item, with minimum definition of scope.	Requirements
40.04-1	Environmental Mitigations are a Lump Sum item, with minimum definition of scope.	Requirements
40.07-1	Pedestrian/Bike Accessways are a Lump Sum item, with minimum definition of scope.	Requirements
SCC 50	**Guideway and Track**	
50.01-1	Scope is not fully defined.	Requirements
50.01-2	Specific vehicle technology has not been defined.	Requirements
50.01-3	Operations Plan has not been developed.	Requirements
50.01-4	The responsible entity for state safety oversight in Hawaii has not been determined.	Requirements
50.01-5	Likely mobilization/de-mobilization will be required between initial DB segment and subsequent segments will add costs to Project.	Construction
50.02-1	Scope is not fully defined.	Requirements
50.02-2	Significant adjustments to and relocations of existing traffic signals will be required.	Requirements
50.03-1	Scope is not fully defined.	Requirements
50.03-2	ROW takes are not defined for substation pads. The cost estimate does address substation as currently scoped. Relocations or reductions in numbers may occur.	Requirements
50.04-1	Scope is not fully defined.	Requirements
50.05-1	Scope is not fully defined.	Requirements
50.06-1	Scope is not fully defined.	Requirements
50.06-2	Fare collection technology has not been selected.	Requirements
50.06-3	This SCC item is not identified in the Master Project Schedule.	Requirements
50.07-1	Scope is not defined.	Requirements

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Risk Number	Description	Risk Category
SCC 60	**Right-of-Way**	
60.01-1	Basis of Estimate is not clearly defined.	Requirements
60.01-2	Potential negative court judgments can occur.	Requirements
60.01-3	ROW schedule has not been developed for 205 property acquisitions that have been identified to date.	Requirements
60.01-4	Resource technical capacity of the ROW Department to maintain schedule is a concern. Other than having authority and relative experience, staffing requirements and accountability with project requirements are unclear.	Requirements
60.01-5	ROW acquisitions may require "economic remainder" judgments or full takes, particularly along Dillingham Boulevard.	Requirements
60.01-6	Temporary and permanent easements scope is unknown.	Requirements
60.01-7	Schedule of property acquisitions is necessary to assess potential impacts to construction and design.	Requirements
60.01-8	Coordination with HDOT will be necessary. No MOU has been executed.	Requirements
60.02-1	Schedule for property acquisition is necessary for assessment of potential impacts to construction and design.	Requirements
60.02-2	ROW schedule is not yet developed for the estimated 205 takes.	Requirements
60.02-3	Resource technical capacity of the ROW Department to maintain schedule is a concern.	Requirements
SCC 70	**Vehicles**	
70.02-1	Technical specifications for rail vehicles have not been fully defined.	Requirements
70.02-2	Quantity of vehicles is insufficient based on transit capacity analysis. PMOC has made an adjustment to BCE.	Requirements
70.02-3	Combining the Vehicles and Systems into a single contract may lower the number of potential bids that can be received and could limit competition for future procurements.	Market
70.06-1	No basis is shown for needs or type of equipment	Requirements
70.07-1	No basis is shown yet for needs, type or method of procurement.	Requirements
SCC 80	**Professional Services**	
80.01-1	Professional service costs are not based on staffing plans or detailed estimates.	Requirements
80.01-2	GEC contract includes an undefined/un-scoped $1 million extra work allowance for PE.	Requirements
80.01-3	GEC contract for PE does not clearly define NTP #3.	Requirements
80.01-4	GEC contract is $85 million but SCC estimate includes $75 million for PE.	Requirements
80.01-5	There are limited or no performance metrics relative to all participants for control of budget and adherence to schedule.	Requirements
80.01-6	There is no scope definition or identification of permits required or third party approvals.	Requirements
80.01-7	PMOC made adjustments to certain line items within SCC 10-70. The SCC 80 costs required adjustments once the SCC 10-70 adjustments were included in the project budget as the SCC80 values are calculated on a percentage basis and thus dependent on the adjusted values.	Requirements
80.02-1	No Basis of Estimate is developed. Costs are based on a percentage of construction value.	Requirements
80.02-2	Final Design cost growth is likely until PE scope, schedule and budget are more developed.	Requirements
80.03-1	No Basis of Estimate is developed. Costs are based on a percentage of construction value.	Requirements
80.03-2	No staffing plan is shown for City or consultants.	Requirements
80.03-3	Initial PMC Contract includes an undefined/un-scoped $1 million extra work allowance.	Requirements

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Risk Number	Description	Risk Category
80.03-4	Identification of performance metrics relative to all participants should be developed to ensure control of budget and adherence to schedule.	Requirements
80.04-1	No Basis of Estimate is developed. Costs are based on a percentage of construction value.	Requirements
80.05-1	Insurance methodology is not yet defined.	Requirements
80.05-2	No Basis of Estimate is developed. Costs are based on a percentage of construction value.	Requirements
80.06-1	No Basis of Estimate is developed. Costs are based on a percentage of construction value.	Requirements
80.06-2	No scope definition or identification of permits required, third party approvals, etc. is provided.	Requirements
80.06-3	Un-anticipated litigation may add cost to the Project (e.g., protests from adversary groups, community groups, adjacent landowners, and other affected parties).	Requirements
80.07-1	No Basis of Estimate is developed. Costs are based on a percentage of construction value.	Requirements
80.08-1	No Basis of Estimate is developed. Costs are based on a percentage of construction value.	Requirements
General		
G-1	Governance, MOUs, Legislative and City Actions – The Project is not clear on who the final decision maker or entity relative to technology, capital financing and the operations and maintenance of the bus and rail system. Furthermore, in the event a transit authority is legislated, its governance, financing, etc. are unknown. As there are at least several MOUs that should be developed, it is uncertain what force they will have and who will be the ultimate arbiter in event of disagreements.	Requirements
G-2	Design is more advanced than cost estimate – Current (Q3/2008) estimate may not capture all design elements (scope is not traceable to estimate).	Requirements
G-3	Soft costs are only calculated as a percentage of construction value (no basis or staffing plans) – For example, PE scope of work is exceptionally detailed but no staffing plan is provided for the City or its consultants. Additionally, it appears that the City has had difficulties in hiring necessary staff, which may be an indication of insufficiently attractive salaries, fringe benefits, moving allowances, etc. It also appears that retention of consultant staff may be an issue.	Requirements
G-4	Identification of performance metrics relative to all participants – control of budget and adherence to schedule – Currently the project documentation with respect to project control lacks real metrics to monitor performance in cost or time, except by broad, end-product oriented deliverables and due dates. In real terms, such lack of performance metrics and the mechanism (e.g., "earned value" techniques) to measure them portends inability to effectively and timely monitor trends and avoid budgetary or schedule problems.	Requirements
G-5	Coordination/Approvals of both design concepts and construction staging by HDOT and the City is an area of concern. This is one of the areas where MOUs can be useful. Failure to bring the HDOT and City agencies into the project management scoping and Project Development Plan will miss the opportunity to inform these entities about the timing and coordination issues and the negative impact delays can cause.	Requirements
G-6	The Chief Procurement Officer of the City/County government has been identified as having the authority for contract approval authority.	Requirements
G-7	The designer is developing the estimates with no independent oversight and without having experienced estimating staff within the City staff reviewing and assessing the consultant's work. Estimating should be overseen and assessed by some other entity who is not the designer.	Requirements

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Risk Number	Description	Risk Category
G-8	No identifiable configuration management/change control mechanism is in place, though it is adequately addressed in the PMP.	Requirements
G-9	Contract packaging must be refined – The City has identified an initial packaging and delivery method. However, they acknowledged that it requires refinements, particularly as the packages could unwittingly lead to lessened competition.	Requirements
G-10	Schedule for contracting DBB work is very tight and potentially unattainable due to workload, insufficient time to recover from poor bids, etc. The City shows more concern over DB schedule and contracting issues than those of DBB. Both have serious issues and planning must provide reasoned, practical contingency in schedules and staffing must be planned to handle.	Design
G-11	Steel, concrete, rail, aggregate, fuel and all construction materials may increase in price due to volatile and unpredictable market conditions. Current estimates and projected inflationary factors must more definitively reflect actual industry and materials cost increases of the recent past.	Market
G-12	A volatile bidding market can be accommodated in yet-to-be seen robust risk-informed estimating.	Market
G-13	The availability of skilled and unskilled labor will require more detailed analysis of the local labor market as it relates to the overall construction being planned in Oahu and the remainder of the State.	Market
G-14	General Conditions and Basis for General Conditions have not yet been developed.	Market
G-15	Delays due to weather can be reflected in a refined Integrated Master Project Schedule, which should be monitored and assessed.	Construction
G-16	Change Orders during construction (varies from 3% ~ 12%) can be accommodated in robust risk-informed estimating.	Construction

Note: The descriptions corresponding to the Risk Number sub-categories listed above are presented in Appendix C.