Los Angeles County
Metropolitan Transportation Authority

Airport Metro Connector

Supplemental Analysis Report

June 2014

Metro

Airport Metro Connector

Phase I – AA/DEIS/DEIR

Supplemental Analysis Report

June 12, 2014

Metro

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ABBREVIATIONS / ACRONYMS

AA.....Alternatives Analysis
AMC .....Airport Metro Connector
APM .....Automated People Mover
BOAC .....Board of Airport Commissioners
CEQA.....California Environmental Quality Act
CONRAC.....Consolidated Rental Car Facility
CTA.....Central Terminal Area
DEIR.....Draft Environmental Impact Report
DEIS .....Draft Environmental Impact Statement
EPB.....Earth Pressure Balance
FAA.....Federal Aviation Administration
FTA.....Federal Transit Administration
ITF .....Intermodal Transportation Facility
LAWA .....Los Angeles World Airports
LAX.....Los Angeles International Airport
LRT .....Light Rail Transit
Metro .....Los Angeles County Metropolitan Transportation Authority
NEPA.....National Environmental Policy Act
SPAS.....Specific Plan Amendment Study
TBIT.....Tom Bradley International Terminal
TBM .....Tunnel Boring Machine
TSA.....Transportation Security Administration

EXECUTIVE SUMMARY

Introduction

The Airport Metro Connector (AMC) Project is a collaboration between the Los Angeles County Metropolitan Transportation Authority (Metro) and the Los Angeles World Airports (LAWA) to identify a reliable and convenient connection for passengers and employees traveling between Los Angeles International Airport (LAX) and Metro Rail. This report presents the results of a supplemental analysis that evaluates and compares four types of potential transit connection points between LAX and Metro's regional rail system:

- Extend an Automated People Mover (APM) from LAX to Metro Rail at Aviation/Century **(Alternatives A1 and A3)** (see Figure 1);
- Extend an APM from LAX to Metro Rail at 96th Street **(Alternative A2)** (see Figure 1);
- Connect an APM and Metro Rail at a midpoint location referred to as the Intermodal Transportation Facility (ITF) **(Alternative B)** (see Figure 2); and
- Extend Metro Rail into the LAX Central Terminal Area **(Alternatives C1, C3 and C4)** (see Figure 3 and Figure 4).

In April 2012, the Metro Board received the Metro Green Line to LAX Alternatives Analysis (AA), which identified six alternatives to move forward into the Draft Environmental document and approved changing the name of the Project to the Airport Metro Connector. In June 2013, the Metro Board directed staff to include the Through ITF Alternative (Alternative B) in the environmental review phase. In October 2013, the Metro Board received the AMC Technical Refinement Study of Alternatives Report, which refined the alternatives based on new information about LAWA's future development plans and analyzed them based on refined policy and forecasting assumptions.

Following the presentation of the Technical Refinement Study in October 2013, the Metro Board requested a feasibility study for relocating the ITF to the planned Crenshaw/LAX Southwestern Yard, including a station in the vicinity of 96th Street. This new 96th Street Station, referred to as Alternative A2 in this Supplemental Analysis Report, was developed because it provided an alternative connection point for an APM alignment just north of 96th Street and is an alignment being examined by LAWA. The feasibility of the Southwestern Yard ITF relocation is discussed is Section 3.4.8.

In January 2014, staff recommended the elimination of Alternatives C2, C3 and C4 (Metro Rail extensions "Through LAX" under the terminals and runways), and advancement of Alternatives A, B, and C1 into the environmental review process. The Metro Board approved the elimination of Alternatives C2, C3 and C4, but requested a Supplemental Analysis Report for Alternatives C3 and C4 to present findings regarding ridership, passenger convenience, time savings and cost to airport and non-airport bound passengers, as well as feasibility and constructability issues and costs.

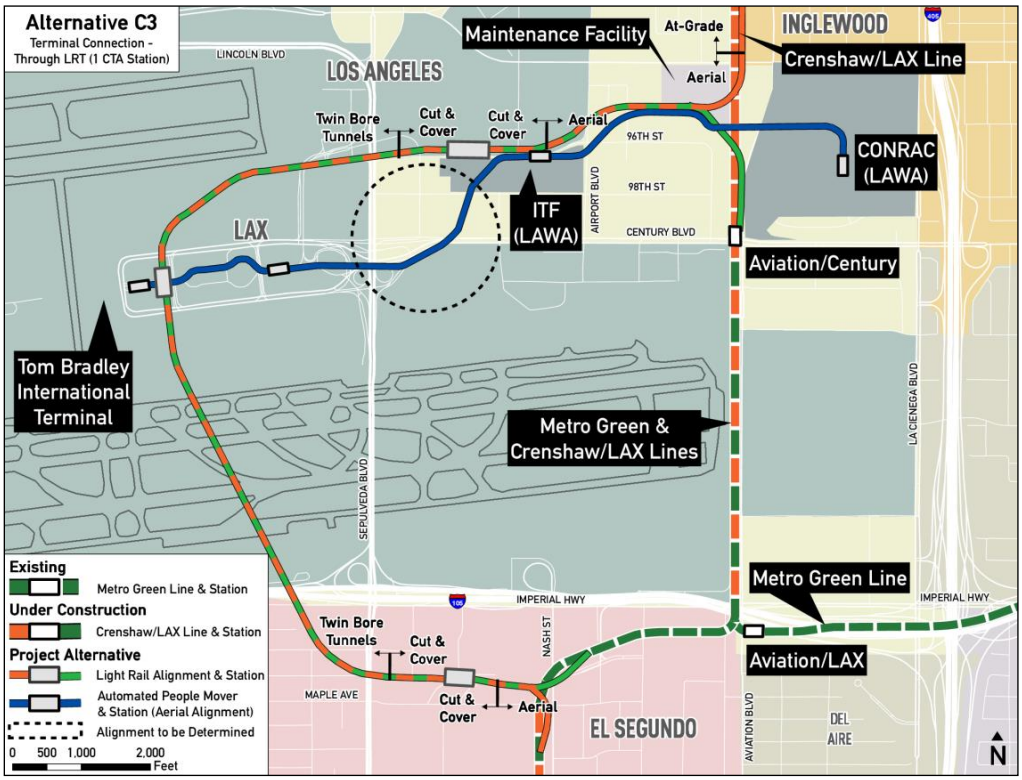
This report responds to the Board direction and was completed in coordination with LAWA using the best available information at the time for LAWA's proposed ground transportation improvements including APM alignment, ITF, and Consolidated Rental Car Facility (CONRAC).

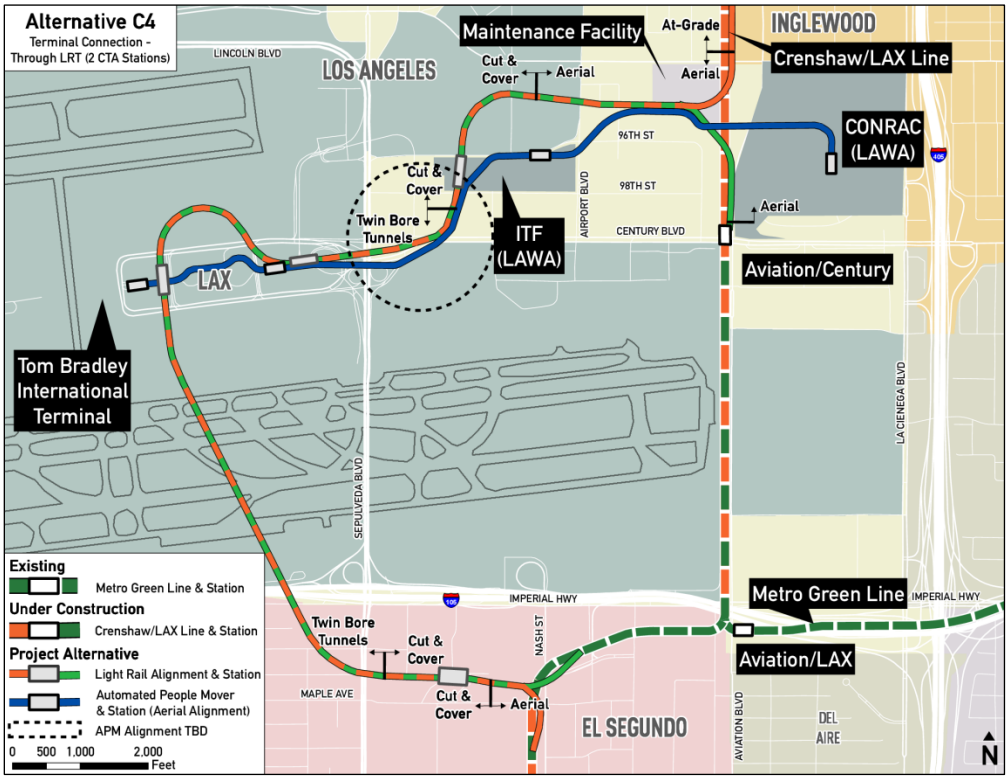
Figure 1: Alternatives A1, A2 and A3

Figure 2: Alternative B

Figure 3: Alternative C1

Figure 4: Alternatives C3 and C4 (Previously Eliminated)





Evaluation of Alternatives

The evaluation of alternatives in this Supplemental Analysis Report focuses on five key evaluation criteria: Cost and Financial Feasibility, Passenger Convenience and Ridership, Compatibility with Metro and LAWA Program Goals, Engineering/Physical Feasibility, and Operational Feasibility. These performance measures build on those used in the 2013 Technical Refinement Study and the 2012 AA Report. Metro staff coordinated with LAWA to develop and define the evaluation criteria, which are detailed in Table 1.

Table 1: Evaluation Criteria and Performance Measures

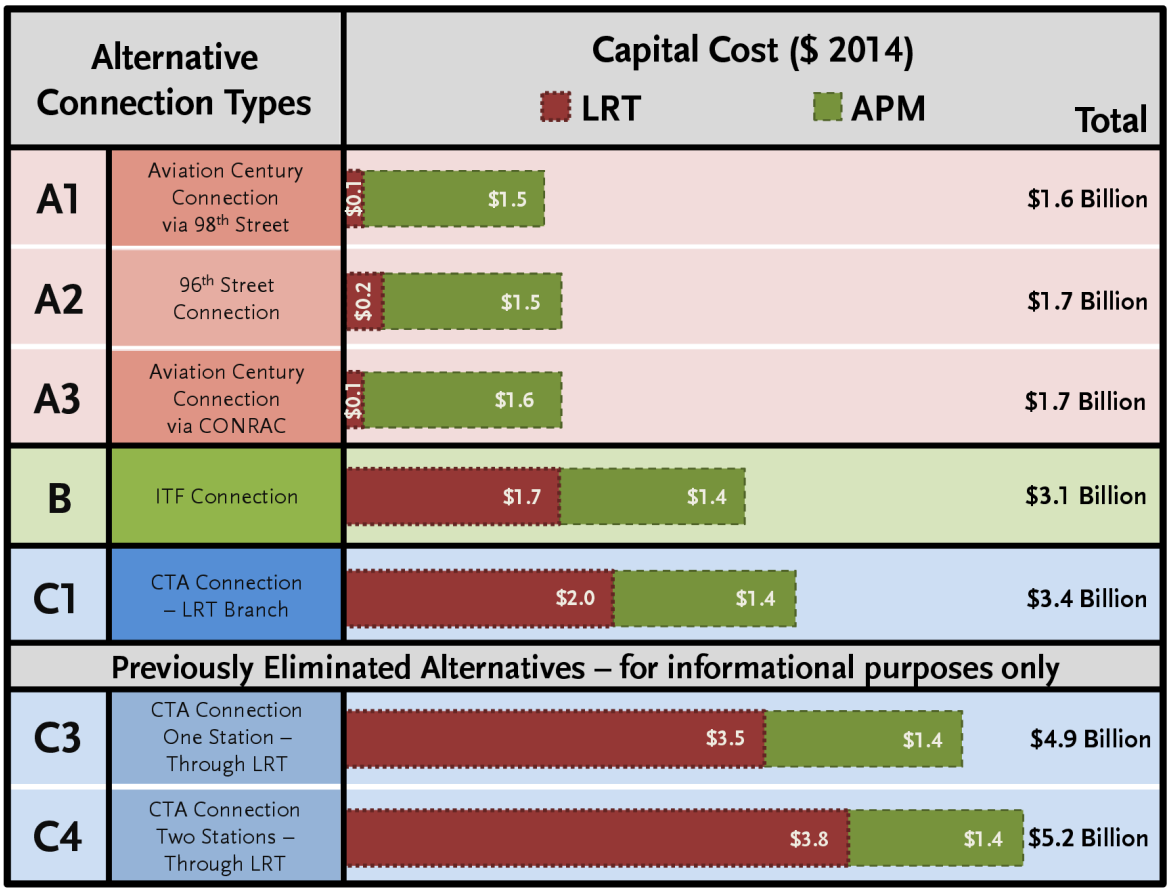
Evaluation Criteria	Performance Measures
Cost and Financial Feasibility	• Total capital cost of APM • Total capital cost of Light Rail Transit (LRT) • Total operating and maintenance cost of APM • Total operating and maintenance cost of LRT
Passenger Convenience and Ridership	• Number of transfers • Number of level changes • Average Walk Time • Travel time for airport destined passengers • Metro Rail boardings • APM boardings • Transit mode share • Baggage check-in at ITF for Alternative B only
Compatibility with Metro and LAWA Programs	• Airport's current and future projects • Metro's current and future projects • Construction schedule compatibility
Engineering/Physical Feasibility	• Impacts to LAX operations • Parking garage foundations (in Central Terminal Area) • Roadway columns, foundations and structures • Utilities • Geotechnical, hazardous materials and soils • Air spaces/Runway Projection Zones
Operational Feasibility	• Systemwide operations feasibility

The supplemental analysis produced several findings that, taken together, provide a sufficient basis for understanding the relative performance of alternatives and compare the benefits and costs.

Cost

There are significant variations in project costs (see Table 2). **Alternatives A1 and A3** have minimal Metro LRT project cost, as they involve only modifications to the Aviation/Century Station to accommodate a potential APM connection and do not require environmental clearance by Metro. The Metro project cost for **Alternative A2** involves the environmental clearance, design, and construction of a new station at 96th Street, associated land acquisition costs, costs to Crenshaw/LAX line to accommodate the station, and costs affiliated with the modifications to the Crenshaw/LAX Southwestern Yard. By contrast, **Alternatives B, C1, C3 and C4** – which involve underground tunnels, track work, elevated structures, junctions, stations and supporting systems – range between $1.7 billion and $3.8 billion ($2014).

Table 2: Capital Cost



Ridership

The type and location of the transit connection to LAX has a minimal effect on LAX-bound transit ridership, even when passenger convenience factors are considered (see Table 3). While the forecasting indicated that those alternatives providing a direct connection into the LAX CTA **(Alternatives C1, C3 and C4)** yield higher airport-bound ridership, the overall increase is marginal and offset by ridership loss for non-LAX bound Metro passengers.

Table 3: Total Metro Daily Boardings (2035)

Alternative Connection Types		Non-Airport Destined (2035)	Airport Destined (2035)	Total
A1	Aviation Century Connection via 98th Street	69,430	1,620	71,050
A2	96th Street Connection	68,840	1,790	70,630
A3	Aviation Century Connection via CONRAC	69,510	1,640	71,150
B	ITF Connection	66,890	1,450	68,340
C1	CTA Connection – LRT Branch	67,790	2,000	69,790
Previously Eliminated Alternatives – for informational purposes only				
C3	CTA Connection One Station – Through LRT	68,810	3,040	71,850
C4	CTA Connection Two Stations – Through LRT	68,670	3,300	71,970

The ridership potential for the APM is very robust (see Table 4), with forecasts between 51,580 and 54,780 average daily boardings at the proposed APM stations. This is largely due to the frequent, reliable, and luggage-friendly service provided 24 hours a day, 365 days a year, between the CTA, ITF, and CONRAC. APM service could provide significant relief to traffic congestion in the CTA by redirecting traffic to areas outside of the CTA where passengers could board the APM for the short trip to one of two stations in the CTA.

Table 4: Daily Boardings on the APM System

Alternative Connection Types		APM System Boardings (2035) Total
A1	Aviation Century Connection via 98th Street	54,770
A2	96th Street Connection	53,700
A3	Aviation Century Connection via CONRAC	54,780
B	ITF Connection	53,370
C1	CTA Connection – LRT Branch	53,270
Previously Eliminated Alternatives – for informational purposes only		
C3	CTA Connection One Station – Through LRT	51,930
C4	CTA Connection Two Stations – Through LRT	51,580

Cost Per Transit Trip

The cost per Metro transit trip to the Airport is calculated by dividing the annualized LRT capital and operating costs by the total number of Metro Rail trips to the Airport. The substantial difference in the cost per Metro transit trip to the Airport is a result of the large disparity in costs between **Alternatives A, B and C** in comparison to relative benefits (see Table 5). This results in a range from a low of $12 per Metro transit trip for **Alternatives A1** and **A3** to a high of $233 per Metro transit trip for **Alternative C4**.

Table 5: Summary of LRT Cost and Ridership

Alternative Connection Types		Metro Rail Capital Cost ($ 2014 billions)	Cost per Metro Transit Trip to the Airport	Public Transit Mode Share to LAX (Air Passenger) (2035)	Airport Daily Boardings on Metro Green and Crenshaw/LAX Lines (2035)	Non-Airport Bound Daily Boardings on Metro Green and Crenshaw/LAX Lines (2035)
A1	Aviation Century Connection via 98th Street	$0.1	$12	1.1%	1,620	69,430
A2	96th Street Connection	$0.2	$19	1.2%	1,790	68,840
A3	Aviation Century Connection via CONRAC	$0.1	$12	1.1%	1,640	69,510
B*	ITF Connection	$1.7	$197	1.0%	1,450	66,890
C1	CTA Connection – LRT Branch	$2.0	$181	1.3%	2,000	67,790
Previously Eliminated Alternatives – for informational purposes only						
C3	CTA Connection One Station – Through LRT	$3.5	$231	1.9%	3,040	68,810
C4	CTA Connection Two Stations – Through LRT	$3.8	$233	2.1%	3,300	68,670

*Assumes an operating plan for Metro Rail where the Crenshaw/LAX Line splits service between the ITF and Aviation/Century and the Metro Green Line splits service between the ITF and South Bay.

Operability

The operability of the service plans for **Alternatives B and C1** is severely limited by system capacity constraints outside the immediate study area. These capacity constraints, specifically at the LAX/Aviation junction and the Redondo Beach terminal, could result in recurring train conflicts that render the overall operations of Alternatives B and C1 questionable. Figure 5 and Figure 6 show the operating plans for Alternatives B and C1, respectively.

Figure 5: Alternative B Operating Plan

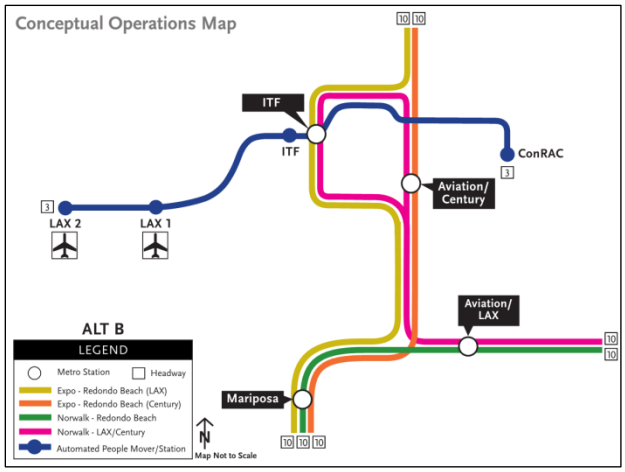
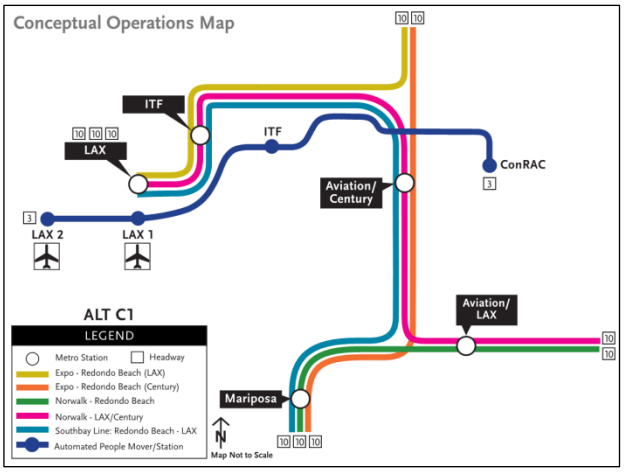


Figure 6: Alternative C1 Operating Plan



ITF Baggage Processing Sensitivity Analysis

Putting a Metro station at the ITF featuring baggage check-in has little effect on the share of transit trips to LAX in **Alternative B** (see Table 6), as the benefit associated with baggage check-in applies to only 28 percent of total air passengers bound for LAX. It should be noted that international passengers were not assumed to have access to the remote baggage check-in service per Transportation Security Administration (TSA) requirements. The analysis showed that the remote baggage check-in is primarily enjoyed by those air travelers who park and fly.

Table 6: Metro Rail and APM Boardings with Baggage Processing

Alternative B	Transit Mode Share	Metro Green, Crenshaw/LAX Lines Daily Boardings		APM Daily Boardings	Change in APM Daily Boardings
		Airport	Non-Airport		
No Baggage Check	1.0%	1,450	66,890	53,370	n/a
Baggage Check	1.0%	1,450	66,890	55,070	**1,700**

Conclusion

Table 7 provides a qualitative assessment of how each alternative performs against key evaluation factors.

Table 7: Summary of Findings

Alternative Connection Types		● High - ○ Low			
		LRT Cost Effectiveness	Compatibility with Metro Program	Compatibility with LAX Plans & Operations	Metro Rail Operational Feasibility
A1	Aviation Century Connection via 98th Street	●	●	○	●
A2	96th Street Connection	●	◔	●	●
A3	Aviation Century Connection via CONRAC	●	◔	◑	●
B	ITF Connection	○	◑	●	◑
C1	CTA Connection – LRT Branch	○	◑	◑	◑
Previously Eliminated Alternatives – for informational purposes only					
C3	CTA Connection One Station – Through LRT	○	◔	○	◑
C4	CTA Connection Two Stations – Through LRT	○	◔	○	◑

1. BACKGROUND

The Los Angeles County Metropolitan Transportation Authority (Metro), in collaboration with Los Angeles World Airports (LAWA), is working to identify a reliable and convenient connection for passengers and employees traveling between Los Angeles International Airport (LAX) and Metro Rail.

The purpose of this supplemental analysis is to refine, evaluate and compare several potential connections between LAX and Metro Rail:

- Extend an Automated People Mover (APM) from LAX to Metro Rail (Alternatives A1 and A3)
- Extend an APM from LAX to Metro Rail at 96th Street (Alternative A2)
- Connect an APM and Metro Rail at a midpoint location referred to as the Intermodal Transportation Facility (ITF) (Alternative B)
- Extend Metro Rail into the LAX Central Terminal Area (Alternatives C1, C3 and C4).

This document presents updated information that informs the selection of alternatives to be carried forward into the environmental phase.

In April 2012, the Metro Board received the Metro Green Line to LAX Alternatives Analysis (AA), which identified six alternatives to move forward into the Draft Environmental document. In June 2013, the Metro Board directed staff to include the Through ITF Alternative (Alternative B) in the environmental review phase. In October 2013, the Metro Board received the Airport Metro Connector (AMC) Technical Refinement Study of Alternatives Report, which refined the alternatives based on new information about LAWA's future development plans and analyzed them based on refined policy and forecasting assumptions.

Following the presentation of the Technical Refinement Study in October 2013, the Metro Board requested a feasibility study of relocating the ITF to the planned Crenshaw/LAX Southwestern Yard, including a station in the vicinity of 96th Street. This new 96th Street Station, referred to as Alternative A2 in this Supplemental Analysis Report, was developed because it also provided an alternative connection point for an APM alignment along 96th Street and is an alignment being analyzed by LAWA. The feasibility of the Southwestern Yard ITF relocation is discussed is Section 3.4.

In January 2014, staff recommended the elimination of Alternatives C2, C3 and C4 (Metro Rail extensions "through LAX" under the terminals and runways), and advancement of Alternatives A, B, and C1 into the environmental review process. The Metro Board approved the staff recommendation, but requested a Supplemental Analysis Report to present findings regarding ridership, passenger convenience, time savings and cost to airport and non-airport bound passengers, as well as feasibility and constructability issues and costs for Alternatives C3 and C4 from the Technical Refinement Study.

This report responds to the Board direction and was completed in coordination with LAWA using the best available information at the time for LAWA's proposed ground transportation improvements including APM alignment, ITF, and CONRAC.

2. DEFINITION OF ALTERNATIVES

This section provides a detailed description of the assumptions and alternatives. The alternatives considered in this Supplemental Analysis Report are generally the same as those studied in the Technical Refinement Study of Alternatives (October 2013). The LAX Ground Transportation Plan section outlines key assumptions that form a common baseline for the LAX ground transportation program. The discussion of each alternative describes the light rail configuration and operations, the APM configuration and operations, and the connection points between the two systems. Based on input from LAWA, the alternatives are organized into three main categories by their interface point between the Metro Rail system and LAX facilities:

The **A Alternatives** connect the Crenshaw/LAX and Metro Green Lines to a LAWA-operated APM along the Crenshaw/LAX corridor currently under construction.

- **Alternative A1: Aviation/Century Connection (via 98th Street)** – the APM follows an alignment along 98th Street and connects to the Crenshaw/LAX and Metro Green Lines at the Aviation/Century Station en route to the LAWA Consolidated Rental Car Facility (CONRAC). This alignment is the most similar to Alternative A from the Technical Refinement Study and is the APM alignment studied in the LAX Specific Plan Amendment Study (SPAS).
- **Alternative A2: 96th Street Connection** – the APM follows an alignment north of 96th Street and connects to the Crenshaw/LAX and Metro Green Lines at a new Metro 96th Street Station en route to the LAWA CONRAC.
- **Alternative A3: Aviation/Century Connection (via CONRAC)** – the APM follows an alignment north of 96th Street, crosses over the Crenshaw/LAX line, serves the LAWA CONRAC and then connects to the Crenshaw/LAX and Metro Green Lines at the Aviation/Century Station as the APM terminus.

Alternative B: ITF Connection - the Crenshaw/LAX and Metro Green Lines "shift" to the west to connect to an APM at the ITF west of Airport Boulevard. Two alignment profiles were considered for this alternative – aerial and below-grade constructed via either cut and cover or tunnel boring machine. LAWA will operate the APM which terminates at the CONRAC.

The **C Alternatives** provide the connection between the Metro Rail and APM in the Central Terminal Area (CTA). It should be noted that the Metro Board eliminated Alternatives C3 and C4 in January 2014.

- **Alternative C1: Light Rail Transit (LRT) Branch, 1 Station in the CTA –** the Crenshaw/LAX and Metro Green Lines branch off to serve stations at the ITF and the eastern CTA. Metro Rail would connect to a LAWA-operated APM at these two stations.

- **Alternative C3: Through LRT, 1 Station in the CTA** (previously eliminated by the Metro Board) – the Crenshaw/LAX and Metro Green Lines branch to go west through the LAX area near the Tom Bradley International Terminal to reconnect to the Metro Rail system south of LAX. This alternative would serve stations at the ITF, the western CTA and Sepulveda Boulevard in El Segundo.
- **Alternative C4: Through LRT, 2 Stations in the CTA** (previously eliminated by the Metro Board) – the Crenshaw/LAX and Metro Green Lines branch to go west through the LAX area near the Tom Bradley International Terminal to reconnect to the Metro Rail system south of LAX. This alternative would serve stations at the ITF, the eastern CTA, the western CTA and Sepulveda Boulevard in El Segundo.

2.1. LAX Ground Transportation Plan

Following the completion of the Technical Refinement Study in October 2013, LAWA has added more definition to their ground transportation plan, which includes an APM system that will provide connections to the terminals within the CTA from off-airport facilities, the development of a multi-modal transportation hub referred to as the ITF, the centralization of all rental car agencies into one convenient off-airport location adjacent to the 405 Freeway referred to as the CONRAC, and significant roadway improvements that will provide efficient access to the ITF, CONRAC and the CTA. These facilities will connect to a modernized CTA with new terminal interfaces that include improvements to the curbside, terminal buildings, and the overall arrival and departure experience. Together, these enhanced passenger facilities will significantly improve how airport users access LAX, and will accommodate a connection with the regional Metro Rail system.

LAWA must complete a project-level California Environmental Quality Act (CEQA) environmental analysis for each project described below and will also comply with National Environmental Policy Act (NEPA) requirements. Each project will be further refined through the environmental, entitlement, and design phases prior to the start of construction.

2.1.1. Automated People Mover (APM)

The proposed APM system will connect the passenger terminals within the CTA to off-airport facilities and the Metro Rail system. Preliminary APM alignments are currently under evaluation by LAWA. These alignments include a scissor and spine alignment within the CTA, with connections to the ITF, CONRAC, and Metro Rail system. The final design of the APM system will require seamless connections from the existing and/or future terminal buildings within the CTA to each proposed off-airport facility and the Metro Rail system. LAWA's goal is to open the APM to the ITF by 2022, and will attempt to accelerate the entire APM program and CONRAC plan. However, LAWA has not provided a date for the completion to the Metro Rail system and CONRAC.

In the Technical Refinement Study, the APM alignment looped around the CTA with five stations inside the CTA – nearly one station per terminal. LAWA staff subsequently adjusted the APM alignment, which is a center spine configuration with two stations in the CTA – one

on the eastern end and one on the western end. As shown in Figure 2-1, this spine alignment based on LAWA staff direction is the assumed configuration for this refined cost ridership analysis. It should be noted that as of the date of this report, this alignment has not been adopted by the LAWA Board of Airport Commissioners (BOAC).

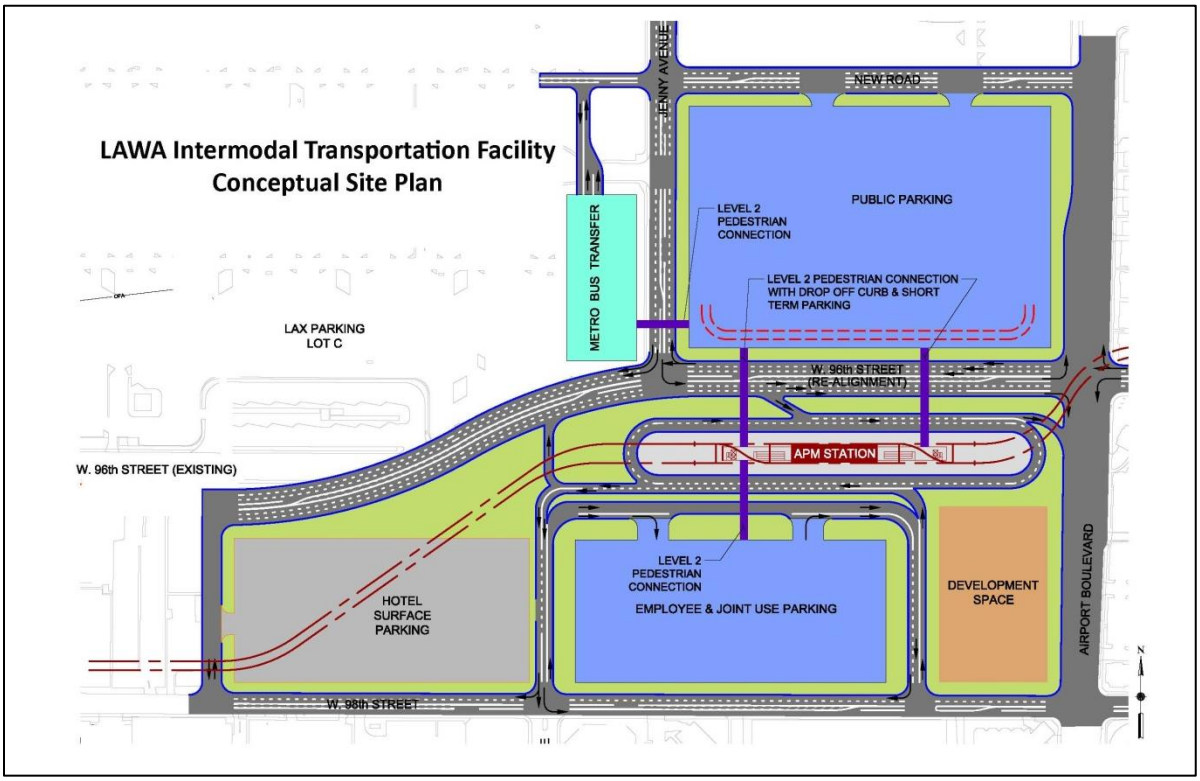
Figure 2-1: LAWA's Proposed APM Spine Alignment in the CTA

(Source: LAWA 2014)

2.1.2. ITF Program

The proposed site for the ITF is east of the CTA within the Century Boulevard hotel/office business district. The facility is roughly bounded by Vicksburg Avenue to the west, 96th Street to the north, Airport Boulevard to the east and 98th Street to the south, in addition to portions of Lot C. LAWA's preliminary analysis of the ITF, which is subject to change and further refinement, envisions an approximately 35 acre multi-modal transportation hub accommodating a full range of ground transportation services including, but not limited to, a bus rotary, meet/greet lot, ground transportation staging area, connection to the LAX City Bus Center, off-airport parking, passenger processing facility (ticketing and baggage check), pedestrian walkways, and other passenger amenities. The ITF would also include substantial airport parking.

Figure 2-2: Conceptual ITF Site Layout



(Source: LAWA 2014)

One of the multiple objectives of the ITF is to reduce the number of trips into the CTA by rerouting certain modes to the ITF, where passengers would connect to the APM to reach the CTA. Table 2-1 summarizes the modes that would be permitted into the CTA or rerouted to the ITF.

Table 2-1: CTA Vehicle Access

Mode	Arriving Passengers			Departing Passengers		
	CTA	ITF	CONRAC	CTA	ITF	CONRAC
Hotel Shuttles		●			●	
Private Parking Shuttles		●			●	
Rental Car Shuttles			●			●
Public Transit Buses		●			●	
Shared Ride Vans	●				●	
FlyAway	●				●	
Taxis	●			●		
Limos	●			●		
Long-Distance Buses	●				●	
Charter Buses	●				●	
Private Vehicles	●			●		

2.1.3. FlyAway

LAWA plans to expand its FlyAway service in the future. In addition to existing service at Union Station, Van Nuys, and Westwood, LAWA will be adding FlyAways to:

- Expo/La Brea (120 minute headways)
- Torrance (120 minute headways)
- Santa Monica (60 minute headways)
- Hollywood (60 minute headways)

The FlyAway service would drop passengers directly at their terminals for the inbound trip and pick-up passengers at the ITF for the outbound trip.

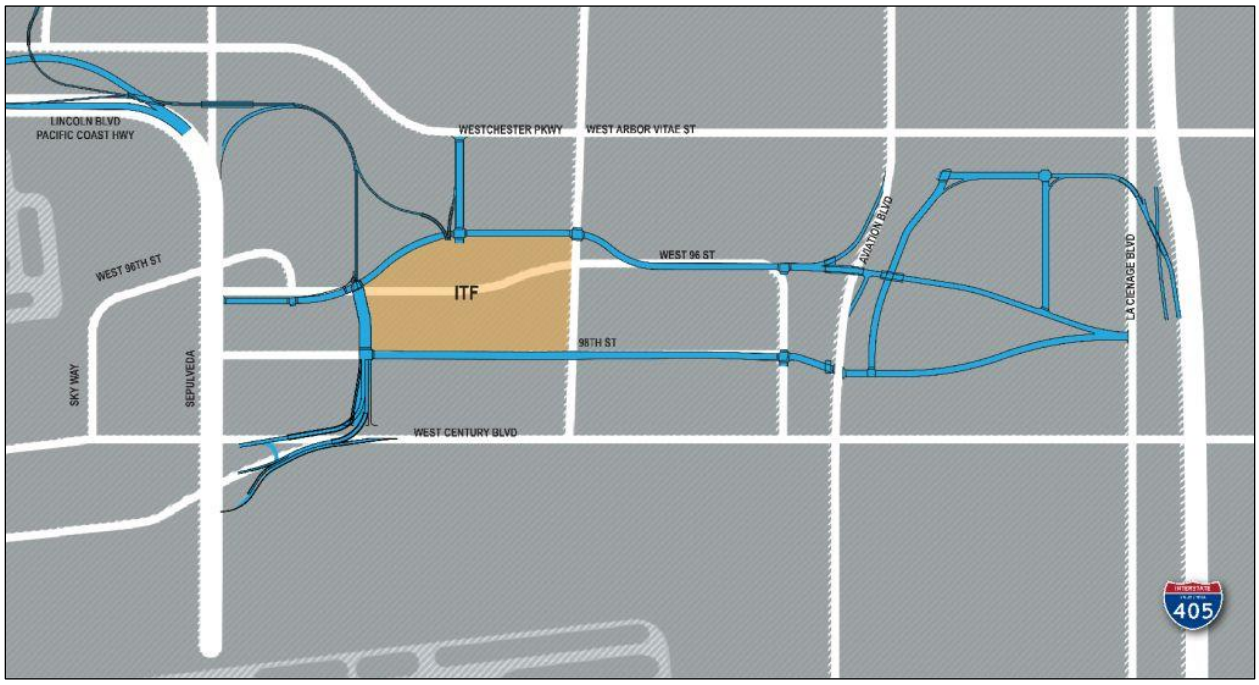
2.1.4. Consolidated Rental Car Facility

The proposed CONRAC will be located at Manchester Square. The facility is anticipated to consolidate all the major rental car operators servicing LAX by providing a new central customer service building, a rental car service/maintenance and return facility, an APM station, and additional parking for rental car operators and the airport. LAWA has not committed to an opening date for the CONRAC facility; however, they will attempt to accelerate the CONRAC plan.

2.1.5. Roadway Improvements

LAWA is developing a conceptual roadway access plan that will improve vehicle ingress and egress to the CTA, the ITF, and CONRAC from both the I-405 and I-105 Freeways and other major arterials. As shown in Figure 2-3, roadway improvements potentially include freeway interchange modifications, street and intersection changes, and new grade separations. These conceptual roadway improvements will be further refined as the APM, ITF and CONRAC facilities are developed, and constructed.

Figure 2-3: LAWA Conceptual Roadway Access Plan



(Source: LAWA 2014)

2.2. APM Connection To Crenshaw/LAX Corridor

Metro and LAWA have worked together to develop three APM alignment alternatives with different connection points between the Metro Rail and APM systems. Metro and LAWA will continue to collaborate as the APM alignment is further refined to best facilitate a connection between Metro Rail and the CTA.

2.2.1. Alternative A1 – Aviation/Century Connection (via 98th Street)

Of the APM alternatives, Alternative A1 is most similar to Alternative A from the Technical Refinement Study and the alternative studied in the LAWA Specific Plan Amendment Study (SPAS) Report and the SPAS Draft Environmental Impact Report. For Alternative A1, there would be no change to the Crenshaw/LAX Project, which has light rail tracks along Aviation Boulevard and a station one mile east of the CTA at Aviation/Century, however, modifications would be made at the station to accommodate the APM. The alignment and station locations for Alternative A1 are displayed in Figure 2-4.

Per Table 2-2 and Figure 2-5, two services would operate along this alignment – a Crenshaw/LAX service from the Exposition Line to the South Bay via Aviation/Century and a Metro Green Line service, which extends from Norwalk on the east to Aviation/Century on the west. The Aviation/Century Station would be served by the Crenshaw/LAX Line and the Metro Green Line, which would operate at 5 and 10 minute headways respectively during peak periods.

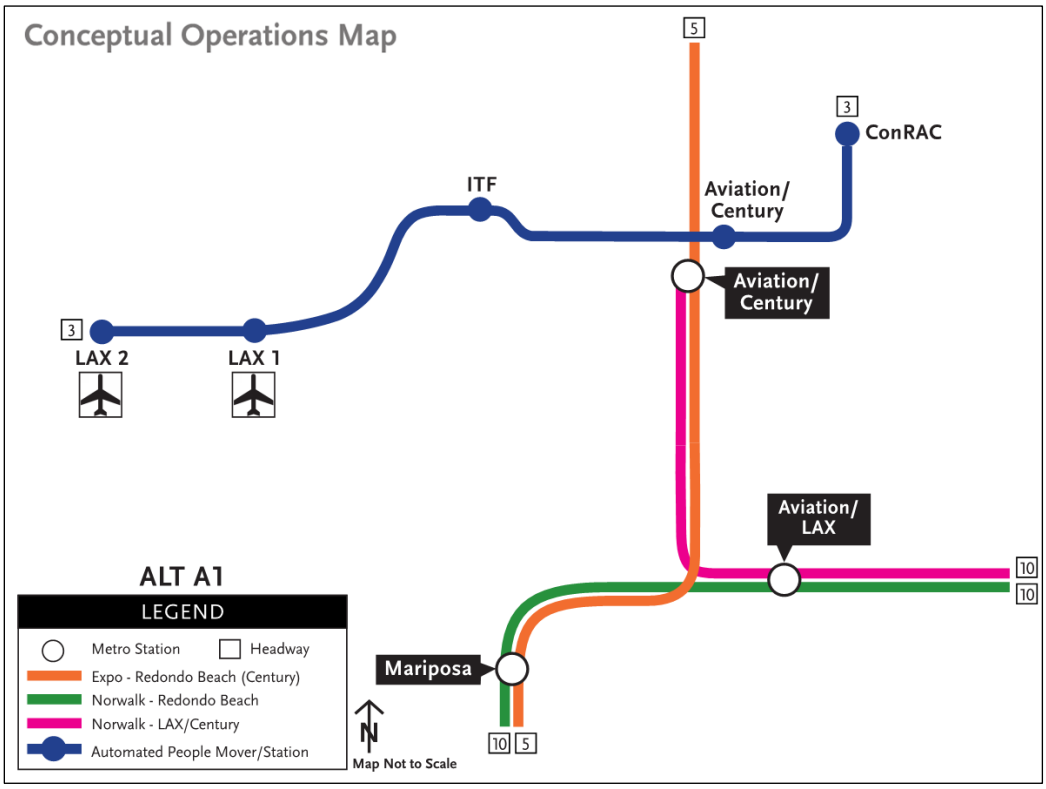
Figure 2-4: Alternative A1 – Aviation/Century Connection (via 98th Street)

Note: APM alignment has not yet been approved by LAWA Board of Airport Commissioners

Table 2-2: Headways – Alternative A1

Line (Destinations)	Peak Headway (min)
Crenshaw/LAX (Expo ←→ South Bay)	5
Metro Green Line (Norwalk ← → South Bay)	10
Metro Green Line (Norwalk ← → Aviation/Century)	10
APM (CTA ←→CONRAC)	3

Figure 2-5: Alternative A1 - Operating Plan



Automated People Mover Alignment and Operations

LAWA would construct and operate the APM independently, but coordinate with the Metro light rail service. The LAWA-operated APM would connect passengers from the two stations in the CTA to the LAWA CONRAC, with intermediate stops at the ITF and the Aviation/Century Station. The APM, as envisioned by LAWA, would run 24 hours a day, 7 days a week, with headways of three minutes during airport peak hours and provide predictable airport-style service.

For the purposes of this analysis, the APM alignment in Alternative A1 would run down the center of the CTA, with two stations in the CTA. The APM station on the east end would serve Terminals 0 (planned), 1, 2, 6, and 7/8. The APM station on the west end of the CTA would serve terminals 2, 3, 4, 5, and Tom Bradley International Terminal (TBIT). For this analysis, it is assumed that the APM alignment would cross Sepulveda Boulevard just south of Century Boulevard and turn northeast to connect to the LAWA ITF at 96th Street and Airport Boulevard. The exact alignment between the CTA and ITF has yet to be determined.

From the ITF, the APM would turn slightly south and then proceed east along 98th Street to connect to the Metro Aviation/Century Station. From the Aviation/Century Station, the APM would turn northeast and continue to the LAWA CONRAC, where it would terminate. According to LAWA's operations plans, the APM in Alternative A1 would run at 3 minute peak headways.

Connections

Regional transit passengers on the Crenshaw/LAX Line or the Metro Green Line could connect to LAX terminals by transferring at Aviation/Century to the LAWA-operated APM. Passengers would disembark at the Aviation/Century Station and walk across Aviation Boulevard on a pedestrian bridge to the APM station. Passengers would then take the APM to one of two stations inside the CTA. CTA stations would be connected to the terminals via covered moving walkways. Travel times from Metro Rail to the CTA are shown in Table 2-3.

Table 2-3: Travel Times from Metro Rail to LAX – Alternative A1

Alternative	Redondo Beach → CTA		Norwalk → CTA		Crenshaw → CTA	
	CTA East	CTA West	CTA East	CTA West	CTA East	CTA West
A1	30.9	32.7	50.2	52.0	32.8	34.6

2.2.1. Alternative A2 – 96th Street Connection

Alternative A2 uses an APM alignment just north of 96th Street and connects to the Crenshaw/LAX Line at a new LRT station at 96th Street. The addition of the LRT station would necessitate a change to the Crenshaw/LAX design as it is currently being constructed, and if approved, would be funded by the AMC project. Preliminary work on the new LRT station can be undertaken now as part of the Crenshaw/LAX project, if directed by the Metro Board. Figure 2-6 displays Alternative A2's alignment and the new LRT and APM stations.

The Metro Aviation/Century and 96th Street Stations would be close to each other (roughly a quarter mile), but would serve two distinct markets. The Aviation/Century Station would provide Metro Rail access to hotels and businesses along the Century Boulevard corridor, while the 96th Street Station would be dedicated to airport bound passengers and employees. Forecasted ridership shows that the additional 96th Street Station would serve approximately 30 percent of the study area's Metro Rail boardings and would serve as the LAX gateway station. The Aviation/Century Station would serve approximately 70 percent of the study area's Metro Rail boardings primarily destined for the employment centers and hotels along Century Boulevard.

Per Table 2-4 and Figure 2-7, three LRT services operate with this alternative – a Crenshaw/LAX service from the Exposition Line to the South Bay, a Metro Green Line service, which extends from Norwalk on the east to the 96th Street station, and a second Metro Green Line Service that extends from Norwalk to the South Bay. The 96th Street and Aviation/Century Stations would be served by the Crenshaw/LAX Line and the Metro Green Line, which would operate at 5 and 10 minute headways respectively during peak periods.

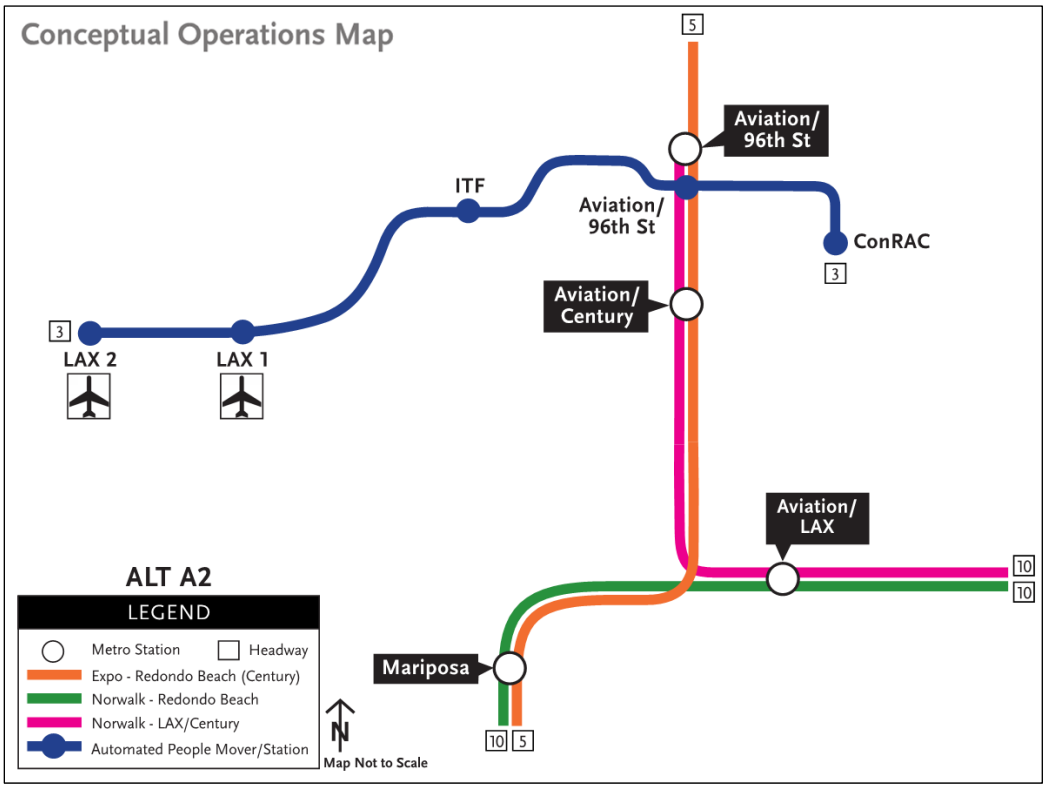
Figure 2-6: Alternative A2 – 96th Street Connection

Note: APM alignment has not yet been approved by LAWA Board of Airport Commissioners

Table 2-4: Headways – Alternative A2

Line (Destinations)	Peak Headway (min)
Crenshaw/LAX (Expo ←→ South Bay)	5
Metro Green Line (Norwalk ← → South Bay)	10
Metro Green Line (Norwalk ← → 96th Street)	10
APM (CTA ←→CONRAC)	3

Figure 2-7: Alternative A2 - Operating Plan



Automated People Mover Alignment and Operations

Similar to Alternative A1, LAWA would construct and operate the APM independently, but coordinate with the Metro light rail service. The LAWA-operated APM would connect passengers from the two stations in the CTA to the CONRAC with intermediate stops at the ITF and the Metro 96th Street Station.

The APM alignment in Alternative A2 would be identical to A1 between the CTA and the ITF, but would vary in its connection to the Metro Rail. From the ITF, the APM would turn northeast and then proceed east along an alignment parallel to, but just north of 96th Street. The APM alignment would curve slightly to the southeast along the Crenshaw/LAX Southwestern Yard property line to connect to the new Metro 96th Street Station. From the 96th Street Station, the APM alignment would continue east to the LAWA CONRAC where it would terminate.

Similar to Alternative A1, the APM in Alternative A2 would run at 3 minute peak headways.

Connection

Regional transit passengers on the Crenshaw/LAX or Metro Green Lines would connect to LAX by transferring at the new Metro 96th Street Station to the LAWA-operated APM. Metro passengers would disembark the at-grade station and take escalators or elevators to an aerial APM station. Passengers would then travel on the APM to one of two stations inside the CTA.

CTA stations would be connected to the terminals via covered moving walkways. Travel times from Metro Rail to the CTA are shown in Table 2-5.

Table 2-5: Travel Time from Metro Rail to LAX – Alternative A2

Alternative	Redondo Beach → CTA		Norwalk → CTA		Crenshaw → CTA	
	CTA East	CTA West	CTA East	CTA West	CTA East	CTA West
A2	29.6	31.4	48.9	50.7	30.5	32.3

2.2.2. Alternative A3 – Aviation/Century Connection (via CONRAC)

The light rail configuration in Alternative A3 is identical to Alternative A2. Figure 2-8 shows Alternative A3's alignment and station locations. Three services would operate along this alignment – a Crenshaw/LAX service from the Exposition Line to the South Bay, a Metro Green Line service, which extends from Norwalk on the east to the 96th Street station, and a second Metro Green Line Service that extends from Norwalk to the South Bay (see Table 2-6 and Figure 2-9). The Aviation/Century Station would be served by the Crenshaw/LAX Line and the Metro Green Line, which would operate at 5 and 10 minute headways respectively during peak periods.

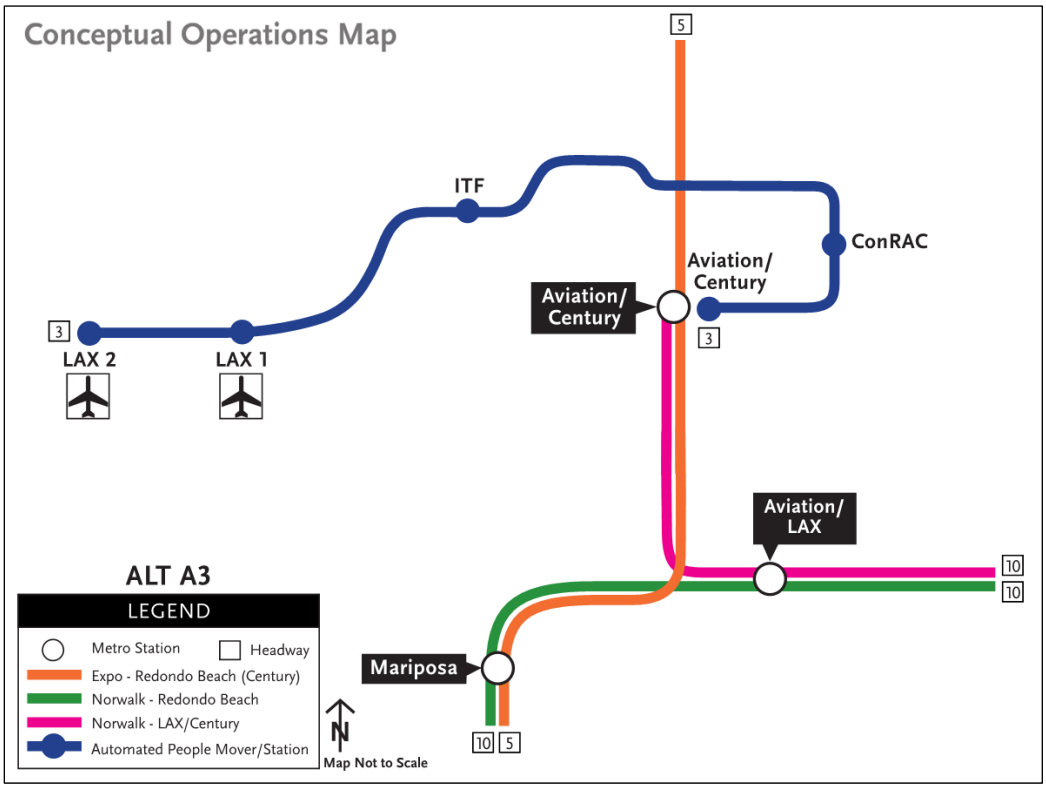
Figure 2-8: Alternative A3 – Aviation/Century Connection (via CONRAC)

Note: APM alignment has not yet been approved by LAWA Board of Airport Commissioners

Table 2-6: Headways – Alternative A3

Line (Destinations)	Peak Headway (min)
Crenshaw/LAX (Expo ←→ South Bay)	5
Metro Green Line (Norwalk ← → South Bay)	10
Metro Green Line (Norwalk ← → Aviation/Century)	10
APM (CTA ←→Aviation/Century)	3

Figure 2-9: Alternative A3 - Operating Plan



Automated People Mover Alignment and Operations

Similar to Alternatives A1 and A2, LAWA would construct and operate the APM independently, but coordinate with Metro light rail service. The LAWA-operated APM would connect passengers from the two stations in the CTA to the Aviation/Century Station with intermediate stops at the ITF and the LAWA CONRAC.

The APM alignment in Alternative A3 would be identical to A2 between the CTA and the CONRAC, but would not include an APM Station at 96th Street and would vary in its connection to the Metro Light Rail system. From the LAWA CONRAC, the APM alignment would turn southwest to loop back to the Metro Aviation/Century Station, where the APM would terminate. Based on LAWA operations plans, the APM in Alternative A3 would run at 3 minute peak headways.

Connection

Regional transit passengers on the Crenshaw/LAX Line or the Metro Green Line would connect to LAX by transferring at the Aviation/Century Station to the LAWA-operated APM. Passengers would disembark at the aerial Aviation/Century Station and take escalators or elevators to a pedestrian bridge across Aviation Boulevard to an aerial APM station. Passengers would then travel on the APM to one of two stations inside the CTA. CTA stations would be connected to the terminals via covered moving walkways. Travel times from Metro Rail to the CTA are shown in Table 2-7.

Table 2-7: Travel Time from Metro Rail to LAX – Alternative A3

Alternative	Redondo Beach → CTA		Norwalk → CTA		Crenshaw → CTA	
	CTA East	CTA West	CTA East	CTA West	CTA East	CTA West
A3	32.2	34.0	51.5	53.3	34.1	35.9

2.3. ALTERNATIVE B – ITF CONNECTION

In Alternative B, some Metro Rail service would be shifted west to serve the ITF and connect with the LAWA-operated APM. The main difference between Alternative B and Alternatives A1, A2 and A3 is that instead of having an APM/Metro Rail transfer point along the Crenshaw/LAX corridor, the transfer point is shifted west to the ITF.

Light Rail Alignment

The APM and light rail alignments and stations for Alternative B are shown in Figure 2-10. From the 105 Freeway, the Crenshaw/LAX and Metro Green Lines share an alignment that enters a tunnel at 104th Street and proceeds north to Century Boulevard, where the alignment would turn west. The tunnel would continue west along the south side of Century Boulevard to Airport Boulevard, where it would turn north to an underground station located between 98th Street and 96th Street. The ITF would provide a transfer point between Metro's below grade station and LAWA's APM station. From the ITF, the light rail tunnel alignment would proceed north along Airport Boulevard and turn east after 96th Street. When the alignment reaches the Crenshaw/LAX Corridor, a new junction would allow operations to split – north for the Crenshaw/LAX service and south for the Metro Green Line service.

Operations

Table 2-8 and Figure 2-11 depict the operating plan for Alternative B. The ITF Station would be served by two Metro Rail lines: Crenshaw/LAX and the Metro Green Line. The Crenshaw/LAX Line would operate between the Expo/Crenshaw Station and Redondo Beach in the South Bay, but would split service near LAX – one service to the ITF and one to the Aviation/Century Station. The Metro Green Line would also split service – one from Norwalk to the ITF and one from Norwalk to Redondo Beach.

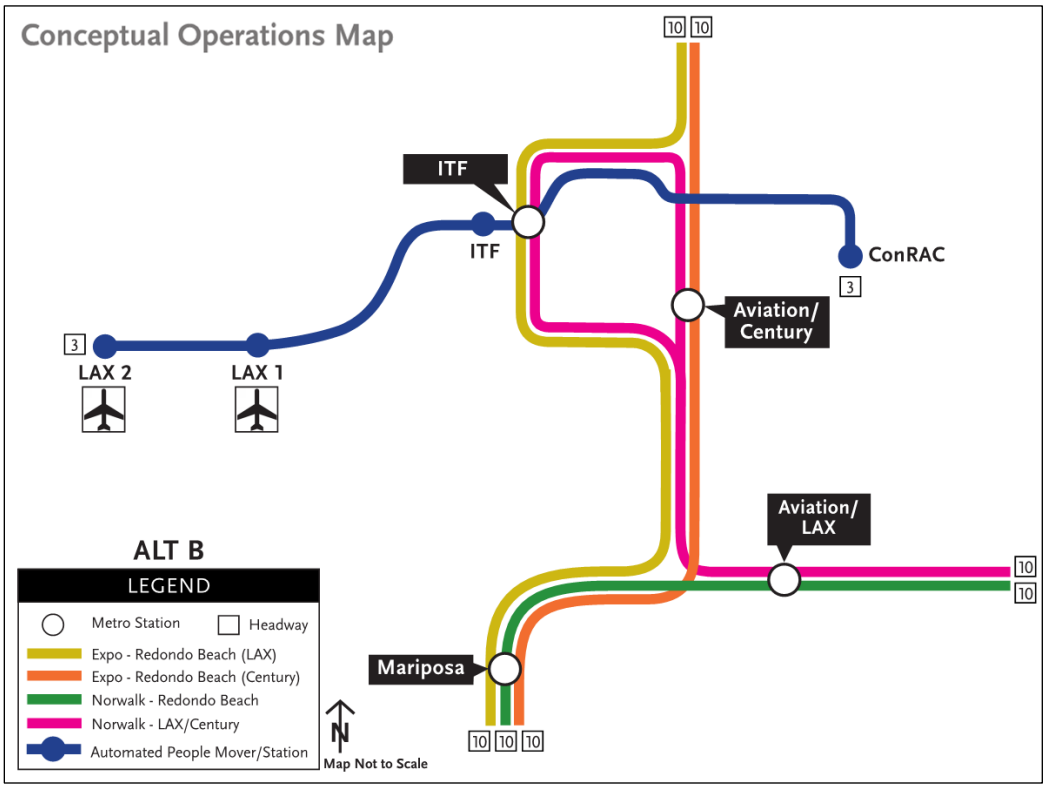
Figure 2-10: Alternative B – ITF Connection

Note: APM alignment has not yet been approved by LAWA Board of Airport Commissioners

Table 2-8: Headways – Alternative B

Line (Destinations)	Peak Headway (min)
Crenshaw/LAX (Expo ←→ Aviation/Century ←→ South Bay)	10
Crenshaw/LAX (Expo ←→ ITF ←→ South Bay)	10
Metro Green Line (Norwalk ←→ South Bay)	10
Metro Green Line (Norwalk → ITF → Aviation/Century → Norwalk)	10
APM (CTA ←→CONRAC)	3

Figure 2-11: Alternative B Operating Plan



Alternative B – ITF Connection (Alternate Operating Plan)

An alternative operating plan was considered for Alternative B as shown in Figure 2-12. To be consistent with Alternative B operations in the 2013 Technical Refinement Study, all service on both the Crenshaw/LAX and Metro Green Lines would be redirected to the ITF. A section of the Crenshaw/LAX mainline, including the Aviation/Century Station would not be used for revenue service under this alternative operating plan.

Table 2-9 and Figure 2-13 display the alternate operating plan for Alternative B. All Crenshaw/LAX Line service would be redirected to the ITF. All Metro Green Line service would also be redirected to the ITF. Metro Green Line service to South Bay would be discontinued, forcing all Metro passengers traveling between Norwalk and South Bay to travel north to the ITF and transfer to the Crenshaw/LAX Line or Metro Green Line.

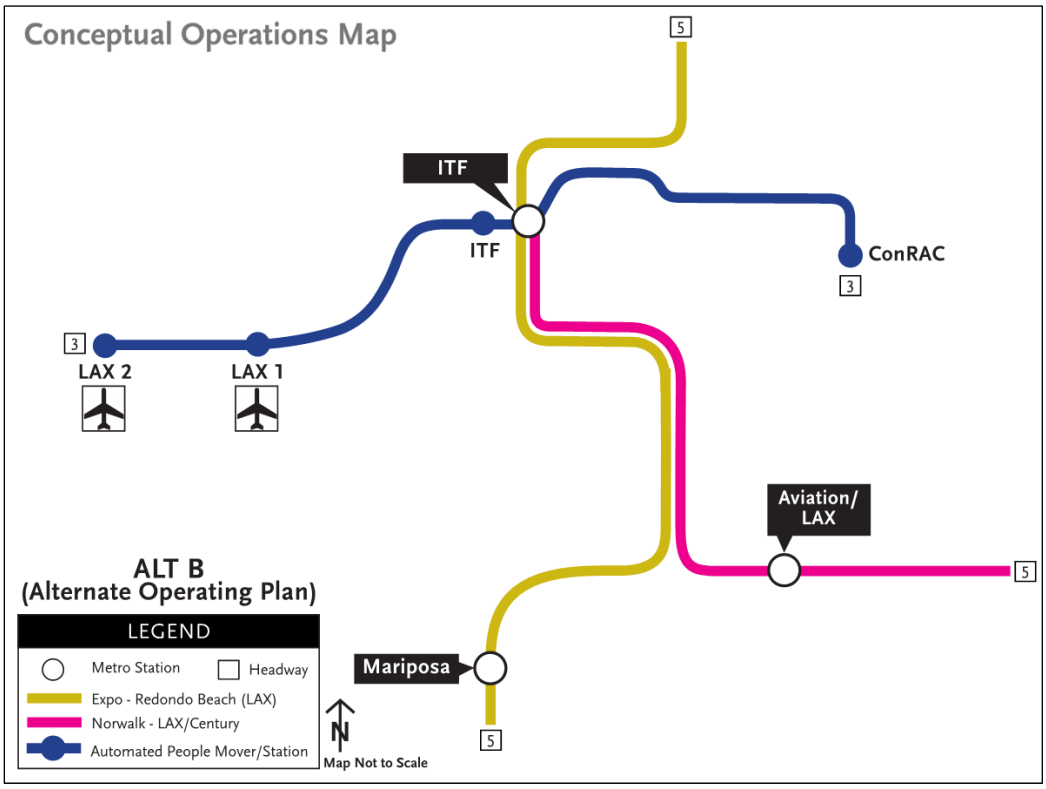
Figure 2-12: Alternative B – ITF Connection (Alternate Operating Plan)

Note: APM alignment has not yet been approved by LAWA Board of Airport Commissioners

Table 2-9: Headways – Alternative B (Alternate Operating Plan)

Line (Destinations)	Peak Headway (min)
Crenshaw/LAX (Expo ←→ ITF ←→ South Bay)	5
Metro Green Line (Norwalk ←→ ITF)	5
APM (CTA ←→CONRAC)	3

Figure 2-13: Alternative B Alternate Operating Plan



Automated People Mover

In both operating plans, the LAWA APM would follow the same alignment and operations as in Alternative A3, but would terminate at the LAWA CONRAC rather than continue to the Aviation/Century Station. LAWA would construct and operate the APM independently, but would coordinate service with Metro Rail. The LAWA-operated APM would connect passengers from the two stations in the CTA to the CONRAC with an intermediate stop at the ITF.

Connections

In both operating plans, regional transit passengers on Crenshaw/LAX and Metro Green Lines would connect to LAX by transferring at the ITF to the LAWA-operated APM. Passengers would disembark at the ITF and walk to the APM station. Because of the number of level changes and the total walk distance, the walk time between Metro Rail and the APM station at ITF is estimated at 7.4 minutes. For transferring passengers that are domestic travelers with bags, the 7.4 minute walk time may be mitigated by the time savings associated with a baggage check-in service at the ITF. Travel times from Metro Rail to the CTA are shown in Table 2-10. LAWA is currently considering alternative ITF configurations that may reduce the walk distance and time.

Table 2-10: Travel Time from Metro Rail to LAX – Alternative B

Alternative	Redondo Beach → CTA		Norwalk → CTA		Crenshaw → CTA	
	CTA East	CTA West	CTA East	CTA West	CTA East	CTA West
B	31.7	33.5	48.9	50.8	34.7	36.6

2.4. TERMINAL CONNECTION ALTERNATIVES (GROUP C)

The Alternative C group consists of three alternatives that connect Metro Rail directly to the LAX CTA:

- Alternative C1 – LRT branch with a terminal station at the eastern end of the CTA and an intermediate station at ITF.

Previously Eliminated Alternatives

- Alternative C3 – LRT loop through the CTA with three stations: one in the CTA, one at the ITF and one near Sepulveda Boulevard/Maple Street.
- Alternative C4 – LRT loop through the CTA with four stations: two in the CTA, one at the ITF and one near Sepulveda Boulevard/Maple Street.

Although Alternatives C3 and C4 were removed from further consideration by the Metro Board in January 2014, the Board requested that Metro staff provide updated ridership, time savings and cost to airport and non-airport bound passengers, as well as feasibility and constructability issues for both alternatives.

2.4.1. Alternative C1 – Stub-end Connection at CTA East

In Alternative C1, the Crenshaw/LAX and Metro Green Lines branch off to serve stations at the ITF and the eastern end of the CTA. Metro Rail would connect to a LAWA-operated APM at both of these stations. Figure 2-14 displays Alternative C1's alignment and stations.

Light Rail Alignment

Alternative C1 includes two new Metro rail stations – one under the eastern CTA and one near the ITF. From the north, the Crenshaw/LAX Line branches west off the mainline just south of Arbor Vitae Street and follows the southern edge of the maintenance facility. The alignment switches from aerial to below-grade just west of Airport Boulevard. The tunnel then turns south to a Metro Station at the ITF. From the ITF, the alignment continues underground to the west to a station near the Administration East Building on the eastern end of the CTA.

From the south, Metro Rail from Norwalk and Redondo Beach would branch to the west just north of Aviation Boulevard. The lines would merge with the northern Crenshaw/LAX branch on the south side of the maintenance yard and proceed to the ITF Station and CTA East Station along the same alignment.

The Metro Station at the CTA would be comprised of two tracks and three platforms. The Metro Station could also be located farther south under current Parking Garage 7. However, this would require demolition of the parking garage. Another option would be to locate the light rail station farther north, below the current Park One parking lot and future Terminal 0. To pursue the Park One option, the light rail station must be built before the construction of Terminal 0.

Figure 2-14: Alternative C1 - Stub-end Connection at CTA East

Note: APM alignment has not yet been approved by LAWA Board of Airport Commissioners

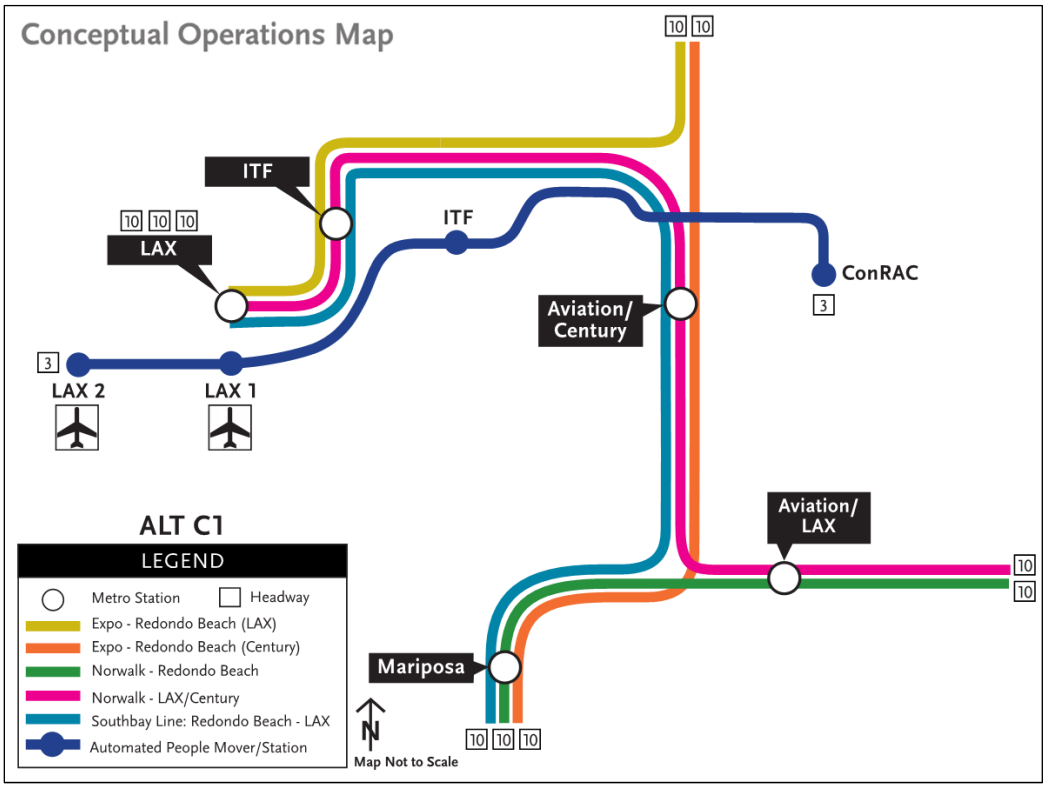
Operations

Table 2-11 and Figure 2-15 displays the operating plan for Alternative C1. Three services operate into the CTA – a Crenshaw/LAX service from the Expo Line, a Crenshaw/LAX service from Redondo Beach, and a Metro Green Line service from Norwalk. The Metro Green Line would also continue its current service from Norwalk to South Bay, and the Crenshaw/LAX Line would provide a non-airport service directly from the Expo Line to Redondo Beach.

Table 2-11: Headways – Alternative C1

Line (Destinations)	Peak Headway (min)
Crenshaw/LAX (Expo ←→ South Bay)	10
Crenshaw/LAX (Expo ←→ CTA)	10
Crenshaw/LAX (South Bay ←→ CTA)	10
Metro Green Line (Norwalk ←→ CTA)	10
Metro Green Line (Norwalk ←→ South Bay)	10
APM (CTA ←→CONRAC)	3

Figure 2-15: Alternative C1 - Operating Plan



Automated People Mover

The LAWA APM would follow the same alignment and operations as in Alternative A3, but terminate at the LAWA CONRAC rather than continue to the Aviation/Century Station. Refer to the Alternative A3 section for a detailed description of the APM alignment. In Alternative C1, the Crenshaw/LAX and Metro Green Lines would connect to the LAWA APM at the ITF and the CTA East stations.

Connections

In Alternative C1, Metro passengers will have direct access to the eastern terminals (Terminals 1, 2, 6, and 7). To reach the terminals on the west (Terminals 3, 4, 5, and TBIT), Metro passengers would transfer to the APM at either the ITF Station or the CTA East Station. It is assumed for this analysis that all Metro Rail passengers heading to the western terminals would make the transfer at the CTA East Station, as this location provides the shorter walk distance between the LRT and APM stations. To make this transfer, passengers would disembark at the CTA East and walk 4.5 minutes to the APM. Travel times from Metro Rail to the CTA are shown in Table 2-12.

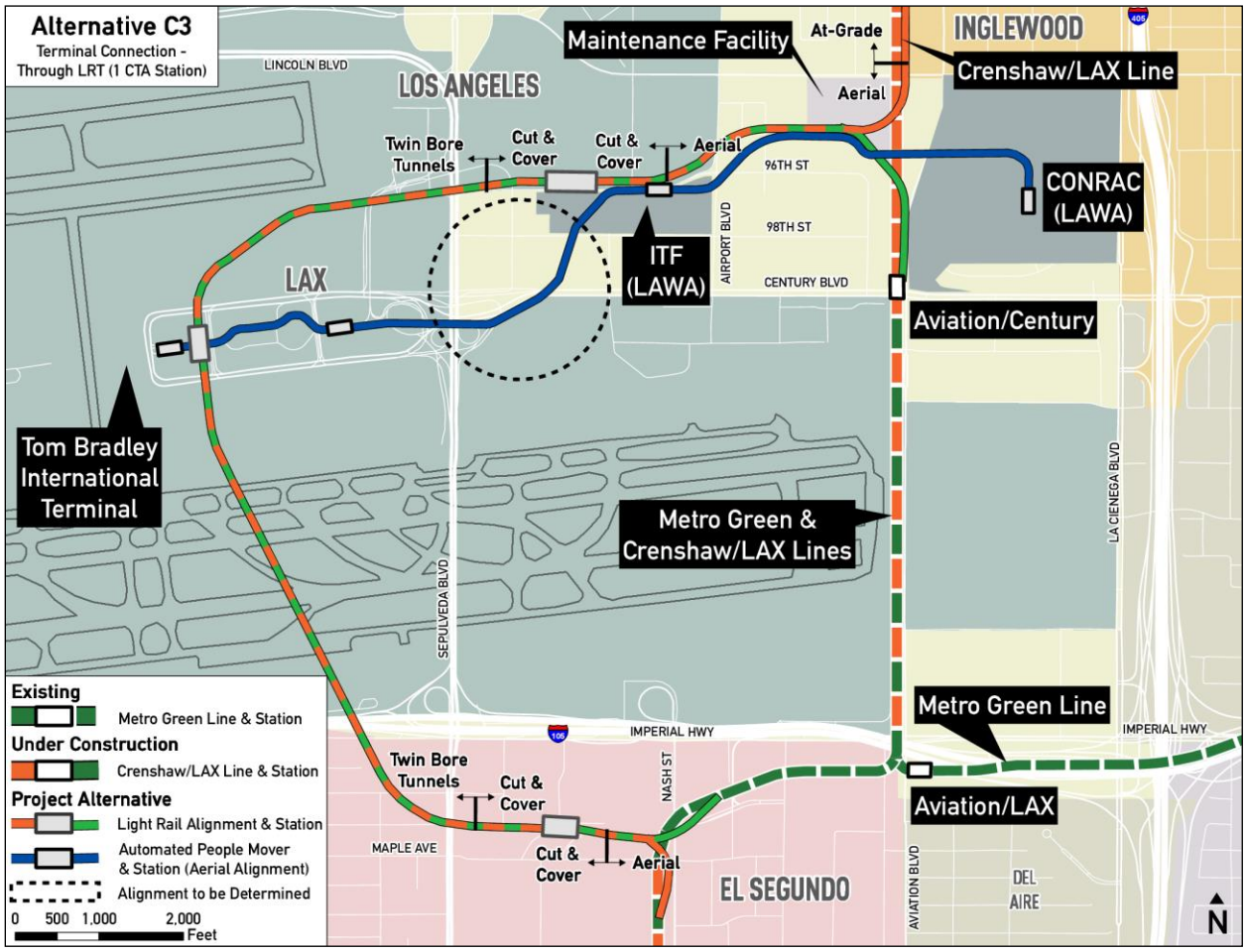
Table 2-12: Travel Time from Metro Rail to LAX – Alternative C1

Alternative	Redondo Beach → CTA		Norwalk → CTA		Crenshaw → CTA	
	CTA East	CTA West	CTA East	CTA West	CTA East	CTA West
C1	24.7	31.5	43.9	50.8	29.3	36.1

2.4.2. Alternative C3 – Through LAX One Station (Previously Eliminated)

In Alternative C3, the Crenshaw/LAX and Metro Green lines route through the CTA in a loop configuration connecting to the Crenshaw/LAX Line near Arbor Vitae Street and Aviation Boulevard and to the Metro Green Line in El Segundo near Maple Avenue and Nash Street. This alternative would add Metro stations at the ITF, the western end of the CTA and Sepulveda Boulevard. Figure 2-16 displays Alternative C3's alignment and stations.

Figure 2-16: Alternative C3 - Through LAX One Station



Note: APM alignment has not yet been approved by LAWA Board of Airport Commissioners

Light Rail Alignment

From the north, the Crenshaw/LAX alignment would branch off the mainline to head west over the maintenance facility. The alignment would switch from aerial to below-grade just west of Airport Boulevard and proceed to the ITF station. Unlike Alternative C1, the Metro LRT station at the ITF would be oriented east-west instead of north-south. Just west of the ITF, the alignment would enter twin-bore tunnels under Sepulveda Boulevard and continue underneath LAX property.

The alignment would turn south with an underground station in the CTA near Tom Bradley International Terminal. The tunnel alignment would then continue south under the south runways, the I-105 Freeway, and then head east under Sepulveda Boulevard to a new station adjacent to Maple Avenue. The alignment would return to aerial west of Nash Street and connect to the existing Metro Green Line aerial structure to proceed south towards Redondo Beach.

The Metro Green Line would follow a similar alignment. From Aviation/Century Station, the Metro Green line would branch west parallel to the maintenance facility. Just west of the maintenance facility, the Metro Green Line would join the Crenshaw/LAX Line in the tunnel alignment previously described. The lines would then split again east of the Maple Avenue Station, where the Metro Green line would continue east back to Aviation/LAX and ultimately Norwalk.

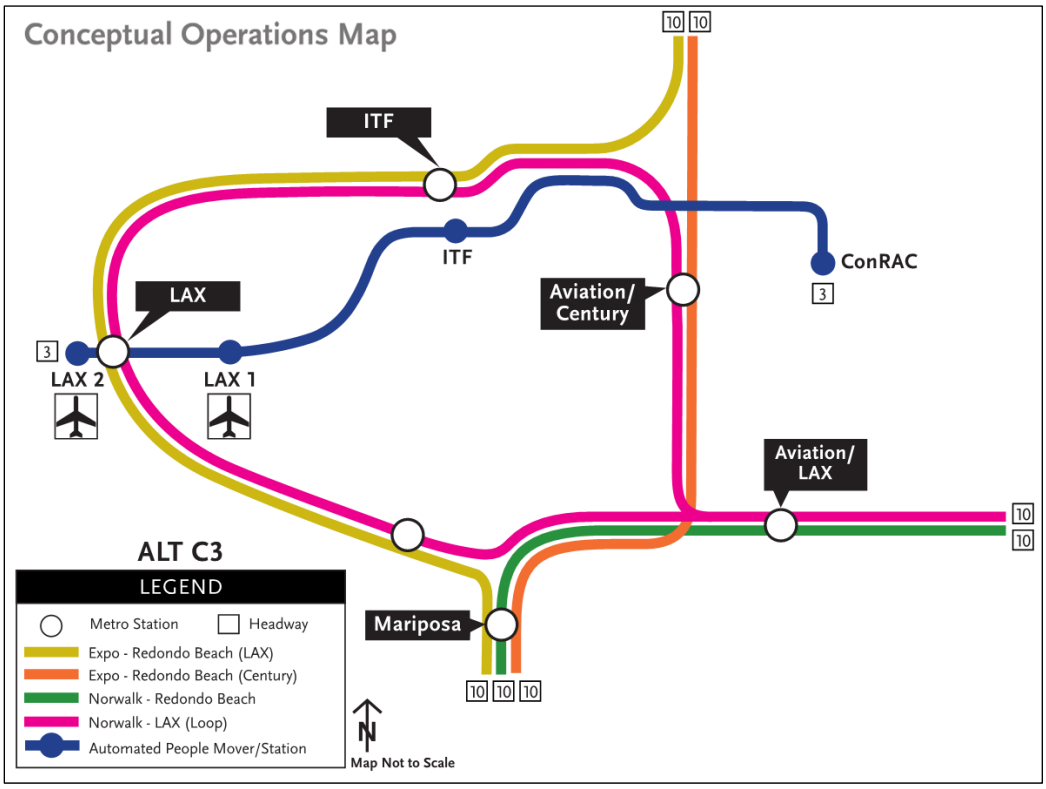
Operations

Table 2-13 and Figure 2-17 present the operating plan for Alternative C3. Each of the two branches of the Crenshaw/LAX Line would run at 10-minute peak period headways. Both Metro Green Line services from Norwalk to the South Bay and from Norwalk to the CTA would each run at 10 minute headways during peak periods. For this analysis, the Norwalk to LAX service operates in a counter-clockwise direction.

Table 2-13: Headways – Alternative C3

Line (Destinations)	Peak Headway (min)
Crenshaw/LAX (Expo ←→ Aviation Century ←→South Bay)	10
Crenshaw/LAX (Expo ←→CTA ←→ South Bay)	10
Metro Green Line (Norwalk ←→ South Bay)	10
Metro Green Line (Norwalk ←→ CTA ←→ Norwalk)	10
APM (CTA ←→CONRAC)	3

Figure 2-17: Alternative C3 - Operating Plan



Automated People Mover Alignment

The LAWA APM would follow the same alignment and operations as in Alternative A3, but terminates at the LAWA CONRAC rather than continue to the Aviation/Century Station. Refer to the Alternative A3 section for a detailed description of the APM alignment. In Alternative C3, the Crenshaw/LAX and Metro Green Lines would connect to the LAWA APM at the ITF and the CTA stations.

Connections

In Alternative C3, Metro passengers would have direct access to the western terminals (Terminals 2, 3, 4, 5, and TBIT). In order to reach the terminals on the east (Terminals 1, 6, and 7), transit passengers would have to transfer to the APM at either the ITF or the CTA West station. Travel times from Metro Rail to the CTA are shown in Table 2-14.

Table 2-14: Travel Times from Metro Rail to LAX – Alternative C3

Alternative	Redondo Beach → CTA		Norwalk → CTA		Crenshaw → CTA	
	CTA East	CTA West	CTA East	CTA West	CTA East	CTA West
C3	34.3	27.5	50.8	44.0	35.8	29.1

2.4.3. Alternative C4 – Through LAX Two Stations (Previously Eliminated)

In Alternative C4, the Crenshaw/LAX and Metro Green lines would route through the CTA in a loop configuration connecting to the Crenshaw/LAX Line near Arbor Vitae Street and Aviation Boulevard and to the Metro Green Line in El Segundo near Maple Avenue and Nash Street. This alternative would add Metro stations at the ITF, the eastern and western ends of the CTA and Sepulveda Boulevard. Figure 2-18 depicts Alternative C4's alignment and stations.

Light Rail Alignment

From the north, the Crenshaw/LAX alignment would branch off the mainline to head west over the maintenance facility. The alignment would switch from aerial to below-grade just west of Airport Boulevard and proceed to the ITF. Unlike Alternative C3, the Metro station at the ITF would be oriented north-south instead of east-west. Just south of the ITF, the alignment would enter twin-bore tunnels and continue west under Sepulveda Boulevard to the CTA East station.

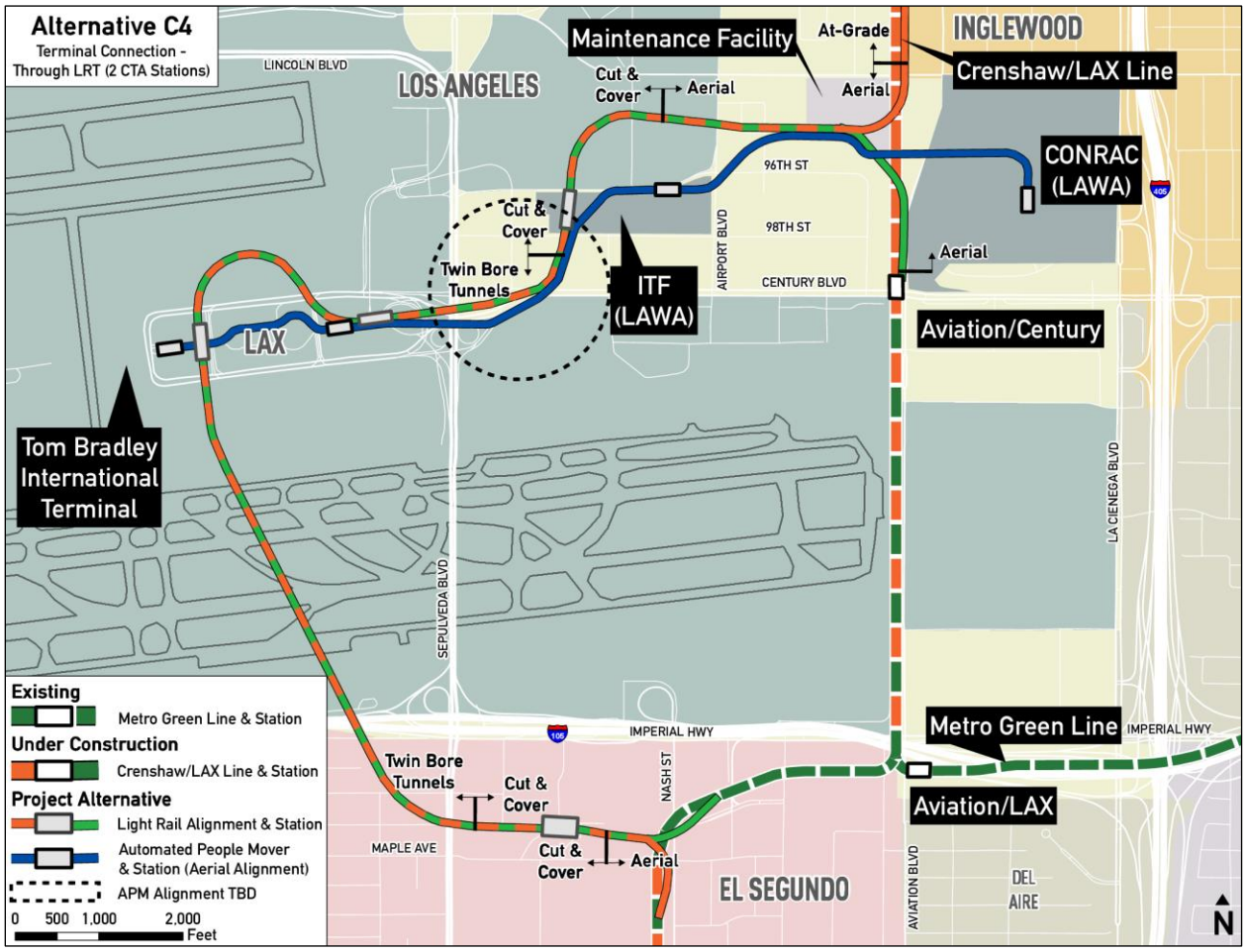
The alignment would then loop around a station near Tom Bradley International Terminal, which is oriented north-south to allow the twin-bored tunnel to continue south under the south runways and the I-105 Freeway. The tunnel alignment would then head east under Sepulveda Boulevard and then enter the Sepulveda station adjacent to Maple Avenue. The alignment would return to aerial west of Nash Street and then connect to the existing Metro Green Line aerial structure to proceed south towards Redondo Beach.

The Metro Green Line would follow a similar alignment. From Aviation/Century Station, the Metro Green line would branch west parallel to the maintenance facility. Just west of the maintenance facility, the Metro Green Line would meet the Crenshaw/LAX Line in the previously described shared right of way. The lines would then split again east of the Sepulveda Station, where the Metro Green line continues east back to Aviation/LAX and ultimately Norwalk.

Operations

The service plan for Alternative C4 is identical to that of Alternative C3 and is summarized in Table 2-15 and Figure 2-19. Each of the two branches of the Crenshaw/LAX Line would run at 10 minute peak period headways. Both Metro Green Line services from Norwalk to the South Bay and from Norwalk to CTA would each run at 10 minute headways during peak periods.

Figure 2-18: Alternative C4 - Through LAX Two Stations

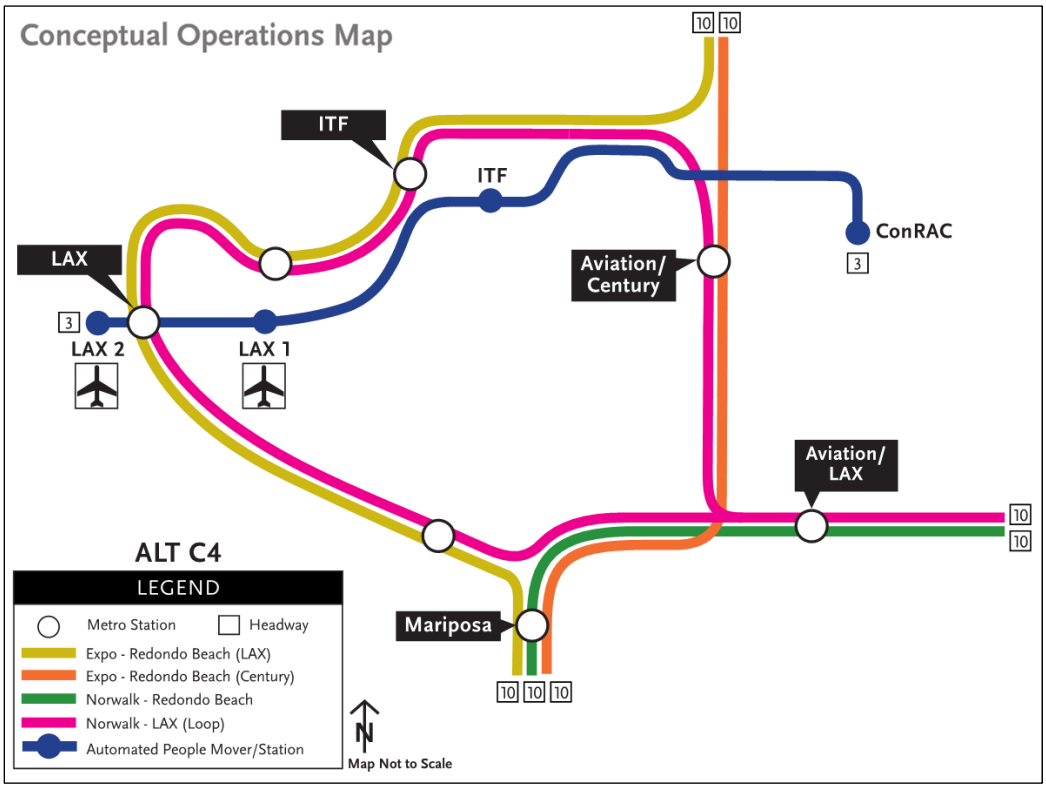


Note: APM alignment has not yet been approved by LAWA Board of Airport Commissioners

Table 2-15: Headways – Alternative C4

Line (Destinations)	Peak Headway (min)
Crenshaw/LAX (Expo ←→ Aviation Century ←→South Bay)	10
Crenshaw/LAX (Expo ←→CTA ←→ South Bay)	10
Metro Green Line (Norwalk ←→ South Bay)	10
Metro Green Line (Norwalk ←→ CTA ←→ Norwalk)	10
APM (CTA ←→CONRAC)	3

Figure 2-19: Alternative C4 - Operating Plan



Automated People Mover

The LAWA APM would follow the same alignment and operations as in Alternative A3, but terminate at the LAWA CONRAC rather than continue to the Aviation/Century Station. Refer to the Alternative A3 section for a detailed description of the APM alignment. In Alternative C4, the Crenshaw/LAX and Metro Green Lines would connect to the LAWA APM at the ITF, CTA East and CTA West stations.

Connections

In Alternative C4, Metro passengers would have direct access to all terminals from the two underground LRT stations and would not need to transfer to the APM. Travel times from Metro Rail to the CTA are shown in Table 2-16.

Table 2-16: Travel Times from Metro Rail to LAX – Alternative C4

Alternative	Redondo Beach → CTA		Norwalk → CTA		Crenshaw → CTA	
	CTA East	CTA West	CTA East	CTA West	CTA East	CTA West
C4	28.0	25.6	43.9	45.7	29.3	31.0

3. EVALUATION OF ALTERNATIVES

The evaluation of alternatives in this Supplemental Analysis Report focuses on five key evaluation criteria:

- **Cost and Financial Feasibility** – This evaluation criterion considers both capital and operating costs. Capital costs include the construction of the guideway, stations, vehicles, and supporting facilities. Operating costs include the cost to operate and maintain the system. This information is used to assess potential fiscal impacts and the cost effectiveness of each alternative. Measure R commits approximately $200 (2008 $) million to the AMC project. The difference between the full capital cost and the $200 million would have to be made up through other funding sources.
- **Passenger Convenience and Ridership** – This evaluation criterion measures the benefit created by this project in terms of increased transit ridership and overall passenger convenience. Information on transit ridership is presented in several forms: daily Metro Rail boardings, daily APM system boardings, and transit mode share. In general, the attractiveness of transit is directly influenced by passenger convenience factors, such as travel time, walk distance, transfers and vertical level changes.
- **Compatibility with Metro and LAWA Programs** – This evaluation criterion assesses compatibility with both Metro and LAWA plans and programs. Conflicts between alternatives and future projects such as Crenshaw/LAX, APM, ITF, CONRAC, roadway improvements and other airport functions could negatively affect project delivery and program implementation.
- **Engineering/Physical Feasibility** – This evaluation criterion focuses on the physical constructability and considers several construction related factors: structures and foundations, utilities, geotechnical issues, as well as construction within an active airport environment.
- **Operational Feasibility** – This evaluation criterion assesses the feasibility of Metro Rail operations under various service scenarios. Several of the alternatives involve interlining, branching and split service, necessitating an operational analysis of the upper capacity limit at several key junctions and terminals in the vicinity of the study area.

These performance measures build on those used in the October 2013 Technical Refinement Study and the April 2012 Alternatives Analysis Report. Metro staff coordinated with LAWA to develop and define the evaluation criteria. The specific performance measures for each evaluation criterion are summarized in Table 3-1.

Table 3-1: Evaluation Criteria and Performance Measures

Evaluation Criteria	Performance Measures
Cost and Financial Feasibility	• Total capital cost of APM • Total capital cost of LRT • Total operating and maintenance cost of APM • Total operating and maintenance cost of LRT
Passenger Convenience and Ridership	• Number of transfers • Number of level changes • Average Walk Time • Travel time for airport destined passengers • Metro Rail boardings • APM boardings • Transit mode share • Baggage check-in at ITF for Alternative B only
Compatibility with Metro and LAWA Programs	• Airport's current and future projects • Metro's current and future projects • Construction schedule compatibility
Engineering/Physical Feasibility	• Impacts to LAX operations • Parking garage foundations (in CTA) • Roadway columns, foundations and structures • Utilities • Geotechnical, hazardous materials and soils • Air spaces/Runway Projection Zones
Operational Feasibility	• Systemwide LRT operations feasibility

3.1. COST AND FINANCIAL FEASIBILITY

3.1.1. Capital Cost

Figure 3-1 presents the capital cost estimates and identifies the amounts attributed to the APM and the LRT portions of the project. All alternatives, except for the A Alternatives, exceed the $200 million allocated to the Project in Measure R and would require additional funding.

APM Capital Costs

Capital costs for the APM, which were provided by LAWA, are high-level rough order-of-magnitude estimates and assume, for purposes of this analysis, a spine APM alignment. The APM configuration is the same for Alternatives A, B, C1, C3 and C4 and has a capital cost that ranges from $1.4 – $1.6 billion. The main factor contributing to the variation in APM costs between Alternatives A1, A2 and A3 is the location of the connection to Metro Rail, which affects the guideway length. As the APM in Alternative A3 requires the longest guideway, it has the highest capital cost at $1.6 billion. The lower cost APM configuration are included with Alternatives B and C1, due to only four APM stations, and has a capital cost of $1.4 billion.

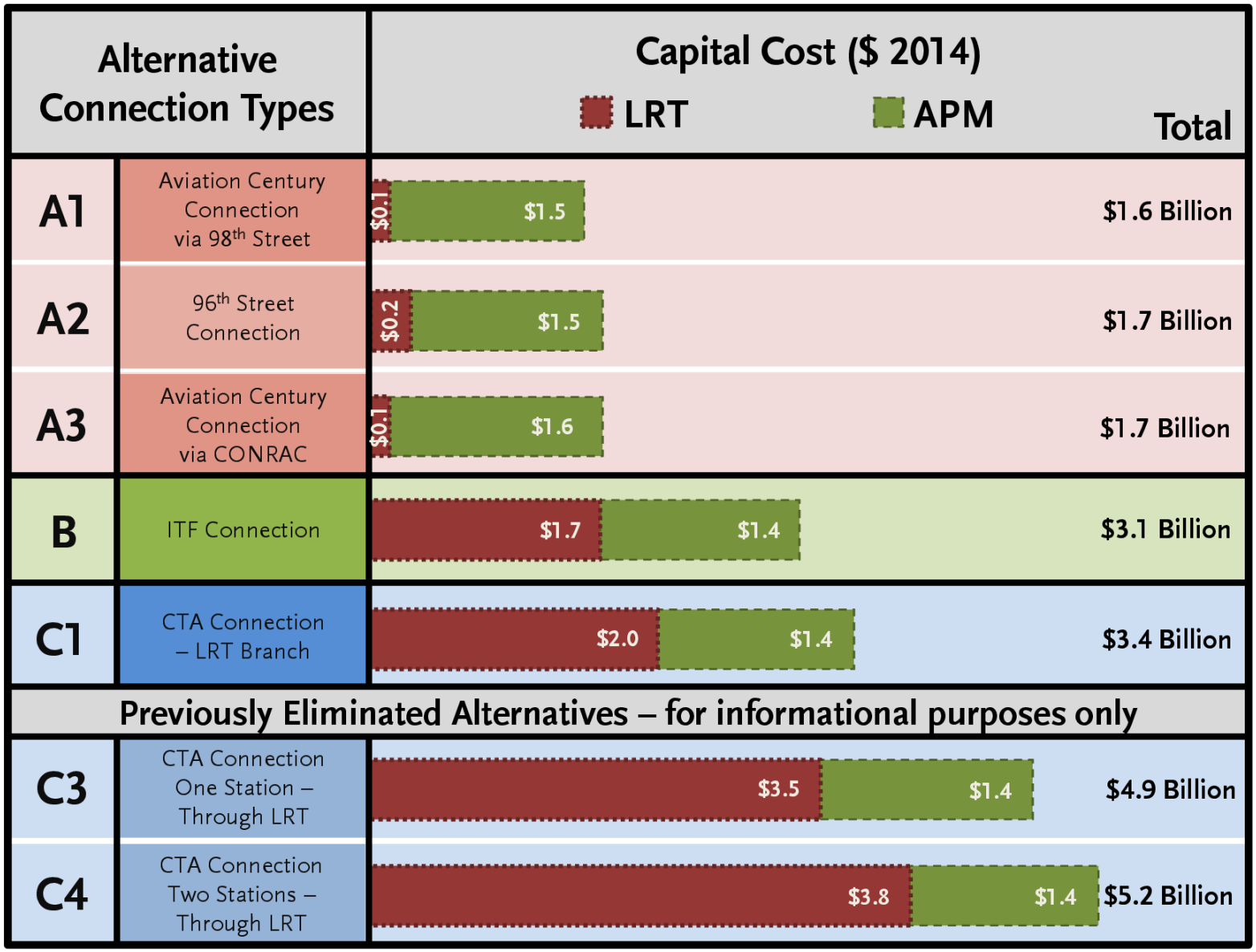
Metro Rail Capital Costs

Alternatives A1 and A3 have minimal Metro LRT project cost since they involve only modifications to the Aviation/Century Station to accommodate for an APM connection, and do not require environmental clearance by Metro. Alternative A2 requires the addition of a new Metro Rail station at 96th Street, accommodations to the Crenshaw/LAX Line, and would cost approximately $200 million. If the cost of the APM is included, the total capital cost for Alternative A1 is $1.6 billion and the total capital cost for Alternatives A2 and A3 is $1.7 billion.

The capital cost of Alternative B is $1.8 billion. The cost estimate assumed a tunnel boring machine (TBM) construction method for the tunnel and cut-and-cover construction method for the ITF station. The cut-and-cover construction method was also explored for the tunnel, but was determined to be more costly due to building demolition, roadway decking, rebuilding Century and Airport Boulevards, relocating several large utilities, and property acquisition. If the cost of the APM is included, the total capital cost for Alternative B is $3.1 billion.

The capital cost is $2 billion for Alternative C1, $3.5 billion for Alternative C3 and $3.8 for Alternative C4. The capital costs are largely driven by tunnel length and the number of underground stations. If the cost of the APM is included, the total capital cost is $3.4 billion for Alternative C1, $4.9 billion for C3, and $5.2 billion for C4.

Figure 3-1: Estimated Capital Costs



The detailed capital cost estimates are available in Appendix B. The major changes in the cost estimate since the 2013 Technical Refinement Study include:

- Lowering of the CTA West Station in Alternatives C3 and C4 to accommodate the newly proposed tunnels under the CTA as identified in LAWA's Midfield Satellite Processor Environmental Impact Report. These tunnels result in the Metro Rail tunnels being 75 feet below ground level, and below the proposed LAX Airside APM system. The associated dollars required to lower the station would not perceptibly impact the overall capital costs of these alternatives.
- Additional conceptual engineering was completed for Alternative B, which allowed for a more comparable analysis of all alternatives.
- LAWA further revised the definition of the APM routes and stations. For example, Metro's 2013 Technical Refinement Study included five APM stations inside the CTA, which has been subsequently reduce to two CTA stations. This change along with further analysis has changed the previous capital cost estimates.

Contingencies applied to the cost estimates, which include individual contingences, as well as an overall unallocated contingency, are consistent with Federal Transit Administration (FTA) guidance. Allocated contingencies (design allowances) range from 15 percent for vehicles and 25 percent for maintenance facilities to 40 percent for utility relocation. The contingencies for most items fall between 30 percent and 35 percent.

The unallocated contingency serves as an overall buffer for the project. Unallocated contingency reflects FTA and Metro guidelines for contingency given that the study area is highly dynamic, physically constrained, complex, and only conceptual engineering has been completed. Because of the high number of stakeholders and the amount of business activity, in addition to the extensive foundations and utilities, 37 percent is deemed to be an appropriate buffer for unallocated contingency. Contingency would be reevaluated when the design is more fully developed and the impacts associated with the Alternatives are more clearly defined.

3.1.2. Operating and Maintenance Costs

The estimated operating and maintenance (O&M) costs for the alternatives are presented in Figure 3-2. The operating costs were calculated based on the operating plan parameters (headway, etc.), and are not a finalized operating plan. Longer alignments and more frequent headways generally result in higher operating costs.

APM Operating and Maintenance Costs

O&M for the APM were provided by LAWA. The APM O&M costs are generally lower than LRT costs because the APM system is automated, reducing labor costs. The APM configuration is the same for Alternatives B, C1, C3 and C4 and has an estimated annual O&M cost of $7.3 million. Because the APM in Alternative A3 requires the longest guideway, it has the highest annual O&M cost at an estimated $7.6 million. Alternative A1 has an annual O&M cost of

approximately $7.4 million and Alternative A2 has an annual O&M cost of roughly $7.2 million.

Metro Rail Operating and Maintenance Costs

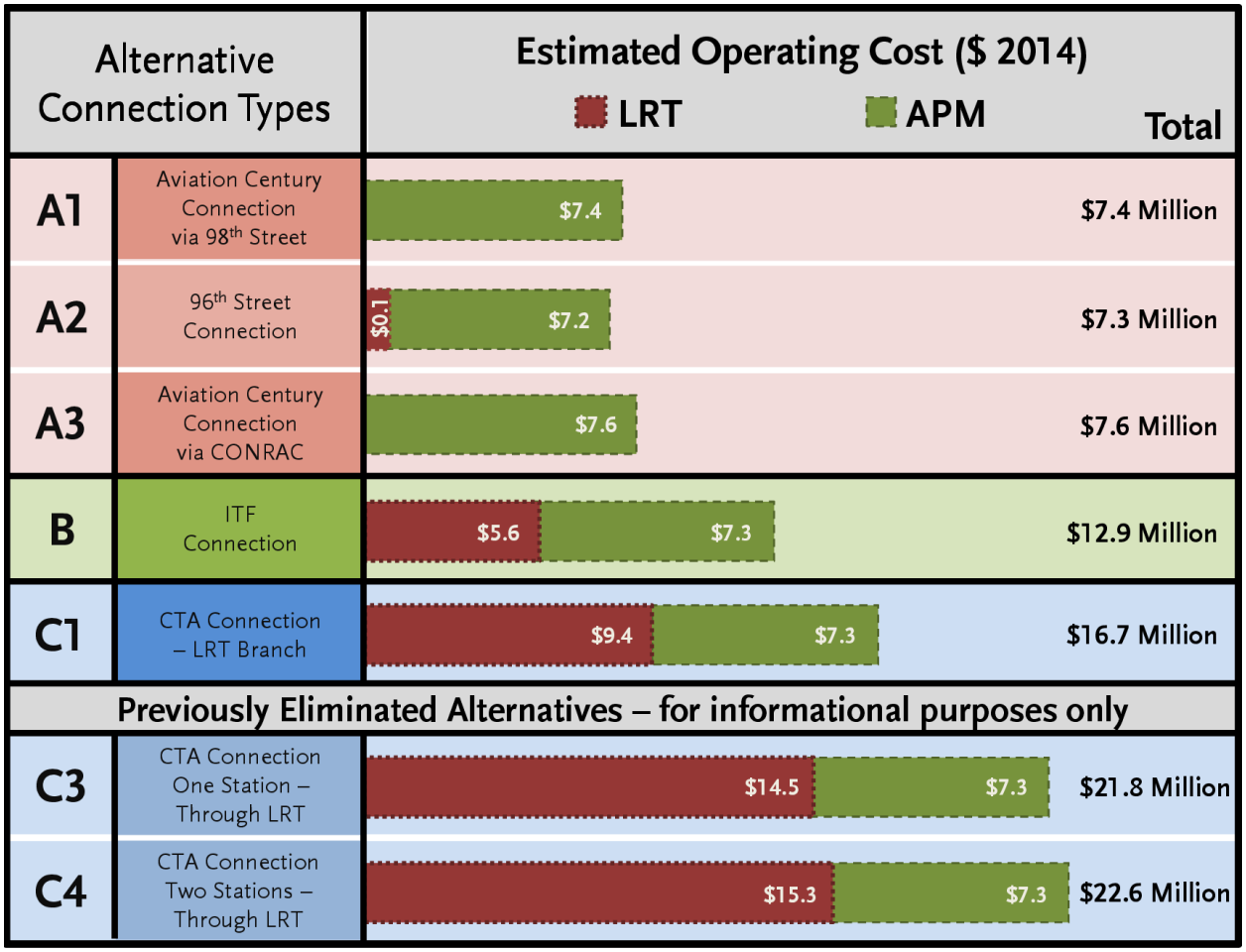
Since the alternatives that include LRT improvements would build upon existing transit service, the operating cost is the incremental difference to add the new service.

The annual O&M cost for Alternative A2, which adds a new Metro Rail station at 96th Street, would cost approximately $100,000. There are no additional Metro Rail O&M costs associated with Alternatives A1 and A3. If the cost of the APM is included, the total annual O&M for Alternative A2 is $7.3 million.

The annual O&M cost of Alternative B is approximately $5.6 million. If the cost of the APM is included, the total annual O&M for Alternative B is estimated at $12.9 million.

The total annual O&M cost is approximately $9.4 million for Alternative C1, $14.5 million for Alternative C3, and $15.3 million for Alternative C4. If the cost of the APM is included, the total annual O&M cost is approximately $16.7 million for Alternative C1, $21.8 million for C3, and $22.6 million for C4.

Figure 3-2: Estimated Operating and Maintenance Costs (Annual)



3.2. Passenger Convenience and Ridership

The purpose of this section is to assess passenger convenience and measure the benefit for each alternative. In general, the attractiveness of transit is directly influenced by passenger convenience factors, such as travel time, walk distance, transfers and vertical level changes. Information on transit ridership is presented in several forms: daily Metro Rail boardings, daily APM system boardings, and transit mode share.

3.2.1. Passenger Convenience

There are four primary measures of passenger convenience: walk times, transfers, vertical level changes, and travel times. Taken together, these factors have a strong influence on the relative attractiveness of various airport transit connection options. Table 3-2 through Table 3-4 present these passenger convenience factors for each alternative.

Table 3-2: Walk Times

Alternative Connection Types		Transfer Walk Time (minutes)	Average Walk Time from CTA Station to Terminal Door (minutes)	Average Total Walk Time to Terminal from Metro Rail (minutes)
A1	Aviation Century Connection via 98th Street	5.5	4.6	10.1
A2	96th Street Connection	4.1	4.6	8.7
A3	Aviation Century Connection via CONRAC	4.5	4.6	9.1
B	ITF Connection	6.0	4.6	10.6
C1*	CTA Connection – LRT Branch	4.5	5.3	8.2
Previously Eliminated Alternatives – for informational purposes only				
C3*	CTA Connection One Station – Through LRT	6.3	5.9	8.1
C4	CTA Connection Two Stations – Through LRT	0	6.7	6.7

*Not all passengers transfer
Note: 7.4 minutes for transfer walk time and 12.0 minutes for total walk time were used for ridership forecasting for Alternative B, based on information provided by LAWA. The 6.0 minute transfer walk time shown in the table represents a new ITF layout concept which was presented after completion of the analysis.

Walk Times

The average walking time is based on the walk from the Metro Rail system to the airport terminal door. The walk time includes the time required to transfer between the Metro Rail and the APM as well as the average time required to walk from the APM or Metro Rail CTA station to the terminal door (assumes moving walkways to terminals).

Several observations can be drawn from the information presented in Table 3-2:

- Alternative B has the longest total walk time, but is only slightly longer than A1.

- Alternatives that extend LRT into the CTA (C Alternatives) have the shortest average walk time because not all passengers need to transfer to the APM, eliminating the transfer walk time.

Transfers

As shown Table 3-3, the transfers and level changes are generally the same across Alternatives A1, A2, and B. Alternative A3 may allow for one less level change at the Aviation/Century transfer due to more flexibility for locating and designing the interface with the APM's terminal station. Alternatives C1, C3 and C4 eliminate a transfer between Metro Rail and APM for most passengers by providing direct access to the CTA. As a result, these alternatives have higher transit attractiveness than the alternatives that force a transfer and generate slightly higher ridership, which is slightly offset by the decrease in non-airport boardings.

Table 3-3: Transfers and Vertical Level Changes

Alternative Connection Types		Number of Transfers from Metro Rail to CTA	Number of Level Changes from Metro Rail to CTA
A1	Aviation Century Connection via 98th Street	1	3
A2	96th Street Connection	1	3
A3	Aviation Century Connection via CONRAC	1	2-3
B	ITF Connection	1	3
C1	CTA Connection – LRT Branch	0-1	3
Previously Eliminated Alternatives – for informational purposes only			
C3	CTA Connection One Station – Through LRT	0-1	3
C4	CTA Connection Two Stations – Through LRT	0	3

Travel Times

Table 3-4 presents the total time it takes Metro passengers to reach the furthest terminal station in the CTA from the Expo/Crenshaw, Redondo Beach, and Norwalk Metro Rail stations. The total travel time includes waiting time, in-vehicle time, transfer time, and average walk time to the terminal door. There are several key observations:

- Alternatives B, C1, C3 and C4 branch or split Metro Rail service, limiting the peak period headways to 10 minutes for the Crenshaw/LAX and Metro Green Lines. The increased headways affect both airport and non-airport bound passengers.
- Alternatives C1, C3, and C4 have the shortest overall travel time because not all passengers are forced to transfer to the APM. While these alternatives have increased headways on Metro Rail, eliminating the transfer off-sets the longer waiting time.
- Alternative B has the longest overall travel time due to alignment curves that slow train speeds, split headways, and a longer transfer walk distance from Metro Rail. Airport bound passengers experience the longest total walk time in traveling from Metro Rail to the airport terminals. For non-airport bound passengers traveling between Norwalk and the Crenshaw Corridor, the overall travel time increases due to the forced transfer at the ITF rather than at the Aviation/Century or 96th Street Stations. In addition, the increased headways for all lines result in longer wait times during the transfer.

Table 3-4: Regional Travel Times for Airport Metro Passengers To Furthest CTA Station (minutes)

Alternative	Redondo Beach → CTA	Norwalk → CTA	Crenshaw → CTA
A1	32.7	52.0	34.6
A2	31.4	50.7	32.3
A3	34.0	53.3	35.9
B	33.5	50.8	36.6
C1	31.5	50.8	36.1
Previously Eliminated Alternatives – for informational purposes only			
C3	34.3	50.8	35.8
C4	28.0	45.7	31.0

3.2.2. Metro Rail Ridership Results

Table 3-5 summarizes the daily boardings on the Crenshaw/LAX and Metro Green Lines for both non-airport and airport destined trips. A few key observations can be drawn from the ridership results:

- Airport destined boardings comprise a small percentage of the overall boardings on the Crenshaw/LAX and Metro Green lines – between two and four percent of all boardings.
- Alternative B has the lowest total daily boardings of all the alternatives due to a decline in both airport and non-airport passenger boardings. This decline is due to the proposed operating plan, which results in Metro Rail passengers experiencing longer wait times due to constraints on service frequency (10-minute peak period headways) and some out-of-direction travel.
- Non-airport destined boardings are highest for Alternatives A1, A2, and A3. This is largely due to the better peak period headways (5-minute frequency in some cases), reduced wait time for non-airport transfers, and no out-of-direction travel for passengers traveling between the Norwalk and Crenshaw Corridors.
- Alternatives C1, C3, and C4 have the largest share of airport-destined boardings on the Crenshaw/LAX and Metro Green Lines. This is because these alternatives provide direct Metro Rail service into the CTA, and are therefore the most attractive to airport-destined transit passengers.
- Compared to Alternative A1, Alternative C4 results in an additional 1,600 airport destined boardings on the Crenshaw/LAX and Metro Green Lines.
- The alternate operating plan for Alternative B (alternate operating plan) yields higher Metro boardings, but that increase is the result of a forced transfer at the ITF for Metro Green Line passengers traveling between Norwalk and the South Bay.

Table 3-5: Daily Boardings on the Crenshaw/LAX and Metro Green Lines

Alternative Connection Types		Non-Airport Destined (2035)	Airport Destined (2035)	Total
A1	Aviation Century Connection via 98th Street	69,430	1,620	71,050
A2	96th Street Connection	68,840	1,790	70,630
A3	Aviation Century Connection via CONRAC	69,510	1,640	71,150
B	ITF Connection	66,890	1,450	68,340
C1	CTA Connection – LRT Branch	67,790	2,000	69,790
Previously Eliminated Alternatives – for informational purposes only				
C3	CTA Connection One Station – Through LRT	68,810	3,040	71,850
C4	CTA Connection Two Stations – Through LRT	68,670	3,300	71,970

3.2.3. Transit Mode Share

Table 3-6 summarizes the public transit mode share to LAX for each alternative. The following conclusions can be drawn from the mode choice model:

- The transit mode share ranges from a low of 0.9 percent in Alternative B to a high of 2.1 percent in Alternative C4. For all alternatives, driving and parking continues to be the largest mode share.
- Alternatives C3 and C4 have the highest transit mode share, but the transit mode share is still relatively small compared to other modes (refer to Figure 3-3 and Figure 3-4).
- Alternative B decreases the transit mode share compared to Alternatives A1, A2, and A3 due to its longer travel time for non-airport bound passengers.
- Alternatives A1, A2, and A3 have relatively similar transit mode shares.

Table 3-6: Public Transit Mode Share to LAX

Alternative	Public Transit Mode Share to LAX (Air Passengers)
A1	1.1%
A2	1.2%
A3	1.1%
B	1.0%
C1	1.3%
C3	1.9%
C4	2.1%

Figure 3-3: Mode Share for Alternative B

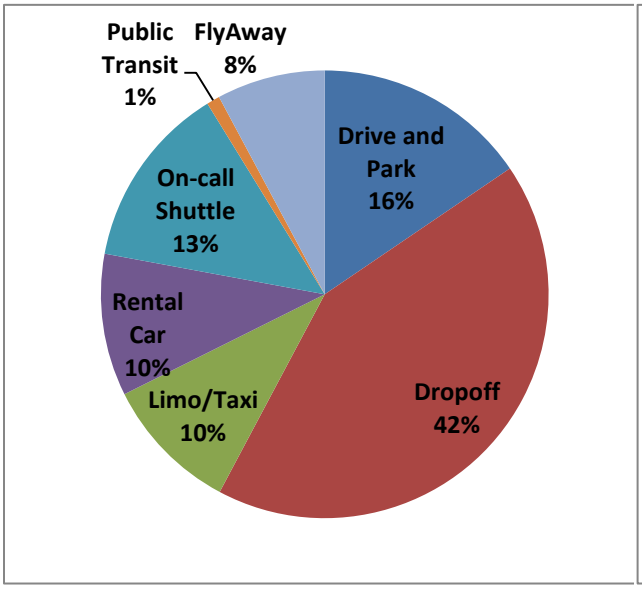
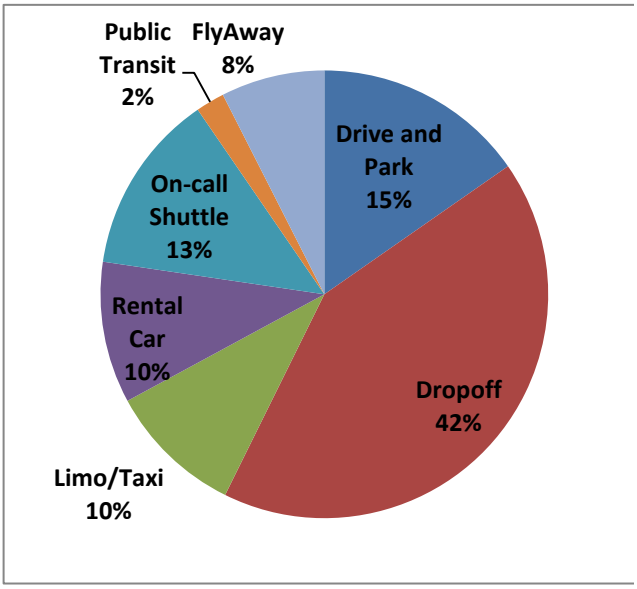


Figure 3-4: Mode Share for Alternative C4



3.2.4. APM Ridership Results

Table 3-7 summarizes the boardings on the APM system. There are several key findings:

- Alternative A3 has the highest APM boardings at 54,780, while Alternative C4 has the lowest APM boardings with 51,580.
- Metro Rail passengers comprise a small percentage of those using the APM system. Most APM boardings are those passengers parking outside the CTA or connecting to the CTA from the CONRAC.
- Alternatives that extend Metro Rail into the CTA have the lowest number of APM boardings due to the duplication of service to the CTA.
- Across all alternatives, boardings on the APM are the highest at the ITF and CTA West stations.

Table 3-7: Daily Boardings on the APM System

Alternative Connection Types		APM System Boardings (2035) Total
A1	Aviation Century Connection via 98th Street	54,770
A2	96th Street Connection	53,700
A3	Aviation Century Connection via CONRAC	54,780
B	ITF Connection	53,370
C1	CTA Connection – LRT Branch	53,270
Previously Eliminated Alternatives – for informational purposes only		
C3	CTA Connection One Station – Through LRT	51,930
C4	CTA Connection Two Stations – Through LRT	51,580

3.2.5. ITF Baggage Processing Sensitivity Analysis

LAWA is planning a baggage check-in service at the ITF, which would offer enhanced convenience and time savings for some air passengers. LAWA estimates that checking bags at the remote facility will result in a travel time savings of approximately 5.4 minutes. The time savings results from:

- 2.2 minutes saved by not walking to a ticket counter at the terminal.
- 1.1 minutes saved due to increased walking speeds for passengers without baggage from the ITF to the airport terminals.
- 2.0 minutes saved due to shorter lines and less congestion at the ITF compared to the check-in counters at the terminals.

Because the travel time savings applies only to inbound domestic passengers with bags, not all passengers benefit from this processing function (approximately 28 percent of total air passengers bound for LAX). It should be noted that international passengers were not assumed to have access to the remote baggage check-in service per TSA requirements. Primarily those who park outside the CTA, those who take on-call shuttles, and those who

take public transit would potentially benefit from the travel time savings because they would utilize the baggage processing on their way to the APM.

A sensitivity analysis was conducted only on Alternative B, which is the only alternative where Metro Rail passengers destined for LAX would transfer at the ITF and could take advantage of the baggage check-in benefit. In the other alternatives, it is assumed that airport bound passengers would take either the APM or Metro Rail directly to their terminal and would not get off at the ITF to check their bags.

Table 3-8 summarizes the rail boardings on the Crenshaw/LAX line, Metro Green Line and APM with and without the ITF baggage processing. The analysis led to the following conclusions:

- There is no significant change to the number of Metro Rail boardings because the baggage check-in benefit applies across modes and is not exclusive to transit riders.
- The baggage check-in benefit increases the percentage of people who park and fly at the ITF.
- The ITF baggage processing increases APM boardings by 1,700 due to a shift in air passengers choosing to park outside the CTA and to on-call shuttles dropping passengers off at the ITF.

Table 3-8: Metro Rail and APM Boardings with Baggage Processing

Alternative B	Transit Mode Share	Metro Green, Crenshaw/LAX Lines Daily Boardings		APM Daily Boardings	Change in APM Daily Boardings
		Airport	Non-Airport		
No Baggage Check	1.0%	1,450	66,890	53,370	n/a
Baggage Check	1.0%	1,450	66,890	55,070	**1,700**

3.2.6. Overall Ridership Model Findings

The results of the modeling yielded several preliminary findings:

- Across all alternatives, the transit mode share for trips into the airport area remains relatively small compared to other modes (1-2 percent mode share depending on the alternative).
- Alternatives that redirect Metro Rail service to the ITF or into the CTA will inconvenience passengers not travelling to LAX, resulting in a decrease in transit ridership for passengers not heading to LAX.
- Alternatives that provide a direct rail connection into the CTA increase airport-destined boardings more than those that require a transfer. However, this increase only translates into approximately 1,600 transit boardings to the Airport and is somewhat offset by a loss in non-airport destined passengers. Across all alternatives, the overwhelming majority of APM boardings are attributed to passengers who park and fly at the ITF and adjacent parking facilities.
- An ITF featuring baggage check-in has no significant effect on the share of transit trips to LAX.

3.3. Compatibility with Metro and LAWA Programs

The purpose of this section is to assess compatibility with both Metro and LAWA programs. Conflicts between alternatives and future project such as Crenshaw/LAX, APM, ITF, CONRAC, roadway improvements, and other airport functions could negatively affect project delivery and program implementation. Table 3-9 provides a qualitative assessment of the compatibility of the alternatives with Metro and LAWA programs.

Table 3-9: Summary of Compatibility with Metro and LAWA Programs

Alternative Connection Types		● High - ○ Low	
		Metro Program	LAWA Program
A1	Aviation Century Connection via 98th Street	●	○
A2	96th Street Connection	◔	●
A3	Aviation Century Connection via CONRAC	◔	◑
B	ITF Connection	◑	●
C1	CTA Connection – LRT Branch	◑	◑
Previously Eliminated Alternatives – for informational purposes only			
C3	CTA Connection One Station – Through LRT	◔	○
C4	CTA Connection Two Stations – Through LRT	◔	○

The following summarizes the compatibility of alternatives with Metro and LAWA programs.

- Alternatives A1 is the most compatible with Metro program goals, as it provides the most direct APM connection between the Metro Aviation/Century Station and the CTA. Alternative A1 would not result in any changes or delays to the Crenshaw/LAX project or inconvenience non-airport passengers.
- Alternatives A2 and A3 also leverage Metro's investment in the Crenshaw/LAX project. However, Alternative A2 would require Metro to construct an additional station at 96th

Street, while Alternative A3 would require Metro passengers bound for LAX to travel east from the Aviation/Century Station to the CONRAC before heading west to the LAX terminals, approximately 2-3 minutes of additional travel time.

- Alternatives B, C1, C3, and C4 are less compatible with Metro program goals. These alternatives could adversely affect the investment made in the Crenshaw/LAX line by reducing the service levels planned for the infrastructure and station at Aviation/Century.
- Changes to the Crenshaw/LAX project scope to accommodate Alternative B have the potential to delay the construction schedule. Such changes to the project could affect the terms of the federal Transportation Infrastructure Finance and Innovation Act (TIFIA) loan, and potentially reopen the environmental process.
- Alternative B best integrates with LAWA's proposed program for the ITF.
- Alternatives A2 and B do not present potential conflicts with projects planned as part of the LAX ground transportation program.
- Alternatives C1, C3, and C4 result in service duplication with LAWA's APM system. Furthermore, Alternatives C3 and C4 could potentially conflict with the LAX Midfield Satellite Concourse program, which includes underground tunnels.

3.4. ENGINEERING AND PHYSICAL FEASIBILITY

The engineering and physical feasibility analysis considers design challenges and identifies issues with the proposed alternatives that render many questionable. The tunnel LRT alternatives each present multiple design and construction challenges, particularly in the highly constrained CTA.

Alternative B, which will be discussed more below, was examined with three construction methods: cut-and-cover, partial TBM, and aerial. While the cut-and-cover and partial TBM methods were both determined to be feasible, the aerial configuration was determined to be infeasible due to engineering and right-of-way constraints.

3.4.1. CTA Parking Structures and Foundations

The LRT alternatives that tunnel into the CTA would cross underneath the foundations for several of the parking garages, as well as underneath the proposed underground tunnels as part of the Midfield Satellite Concourse program. Alternative C1, which is the shortest tunnel, would be located within close proximity to the foundations for parking structures P1 and P7, but would be designed to avoid parking structure piles. Alternative C3 would be in close proximity to parking structures P2, P3, P4, and P5 along West Way. Alternative C4 would cross underneath P1 at East Way and in close proximity to P2, P3, P4, and P5 along West Way. Both C3 and C4 would pass below the proposed underground tunnels included in the Midfield Satellite Concourse program, providing a minimum clearance of one tunnel diameter or more.

3.4.2. Roadway Columns and Foundations

In Alternative C1, the tunnel will clear the deep second level deck piles, Control Tower foundation, and the Century/Sepulveda overcrossing. The alignment will also cross underneath the Administration East Building. In Alternative C3, the tunnel will cross underneath World Way North, World Way South, and in close proximity to the West Way second deck level. In Alternative C4, the tunnel will cross underneath World Way North, World Way South, and underneath West Way and East Way second level deck.

3.4.3. Off-CTA Roadways and Structures

All LRT alternatives except Alternative B would avoid impacts to off-CTA roadway and structures. Each of the three construction methods analyzed for Alternative B would encounter constructability challenges. In order to pass under the Crenshaw/LAX mainline tracks south of the Aviation/Century Station, all three methods – aerial, partial TBM, and cut-and cover – would have to demolish and deck a portion of Aviation Boulevard and 104th Street during construction. Passing over the Crenshaw/LAX mainline tracks was deemed infeasible due to the runway protection zones and other airfield and runway restrictions. All three methods would also impact an existing drainage ditch running along 104th Street.

Under a cut-and-cover method, Alternative B would impact existing structures significantly enough to become the most expensive method of constructing this alternative. Demolishing, decking, and reconstructing portions of Century and Airport Boulevards would be a considerable undertaking. This construction would occur primarily via night closure of the roadways, accommodating LAX traffic peaks as much as feasible. As the warehouse structures on the south side of Century Boulevard conduct business at night, construction scheduling on this portion would have to be addressed in greater detail. Several structures would be partially or fully demolished to make way for the cut-and-cover construction.

Were the partial TBM construction method to be used, Alternative B would still utilize cut-and-cover methods for portions of the corridor in the north and south. In the south, cut-and-cover would be used to pass under the Crenshaw/LAX mainline tracks at the junction near 104th Street. A parcel of the existing parking lot outside the Federal Aviation Administration (FAA) airfield on the west site of 104th Street would be acquired temporarily to serve as a TBM launch site.

In the north, cut-and-cover would be used at the LAWA-owned Belford Property where no obstructions exist and cut-and-cover would be less expensive, and where a TBM launch site could be built. Between the two launch sites, dual tunnels would be bored, staying primarily below existing roadways to avoid existing properties and their underground deep piles and parking structures. The Metro station at the ITF and adjoining special trackwork would require a portion of Airport Boulevard to be partially decked during construction.

3.4.4. Utilities

There are no utility conflicts with the LRT tunnel segments for all alternatives provided adequate depth of cover. Along the tunnel alignment in the CTA, the majority of utilities are located within five feet of the surface. The deepest is the Central Outfall Sewer with the bottom of the pipe averaging 15 to 20 feet below the surface. The new LAX Central Utility Plant (CUP) hot and chilled water supply and return lines average 30 feet below the surface. Any tunnel in the CTA associated with the LRT Alternatives C1, C3, and C4 are proposed with the top of the tunnel at a depth of 75 feet.

The major utility conflicts will occur at the proposed stations during the trenching construction. To construct both the West and East CTA Stations, locations of existing utilities will have to be well documented when constructing the station exterior walls. The majority of the existing utilities will have to be exposed and protected in-place by hanging underneath a temporary decking system, and kept in service during the entire construction phase. LAWA requested that all LRT alternatives be underground in the CTA in order to leave clearance for the aerial APM.

Outside of the CTA, Alternative B crosses the path of significant utilities. All construction methods evaluated would impact a large drainage ditch along 104th Street, which would be costly and complex to relocate. If constructed via cut-and-cover, the 75-inch storm drain running along Century Boulevard would have to be protected in place. This extra-large utility would be prohibitively expensive to relocate because its status as an out-of-date facility would trigger a retrofit or reconstruction of its entire length if any portion of it were touched.

3.4.5. LAWA Identified Risk Areas

LAWA has identified three areas that they believe to be higher risk for tunneling due to vital airport operations. These areas include: the runways, World Way, and terminals. LAWA is concerned that tunneling underneath these vital components of airport operations carries additional risk that should be considered.

Alternatives C3 and C4 will require tunneling under risk areas as defined by LAWA. While soil conditions in the Study Area (including West Sepulveda) are similar to other locations where tunneling has been successfully completed with no noticeable settlement, there are unique challenges (i.e. maintaining runway operations during tunnel construction) associated with tunneling under sensitive airport environments regulated by FAA.

3.4.6. Geotechnical, Soils and Hazardous Materials

Alternatives B, C1, C3 and C4 all require a portion of the alignment to be underground. The general depth of the tunnel is anticipated to be 75 feet below existing surface utilities. The potential underground segment includes twin-bored tunnels, cut and cover tunnels, portal and station excavations, cross-passages, and sump structures. Alternative C1 does not pass beneath the runways, and Alternatives C3 and C4 pass beneath the south runways.

Preliminary geotechnical investigations concluded the following:

- Soils along the underground segment of the proposed alternatives consist of either older dune sand or alluvium. Groundwater is expected to be encountered below tunnel and station inverts. Perched groundwater may be encountered in excavations.
- Tunneled alternatives are deemed feasible from a geotechnical perspective.
- The presence of existing structures that are sensitive to ground deformation will dictate that earth pressure balance (EPB) and/or slurry shield TBMs are used for tunneling.
- Gasketed tunnel liners and safety systems at stations will be required to mitigate hazardous soil gas conditions, which will increase the cost of constructing and operating the project.
- EPB or slurry shield TBMs are well suited for the subsurface conditions along the proposed underground segments. Older dune sands, anticipated along most of the underground segments, will likely facilitate tunneling due to its predominantly uniform nature and lack of cobbles and boulders.

3.4.7. Airspace/Runway Protection Zone

The dedicated guideway or stations for a transit system are subject to regulations and policies established by FAA to protect the safety of runway operations and minimize interference with air traffic control systems. In particular, off-airport routing options that encroach into areas designated as Runway Protection Zones (RPZs) may result in significant issues. Based on the current level of design, all alternatives under consideration avoid the RPZ and Runway Approach airspace, both during construction and upon completion.

3.4.8. ITF at Southwestern Maintenance Yard

As requested by the Metro Board in October 2013, an analysis on relocating the ITF at or over the Southwestern Yard was conducted. It was determined that relocating the ITF to the Metro Yard would present several challenging issues listed below and is therefore not recommended.

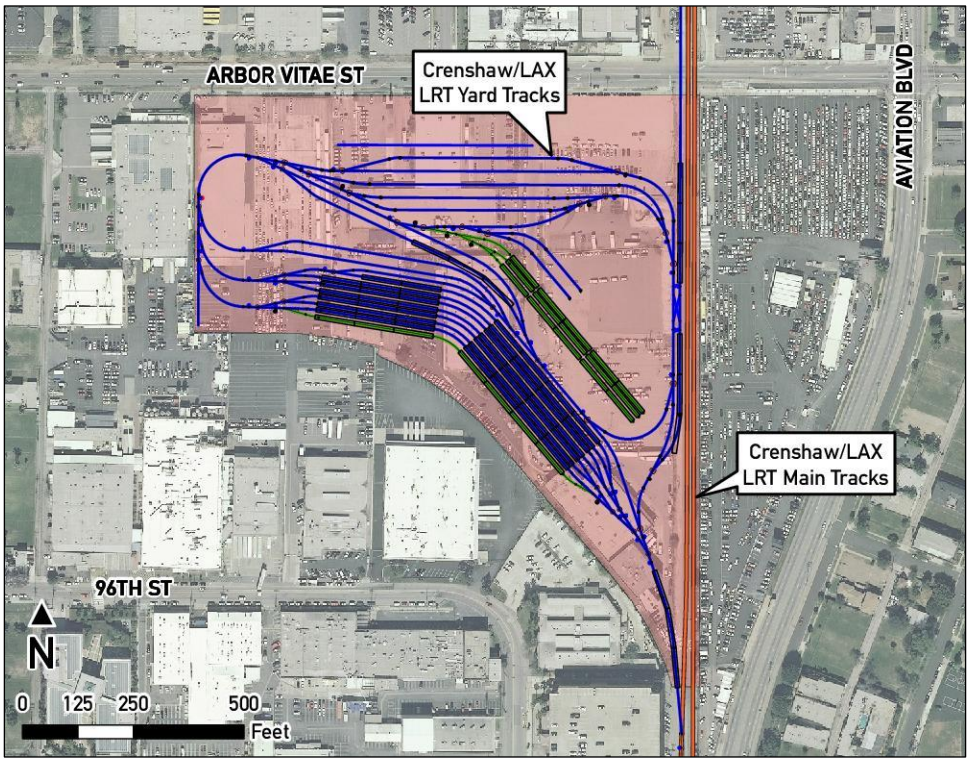
- **Yard Layout** – As shown in Figure 3-5, the Southwestern Yard was designed on a very constrained parcel. In order to fit all the required facilities and operations, some deviations to Metro Design Criteria's minimum horizontal tangent and curve dimensions were assumed. Any remaining space between tracks accommodates yard buildings, staff parking, and fire lanes. Due to this constrained environment, very little flexibility exists to accommodate structures to support an upper deck for the ITF. An in-depth structural analysis would be required to determine if such a structure is feasible and yard layout impacts.
- **Property Acquisition** – In order to access the ITF, a roadway network would be required, including ramps. The Belford property to the west of the Southwestern Yard is the one logical place for a vehicular ramp access from the road to the upper deck. This property is

currently owned by LAWA and the future development on the property has not yet been determined.

- **Security Monitoring** – The Southwestern Yard requires security monitoring, which depends upon an unobscured line of sight from the observation tower. The tower is located on the east end of the main shop and is 52 feet high, making it the tallest structure in the yard. The addition of the ITF above the yard would obscure the line of sight from the observation tower. Alternatively, yard security monitoring could occur via closed circuit television, eliminating the need for the tower and removing the height restriction for the ITF structure.
- **LAX Height Restrictions** – The height of the ITF may exceed height restrictions imposed by the LAX runway approaches. This Runway Approach height restriction is distinct from the RPZ restrictions.

In addition to these considerations, the ITF is a LAWA facility. Therefore, the location and design of the facility is not within Metro's purview. While this concept was not recommended by Metro or LAWA staff, both agencies continue to explore opportunities associated with a new LRT and APM transfer facility near 96th Street and Aviation Boulevard.

Figure 3-5: Southwestern Yard Layout



3.5. Operational Feasibility

With the exception of the A Alternatives, all alternatives under consideration involve branching and merging the Crenshaw/LAX and Metro Green Lines, creating exceedingly

complex operating conditions. The analysis of the operations feasibility focused on three key issues:

- Terminal Capacity
- Junction Operations
- Yard Access

The operations analyses identified capacity constraints at several key junctions and terminals outside the Study Area. These capacity constraints, specifically at two locations – the LAX/Aviation Junction and the Redondo Beach Terminal – result in train conflicts that put into question the practical operating capacity for Alternatives B, C1, C3, and C4. Appendix C presents the operations analysis for the Redondo Beach terminus station and Alternative B.

3.5.1.1. Terminal Capacity

The operations analysis began by determining the terminal capacity for Alternative C1, which is the only alternative with a terminal station (end of line) in the CTA area. All of the A Alternatives, B, C3, and C4 do not involve terminal stations in the CTA area, and therefore were not part of the terminal capacity analysis.

Table 3-10 presents the maximum headways that could be supported along each of the three branches (Green Line Norwalk-LAX, Crenshaw Redondo Beach-LAX and Crenshaw Expo-LAX) in Alternative C1. With tail tracks and pocket tracks on the inbound side, a two-track stub-end configuration can accommodate a maximum headway of eight-minutes on each of the three branches. Therefore, it should be feasible to accommodate the proposed 10 minute headways on each branch in Alternative C1 at the CTA East Station. The CTA East Station itself would need to be constructed with three platform tracks to process the number of trains operating in this scenario.

Table 3-10: Maximum Headways

Branch Terminal Configuration	Practical Headway on Each Branch
Stub-End no tail tracks	11.25 min
Stub-End with tail tracks and pocket tracks	>8.18 min

Another key terminal in the Metro Rail system is the Redondo Beach Station. The existing configuration at the Redondo Beach Station is not capable of supporting the proposed operations for Alternatives B, C1, C3, and C4. The absence of tracks beyond the station platform requires trains to enter the station at reduced speeds, which when combined with necessary switch realignment times, creates too long of a cycle per train to maintain the required combined headway. This issue could potentially be solved with construction of tail tracks beyond the station, allowing for higher speeds. The cost for the tail tracks at the Redondo Beach Station would be roughly $25 million and are not included in the cost information shown in Section 3.1.1.

3.5.1.2. Junction Operations

There are two critical junctions in the AMC operating system – the grade-separated junction north of the Aviation/Century Station and the flat junction west of the Aviation/LAX Station. Flat junctions are those that have two tracks and cross each other at-grade, but the two tracks do not connect to each other. To determine whether the C Alternatives could feasibly operate through these two junctions, two operating simulations were run – one for Alternative C1 and one for Alternative C3.

Both simulations showed little delay to revenue trains at the junctions, both in frequency and duration. However, many of the trains enter and exit the junctions only a few seconds apart, meaning they could easily be delayed once randomization factors (e.g. station and traffic delays) are added as would exist in regular operations. Alternative C4 functions similarly to Alternative C3, and thus the junctions for that scenario perform the same as those in C3.

Due to the four different operating moves in Alternative B, there are three critical junctions - the grade-separated junction south of the Aviation/Century Station, the flat junction west of the Aviation/LAX Station, and the junction south of the Hindry Station. Despite the fact that the operations analysis for Alternative B suggests it is mathematically possible to run all four different branches through the junctions at 10 minute headways, the analysis did not explicitly account for the impact of the train control system, which reduces the capacity of the junctions in trains per hour.

Additionally, the calculations did not factor in normal daily random factors such as variations in dwell time at stations and traffic delays on the Crenshaw/LAX line. These two factors could create delays and variations in train operations greater than the slim operating margin of the theoretical results, meaning this scenario may not be able to be successfully operated in practice. Given the external variables that can and will affect schedule adherence for Crenshaw/LAX service, it is very unlikely that recurring conflicts at junctions can be avoided.

3.5.1.3. Yard Access

The third operations issue is yard access – moving trains in and out of the yard at the beginning and end of the day, as well as during changes in service frequency (e.g., peak to midday service). The same operations simulations for Alternative C1 and C3 were run to determine the operability of yard access without a western lead – meaning all trains would be forced to enter and exit the yard through the Crenshaw/LAX line. The operations analysis concluded that the yard access lead could feasibly operate under these two alternatives.

4. SUMMARY

This Supplemental Analysis Report supports the main conclusions of the 2013 Technical Refinement Study. While the alternatives that connect Metro Rail to the ITF or CTA marginally improve transit ridership, they do so at very high cost. Table 4-1 summarizes several key findings:

- The type of transit connection to LAX has no meaningful effect on LAX-bound transit ridership. While the ridership forecasting indicated that those alternatives that provide a direct connection into the CTA (Alternatives C1, C3 and C4) yield higher airport-bound ridership, the overall increase is marginal and slightly offset by ridership loss for non-LAX bound Metro passengers.
- While there is minimal difference in transit attractiveness by connection type, there are considerable variations in project costs. Alternatives A1, A2, and A3 have minimal Metro project cost, since they involve only minor modifications to the Crenshaw/LAX Line. The Metro project cost for Alternative A2 involves the construction of a new station at 96th Street, and associated land acquisition costs. By contrast, Alternatives B, C1, C3 and C4 – which involve underground tunnels, special trackwork, elevated structures, junctions, stations and supporting systems – range between $1.8 billion and $3.8 billion.
- There is a significant difference in the cost per Metro transit trip to the Airport as a result of the large disparity in costs between Alternatives A, B and C in comparison to relative benefits. The cost per Metro transit trip to the Airport is calculated by dividing the annualized LRT capital and operating costs by the total number of Metro Rail trips to the Airport. This results in a range from a low of $12 per Metro transit trip to the Airport for Alternatives A1 and A3 to a high of $233 per Metro transit trip to the Airport for Alternative C4.
- The operability of the service plans for Alternatives B and C is severely limited by system capacity constraints outside the immediate study area. These capacity constraints, specifically at two locations – the LAX/Aviation junction and the Redondo Beach terminal – could result in recurring train conflicts that render the overall operations of Alternatives B and C questionable.
- Including a baggage check-in service at the ITF has little effect on the share of transit trips to LAX. This is because the benefit associated with baggage check-in applies to only 28% of total air passengers bound for LAX (i.e. domestic travelers with bags), and is enjoyed primarily by air travelers who park and fly.

Table 4-1: Summary Table of LRT Cost and Ridership Results

Alternative Connection Types		Metro Rail Capital Cost ($ 2014 billions)	Cost per Metro Transit Trip to the Airport	Public Transit Mode Share to LAX (Air Passenger) (2035)	Airport Daily Boardings on Metro Green and Crenshaw/LAX Lines (2035)	Non-Airport Bound Daily Boardings on Metro Green and Crenshaw/LAX Lines (2035)
A1	Aviation Century Connection via 98th Street	$0.1	$12	1.1%	1,620	69,430
A2	96th Street Connection	$0.2	$19	1.2%	1,790	68,840
A3	Aviation Century Connection via CONRAC	$0.1	$12	1.1%	1,640	69,510
B*	ITF Connection	$1.7	$197	1.0%	1,450	66,890
C1	CTA Connection – LRT Branch	$2.0	$181	1.3%	2,000	67,790
Previously Eliminated Alternatives – for informational purposes only						
C3	CTA Connection One Station – Through LRT	$3.5	$231	1.9%	3,040	68,810
C4	CTA Connection Two Stations – Through LRT	$3.8	$233	2.1%	3,300	68,670

Table 4-2 provides a qualitative assessment of how each alternative performs against key evaluation factors. Based on this evaluation, the following can be concluded about each alternative:

- **Alternative A1** has high compatibility with the Metro program since it utilizes the Aviation/Century Station being built for the Crenshaw/LAX Line and provides a direct connection to the CTA via the APM. In addition, this alternative allows for more frequent Metro Rail service and would not inconvenience non-airport passengers on either the Crenshaw/LAX or Metro Green Lines. However, the APM alignment along 98th Street may conflict with LAWA's proposed roadway improvements for connecting to the CONRAC. Alternative A1 does not require complex trackwork (i.e. junctions and new terminal station) or additional operating cost for Metro.
- **Alternative A2** is less compatible with the Metro program than Alternative A1 due to the construction of a new Metro Rail station near 96th Street. The construction of the new Metro station will require modifications to the Crenshaw/LAX Line, which is currently under construction. Alternative A2 is compatible with LAWA's plans and operations as the location of the Metro 96th Street station allows for a more efficient LRT/APM transfer point due to a shorter walk distance and does not conflict with LAWA's proposed roadway improvements. The 96th Street LRT station can provide similar operational capacity as currently designed for the Aviation/Century Station. This alternative includes only minimal additional operating cost for Metro.

- **Alternative A3** is compatible with the Metro program since it utilizes the Aviation/Century station being built for the Crenshaw/LAX Line, but does not provide a direct connection to the CTA via the APM. Metro Rail passengers must travel east through the CONRAC before proceeding west to the airport. Similar to Alternative A1, this alternative allows for more frequent Metro Rail service and would not inconvenience non-airport passengers on either the Crenshaw/LAX or Metro Green Lines. Alternative A3 is less compatible with LAWA plans and operations as it requires the construction of a longer APM guideway and could also potentially constrain development within Manchester Square, the proposed site of the CONRAC facility, based on preliminary discussions with LAWA staff. Alternative A3 does not require complex trackwork (i.e. junctions and new terminal station) or additional operating cost for Metro.
- **Alternative B** is somewhat compatible with the Metro program because it utilizes the Crenshaw/LAX corridor. However, based on the operating plan analyzed, service to the Aviation/Century Station is reduced so that new LRT service can be shifted to the west to serve the ITF. All Metro Rail passengers experience longer wait times due to constraints on service frequency (10-minute minimum headways). Alternative B best integrates with LAWA's proposed program for the ITF. Alternative B requires complex trackwork (i.e. junctions and new terminal station) and additional operating cost for Metro.
- **Alternative C1** is somewhat compatible with the Metro program in that it provides a direct LRT connection to the eastern CTA. However, all Metro Rail passengers experience longer wait times due to constraints on service frequency (10-minute minimum headways). This alternative duplicates LAWA's APM service between the ITF and the eastern CTA and also requires some passengers to transfer to the APM to reach their terminals. Alternative C1 requires complex trackwork (i.e. junctions and new terminal station) and additional operating cost for Metro.
- **Alternative C3** is marginally compatible with the Metro program in that it provides a direct LRT connection to the western CTA. However, all Metro Rail passengers experience longer wait times due to constraints on service frequency (10-minute minimum headways). This alternative also duplicates LAWA's APM service between the ITF and the CTA and requires some passengers to transfer to the APM to reach their terminals. For LAWA, this alternative may present significant risk to airport operations during construction of LRT tunnels under critical airport facilities (i.e. runways, terminals, and roadways). Alternative C3 requires complex trackwork (i.e. junctions and new terminal station) and additional operating cost for Metro.
- **Alternative C4**, which is similar to Alternative C3, but adds a second underground station inside the CTA and possesses greater construction challenges.

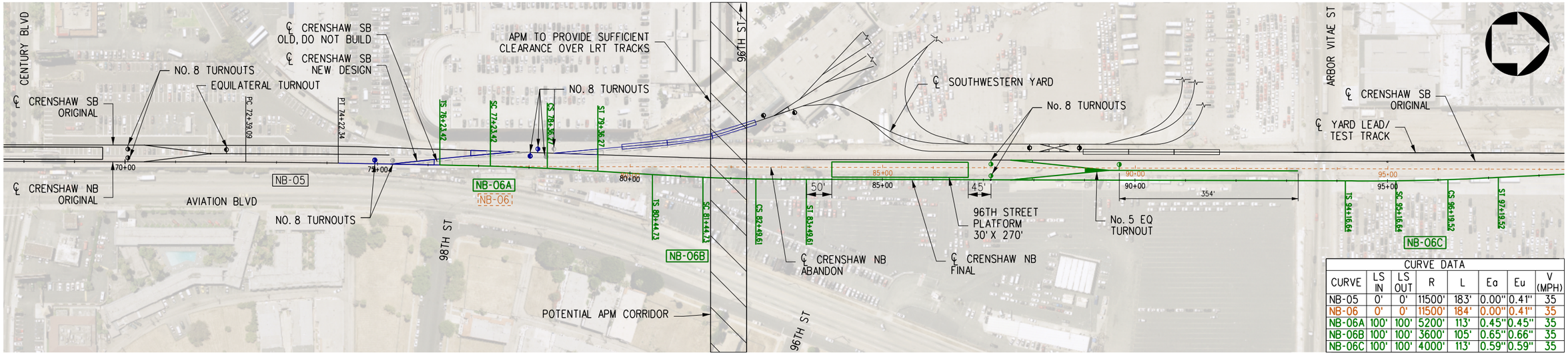
Table 4-2: Summary of Findings

Alternative Connection Types		● High - ○ Low		
		Compatibility with Metro Program	Compatibility with LAX Plans & Operations	Metro Rail Operational Feasibility
A1	Aviation Century Connection via 98th Street	●	○	●
A2	96th Street Connection	◔	●	●
A3	Aviation Century Connection via CONRAC	◔	◐	●
B	ITF Connection	◐	●	◐
C1	CTA Connection – LRT Branch	◐	◐	◐
Previously Eliminated Alternatives – for informational purposes only				
C3	CTA Connection One Station – Through LRT	◔	○	◐
C4	CTA Connection Two Stations – Through LRT	◔	○	◐

Metro will continue to work closely with LAWA to identify a transit connection to LAX that best serves Metro Rail passengers and LAWA's need to connect several transportation facilities identified in the SPAS.

APPENDIX A
Engineering Maps

SUPPLEMENTAL ANALYSIS REORT - APPENDIX A



CURVE DATA

CURVE	LS IN	LS OUT	R	L	Ea	Eu	V (MPH)
NB-05	0'	0'	11500'	183'	0.00"	0.41"	35
NB-06	0'	0'	11500'	184'	0.00"	0.41"	35
NB-06A	100'	100'	5200'	113'	0.45"	0.45"	35
NB-06B	100'	100'	3600'	105'	0.65"	0.66"	35
NB-06C	100'	100'	4000'	113'	0.59"	0.59"	35

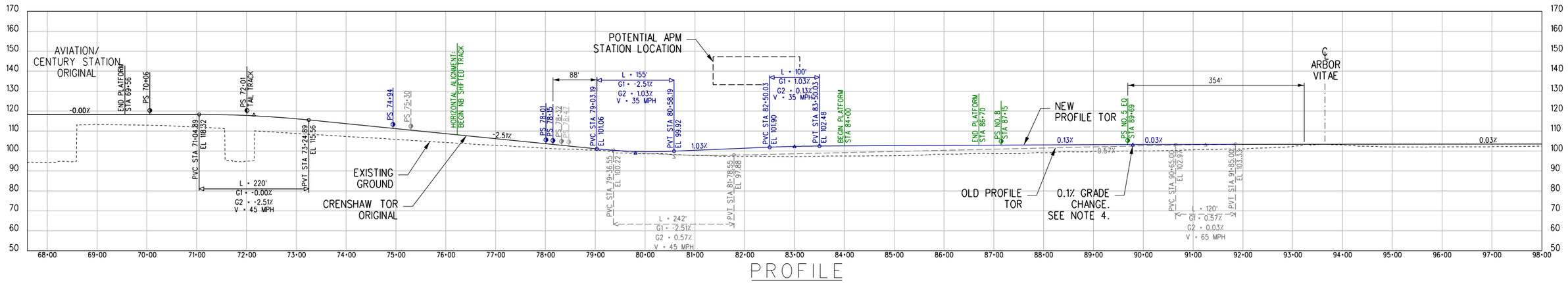
PLAN

Notes

1. MAINLINE TURNOUTS ARE REQUIRED TO BE No. 10 OR LARGER, BUT IT IS NOT UNCOMMON FOR No. 8 TO BE USED ON METRO PROJECTS WITH A DEVIATION REQUEST.
2. 354' TAIL TRACK INCLUDES 270' FOR TRAINS, 10' CLEAR TO TURNOUT, 10' CLEAR FOR BUMPER POST, AND THEN AN ADDITIONAL 64' MORE THAT THE TRACK COULD BE TRUNCATED TO STAY CLEAR OF THE EDGE OF THE PARCEL WHERE IT MEETS THE SIDEWALK.
3. A MINIMUM HORIZONTAL TANGENT OF 50' IS REQUIRED BETWEEN A POINT OF HORIZONTAL CURVATURE AND THE EDGE OF A PLATFORM. THIS DESIGN PROVIDES 45' AT THE PLATFORM'S NORTH END, WHICH IS A MODIFICATION TO BE COVERED BY A DESIGN VARIANCE REQUEST.
4. THE SEPULVEDA PASS/COASTAL CORRIDOR IS PRESUMED TO JOIN ELSEWHERE, NOT AT THE SOUTHWESTERN YARD.

Key

- CRENSHAW & YARD CENTERLINE, ORIGINAL
- CRENSHAW & YARD CENTERLINE, OLD DESIGN, DO NOT BUILD
- CRENSHAW CENTERLINE, INTERIM DESIGN, TO BE ABANDONED
- CRENSHAW & YARD CENTERLINE, NEW DESIGN
- CRENSHAW CENTERLINE, FINAL CONFIGURATION
- ORIGINAL GROUND



PROFILE

Notes

1. THE VERTICAL ALIGNMENT REFLECTS THE ORIGINAL CRENSHAW DESIGN THAT DOES NOT ACCOMODATE A WEST CONNECTION SEPULVEDA PASS/COASTAL CORRIDOR ADJACENT TO THE SOUTH YARD LEAD.
2. A MAXIMUM HEIGHT ABOVE THE FINISHED GRADE OF THE YARD (ELEV 100) IS DICTATED BY LAX RUNWAY APPROACHES. STRUCTURES AND CONSTRUCTION MUST STAY AT A HEIGHT OF 79' OR LOWER IN THIS REGION.
3. CURVE SPEED HAS BEEN LOWERED FROM 45 MPH TO 35 MPH TO MATCH THE HORIZONTAL CURVE SPEEDS AND ALLOW FOR SHORTER VERTICAL CURVES IN THIS CONSTRAINED AREA.
4. LAMRDC ALLOWS FOR CHANGES IN GRADE UP TO Δ = 0.1% TO OCCUR WITHOUT A CURVE.

100' 0 100' 200'
V: 1"=25'

100' 0 100' 200'
H: 1"=100'

CONCEPTUAL DESIGN

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY
DRAWN BY
CHECKED BY
IN CHARGE
DATE

EXHIBIT FOR INTERNAL DISCUSSION

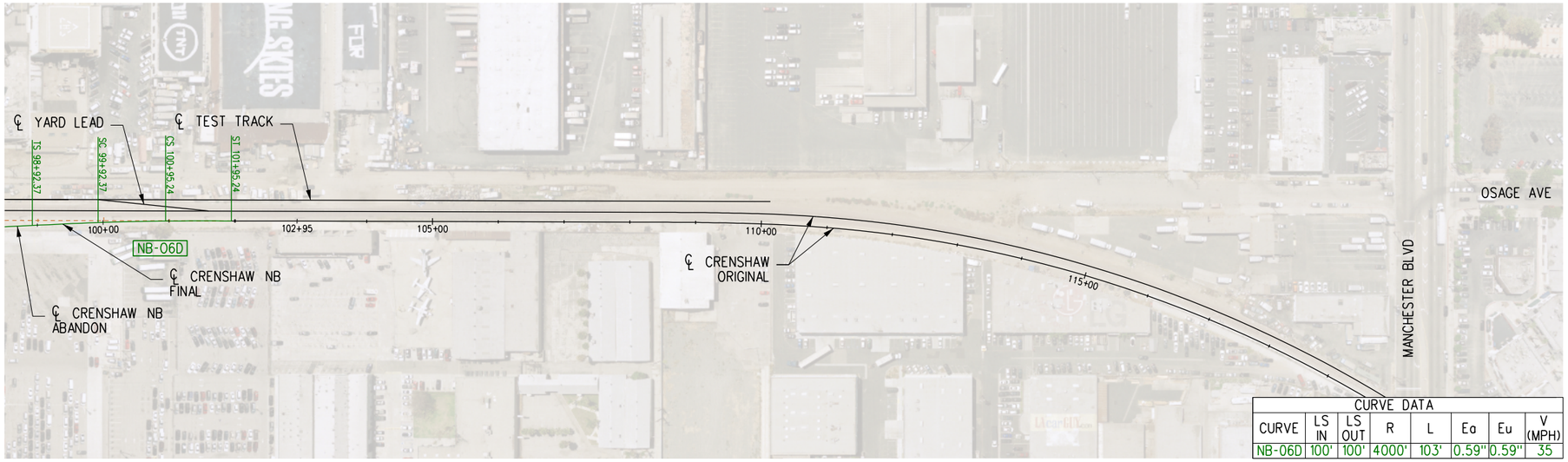
LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY
Metro
AIRPORT METRO CONNECTOR

STV Incorporated
ENGINEERS/ARCHITECTS/PLANNERS/CONSTRUCTION MANAGERS
1055 WEST SEVENTH STREET, SUITE 3150
LOS ANGELES, CA 90017-2556

ALTERNATIVE A2 SHEET - SOUTH

CONTRACT NO
DRAWING NO
REV
SCALE AS SHOWN
SHEET NO

SUPPLEMENTAL ANALYSIS REORT - APPENDIX A



CURVE DATA							
CURVE	LS IN	LS OUT	R	L	Ea	Eu	V (MPH)
NB-06D	100'	100'	4000'	103'	0.59"	0.59"	35

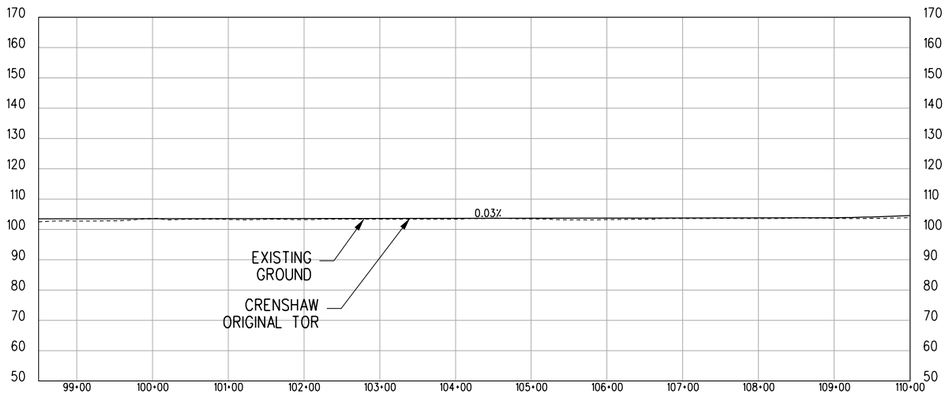
PLAN

Notes

1. THE SEPULVEDA PASS/COASTAL CORRIDOR IS PRESUMED TO JOIN ELSEWHERE, NOT AT THE SOUTHWESTERN YARD.

Key

- CRENSHAW CENTERLINE, ORIGINAL
- CRENSHAW CENTERLINE, INTERIM DESIGN, TO BE ABANDONED
- CRENSHAW CENTERLINE, FINAL CONFIGURATION
- ORIGINAL GROUND



PROFILE

Notes

1. NO VERTICAL ADJUSTMENTS REQUIRED IN THIS AREA.

100' 0 100' 200'
V: 1"=25'

100' 0 100' 200'
H: 1"=100'

CONCEPTUAL DESIGN

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY
DRAWN BY
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DATE

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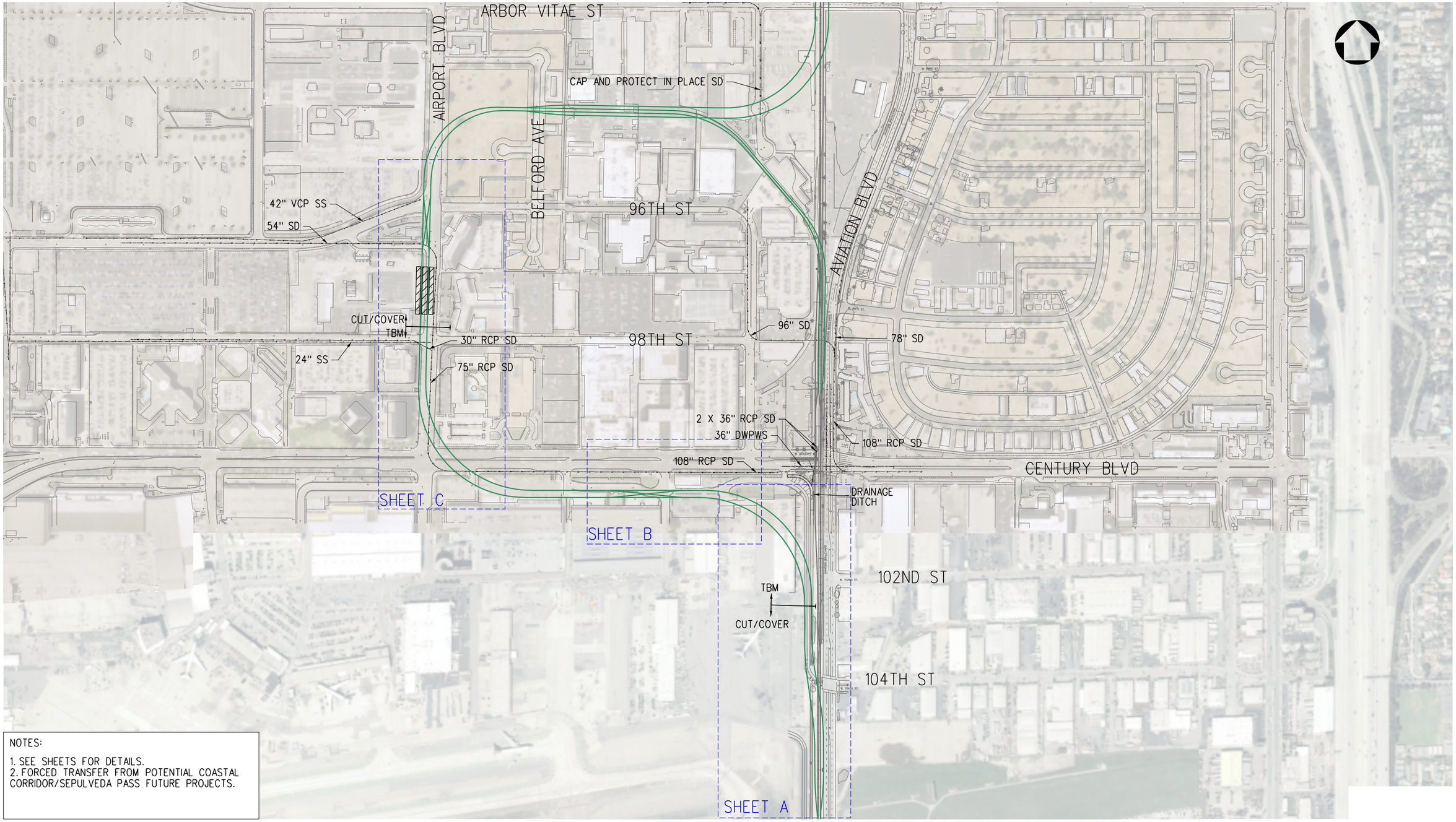
LOS ANGELES, CA 90017-2556

ALTERNATIVE A2 SHEET - NORTH

CONTRACT NO
DRAWING NO
REV
SCALE AS SHOWN
SHEET NO



NOTES:

1. SEE SHEETS FOR DETAILS.
2. FORCED TRANSFER FROM POTENTIAL COASTAL CORRIDOR/SEPULVEDA PASS FUTURE PROJECTS.

CONCEPTUAL DESIGN

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

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IN CHARGE
DATE 3-14-14

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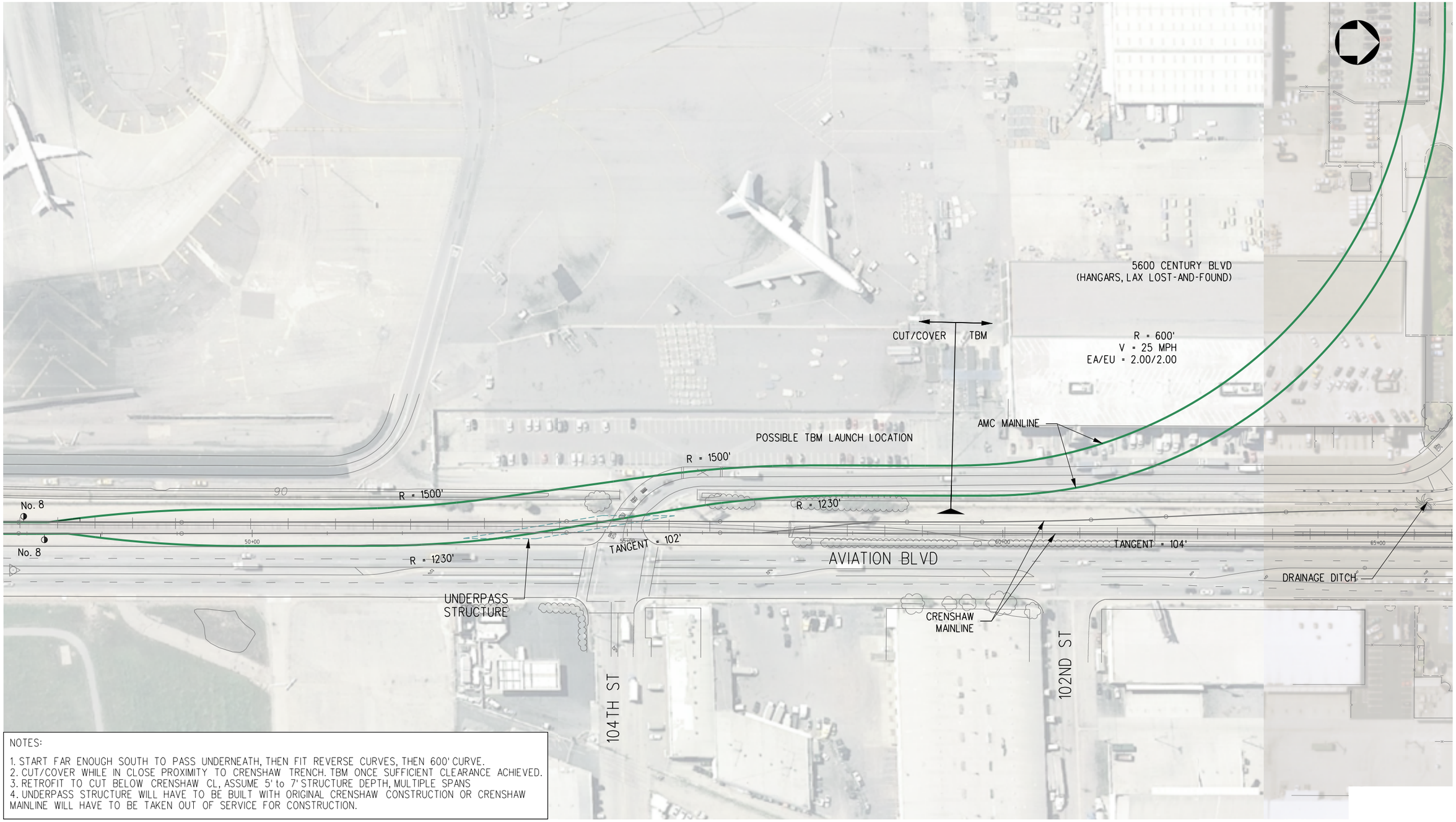
LOS ANGELES, CA 90017-2556

ALTERNATIVE B OVERVIEW

CONTRACT NO
DRAWING NO
REV
SCALE
SHEET NO



NOTES:

1. START FAR ENOUGH SOUTH TO PASS UNDERNEATH, THEN FIT REVERSE CURVES, THEN 600' CURVE.
2. CUT/COVER WHILE IN CLOSE PROXIMITY TO CRENSHAW TRENCH. TBM ONCE SUFFICIENT CLEARANCE ACHIEVED.
3. RETROFIT TO CUT BELOW CRENSHAW CL, ASSUME 5' to 7' STRUCTURE DEPTH, MULTIPLE SPANS
4. UNDERPASS STRUCTURE WILL HAVE TO BE BUILT WITH ORIGINAL CRENSHAW CONSTRUCTION OR CRENSHAW MAINLINE WILL HAVE TO BE TAKEN OUT OF SERVICE FOR CONSTRUCTION.

CONCEPTUAL DESIGN

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

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IN CHARGE
DATE 3-14-14

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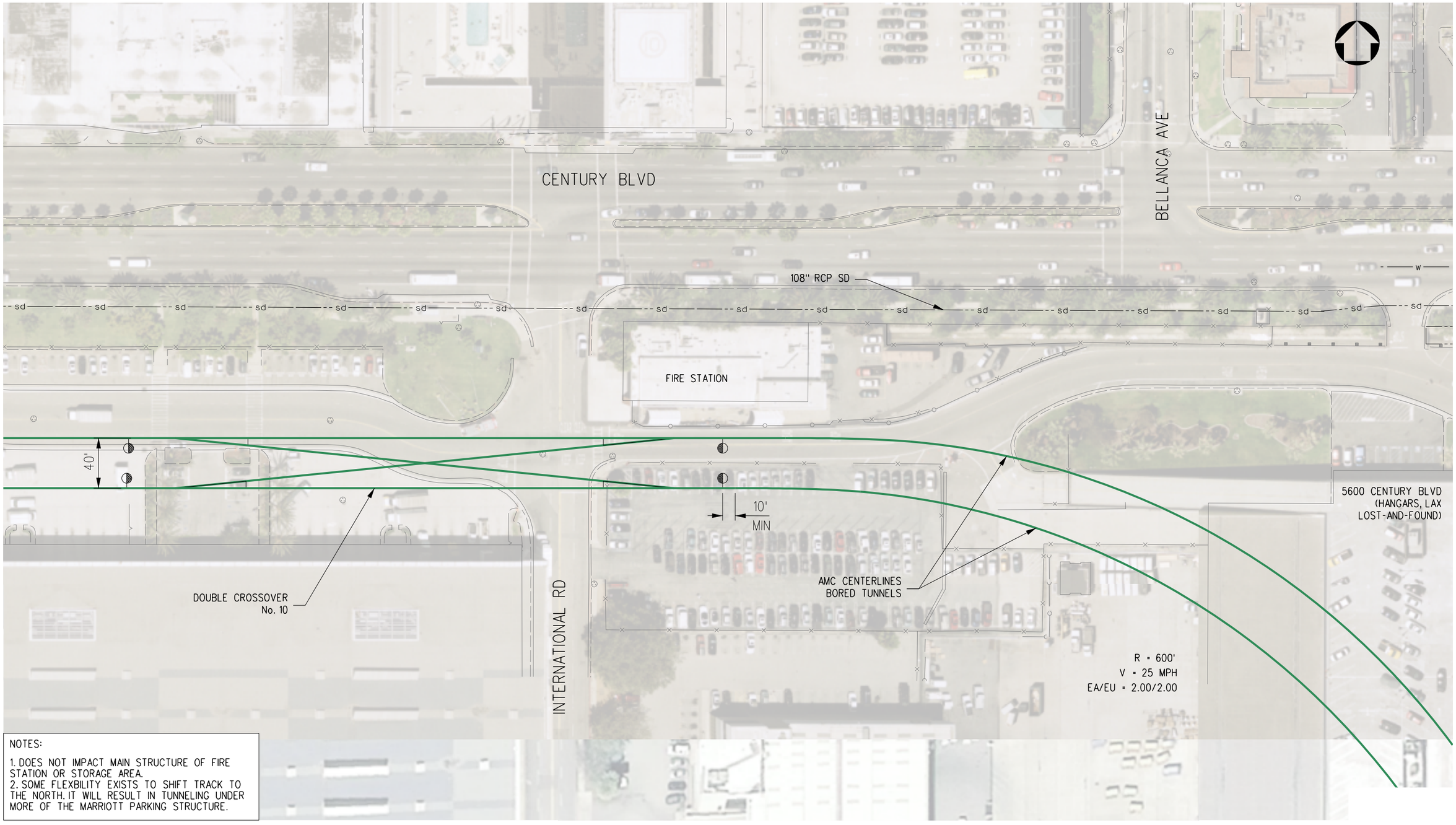
LOS ANGELES, CA 90017-2556

ALTERNATIVE B
SHEET A

CONTRACT NO
DRAWING NO | REV
SCALE
SHEET NO

Plotted By: terrellb 11:35:41 AM 4/30/2014 I:\projects\4015134\4015134_0001\90_CAD Models and Sheets\04_CK_Track_Roll\3.0 ITF Mod\Exhibit Sheet 04.2-A.dgn



NOTES:

1. DOES NOT IMPACT MAIN STRUCTURE OF FIRE STATION OR STORAGE AREA.
2. SOME FLEXBILITY EXISTS TO SHIFT TRACK TO THE NORTH. IT WILL RESULT IN TUNNELING UNDER MORE OF THE MARRIOTT PARKING STRUCTURE.

CONCEPTUAL DESIGN

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY
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IN CHARGE
DATE 3-14-14

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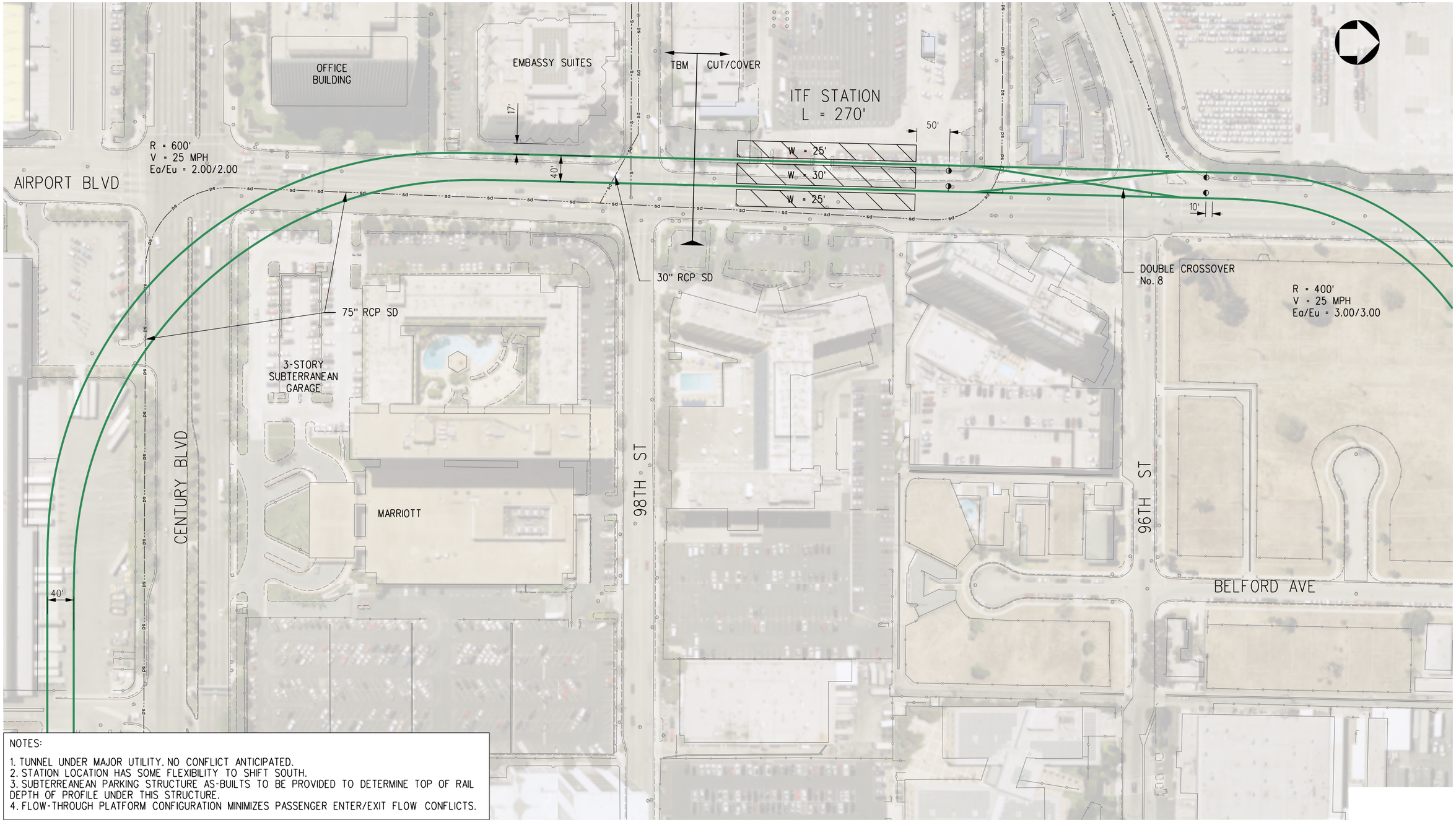
LOS ANGELES, CA 90017-2556

ALTERNATIVE B
SHEET B

CONTRACT NO
DRAWING NO | REV
SCALE
SHEET NO

SUPPLEMENTAL ANALYSIS REPORT - APPENDIX A



NOTES:

1. TUNNEL UNDER MAJOR UTILITY. NO CONFLICT ANTICIPATED.
2. STATION LOCATION HAS SOME FLEXIBILITY TO SHIFT SOUTH.
3. SUBTERREANEAN PARKING STRUCTURE AS-BUILTS TO BE PROVIDED TO DETERMINE TOP OF RAIL DEPTH OF PROFILE UNDER THIS STRUCTURE.
4. FLOW-THROUGH PLATFORM CONFIGURATION MINIMIZES PASSENGER ENTER/EXIT FLOW CONFLICTS.

CONCEPTUAL DESIGN

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

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IN CHARGE
DATE 3-14-14

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Metro
AIRPORT METRO CONNECTOR

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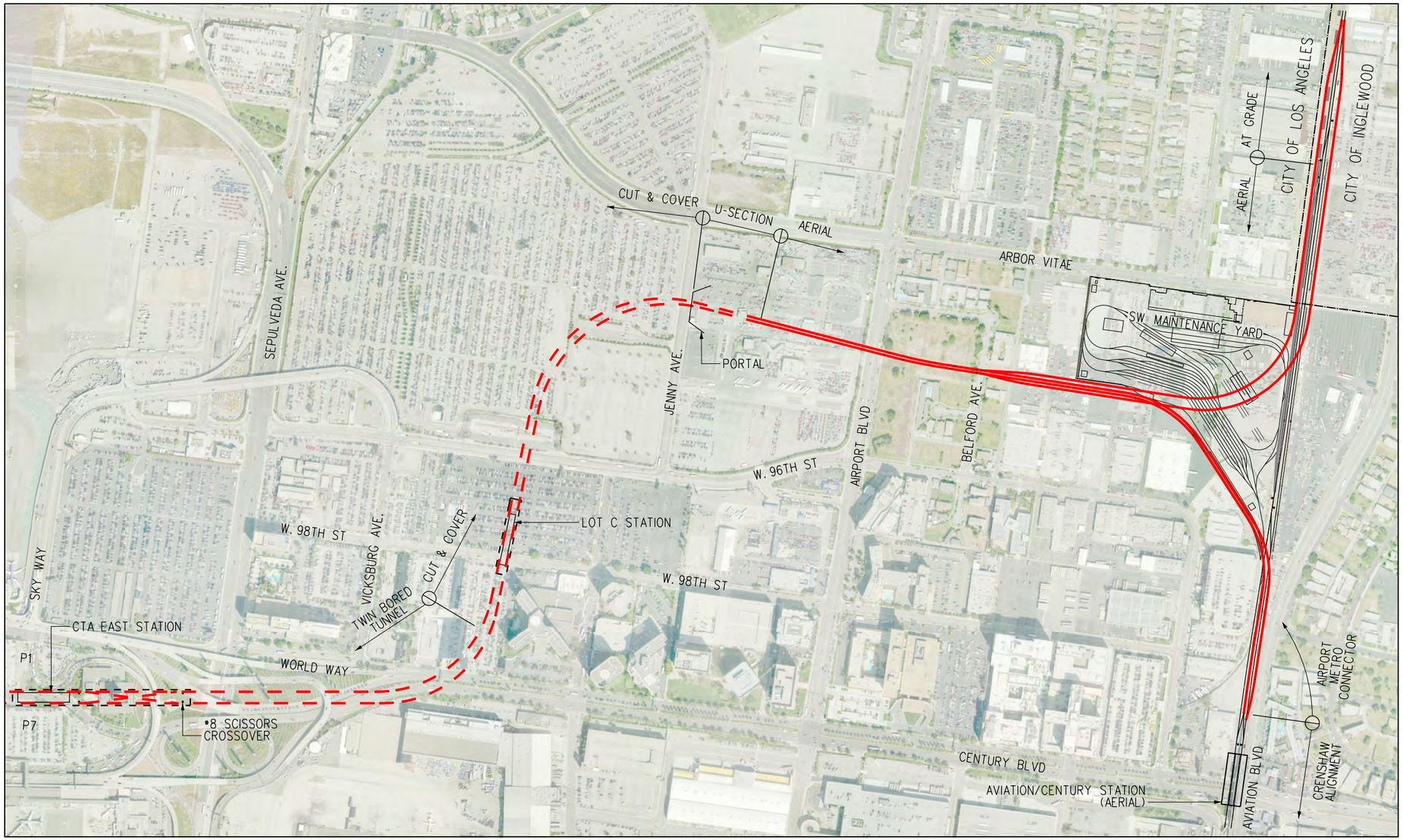
ENGINEERS/ARCHITECTS/PLANNERS/CONSTRUCTION MANAGERS
1055 WEST SEVENTH STREET, SUITE 3150
LOS ANGELES, CA 90017-2556

ALTERNATIVE B
SHEET C

CONTRACT NO
DRAWING NO | REV
SCALE
SHEET NO

SUPPLEMENTAL ANALYSIS REPORT - APPENDIX A



300' 0 300' 600'

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

FOR COSTING PURPOSES NOT FOR CONSTRUCTION

Metro

LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CONNECT LAX
STV Inc. | PB Americas Inc.

Hatch Mott MacDonald
6151 W. Century Blvd.
Suite 800
Los Angeles, CA 90045
Phone: 310-337-0500
Fax: 310-337-0042

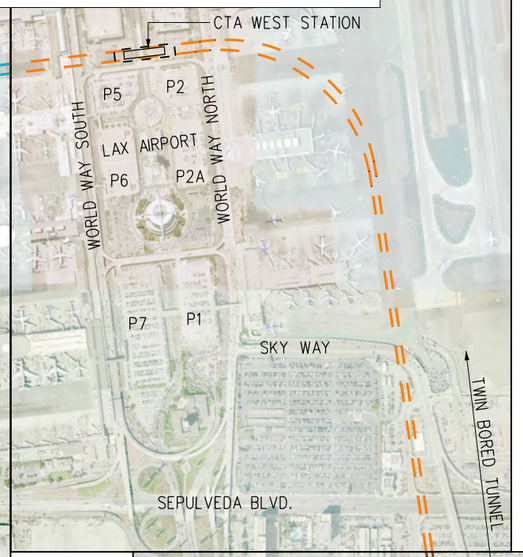
ALTERNATIVE C1

DRAWING NO

SCALE AS SHOWN

SHEET NO

SUPPLEMENTAL ANALYSIS REPORT - APPENDIX A



500' 0 500' 1000'

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

FOR COSTING PURPOSES NOT FOR CONSTRUCTION

Metro

LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CONNECT LAX
STV Inc. | PB Americas Inc.

Hatch Mott MacDonald
6151 W. Century Blvd.
Suite 800
Los Angeles, CA 90045
Phone: 310-337-0500
Fax: 310-337-0042

ALTERNATIVE C3

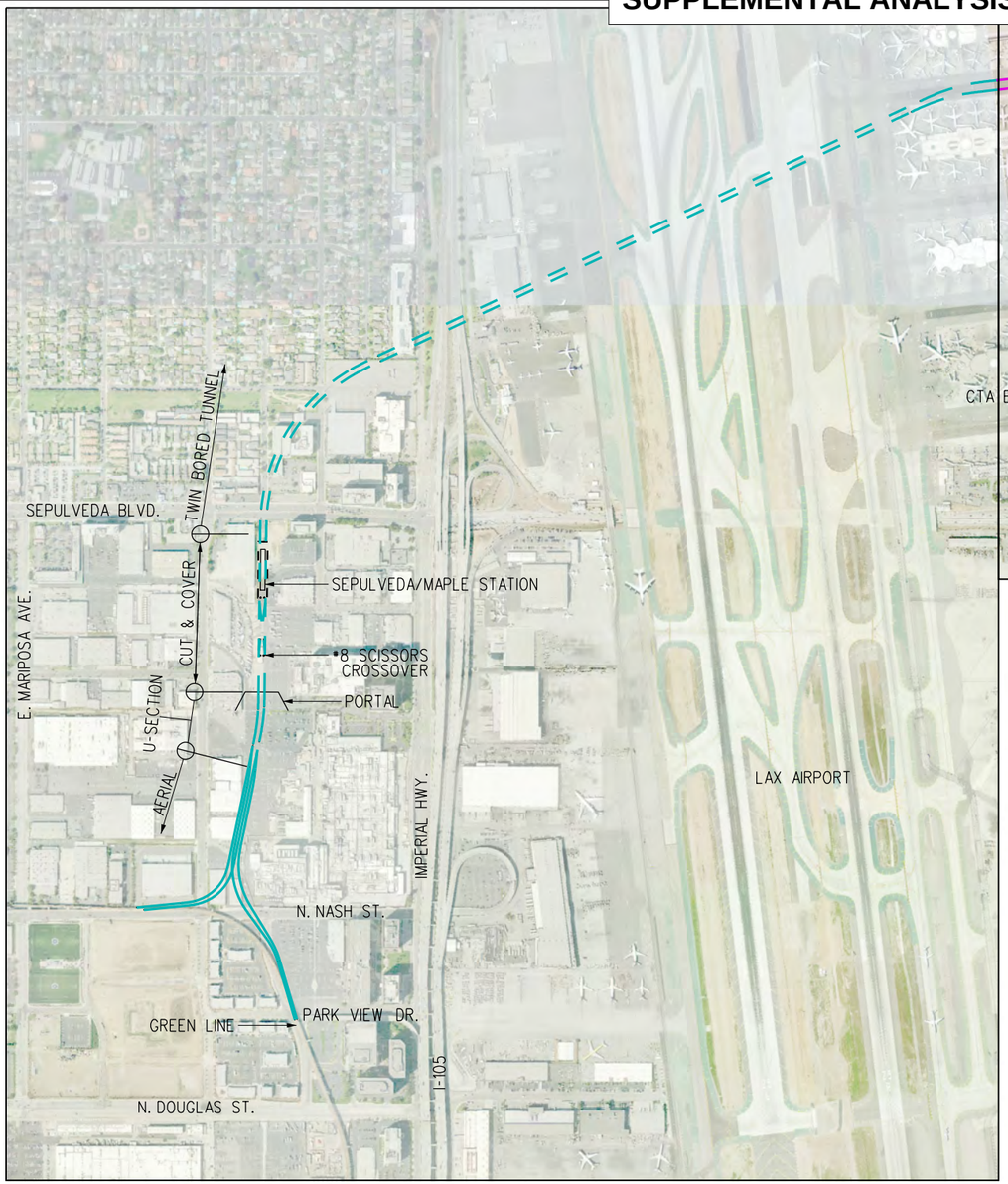
CONTRACT NO

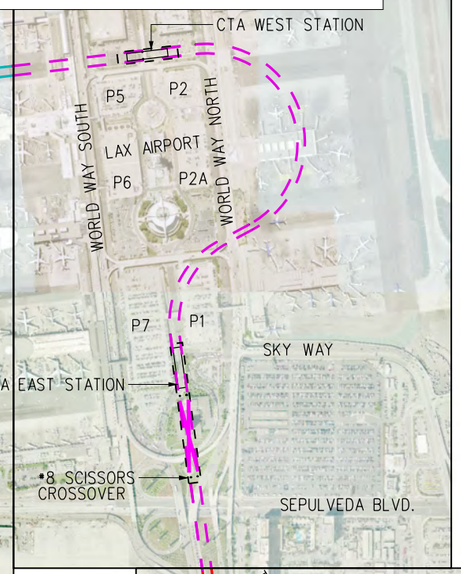
DRAWING NO | REV

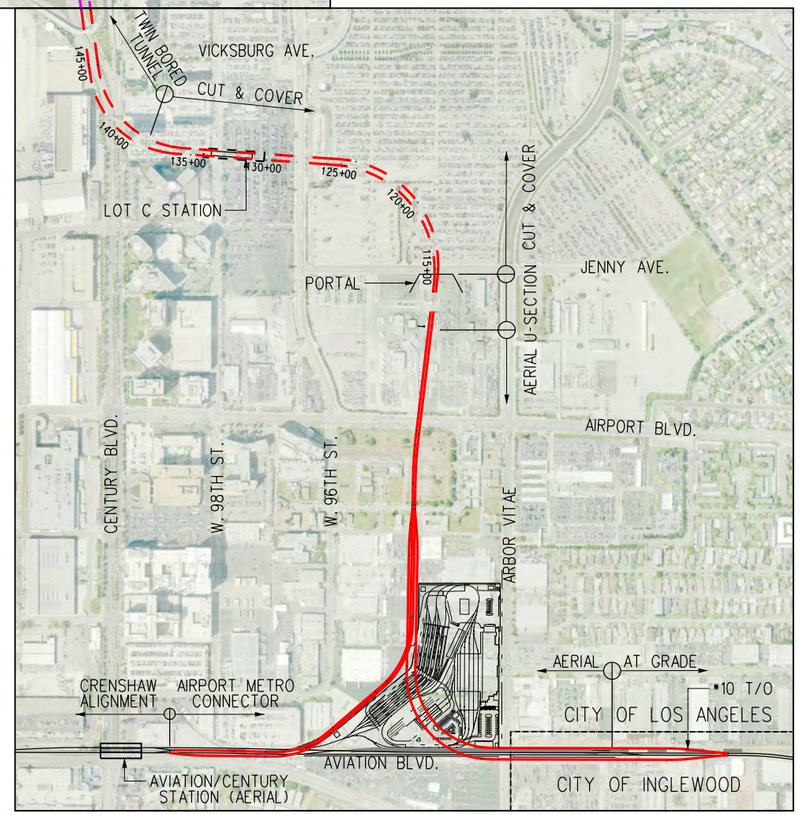
SCALE AS SHOWN

SHEET NO

SUPPLEMENTAL ANALYSIS REPORT - APPENDIX A







500' 0 500' 1000'

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

FOR COSTING PURPOSES NOT FOR CONSTRUCTION

Metro

LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY

CONNECT LAX
STV Inc. | PB Americas Inc.

Hatch Mott MacDonald
6151 W. Century Blvd.
Suite 800
Los Angeles, CA 90045
Phone: 310-337-0500
Fax: 310-337-0042

ALTERNATIVE C4

CONTRACT NO

DRAWING NO | REV

SCALE AS SHOWN

SHEET NO

APPENDIX B
Capital Cost Estimate SCC Sheets

		96th Street (0 vehicles)		
		Base Year Dollars w/o Contingency (X000)	Base Year Dollars Allocated Contingency (X000)	Base Year Dollars TOTAL (X000)
10	**GUIDEWAY & TRACK ELEMENTS**	731	213	**944**
10.01	Guideway: At-grade Exclusive Right-of-way	104	37	141
10.02	Guideway: At-grade Semi-exclusive (Allows Cross-traffic)	0	0	0
10.03	Guideway: At-grade in Mixed Traffic	0	0	0
10.04	Guideway: Aerial Structure	0	0	0
10.05	Guideway: Built-up Fill	0	0	0
10.06	Guideway: Underground Cut-and-cover	0	0	0
10.07	Guideway: Underground Tunnel	0	0	0
10.08	Guideway: Retained Cut or Fill	198	69	268
10.09	Track: Direct Fixation	0	0	0
10.10	Track: Embedded	0	0	0
10.11	Track: Ballasted	19	5	23
10.12	Track: Special (Switches, Turnouts)	410	103	513
10.13	Track: Vibration and Noise Dampening	0	0	0
20	**STATIONS, STOPS, TERMINALS, INTERMODAL**	5,300	1,590	**6,890**
20.01	At-grade Station, Stop, Shelter, Mall, Terminal, Platform	4,500	1,350	5,850
20.02	Aerial Station, Stop, Shelter, Mall, Terminal, Platform	0	0	0
20.03	Underground Station, Stop, Shelter, Mall, Terminal, Platform	0	0	0
20.04	Other Stations, Landings, Terminals: Intermodal, Ferry, Trolley, Etc.	0	0	0
20.05	Joint Development	0	0	0
20.06	Automobile Parking Multi-story Structure	0	0	0
20.07	Elevators, Escalators	800	240	1,040
30	**SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS**	64,000	640	**64,640**
30.01	Administration Building: Office, Sales, Storage, Revenue Counting	0	0	0
30.02	Light Maintenance Facility	0	0	0
30.03	Heavy Maintenance Facility	64,000	640	64,640
30.04	Storage or Maintenance of Way Building	0	0	0
30.05	Yard and Yard Track	0	0	0
40	**SITEWORK & SPECIAL CONDITIONS**	9,019	3,187	**12,206**
40.01	Demolition, Clearing, Earthwork	10	4	14
40.02	Site Utilities, Utility Relocation	633	253	886
40.03	Hazardous material, Contaminated Soil Removal and Mitigation, Ground Water Treatments	204	71	275
40.04	Environmental Mitigation, E.G. Wetlands, Historic and Archeologic, Parks	16	6	22
40.05	Site Structures Including Retaining Walls, Sound Walls	10	4	14
40.06	Pedestrian and Bike Access and Accommodation, Landscaping	387	135	522
40.07	Automobile, Bus, Van Access Ways Including Roads, Parking Lots	25	8	33
40.08	Temporary Facilities and Other Indirect Costs During Construction	7,734	2,707	10,441
50	**SYSTEMS**	6,415	2,245	**8,660**
50.01	Train Control and Signals	240	84	324
50.02	Traffic Signals and Crossing Protection	0	0	0
50.03	Traction Power Supply: Substations	2,500	875	3,375
50.04	Traction Power Distribution: Catenary and Third Rail	320	112	432
50.05	Communications	320	112	432
50.06	Fare Collection System and Equipment	2,939	1,029	3,968
50.07	Central Control	96	34	130
Construction Subtotal (10 - 50)		85,465	7,875	**93,341**
60	**ROW, LAND, EXISTING IMPROVEMENTS**	20,020	5,005	**25,025**
60.01	Purchase or Lease of Real Estate	20,020	5,005	25,025
60.02	Relocation of Existing Households and Businesses	0	0	0
70	**VEHICLES (number)**	0	0	**0**
70.01	Light Rail	0	0	0
70.02	Heavy Rail	0	0	0
70.03	Commuter Rail	0	0	0
70.04	Bus	0	0	0
70.05	Other	0	0	0
70.06	Non-revenue Vehicles	0	0	0
70.07	Spare Parts	0	0	0
80	**PROFESSIONAL SERVICES (Applies to Categories 10-50)**	32,499	4,957	**37,456**
80.01	Preliminary Engineering	10,279	513	10,791
80.02	Final Design	5,128	1,026	6,154
80.03	Project Management for Design and Construction	6,837	1,367	8,205
80.04	Construction Administration and Management	3,419	684	4,102
80.05	Professional Liability and Other Non-Construction Insurance	0	0	0
80.06	Legal, Permits, Review Fees by Other Agencies, Cities, Etc.	855	171	1,026
80.07	Surveys, Testing, Investigation, Inspection	1,709	342	2,051
80.08	Start Up	4,273	855	5,128
Subtotal (10 - 80)		137,985	17,837	**155,822**
90	**UNALLOCATED CONTINGENCY**			**57,654**
Subtotal (10 - 90)				**213,476**
100	**FINANCE CHARGES**			**0**
Total Project Cost (10 - 100)				**213,476**
Inflation (5%)				**10,674**
Current Dollars Total				**224,150**

FTA #	Item Description	Unit Cost	Unit	Quantity	Base Cost	Contin.	Total Cost
10	**Guideway & Track Elements**				**$ 731,270**		**$ 944,340**
10.01	Guideway: At-Grade Exclusive Right-of-Way				$ 104,360		$ 140,886
	Guideway Grading	$ 20	CY	900	$ 18,000	35%	$ 24,300
	Storm Drainage System	$ 120,000	RM	0.10	$ 12,000	35%	$ 16,200
	Subballast	$ 45	CY	908	$ 40,860	35%	$ 55,161
	Ballast Retainer	$ 44	LF	0		35%	
	Shift ROW Fence	$ 20	LF	1675	$ 33,500	35%	$ 45,225
10.02	Guideway: At-grade Semi-exclusive (Allows Cross-traffic)			0			
10.03	Guideway: At-grade in Mixed Traffic			0			
10.04	Guideway: Aerial Structure				$ -		$ -
	Superstructure: Single Column, Avg Height 25'	$ 11,100	RF	0		35%	
	Superstructure: Single Column, Avg Height 30'	$ 12,400	RF	0		35%	
	Superstructure: Single Column, Avg Height 35'	$ 12,500	RF	0		35%	
	Superstructure: Single Column, Avg Height 40'	$ 12,700	RF	0		35%	
	Superstructure: Single Column, Avg Height 45'	$ 12,800	RF	0		35%	
	Superstructure: Single Column, Avg Height 50'	$ 12,900	RF	0		35%	
	Superstructure: Double Column, Avg Height 35'	$ 20,900	RF	0		35%	
	Extra Decking for Long Spans			0		35%	
	Superstructure: Straddle bents	$ 440,000	RF	0		35%	
	Railing	$ 46	LF	0		35%	
	Drainage System	$ 200	LF	0			
10.05	Guideway: Built-up Fill			0			
10.06	Guideway: Underground Cut and Cover				$ -		$ -
	Cut and Cover Guideway	$ 6,000	TF	0		35%	
	Cut and Cover Guideway Under Existing Roadway	$ 50,645	TF	0		35%	
	Cut and Cover FAA Safety Barrier	$ 3,972	TF	0		35%	
10.07	Guideway: Underground Tunnel				$ -		$ -
	TBM Guideway	$ 12,000	TF	0		35%	
10.08	Guideway: Retained Cut or Fill				$ 198,160		$ 267,516
	Retaining Wall (Includes Footings)	$ 55	SF	1,900	$ 104,500	35%	$ 141,075
	Retained Fill	$ 30	CY	3122	$ 93,660	35%	$ 126,441
	Subballast	$ 45	CY	0		35%	
	Subdrainage System (Includes Cleanouts and Outlets)	$ 100	LF	0		35%	
	Railing	$ 45.90	LF	0		35%	
10.09	Track: Direct Fixation	$ 375	TF	0	$ -	25%	
10.10	Track: Embedded	$ 450	TF	0	$ -	25%	
10.11	Track: Ballasted				$ 18,750		$ 23,438
	Light Rail Ballasted Track	$ 250	TF	75	$ 18,750	25%	$ 23,438
10.12	Track: Special (Switches, Turnouts)				$ 410,000		$ 512,500
	Turnouts: No. 10	$ 165,000	EA	0		25%	
	Double Crossovers: No. 10	$ 700,000	EA	0		25%	
	Turnouts: No. 8	$ 150,000	EA	2	$ 300,000	25%	$ 375,000
	Turnouts: No. 5 Equilateral	$ 110,000	EA	1	$ 110,000	25%	$ 137,500
10.13	Track: Vibration and Noise Damping				$ -		$ -
	Sound Wall (low height)	$ 96	LF		$ -	35%	
20	**Stations, Stops, Terminals, Intermodal**				**$ 5,300,000**		**$ 6,890,000**
20.01	At-grade station, stop, shelter, mall, terminal, platform				$ 4,500,000		$ 5,850,000
	At-grade Station (270' Platform, 3 cars)	$ 4,500,000	EA	1	$ 4,500,000	30%	$ 5,850,000
20.02	Aerial station, stop, shelter, mall, terminal, platform						
20.03	Underground Station, Stop, Shelter, Mall, Terminal, Platform						
20.04	Other Stations, Landings, Terminals: Intermodal, Ferry, Trolley, Etc			0			
20.05	Joint Development			0			
20.06	Automobile Parking Multi-story Structure			0			
20.07	Escalators (additional)	$ 400,000	EA	1	$ 400,000	30%	$ 520,000
20.07	Elevators (additional)	$ 400,000	EA	1	$ 400,000	30%	$ 520,000
30	**Support Facilities: Yards, Shops, Admin. Buildings**				**$ 64,000,000**		**$ 64,640,000**
30.03	Heavy Maintenance Facility				$ 64,000,000		$ 64,640,000
	Contribution to Southwestern Yard to Accommodate AMC Vehicles	$ 64,000,000	LS	1	$ 64,000,000	1%	$ 64,640,000
	Potential modifications to the Southwestern Yard to Accommodate Aerial Structures	$ 200,000	LS	0		1%	

FTA #	Item Description	Unit Cost	Unit	Quantity	Base Cost	Contin.	Total Cost
40	**Sitework & Special Conditions**				**$ 9,019,085**		**$ 12,206,161**
40.01	Demolition, Clearing, Earthwork				$ 10,035		$ 13,547
	General Site Clearing	$ 3,345	ACRE	3	$ 10,035	35%	$ 13,547
40.02	Site Utilities, Utility Relocation: Existing ROW				$ 632,908		$ 886,071
	Relocate					40%	
	Major Utility Deconstruct and Rebuild, Surface Level Drainage Ditch	$ 214	LF	0		40%	
	Major Utility Relocation, Underground - Level 6: ≥60" Diameter	$ 1,333	LF	0		40%	
	Major Utility Relocation, Underground - Level 5: ≥48" Dia. To <60" Dia.	$ 973	LF	0		40%	
	Major Utility Relocation, Underground - Level 4: ≥36" Dia. To <48" Dia.	$ 770	LF	0		40%	
	Major Utility Relocation, Underground - Level 3: ≥24" Dia. To <36" Dia.	$ 645	LF	0		40%	
	Major Utility Relocation, Underground - Level 2: ≥12" Dia. To <24" Dia.	$ 390	LF	32	$ 12,480	40%	$ 17,472
	Major Utility Relocation, Underground - Level 1: <12" Dia.	$ 218	LF	2,846	$ 620,428	40%	$ 868,599
	Major Utility Relocation, Aerial OH Transmission Line - Level C: ≥240kV	$ 4,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level B: <240kV	$ 1,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level A: Other OH	$ 750	LF	0		40%	
	Protect in Place					40%	
	Major Utility Relocation, Underground - Level 6: ≥60" Diameter	$ 900	LF	0		40%	
	Major Utility Relocation, Underground - Level 3: ≥24" Dia. To <36" Dia.	$ 600	LF	0		40%	
40.03	Haz. Mat'l Contaminated Soil Removal/Mitigation, Ground Water Treatments				$ 204,000		$ 275,400
	Standard	$ 680,000	RM	0.30	$ 204,000	35%	$ 275,400
	On-CTA	$ 1,700,000	RM	0.00		35%	
	Terminals 6 - 8	$ 2,720,000	RM	0.00		35%	
40.04	Environmental Mitigation, E.G. Wetlands, Historic/Archeological, Parks	$ 100,000	RM	0.16	$ 16,000	35%	$ 21,600
40.05	Site Structures Including Retaining Walls, Sound Walls	$ 10,000	LS	1	$ 10,000	35%	$ 13,500
40.06	Pedestrian/Bike Access & Accommodation, Landscaping						
40.06	Pedestrian/Bike Access & Accommodation, Landscaping: Art Work	0.5%	10-50		$ 386,721	35%	$ 522,073
40.07	Automobile, Bus, Van Access Ways Including Roads				$ 25,000		$ 32,500
	Arbor Vitae Expanded Grade Crossing	$ 25,000	LS	1	$ 25,000	30%	$ 32,500
40.07	Automobile, Bus, Van Access Ways Including Parking Lots						
40.08	Temporary Facilities and Other Indirect Costs During Construction	10.0%	10-50		$ 7,734,421	35%	$ 10,441,469
50	**Systems**				**$ 6,415,000**		**$ 8,660,250**
50.01	Train Control and Signals				$ 240,000		$ 324,000
	Light Rail	$ 1,500,000	RM	0.16	$ 240,000	35%	$ 324,000
50.02	Traffic Signals and Crossing Protection						
50.03	Traction Power Supply: Substations	$ 2,500,000	EA	1	$ 2,500,000	35%	$ 3,375,000
50.04	Traction Power Distribution: Catenary	$ 2,000,000	RM	0.16	$ 320,000	35%	$ 432,000
50.05	Communications	$ 2,000,000	RM	0.16	$ 320,000	35%	$ 432,000
50.06	Fare Collection System and Equipment				$ 2,939,000		$ 3,967,650
	Gates	$ 356,500	EA	6	$ 2,139,000	35%	$ 2,887,650
	Ticket Vending Machines	$ 160,000	EA	5	$ 800,000	35%	$ 1,080,000
50.07	Central Control	$ 600,000	RM	0.16	$ 96,000	35%	$ 129,600
10-50	**Construction Total**				**$ 85,465,355**		**$ 93,340,750**
60	**ROW, Land, Existing Improvements**				**$ 20,020,000**		**$ 25,025,000**
60.01	Purchase or Lease of Real Estate	$ 1,000,000	LS	20.02	$ 20,020,000	25%	$ 25,025,000
60.02	Relocation of Existing Households and Businesses	$ 1,000,000	LS	0	$ -	25%	$ -
70	**Vehicles**				**$ -**		**$ -**
70.01	Light Rail	$ 3,800,000	VEH	0	$ -	10%	$ -
70.02	Heavy Rail			0			
70.03	Commuter Rail			0			
70.04	Bus			0			
70.05	Other			0			
70.06	Non-Revenue Vehicles			0			
70.07	Spare Parts	10%	VEH	0	$ -	10%	$ -
80	**Professional Services**				**$ 32,499,498**		**$ 37,456,488**
80.01	AA / Draft EIS/EIR / Final EIS/EIR				$ 7,714,545		$ 7,714,545
	Alternative Analysis	$ 1,818,428	LS	1	$ 1,818,428		$ 1,818,428
	Draft EIS/EIR	$ 3,691,961	LS	1	$ 3,691,961		$ 3,691,961
	Final EIS/EIR	$ 2,204,156	LS	1	$ 2,204,156		$ 2,204,156
80.01	Preliminary Engineering	3%	10-50		$ 2,563,961	20%	$ 3,076,753
80.02	Final Design	6%	10-50		$ 5,127,921	20%	$ 6,153,506
80.03	Project Management for Design and Construction (Agency)	8%	10-50		$ 6,837,228	20%	$ 8,204,674
80.04	Construction Administration and Management (Consultants)	4%	10-50		$ 3,418,614	20%	$ 4,102,337
80.05	Professional Liability and Other Non-Construction Insurance	0%	10-50		$ -	20%	$ -
80.06	Legal; Permits; Review Fees by Other Agencies, Cities, Etc.	1%	10-50		$ 854,654	20%	$ 1,025,584
80.07	Surveys, Testing, Investigation, Inspection	2%	10-50		$ 1,709,307	20%	$ 2,051,169
80.08	Start Up	5%	10-50		$ 4,273,268	20%	$ 5,127,921
10-80	**Total**				**$ 137,984,853**		**$ 155,822,238**
90	**Unallocated Contingency**	37%	10-80				**$ 57,654,228**
	10-90 Total				**$ 137,984,853**		**$ 213,476,467**
100	**Finance Charges**						**$ -**
10-100	**Total**				**$ 137,984,853**		**$ 213,476,467**

		Partial TBM (3 Vehicles)		
		Base Year Dollars w/o Contingency (X000)	Base Year Dollars Allocated Contingency (X000)	Base Year Dollars TOTAL (X000)
10 GUIDEWAY & TRACK ELEMENTS		351,056	121,887	**472,943**
10.01	Guideway: At-grade Exclusive Right-of-way	186	65	252
10.02	Guideway: At-grade Semi-exclusive (Allows Cross-traffic)	0	0	0
10.03	Guideway: At-grade in Mixed Traffic	0	0	0
10.04	Guideway: Aerial Structure	17,098	5,984	23,082
10.05	Guideway: Built-up Fill	0	0	0
10.06	Guideway: Underground Cut-and-cover	256,469	89,764	346,233
10.07	Guideway: Underground Tunnel	66,120	23,142	89,262
10.08	Guideway: Retained Cut or Fill	1,358	475	1,833
10.09	Track: Direct Fixation	7,447	1,862	9,308
10.10	Track: Embedded	0	0	0
10.11	Track: Ballasted	299	75	374
10.12	Track: Special (Switches, Turnouts)	2,080	520	2,600
10.13	Track: Vibration and Noise Dampening	0	0	0
20 STATIONS, STOPS, TERMINALS, INTERMODAL		109,000	32,700	**141,700**
20.01	At-grade Station, Stop, Shelter, Mall, Terminal, Platform	0	0	0
20.02	Aerial Station, Stop, Shelter, Mall, Terminal, Platform	0	0	0
20.03	Underground Station, Stop, Shelter, Mall, Terminal, Platform	109,000	32,700	141,700
20.04	Other Stations, Landings, Terminals: Intermodal, Ferry, Trolley, Etc.	0	0	0
20.05	Joint Development	0	0	0
20.06	Automobile Parking Multi-story Structure	0	0	0
20.07	Elevators, Escalators	0	0	0
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS		64,000	640	**64,640**
30.01	Administration Building: Office, Sales, Storage, Revenue Counting	0	0	0
30.02	Light Maintenance Facility	0	0	0
30.03	Heavy Maintenance Facility	64,000	640	64,640
30.04	Storage or Maintenance of Way Building	0	0	0
30.05	Yard and Yard Track	0	0	0
40 SITEWORK & SPECIAL CONDITIONS		175,199	61,499	**236,698**
40.01	Demolition, Clearing, Earthwork	10	4	14
40.02	Site Utilities, Utility Relocation	4,386	1,755	6,141
40.03	Hazardous material, Contaminated Soil Removal and Mitigation, Ground Water Treatments	1,578	552	2,130
40.04	Environmental Mitigation, E.G. Wetlands, Historic and Archeologic, Parks	232	81	313
40.05	Site Structures Including Retaining Walls, Sound Walls	0	0	0
40.06	Pedestrian and Bike Access and Accommodation, Landscaping	2,757	965	3,722
40.07	Automobile, Bus, Van Access Ways Including Roads, Parking Lots	800	240	1,040
40.08	Temporary Facilities and Other Indirect Costs During Construction	165,436	57,903	223,339
50 SYSTEMS		20,391	7,137	**27,528**
50.01	Train Control and Signals	3,480	1,218	4,698
50.02	Traffic Signals and Crossing Protection	0	0	0
50.03	Traction Power Supply: Substations	2,500	875	3,375
50.04	Traction Power Distribution: Catenary and Third Rail	4,640	1,624	6,264
50.05	Communications	4,640	1,624	6,264
50.06	Fare Collection System and Equipment	3,739	1,309	5,048
50.07	Central Control	1,392	487	1,879
Construction Subtotal (10 - 50)		719,646	223,863	**943,509**
60 ROW, LAND, EXISTING IMPROVEMENTS		30	8	**38**
60.01	Purchase or Lease of Real Estate	30	8	38
60.02	Relocation of Existing Households and Businesses	0	0	0
70 VEHICLES (number)		12,540	1,254	**13,794**
70.01	Light Rail	11,400	1,140	12,540
70.02	Heavy Rail	0	0	0
70.03	Commuter Rail	0	0	0
70.04	Bus	0	0	0
70.05	Other	0	0	0
70.06	Non-revenue Vehicles	0	0	0
70.07	Spare Parts	1,140	114	1,254
80 PROFESSIONAL SERVICES (Applies to Categories 10-50)		216,412	41,739	**258,151**
80.01	Preliminary Engineering	29,304	4,318	33,622
80.02	Final Design	43,179	8,636	51,815
80.03	Project Management for Design and Construction	57,572	11,514	69,086
80.04	Construction Administration and Management	28,786	5,757	34,543
80.05	Professional Liability and Other Non-Construction Insurance	0	0	0
80.06	Legal, Permits, Review Fees by Other Agencies, Cities, Etc.	7,196	1,439	8,636
80.07	Surveys, Testing, Investigation, Inspection	14,393	2,879	17,272
80.08	Start Up	35,982	7,196	43,179
Subtotal (10 - 80)		948,628	266,864	**1,215,492**
90 UNALLOCATED CONTINGENCY				**449,732**
Subtotal (10 - 90)				**1,665,224**
100 FINANCE CHARGES				**0**
Total Project Cost (10 - 100)				**1,665,224**
Inflation (5%)				**83,261**
Current Dollars Total				**1,748,486**

FTA #	Item Description	Unit Cost	Unit	Quantity	Base Cost	Contin.	Total Cost
10	**Guideway & Track Elements**				**$ 351,056,206**		**$ 472,943,302**
10.01	Guideway: At-Grade Exclusive Right-of-Way				$ 186,310		$ 251,519
	Guideway Grading	$ 20	CY	700	$ 14,000	35%	$ 18,900
	Storm Drainage System	$ 120,000	RM	0.27	$ 32,400	35%	$ 43,740
	Subballast	$ 45	CY	1118	$ 50,310	35%	$ 67,919
	Ballast Retainer	$ 44	LF	1400	$ 61,600	35%	$ 83,160
	Shift ROW Fence	$ 20	LF	1400	$ 28,000	35%	$ 37,800
10.02	Guideway: At-grade Semi-exclusive (Allows Cross-traffic)			0			
10.03	Guideway: At-grade in Mixed Traffic			0			
10.04	Guideway: Aerial Structure				$ 17,097,563		$ 23,081,710
	Superstructure: Single Column, Avg Height 25'	$ 11,100	RF	393	$ 4,362,300	35%	$ 5,889,105
	Superstructure: Single Column, Avg Height 30'	$ 12,400	RF	308	$ 3,819,200	35%	$ 5,155,920
	Superstructure: Single Column, Avg Height 35'	$ 12,500	RF	686	$ 8,575,000	35%	$ 11,576,250
	Superstructure: Single Column, Avg Height 40'	$ 12,700	RF	0		35%	
	Superstructure: Single Column, Avg Height 45'	$ 12,800	RF	0		35%	
	Superstructure: Single Column, Avg Height 50'	$ 12,900	RF	0		35%	
	Superstructure: Double Column, Avg Height 35'	$ 20,900	RF	0		35%	
	Railing	$ 46	LF	1387	$ 63,663	35%	$ 85,945
	Drainage System	$ 200	LF	1387	$ 277,400	35%	$ 374,490
10.05	Guideway: Built-up Fill			0			
10.06	Guideway: Underground Cut-and-cover				$ 256,468,762		$ 346,232,829
	Cut-and-cover Guideway	$ 6,000	TF	8900	$ 53,400,000	35%	$ 72,090,000
	Cut-and-cover Guideway Under Existing Roadway	$ 50,645	TF	3966	$ 200,856,234	35%	$ 271,155,916
	Cut-and-cover FAA Safety Barrier	$ 3,972	TF	557	$ 2,212,528	35%	$ 2,986,913
10.07	Guideway: Underground Tunnel				$ 66,120,000		$ 89,262,000
	TBM Guideway	$ 12,000	TF	5510	$ 66,120,000	35%	$ 89,262,000
10.08	Guideway: Retained Cut or Fill				$ 1,357,820		$ 1,833,057
	Retaining Wall (Includes Footings)	$ 55	SF	16890	$ 928,950	35%	$ 1,254,083
	Retained Fill	$ 30	CY	4886	$ 146,580	35%	$ 197,883
	Subballast	$ 45	CY	797	$ 35,865	35%	$ 48,418
	Subdrainage System (Includes Cleanouts and Outlets)	$ 100	LF	1689	$ 168,900	35%	$ 228,015
	Railing	$ 45.90	LF	1689	$ 77,525	35%	$ 104,659
10.09	Track: Direct Fixation	$ 375	TF	19,858	$ 7,446,750	25%	$ 9,308,438
10.10	Track: Embedded			0			
10.11	Track: Ballasted				$ 299,000		$ 373,750
	Light Rail Ballasted Track	$ 250	TF	1196	$ 299,000	25%	$ 373,750
10.12	Track: Special (Switches, Turnouts)				$ 2,080,000		$ 2,600,000
	Turnouts: No. 10	$ 165,000	EA	2	$ 330,000	25%	$ 412,500
	Double Crossovers: No. 10	$ 700,000	EA	1	$ 700,000	25%	$ 875,000
	Turnouts: No. 8	$ 150,000	EA	3	$ 450,000	25%	$ 562,500
	Double Crossovers: No. 8	$ 600,000	EA	1	$ 600,000	25%	$ 750,000
10.13	Track: Vibration and Noise Damping						
20	**Stations, Stops, Terminals, Intermodal**				**$ 109,000,000**		**$ 141,700,000**
20.01	At-grade station, stop, shelter, mall, terminal, platform			0			
20.02	Aerial station, stop, shelter, mall, terminal, platform			0			
20.03	Underground Station, Stop, Shelter, Mall, Terminal, Platform				$ 109,000,000		$ 141,700,000
	Cut-and-cover Station (270' Center Platform, 3 Cars)	$ 100,000,000	EA	1	$ 100,000,000	30%	$ 130,000,000
	Additional Side Platforms (Flow-Through) and Amenities	$ 8,000,000	EA	1	$ 8,000,000	30%	$ 10,400,000
	Additional Circulation Toward Connections	$ 1,000,000	EA	1	$ 1,000,000	30%	$ 1,300,000
20.04	Other Stations, Landings, Terminals: Intermodal, Ferry, Trolley, Etc			0			
20.05	Joint Development			0			
20.06	Automobile Parking Multi-story Structure			0			
20.07	Escalators (Additional)	$ 400,000	EA	0		30%	
20.07	Elevators (Additional)	$ 400,000	EA	0		30%	
30	**Support Facilities: Yards, Shops, Admin. Buildings**				**$ 64,000,000**		**$ 64,640,000**
30.03	Heavy Maintenance Facility				$ 64,000,000		$ 64,640,000
	Contribution to Southwestern Yard to Accommodate AMC Vehicles	$ 64,000,000	LS	1	$ 64,000,000	1%	$ 64,640,000

FTA #	Item Description	Unit Cost	Unit	Quantity	Base Cost	Contin.	Total Cost
40	**Sitework & Special Conditions**				**$ 175,199,132**		**$ 236,698,143**
40.01	Demolition, Clearing, Earthwork				$ 10,035		$ 13,547
	General Site Clearing	$ 3,345	ACRE	3	$ 10,035	35%	$ 13,547
40.02	Site Utilities, Utility Relocation: Existing ROW				$ 4,386,292		$ 6,140,809
	Relocate					40%	
	Major Utility Deconstruct and Rebuild, Surface Level Drainage Ditch	$ 214	LF	1086	$ 232,404	40%	$ 325,366
	Major Utility Relocation, Underground - Level 6: ≥60" Diameter	$ 1,333	LF	0		40%	
	Major Utility Relocation, Underground - Level 5: ≥48" Dia. To <60" Dia.	$ 973	LF	0		40%	
	Major Utility Relocation, Underground - Level 4: ≥36" Dia. To <48" Dia.	$ 770	LF	309	$ 237,930	40%	$ 333,102
	Major Utility Relocation, Underground - Level 3: ≥24" Dia. To <36" Dia.	$ 645	LF	17	$ 11,094	40%	$ 15,532
	Major Utility Relocation, Underground - Level 2: ≥12" Dia. To <24" Dia.	$ 390	LF	3971	$ 1,548,807	40%	$ 2,168,330
	Major Utility Relocation, Underground - Level 1: <12" Diameter	$ 218	LF	10808	$ 2,356,057	40%	$ 3,298,480
	Major Utility Relocation, Aerial OH Transmission Line - Level C: ≥240kV	$ 4,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level B: <240kV	$ 1,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level A: Other OH	$ 750	LF	0		40%	
	Protect in Place					40%	
	Major Utility Relocation, Underground - Level 6: ≥60" Diameter	$ 900	LF	0		40%	
	Major Utility Relocation, Underground - Level 3: ≥24" Dia. To <36" Diameter	$ 600	LF	0		40%	
40.03	Haz. Mat'l Contaminated Soil Removal/Mitigation, Ground Water Treatments				$ 1,577,600		$ 2,129,760
	Standard	$ 680,000	RM	2.32	$ 1,577,600	35%	$ 2,129,760
40.04	Environmental Mitigation, E.G. Wetlands, Historic/Archeological, Parks	$ 100,000	RM	2.32	$ 232,000	35%	$ 313,200
40.05	Site Structures Including Retaining Walls, Sound Walls						
40.06	Pedestrian/Bike Access & Accommodation, Landscaping						
40.06	Pedestrian/Bike Access & Accommodation, Landscaping: Art Work	0.5%	10-50		$ 2,757,266	35%	$ 3,722,309
40.07	Automobile, Bus, Van Access Ways Including Roads				$ 800,000		$ 1,040,000
	Arbor Vitae Expanded Grade Crossing	$ 800,000	LS	1	$ 800,000	30%	$ 1,040,000
40.07	Automobile, Bus, Van Access Ways Including Parking Lots						
40.08	Temporary Facilities and Other Indirect Costs During Construction	30.0%	10-50		$ 165,435,940	35%	$ 223,338,519
50	**Systems**				**$ 20,391,000**		**$ 27,527,850**
50.01	Train Control and Signals				$ 3,480,000		$ 4,698,000
	Light Rail	$ 1,500,000	RM	2.32	$ 3,480,000	35%	$ 4,698,000
50.02	Traffic Signals and Crossing Protection						
50.03	Traction Power Supply: Substations	$ 2,500,000	EA	1	$ 2,500,000	35%	$ 3,375,000
50.04	Traction Power Distribution: Catenary	$ 2,000,000	RM	2.32	$ 4,640,000	35%	$ 6,264,000
50.05	Communications	$ 2,000,000	RM	2.32	$ 4,640,000	35%	$ 6,264,000
50.06	Fare Collection System and Equipment				$ 3,739,000		$ 5,047,650
	Gates	$ 356,500	EA	6	$ 2,139,000	35%	$ 2,887,650
	Ticket Vending Machines	$ 160,000	EA	10	$ 1,600,000	35%	$ 2,160,000
50.07	Central Control	$ 600,000	RM	2.32	$ 1,392,000	35%	$ 1,879,200
10-50	**Construction Total**				**$ 719,646,338**		**$ 943,509,295**
60	**ROW, Land, Existing Improvements**				**$ 30,000**		**$ 37,500**
60.01	Purchase or Lease of Real Estate	$ 1,000,000	LS	0.03	$ 30,000	25%	$ 37,500
60.02	Relocation of Existing Households and Businesses	$ 1,000,000	LS	0		25%	
70	**Vehicles**				**$ -**		**$ -**
70.01	Light Rail	$ 3,800,000	VEH	0		10%	
70.02	Heavy Rail			0			
70.03	Commuter Rail			0			
70.04	Bus			0			
70.05	Other			0			
70.06	Non-Revenue Vehicles			0			
70.07	Spare Parts	10%	VEH	0		10%	
80	**Professional Services**				**$ 216,411,983**		**$ 258,151,470**
80.01	AA / Draft EIS/EIR / Final EIS/EIR				$ 7,714,545		$ 7,714,545
	Alternative Analysis	$ 1,818,428	LS	1	$ 1,818,428		$ 1,818,428
	Draft EIS/EIR	$ 3,691,961	LS	1	$ 3,691,961		$ 3,691,961
	Final EIS/EIR	$ 2,204,156	LS	1	$ 2,204,156		$ 2,204,156
80.01	Preliminary Engineering	3%	10-50		$ 21,589,390	20%	$ 25,907,268
80.02	Final Design	6%	10-50		$ 43,178,780	20%	$ 51,814,536
80.03	Project Management for Design and Construction (Agency)	8%	10-50		$ 57,571,707	20%	$ 69,086,048
80.04	Construction Administration and Management (Consultants)	4%	10-50		$ 28,785,854	20%	$ 34,543,024
80.05	Professional Liability and Other Non-Construction Insurance	0%	10-50		$ -	20%	$ -
80.06	Legal, Permits, Review Fees by Other Agencies, Cities, Etc.	1%	10-50		$ 7,196,463	20%	$ 8,635,756
80.07	Surveys, Testing, Investigation, Inspection	2%	10-50		$ 14,392,927	20%	$ 17,271,512
80.08	Start Up	5%	10-50		$ 35,982,317	20%	$ 43,178,780
10-80	**Total**				**$ 936,088,320**		**$ 1,201,698,266**
90	**Unallocated Contingency**	37%	10-80				**$ 444,628,358**
	10-90 Total				**$ 936,088,320**		**$ 1,646,326,624**
100	**Finance Charges**						**$ -**
10-100	**Total**				**$ 936,088,320**		**$ 1,646,326,624**

		Alt C1 Direct: 1-Station CTA (10-minute)			Alt C3 Thru: 1-Station CTA			Alt C4 Thru: 2-Station CTA		
		Base Year Dollars w/o Contingency (X000)	Base Year Dollars Allocated Contingency (X000)	Base Year Dollars TOTAL (X000)	Base Year Dollars w/o Contingency (X000)	Base Year Dollars Allocated Contingency (X000)	Base Year Dollars TOTAL (X000)	Base Year Dollars w/o Contingency (X000)	Base Year Dollars Allocated Contingency (X000)	Base Year Dollars TOTAL (X000)
10 GUIDEWAY & TRACK ELEMENTS		185,028	63,858	**248,886**	452,496	156,462	**608,958**	468,570	161,974	**630,544**
10.01	Guideway: At-grade Exclusive Right-of-way	170	59	229	170	59	229	170	59	229
10.02	Guideway: At-grade Semi-exclusive (Allows Cross-traffic)	0	0	0	0	0	0	0	0	0
10.03	Guideway: At-grade in Mixed Traffic	0	0	0	0	0	0	0	0	0
10.04	Guideway: Aerial Structure	64,744	22,660	87,405	116,969	40,939	157,908	89,051	31,168	120,219
10.05	Guideway: Built-up Fill	0	0	0	0	0	0	0	0	0
10.06	Guideway: Underground Cut-and-cover	29,400	10,290	39,690	34,800	12,180	46,980	43,200	15,120	58,320
10.07	Guideway: Underground Tunnel	77,088	26,981	104,069	269,112	94,189	363,301	306,408	107,243	413,651
10.08	Guideway: Retained Cut or Fill	4,609	1,613	6,222	12,333	4,316	16,649	9,485	3,320	12,805
10.09	Track: Direct Fixation	7,309	1,827	9,136	16,274	4,068	20,342	17,517	4,379	21,896
10.10	Track: Embedded	0	0	0	0	0	0	0	0	0
10.11	Track: Ballasted	299	75	374	299	75	374	299	75	374
10.12	Track: Special (Switches, Turnouts)	1,410	353	1,763	2,540	635	3,175	2,440	610	3,050
10.13	Track: Vibration and Noise Dampening	0	0	0	0	0	0	0	0	0
20 STATIONS, STOPS, TERMINALS, INTERMODAL		334,622	100,387	**435,009**	308,368	92,510	**400,879**	544,006	163,202	**707,208**
20.01	At-grade Station, Stop, Shelter, Mall, Terminal, Platform	100,184	30,055	130,239	200,368	60,110	260,479	200,368	60,110	260,479
20.02	Aerial Station, Stop, Shelter, Mall, Terminal, Platform	233,638	70,091	303,729	107,200	32,160	139,360	342,838	102,851	445,689
20.03	Underground Station, Stop, Shelter, Mall, Terminal, Platform	0	0	0	0	0	0	0	0	0
20.04	Other Stations, Landings, Terminals: Intermodal, Ferry, Trolley, Etc.	0	0	0	0	0	0	0	0	0
20.05	Joint Development	0	0	0	0	0	0	0	0	0
20.06	Automobile Parking Multi-story Structure	0	0	0	0	0	0	0	0	0
20.07	Elevators, Escalators	800	240	1,040	800	240	1,040	800	240	1,040
30 SUPPORT FACILITIES: YARDS, SHOPS, ADMIN. BLDGS		64,260	3,213	**67,473**	64,400	3,220	**67,620**	64,460	3,223	**67,683**
30.01	Administration Building: Office, Sales, Storage, Revenue Counting	0	0	0	0	0	0	0	0	0
30.02	Light Maintenance Facility	0	0	0	0	0	0	0	0	0
30.03	Heavy Maintenance Facility	64,260	3,213	67,473	64,400	3,220	67,620	64,460	3,223	67,683
30.04	Storage or Maintenance of Way Building	0	0	0	0	0	0	0	0	0
30.05	Yard and Yard Track	0	0	0	0	0	0	0	0	0
40 SITEWORK & SPECIAL CONDITIONS		195,018	68,371	**263,389**	302,257	105,916	**408,173**	387,719	135,891	**523,610**
40.01	Demolition, Clearing, Earthwork	3	1	5	974	341	1,316	974	341	1,316
40.02	Site Utilities, Utility Relocation	2,302	921	3,223	2,512	1,005	3,517	3,795	1,518	5,313
40.03	Hazardous material, Contaminated Soil Removal and Mitigation, Ground Water Treatments	1,727	605	2,332	4,831	1,691	6,522	5,103	1,786	6,890
40.04	Environmental Mitigation, E.G. Wetlands, Historic and Archeologic, Parks	197	69	266	392	137	529	434	152	586
40.05	Site Structures Including Retaining Walls, Sound Walls	0	0	0	0	0	0	0	0	0
40.06	Pedestrian and Bike Access and Accommodation, Landscaping	3,038	1,063	4,101	4,357	1,525	5,882	5,650	1,978	7,628
40.07	Automobile, Bus, Van Access Ways Including Roads, Parking Lots	0	0	0	0	0	0	0	0	0
40.08	Temporary Facilities and Other Indirect Costs During Construction	187,751	65,713	253,463	289,190	101,216	390,406	371,762	130,117	501,878
50 SYSTEMS		19,362	6,777	**26,139**	37,470	13,115	**50,585**	42,674	14,936	**57,610**
50.01	Train Control and Signals	2,955	1,034	3,989	7,416	2,596	10,012	8,013	2,804	10,817
50.02	Traffic Signals and Crossing Protection	0	0	0	0	0	0	0	0	0
50.03	Traction Power Supply: Substations	2,500	875	3,375	5,000	1,750	6,750	5,000	1,750	6,750
50.04	Traction Power Distribution: Catenary and Third Rail	3,940	1,379	5,319	7,888	2,761	10,649	8,683	3,039	11,723
50.05	Communications	3,940	1,379	5,319	7,888	2,761	10,649	8,683	3,039	11,723
50.06	Fare Collection System and Equipment	4,845	1,696	6,541	6,911	2,419	9,330	9,690	3,392	13,082
50.07	Central Control	1,182	414	1,596	2,366	828	3,195	2,605	912	3,517
Construction Subtotal (10 - 50)		798,290	242,606	**1,040,896**	1,164,991	371,223	**1,536,214**	1,507,429	479,226	**1,986,655**
60 ROW, LAND, EXISTING IMPROVEMENTS		32,469	8,117	**40,586**	51,348	12,837	**64,185**	71,820	17,955	**89,775**
60.01	Purchase or Lease of Real Estate	8,106	2,027	10,133	34,452	8,613	43,065	34,519	8,630	43,149
60.02	Relocation of Existing Households and Businesses	24,363	6,091	30,453	16,896	4,224	21,121	37,301	9,325	46,626
70 VEHICLES (number)		12,540	1,254	**13,794**	12,540	1,254	**13,794**	12,540	1,254	**13,794**
70.01	Light Rail	11,400	1,140	12,540	11,400	1,140	12,540	11,400	1,140	12,540
70.02	Heavy Rail	0	0	0	0	0	0	0	0	0
70.03	Commuter Rail	0	0	0	0	0	0	0	0	0
70.04	Bus	0	0	0	0	0	0	0	0	0
70.05	Other	0	0	0	0	0	0	0	0	0
70.06	Non-revenue Vehicles	0	0	0	0	0	0	0	0	0
70.07	Spare Parts	1,140	114	1,254	1,140	114	1,254	1,140	114	1,254
80 PROFESSIONAL SERVICES (Applies to Categories 10-50)		239,219	46,301	**285,519**	345,562	67,570	**413,132**	444,869	87,431	**532,300**
80.01	Preliminary Engineering	31,663	4,790	36,453	42,664	6,990	49,654	52,937	9,045	61,982
80.02	Final Design	47,897	9,579	57,477	69,899	13,980	83,879	90,446	18,089	108,535
80.03	Project Management for Design and Construction	63,863	12,773	76,636	93,199	18,640	111,839	120,594	24,119	144,713
80.04	Construction Administration and Management	31,932	6,386	38,318	46,600	9,320	55,920	60,297	12,059	72,357
80.05	Professional Liability and Other Non-Construction Insurance	0	0	0	0	0	0	0	0	0
80.06	Legal, Permits, Review Fees by Other Agencies, Cities, Etc.	7,983	1,597	9,579	11,650	2,330	13,980	15,074	3,015	18,089
80.07	Surveys, Testing, Investigation, Inspection	15,966	3,193	19,159	23,300	4,660	27,960	30,149	6,030	36,178
80.08	Start Up	39,915	7,983	47,897	58,250	11,650	69,899	75,371	15,074	90,446
Subtotal (10 - 80)		1,082,517	298,278	**1,380,795**	1,574,442	452,884	**2,027,325**	2,036,658	585,866	**2,622,524**
90 UNALLOCATED CONTINGENCY				**513,749**			**1,303,835**			**970,939**
Subtotal (10 - 90)				**1,894,544**			**3,331,160**			**3,593,463**
100 FINANCE CHARGES				**0**			**0**			**0**
Total Project Cost (10 - 100)				**1,894,544**			**3,331,160**			**3,593,463**
Inflation (5%)				**94,727**			**166,558**			**179,673**
Current Dollars Total				**1,989,271**			**3,497,718**			**3,773,136**

FTA #	Item Description	Unit Cost	Unit	Quantity	Base Cost	Contin.	Total Cost
10	**Guideway & Track Elements**				**$ 185,028,106**		**$ 248,886,168**
10.01	Guideway: At-Grade Exclusive Right-of-Way				$ 169,510		$ 228,839
	Guideway Grading	$ 20	CY	700	$ 14,000	35%	$ 18,900
	Storm Drainage System	$ 120,000	RM	0.13	$ 15,600	35%	$ 21,060
	Subballast	$ 45	CY	1118	$ 50,310	35%	$ 67,919
	Ballast Retainer	$ 44	LF	1400	$ 61,600	35%	$ 83,160
	Shift ROW Fence	$ 20	LF	1400	$ 28,000	35%	$ 37,800
10.02	Guideway: At-grade Semi-exclusive (Allows Cross-traffic)			0			
10.03	Guideway: At-grade in Mixed Traffic			0			
10.04	Guideway: Aerial Structure				$ 64,744,229		$ 87,404,709
	Superstructure: Single Column, Avg Height 25'	$ 11,100	RF	589	$ 6,537,900	35%	$ 8,826,165
	Superstructure: Single Column, Avg Height 30'	$ 12,400	RF	1559	$ 19,331,600	35%	$ 26,097,660
	Superstructure: Single Column, Avg Height 35'	$ 12,500	RF	1412	$ 17,650,000	35%	$ 23,827,500
	Superstructure: Single Column, Avg Height 40'	$ 12,700	RF	199	$ 2,527,300	35%	$ 3,411,855
	Superstructure: Single Column, Avg Height 45'	$ 12,800	RF	378	$ 4,838,400	35%	$ 6,531,840
	Superstructure: Single Column, Avg Height 50'	$ 12,900	RF	935	$ 12,061,500	35%	$ 16,283,025
	Railing	$ 46	LF	7310	$ 335,529	35%	$ 452,964
	Drainage System	$ 200	LF	7310	$ 1,462,000	35%	$ 1,973,700
10.05	Guideway: Built-up Fill			0			
10.06	Guideway: Underground Cut and Cover			0	$ 29,400,000		$ 39,690,000
	Cut and Cover Guideway	$ 6,000	TF	4900	$ 29,400,000	35%	$ 39,690,000
10.07	Guideway: Underground Tunnel			0	$ 77,088,000		$ 104,068,800
	TBM Guideway	$ 12,000	TF	6424	$ 77,088,000	35%	$ 104,068,800
10.08	Guideway: Retained Cut or Fill			0	$ 4,608,617		$ 6,221,633
	Retaining Wall (Includes Footings)	$ 55	SF	54,712	$ 3,009,160	35%	$ 4,062,366
	Retained Fill	$ 30	CY	33,576	$ 1,007,280	35%	$ 1,359,828
	Subballast	$ 45	CY	1066	$ 47,970	35%	$ 64,760
	Subdrainage System (Includes Cleanouts and Outlets)	$ 100	LF	3730	$ 373,000	35%	$ 503,550
	Railing	$ 45.90	LF	3730	$ 171,207	35%	$ 231,129
10.09	Track: Direct Fixation	$ 375	TF	19,490	$ 7,308,750	25%	$ 9,135,938
10.10	Track: Embedded			0			
10.11	Track: Ballasted			0	$ 299,000		$ 373,750
	Light Rail Ballasted Track	$ 250	TF	1196	$ 299,000	25%	$ 373,750
10.12	Track: Special (Switches, Turnouts)				$ 1,410,000		$ 1,762,500
	Turnouts: No. 10	$ 165,000	EA	4	$ 660,000	25%	$ 825,000
	Double Crossovers: No. 10	$ 700,000	EA	0		25%	
	Turnouts: No. 8	$ 150,000	EA	1	$ 150,000	25%	$ 187,500
	Double Crossovers: No. 8	$ 600,000	EA	1	$ 600,000	25%	$ 750,000
10.13	Track: Vibration and Noise Damping						
20	**Stations, Stops, Terminals, Intermodal**				**$ 334,622,100**		**$ 435,008,730**
20.01	Underground Station, Cut and Cover				$ 100,000,000		$ 130,000,000
	Cut and Cover Station (270' Platform, 3 cars)	$ 100,000,000	EA	1	$ 100,000,000	30%	$ 130,000,000
20.01	Underground Station, Cut and Cover, Amenities				$ 184,100		$ 239,330
	Ground Level Amenities for Cut and Cover Station	$ 184,100	LS	1	$ 184,100	30%	$ 239,330
20.02	CTA Station, East Location (270' Platform + Box)				$ 233,638,000		$ 303,729,400
	Mined Length	$ 390,000	LF	43	$ 16,770,000	30%	$ 21,801,000
	Trenched Length	$ 238,000	LF	886	$ 210,868,000	30%	$ 274,128,400
	Platform (50' wide) and Amenities	$ 3,000,000	EA	1	$ 3,000,000	30%	$ 3,900,000
	Additional Circulation Toward Connections or Terminals	$ 1,000,000	EA	1	$ 1,000,000	30%	$ 1,300,000
	Underpin Column	$ 2,000,000	EA	1	$ 2,000,000	30%	$ 2,600,000
20.02	CTA Station, West Location (270' Platform + Box)			0	$ -		$ -
	Mined Length	$ 390,000	LF	0		30%	
	Trenched Length	$ 238,000	LF	0		30%	
	Platform (50' wide) and Amenities	$ 3,000,000	EA	0		30%	
	Additional Circulation Toward Connections or Terminals	$ 1,000,000	EA	0		30%	
	Underpin Columns and Major Utilities	$ 2,000,000	EA	0		30%	
20.03	Underground Station, Stop, Shelter, Mall, Terminal, Platform			0			
20.04	Other Stations, Landings, Terminals: Intermodal, Ferry, Trolley, Etc			0			
20.05	Joint Development			0			
20.06	Automobile Parking Multi-story Structure			0			
20.07	Deep Escalators (Base Station Cost Includes Regular Escalators)	$ 400,000	EA	1	$ 400,000	30%	$ 520,000
20.07	Deep Elevators (Base Station Cost Includes Regular Elevators)	$ 400,000	EA	1	$ 400,000	30%	$ 520,000
30	**Support Facilities: Yards, Shops, Admin. Buildings**				**$ 64,260,000**		**$ 67,473,000**
30.03	Heavy Maintenance Facility				$ 64,260,000		$ 67,473,000
	Contribution to Southwestern Yard to Accommodate AMC Vehicles	$ 64,000,000	LS	1	$ 64,000,000	5%	$ 67,200,000
	Potential modifications to the Southwestern Yard to Accommodate Aerial Structures	$ 200,000	LS	1.3	$ 260,000	5%	$ 273,000

FTA #	Item Description	Unit Cost	Unit	Quantity	Base Cost	Contin.	Total Cost
40	**Sitework & Special Conditions**				**$ 195,017,801**		**$ 263,389,140**
40.01	Demolition, Clearing, Earthwork				$ 3,345		$ 4,516
	Aerial Structure Demolition	$ 25	SF	0		35%	
	General Site Clearing	$ 3,345	ACRE	1	$ 3,345	35%	$ 4,516
40.02	Site Utilities, Utility Relocation: Existing ROW				$ 2,302,170		$ 3,223,038
	On-CTA					40%	
	Major Utility Relocation, Underground - Level 7: Duct Banks & Fiber Optic Lines	$ 900	LF	390	$ 351,000	40%	$ 491,400
	Major Utility Relocation, Underground - Level 6: ≥60" Diameter	$ 1,333	LF	0		40%	
	Major Utility Relocation, Underground - Level 5: ≥48" Dia. To <60" Dia.	$ 973	LF	0		40%	
	Major Utility Relocation, Underground - Level 4: ≥36" Dia. To <48" Dia.	$ 770	LF	0		40%	
	Major Utility Relocation, Underground - Level 3: ≥24" Dia. To <36" Dia.	$ 645	LF	322	$ 207,690	40%	$ 290,766
	Major Utility Relocation, Underground - Level 2: ≥12" Dia. To <24" Dia.	$ 390	LF	409	$ 159,510	40%	$ 223,314
	Major Utility Relocation, Underground - Level 1: <12" Dia.	$ 218	LF	340	$ 74,120	40%	$ 103,768
	Major Utility Relocation, Aerial OH Transmission Line - Level C: ≥240kV	$ 4,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level B: <240kV	$ 1,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level A: Other OH	$ 750	LF	0		40%	
	Off-CTA					40%	
	Major Utility Relocation, Underground - Level 7: Duct banks & fiber optic lines	$ 900	LF	20	$ 18,000	40%	$ 25,200
	Major Utility Relocation, Underground - Level 6: ≥60" Dia.	$ 1,333	LF	0		40%	
	Major Utility Relocation, Underground - Level 5: ≥48" Dia. To <60" Dia.	$ 973	LF	50	$ 48,650	40%	$ 68,110
	Major Utility Relocation, Underground - Level 4: ≥36" Dia. To <48" Dia.	$ 770	LF	100	$ 77,000	40%	$ 107,800
	Major Utility Relocation, Underground - Level 3: ≥24" Dia. To <36" Dia.	$ 645	LF	400	$ 258,000	40%	$ 361,200
	Major Utility Relocation, Underground - Level 2: ≥12" Dia. To <24" Dia.	$ 390	LF	1500	$ 585,000	40%	$ 819,000
	Major Utility Relocation, Underground - Level 1: <12" Dia.	$ 218	LF	2400	$ 523,200	40%	$ 732,480
	Major Utility Relocation, Aerial OH Transmission Line - Level C: ≥240kV	$ 4,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level B: <240kV	$ 1,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level A: Other OH	$ 750	LF	0		40%	
40.03	Haz. Mat'l Contaminated Soil Removal/Mitigation, Ground Water Treatments				$ 1,727,200		$ 2,331,720
	Standard	$ 680,000	RM	1.59	$ 1,081,200	35%	$ 1,459,620
	On-CTA	$ 1,700,000	RM	0.38	$ 646,000	35%	$ 872,100
	Terminals 6 - 8	$ 2,720,000	RM	0		35%	
40.04	Environmental Mitigation, E.G. Wetlands, Historic/Archeological, Parks	$ 100,000	RM	1.97	$ 197,000	35%	$ 265,950
40.05	Site Structures Including Retaining Walls, Sound Walls				$ -		$ -
40.06	Pedestrian/Bike Access & Accommodation, Landscaping				$ -		$ -
40.06	Pedestrian/Bike Access & Accommodation, Landscaping: Art Work	0.5%	10-50		$ 3,037,510	35%	$ 4,100,638
40.07	Automobile, Bus, Van Access Ways Including Roads				$ -		$ -
40.07	Automobile, Bus, Van Access Ways Including Parking Lots				$ -		$ -
40.08	Temporary Facilities and Other Indirect Costs During Construction	30.0%	10-50		$ 187,750,576	35%	$ 253,463,278
50	**Systems**				**$ 19,362,000**		**$ 26,138,700**
50.01	Train Control and Signals				$ 2,955,000		$ 3,989,250
	Light Rail	$ 1,500,000	RM	1.97	$ 2,955,000	35%	$ 3,989,250
50.02	Traffic Signals and Crossing Protection			0	$ -		$ -
50.03	Traction Power Supply: Substations	$ 2,500,000	EA	1	$ 2,500,000	35%	$ 3,375,000
50.04	Traction Power Distribution: Catenary	$ 2,000,000	RM	1.97	$ 3,940,000	35%	$ 5,319,000
50.05	Communications	$ 2,000,000	RM	1.97	$ 3,940,000	35%	$ 5,319,000
50.06	Fare Collection System and Equipment			0	$ 4,845,000		$ 6,540,750
	Gates	$ 356,500	EA	10	$ 3,565,000	35%	$ 4,812,750
	Ticket Vending Machines	$ 160,000	EA	8	$ 1,280,000	35%	$ 1,728,000
50.07	Central Control	$ 600,000	RM	1.97	$ 1,182,000	35%	$ 1,595,700
10-50	**Construction Total**				**$ 798,290,007**		**$ 1,040,895,738**
60	**ROW, Land, Existing Improvements**				**$ 32,468,770**		**$ 40,585,963**
60.01	Purchase or Lease of Real Estate	$ 1,000,000	LS	8.10607	$ 8,106,070	25%	$ 10,132,588
60.02	Relocation of Existing Households and Businesses	$ 1,000,000	LS	24.3627	$ 24,362,700	25%	$ 30,453,375
70	**Vehicles**				**$ -**		**$ -**
80	**Professional Services**				**$ 239,218,647**		**$ 285,519,467**
80.01	AA / Draft EIS/EIR / Final EIS/EIR				$ 7,714,545		$ 7,714,545
	Alternative Analysis	$ 1,818,428	LS	1	$ 1,818,428		$ 1,818,428
	Draft EIS/EIR	$ 3,691,961	LS	1	$ 3,691,961		$ 3,691,961
	Final EIS/EIR	$ 2,204,156	LS	1	$ 2,204,156		$ 2,204,156
80.01	Preliminary Engineering	3%	10-50		$ 23,948,700	20%	$ 28,738,440
80.02	Final Design	6%	10-50		$ 47,897,400	20%	$ 57,476,880
80.03	Project Management for Design and Construction (Agency)	8%	10-50		$ 63,863,201	20%	$ 76,635,841
80.04	Construction Administration and Management (Consultants)	4%	10-50		$ 31,931,600	20%	$ 38,317,920
80.05	Professional Liability and Other Non-Construction Insurance	0%	10-50		$ -	20%	$ -
80.06	Legal; Permits; Review Fees by Other Agencies, Cities, Etc.	1%	10-50		$ 7,982,900	20%	$ 9,579,480
80.07	Surveys, Testing, Investigation, Inspection	2%	10-50		$ 15,965,800	20%	$ 19,158,960
80.08	Start Up	5%	10-50		$ 39,914,500	20%	$ 47,897,400
10-80	**Total**				**$ 1,069,977,424**		**$ 1,367,001,167**
90	**Unallocated Contingency**	37%	10-80				**$ 505,790,432**
	10-90 Total				**$ 1,069,977,424**		**$ 1,872,791,599**
100	**Finance Charges**						**$ -**
10-100	**Total**				**$ 1,069,977,424**		**$ 1,872,791,599**

FTA #	Item Description	Unit Cost	Unit	Quantity	Base Cost	Contin.	Total Cost
10	**Guideway & Track Elements**				**$ 452,495,878**		**$ 608,958,185**
10.01	Guideway: At-Grade Exclusive Right-of-Way				$ 169,819		$ 229,256
	Guideway Grading	$ 20	CY	700	$ 14,000	35%	$ 18,900
	Storm Drainage System	$ 120,000	RM	0.13	$ 15,909	35%	$ 21,477
	Subballast	$ 45	CY	1118	$ 50,310	35%	$ 67,919
	Ballast Retainer	$ 44	LF	1400	$ 61,600	35%	$ 83,160
	Shift ROW Fence	$ 20	LF	1400	$ 28,000	35%	$ 37,800
10.02	Guideway: At-grade Semi-exclusive (Allows Cross-traffic)			0			
10.03	Guideway: At-grade in Mixed Traffic			0			
10.04	Guideway: Aerial Structure			0	$ 116,968,806		$ 157,907,889
	Superstructure: Single Column, Avg Height 25'	$ 11,100	RF	1030	$ 11,433,000	35%	$ 15,434,550
	Superstructure: Single Column, Avg Height 30'	$ 12,400	RF	2583	$ 32,029,200	35%	$ 43,239,420
	Superstructure: Single Column, Avg Height 35'	$ 12,500	RF	1083	$ 13,537,500	35%	$ 18,275,625
	Superstructure: Single Column, Avg Height 40'	$ 12,700	RF	3864	$ 49,072,800	35%	$ 66,248,280
	Superstructure: Single Column, Avg Height 45'	$ 12,800	RF	0		35%	
	Superstructure: Single Column, Avg Height 50'	$ 12,900	RF	632	$ 8,152,800	35%	$ 11,006,280
	Railing	$ 46	LF	11157	$ 512,106	35%	$ 691,344
	Drainage System	$ 200	LF	11157	$ 2,231,400	35%	$ 3,012,390
10.05	Guideway: Built-up Fill			0			
10.06	Guideway: Underground Cut and Cover			0	$ 34,800,000		$ 46,980,000
	Cut and Cover Guideway	$ 6,000	TF	5800	$ 34,800,000	35%	$ 46,980,000
10.07	Guideway: Underground Tunnel			0	$ 269,112,000		$ 363,301,200
	TBM Guideway	$ 12,000	TF	22426	$ 269,112,000	35%	$ 363,301,200
10.08	Guideway: Retained Cut or Fill			0	$ 12,332,752		$ 16,649,216
	Retaining Wall (Includes Footings)	$ 55	SF	158,356	$ 8,709,580	35%	$ 11,757,933
	Retained Fill	$ 30	CY	69,783	$ 2,093,490	35%	$ 2,826,212
	Subballast	$ 45	CY	2913	$ 131,085	35%	$ 176,965
	Subdrainage System (Includes Cleanouts and Outlets)	$ 100	LF	9586	$ 958,600	35%	$ 1,294,110
	Railing	$ 45.90	LF	9586	$ 439,997	35%	$ 593,996
10.09	Track: Direct Fixation	$ 375	TF	43,396	$ 16,273,500	25%	$ 20,341,875
10.10	Track: Embedded			0			
10.11	Track: Ballasted				$ 299,000		$ 373,750
	Light Rail Ballasted Track	$ 250	TF	1196	$ 299,000	25%	$ 373,750
10.12	Track: Special (Switches, Turnouts)				$ 2,540,000		$ 3,175,000
	Turnouts: No. 10	$ 165,000	EA	6	$ 990,000	25%	$ 1,237,500
	Double Crossovers: No. 10	$ 700,000	EA	2	$ 1,400,000	25%	$ 1,750,000
	Turnouts: No. 8	$ 150,000	EA	1	$ 150,000	25%	$ 187,500
	Double Crossovers: No. 8	$ 600,000	EA	0		25%	
10.13	Track: Vibration and Noise Damping						
20	**Stations, Stops, Terminals, Intermodal**				**$ 308,368,200**		**$ 400,878,660**
20.01	Underground Station, Cut and Cover				$ 200,000,000		$ 260,000,000
	Cut and Cover Station (270' Platform, 3 cars)	$ 100,000,000	EA	2	$ 200,000,000	30%	$ 260,000,000
20.01	Underground Station, Cut and Cover, Amenities				$ 368,200		$ 478,660
	Ground Level Amenities for Cut and Cover Station	$ 184,100	LS	2	$ 368,200	30%	$ 478,660
20.02	CTA Station, East Location (270' Platform + Box)				$ -		$ -
	Mined Length	$ 390,000	LF	0		30%	
	Trenched Length	$ 238,000	LF	0		30%	
	Platform (50' wide) and Amenities	$ 3,000,000	EA	0		30%	
	Additional Circulation Toward Connections or Terminals	$ 1,000,000	EA	0		30%	
	Underpin Column	$ 2,000,000	EA	0		30%	
20.02	CTA Station, West Location (270' Platform + Box)			0	$ 107,200,000		$ 139,360,000
	Mined Length	$ 390,000	LF	0		30%	
	Trenched Length	$ 238,000	LF	400	$ 95,200,000	30%	$ 123,760,000
	Platform (50' wide) and Amenities	$ 3,000,000	EA	1	$ 3,000,000	30%	$ 3,900,000
	Additional Circulation Toward Connections or Terminals	$ 1,000,000	EA	1	$ 1,000,000	30%	$ 1,300,000
	Underpin Columns and Major Utilities	$ 2,000,000	EA	4	$ 8,000,000	30%	$ 10,400,000
20.03	Underground Station, Stop, Shelter, Mall, Terminal, Platform			0			
20.04	Other Stations, Landings, Terminals: Intermodal, Ferry, Trolley, Etc			0			
20.05	Joint Development			0			
20.06	Automobile Parking Multi-story Structure			0			
20.07	Deep Escalators (Base Station Cost Includes Regular Escalators)	$ 400,000	EA	1	$ 400,000	30%	$ 520,000
20.07	Deep Elevators (Base Station Cost Includes Regular Elevators)	$ 400,000	EA	1	$ 400,000	30%	$ 520,000
30	**Support Facilities: Yards, Shops, Admin. Buildings**				**$ 64,400,000**		**$ 67,620,000**
30.03	Heavy Maintenance Facility				$ 64,400,000		$ 67,620,000
	Contribution to Southwestern Yard to Accommodate AMC Vehicles	$ 64,000,000	LS	1	$ 64,000,000	5%	$ 67,200,000
	Potential modifications to the Southwestern Yard to Accommodate Aerial Structures	$ 200,000	LS	2	$ 400,000	5%	$ 420,000

FTA #	Item Description	Unit Cost	Unit	Quantity	Base Cost	Contin.	Total Cost
40	**Sitework & Special Conditions**				**$ 302,257,228**		**$ 408,172,875**
40.01	Demolition, Clearing, Earthwork				$ 974,445		$ 1,315,501
	Aerial Structure Demolition	$ 25	SF	38844	$ 971,100	35%	$ 1,310,985
	General Site Clearing	$ 3,345	ACRE	1	$ 3,345	35%	$ 4,516
40.02	Site Utilities, Utility Relocation: Existing ROW				$ 2,512,355		$ 3,517,297
	On-CTA					40%	
	Major Utility Relocation, Underground - Level 7: Duct Banks & Fiber Optic Lines	$ 900	LF	1150	$ 1,035,000	40%	$ 1,449,000
	Major Utility Relocation, Underground - Level 6: ≥60" Diameter	$ 1,333	LF	0		40%	
	Major Utility Relocation, Underground - Level 5: ≥48" Dia. To <60" Dia.	$ 973	LF	0		40%	
	Major Utility Relocation, Underground - Level 4: ≥36" Dia. To <48" Dia.	$ 770	LF	170	$ 130,900	40%	$ 183,260
	Major Utility Relocation, Underground - Level 3: ≥24" Dia. To <36" Dia.	$ 645	LF	170	$ 109,650	40%	$ 153,510
	Major Utility Relocation, Underground - Level 2: ≥12" Dia. To <24" Dia.	$ 390	LF	510	$ 198,900	40%	$ 278,460
	Major Utility Relocation, Underground - Level 1: <12" Dia.	$ 218	LF	85	$ 18,530	40%	$ 25,942
	Major Utility Relocation, Aerial OH Transmission Line - Level C: ≥240kV	$ 4,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level B: <240kV	$ 1,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level A: Other OH	$ 750	LF	0		40%	
	Off-CTA					40%	
	Major Utility Relocation, Underground - Level 7: Duct banks & fiber optic lines	$ 900	LF	20	$ 18,000	40%	$ 25,200
	Major Utility Relocation, Underground - Level 6: ≥60" Dia.	$ 1,333	LF	0		40%	
	Major Utility Relocation, Underground - Level 5: ≥48" Dia. To <60" Dia.	$ 973	LF	25	$ 24,325	40%	$ 34,055
	Major Utility Relocation, Underground - Level 4: ≥36" Dia. To <48" Dia.	$ 770	LF	100	$ 77,000	40%	$ 107,800
	Major Utility Relocation, Underground - Level 3: ≥24" Dia. To <36" Dia.	$ 645	LF	250	$ 161,250	40%	$ 225,750
	Major Utility Relocation, Underground - Level 2: ≥12" Dia. To <24" Dia.	$ 390	LF	1000	$ 390,000	40%	$ 546,000
	Major Utility Relocation, Underground - Level 1: <12" Dia.	$ 218	LF	1600	$ 348,800	40%	$ 488,320
	Major Utility Relocation, Aerial OH Transmission Line - Level C: ≥240kV	$ 4,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level B: <240kV	$ 1,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level A: Other OH	$ 750	LF	0		40%	
40.03	Haz. Mat'l Contaminated Soil Removal/Mitigation, Ground Water Treatments				$ 4,831,400		$ 6,522,390
	Standard	$ 680,000	RM	1.98	$ 1,346,400	35%	$ 1,817,640
	On-CTA	$ 1,700,000	RM	1.81	$ 3,077,000	35%	$ 4,153,950
	Terminals 6 - 8	$ 2,720,000	RM	0.15	$ 408,000	35%	$ 550,800
40.04	Environmental Mitigation, E.G. Wetlands, Historic/Archeological, Parks	$ 100,000	RM	3.92	$ 391,900	35%	$ 529,065
40.05	Site Structures Including Retaining Walls, Sound Walls				$ -		$ -
40.06	Pedestrian/Bike Access & Accommodation, Landscaping				$ -		$ -
40.06	Pedestrian/Bike Access & Accommodation, Landscaping: Art Work	0.5%	10-50		$ 4,357,222	35%	$ 5,882,249
40.07	Automobile, Bus, Van Access Ways Including Roads				$ -		$ -
40.07	Automobile, Bus, Van Access Ways Including Parking Lots				$ -		$ -
40.08	Temporary Facilities and Other Indirect Costs During Construction	30.0%	10-50		$ 289,189,906	35%	$ 390,406,373
50	**Systems**				**$ 37,470,186**		**$ 50,584,751**
50.01	Train Control and Signals				$ 7,416,193		$ 10,011,861
	Light Rail	$ 1,500,000	RM	4.94	$ 7,416,193	35%	$ 10,011,861
50.02	Traffic Signals and Crossing Protection				$ -		$ -
50.03	Traction Power Supply: Substations	$ 2,500,000	EA	2	$ 5,000,000	35%	$ 6,750,000
50.04	Traction Power Distribution: Catenary	$ 2,000,000	RM	3.94	$ 7,888,258	35%	$ 10,649,148
50.05	Communications	$ 2,000,000	RM	3.94	$ 7,888,258	35%	$ 10,649,148
50.06	Fare Collection System and Equipment				$ 6,911,000		$ 9,329,850
	Gates	$ 356,500	EA	14	$ 4,991,000	35%	$ 6,737,850
	Ticket Vending Machines	$ 160,000	EA	12	$ 1,920,000	35%	$ 2,592,000
50.07	Central Control	$ 600,000	RM	3.94	$ 2,366,477	35%	$ 3,194,744
10-50	**Construction Total**				**$ 1,164,991,491**		**$ 1,536,214,471**
60	**ROW, Land, Existing Improvements**				**$ 51,348,223**		**$ 64,185,279**
60.01	Purchase or Lease of Real Estate	$ 1,000,000	LS	34.451823	$ 34,451,823	25%	$ 43,064,779
60.02	Relocation of Existing Households and Businesses	$ 1,000,000	LS	16.896400	$ 16,896,400	25%	$ 21,120,500
70	**Vehicles**				**$ -**		**$ -**
80	**Professional Services**				**$ 345,562,077**		**$ 413,131,584**
80.01	AA / Draft EIS/EIR / Final EIS/EIR				$ 7,714,545		$ 7,714,545
	Alternative Analysis	$ 1,818,428	LS	1	$ 1,818,428		$ 1,818,428
	Draft EIS/EIR	$ 3,691,961	LS	1	$ 3,691,961		$ 3,691,961
	Final EIS/EIR	$ 2,204,156	LS	1	$ 2,204,156		$ 2,204,156
80.01	Preliminary Engineering	3%	10-50		$ 34,949,745	20%	$ 41,939,694
80.02	Final Design	6%	10-50		$ 69,899,489	20%	$ 83,879,387
80.03	Project Management for Design and Construction (Agency)	8%	10-50		$ 93,199,319	20%	$ 111,839,183
80.04	Construction Administration and Management (Consultants)	4%	10-50		$ 46,599,660	20%	$ 55,919,592
80.05	Professional Liability and Other Non-Construction Insurance	0%	10-50		$ -	20%	$ -
80.06	Legal; Permits; Review Fees by Other Agencies, Cities, Etc.	1%	10-50		$ 11,649,915	20%	$ 13,979,898
80.07	Surveys, Testing, Investigation, Inspection	2%	10-50		$ 23,299,830	20%	$ 27,959,796
80.08	Start Up	5%	10-50		$ 58,249,575	20%	$ 69,899,489
10-80	**Total**				**$ 1,561,901,791**		**$ 2,013,531,333**
90	**Unallocated Contingency**	37%	10-80				**$ 745,006,593**
	10-90 Total				**$ 1,561,901,791**		**$ 2,758,537,927**
100	**Finance Charges**						**$ -**
10-100	**Total**				**$ 1,561,901,791**		**$ 2,758,537,927**

FTA #	Item Description	Unit Cost	Unit	Quantity	Base Cost	Contin.	Total Cost
10	**Guideway & Track Elements**				**$ 468,569,727**		**$ 630,543,531**
10.01	Guideway: At-Grade Exclusive Right-of-Way				$ 169,510		$ 228,839
	Guideway Grading	$ 20	CY	700	$ 14,000	35%	$ 18,900
	Storm Drainage System	$ 120,000	RM	0.13	$ 15,600	35%	$ 21,060
	Subballast	$ 45	CY	1118	$ 50,310	35%	$ 67,919
	Ballast Retainer	$ 44	LF	1400	$ 61,600	35%	$ 83,160
	Shift ROW Fence	$ 20	LF	1400	$ 28,000	35%	$ 37,800
10.02	Guideway: At-grade Semi-exclusive (Allows Cross-traffic)			0			
10.03	Guideway: At-grade in Mixed Traffic			0			
10.04	Guideway: Aerial Structure				$ 89,051,016		$ 120,218,872
	Superstructure: Single Column, Avg Height 25'	$ 11,100	RF	1417	$ 15,728,700	35%	$ 21,233,745
	Superstructure: Single Column, Avg Height 30'	$ 12,400	RF	2188	$ 27,131,200	35%	$ 36,627,120
	Superstructure: Single Column, Avg Height 35'	$ 12,500	RF	1920	$ 24,000,000	35%	$ 32,400,000
	Superstructure: Single Column, Avg Height 40'	$ 12,700	RF	199	$ 2,527,300	35%	$ 3,411,855
	Superstructure: Single Column, Avg Height 45'	$ 12,800	RF	378	$ 4,838,400	35%	$ 6,531,840
	Superstructure: Single Column, Avg Height 50'	$ 12,900	RF	935	$ 12,061,500	35%	$ 16,283,025
	Railing	$ 46	LF	11240	$ 515,916	35%	$ 696,487
	Drainage System	$ 200	LF	11240	$ 2,248,000	35%	$ 3,034,800
10.05	Guideway: Built-up Fill						
10.06	Guideway: Underground Cut and Cover				$ 43,200,000		$ 58,320,000
	Cut and Cover Guideway	$ 6,000	TF	7200	$ 43,200,000	35%	$ 58,320,000
10.07	Guideway: Underground Tunnel				$ 306,408,000		$ 413,650,800
	TBM Guideway	$ 12,000	TF	25534	$ 306,408,000	35%	$ 413,650,800
10.08	Guideway: Retained Cut or Fill				$ 9,485,201		$ 12,805,021
	Retaining Wall (Includes Footings)	$ 55	SF	112,860	$ 6,207,300	35%	$ 8,379,855
	Retained Fill	$ 30	CY	68,714	$ 2,061,420	35%	$ 2,782,917
	Subballast	$ 45	CY	2606	$ 117,270	35%	$ 158,315
	Subdrainage System (Includes Cleanouts and Outlets)	$ 100	LF	7534	$ 753,400	35%	$ 1,017,090
	Railing	$ 45.90	LF	7534	$ 345,811	35%	$ 466,844
10.09	Track: Direct Fixation	$ 375	TF	46,712	$ 17,517,000	25%	$ 21,896,250
10.10	Track: Embedded			0			
10.11	Track: Ballasted				$ 299,000		$ 373,750
	Light Rail Ballasted Track	$ 250	TF	1196	$ 299,000	25%	$ 373,750
10.12	Track: Special (Switches, Turnouts)				$ 2,440,000		$ 3,050,000
	Turnouts: No. 10	$ 165,000	EA	6	$ 990,000	25%	$ 1,237,500
	Double Crossovers: No. 10	$ 700,000	EA	1	$ 700,000	25%	$ 875,000
	Turnouts: No. 8	$ 150,000	EA	1	$ 150,000	25%	$ 187,500
	Double Crossovers: No. 8	$ 600,000	EA	1	$ 600,000	25%	$ 750,000
10.13	Track: Vibration and Noise Damping						
20	**Stations, Stops, Terminals, Intermodal**				**$ 544,006,200**		**$ 707,208,060**
20.01	Underground Station, Cut and Cover				$ 200,000,000		$ 260,000,000
	Cut and Cover Station (270' Platform, 3 cars)	$ 100,000,000	EA	2	$ 200,000,000	30%	$ 260,000,000
20.01	Underground Station, Cut and Cover, Amenities				$ 368,200		$ 478,660
	Ground Level Amenities for Cut and Cover Station	$ 184,100	LS	2	$ 368,200	30%	$ 478,660
20.02	CTA Station, East Location (270' Platform + Box)				$ 235,638,000		$ 306,329,400
	Mined Length	$ 390,000	LF	43	$ 16,770,000	30%	$ 21,801,000
	Trenched Length	$ 238,000	LF	886	$ 210,868,000	30%	$ 274,128,400
	Platform (50' wide) and Amenities	$ 3,000,000	EA	1	$ 3,000,000	30%	$ 3,900,000
	Additional Circulation Toward Connections or Terminals	$ 1,000,000	EA	1	$ 1,000,000	30%	$ 1,300,000
	Underpin Column	$ 2,000,000	EA	2	$ 4,000,000	30%	$ 5,200,000
20.02	CTA Station, West Location (270' Platform + Box)				$ 107,200,000		$ 139,360,000
	Mined Length	$ 390,000	LF	0		30%	
	Trenched Length	$ 238,000	LF	400	$ 95,200,000	30%	$ 123,760,000
	Platform (50' wide) and Amenities	$ 3,000,000	EA	1	$ 3,000,000	30%	$ 3,900,000
	Additional Circulation Toward Connections or Terminals	$ 1,000,000	EA	1	$ 1,000,000	30%	$ 1,300,000
	Underpin Columns and Major Utilities	$ 2,000,000	EA	4	$ 8,000,000	30%	$ 10,400,000
20.03	Underground Station, Stop, Shelter, Mall, Terminal, Platform			0			
20.04	Other Stations, Landings, Terminals: Intermodal, Ferry, Trolley, Etc			0			
20.05	Joint Development			0			
20.06	Automobile Parking Multi-story Structure			0			
20.07	Deep Escalators (Base Station Cost Includes Regular Escalators)	$ 400,000	EA	1	$ 400,000	30%	$ 520,000
20.07	Deep Elevators (Base Station Cost Includes Regular Elevators)	$ 400,000	EA	1	$ 400,000	30%	$ 520,000
30	**Support Facilities: Yards, Shops, Admin. Buildings**				**$ 64,460,000**		**$ 67,683,000**
30.03	Heavy Maintenance Facility				$ 64,460,000		$ 67,683,000
	Contribution to Southwestern Yard to Accommodate AMC Vehicles	$ 64,000,000	LS	1	$ 64,000,000	5%	$ 67,200,000
	Potential modifications to the Southwestern Yard to Accommodate Aerial Structures	$ 200,000	LS	2.3	$ 460,000	5%	$ 483,000

FTA #	Item Description	Unit Cost	Unit	Quantity	Base Cost	Contin.	Total Cost
40	**Sitework & Special Conditions**				**$ 387,719,021**		**$ 523,610,436**
40.01	Demolition, Clearing, Earthwork				$ 974,445		$ 1,315,501
	Aerial Structure Demolition	$ 25	SF	38844	$ 971,100	35%	$ 1,310,985
	General Site Clearing	$ 3,345	ACRE	1	$ 3,345	35%	$ 4,516
40.02	Site Utilities, Utility Relocation: Existing ROW				$ 3,795,150		$ 5,313,210
	On-CTA					40%	
	Major Utility Relocation, Underground - Level 7: Duct Banks & Fiber Optic Lines	$ 900	LF	1540	$ 1,386,000	40%	$ 1,940,400
	Major Utility Relocation, Underground - Level 6: ≥60" Diameter	$ 1,333	LF	0		40%	
	Major Utility Relocation, Underground - Level 5: ≥48" Dia. To <60" Dia.	$ 973	LF	0		40%	
	Major Utility Relocation, Underground - Level 4: ≥36" Dia. To <48" Dia.	$ 770	LF	170	$ 130,900	40%	$ 183,260
	Major Utility Relocation, Underground - Level 3: ≥24" Dia. To <36" Dia.	$ 645	LF	492	$ 317,340	40%	$ 444,276
	Major Utility Relocation, Underground - Level 2: ≥12" Dia. To <24" Dia.	$ 390	LF	919	$ 358,410	40%	$ 501,774
	Major Utility Relocation, Underground - Level 1: <12" Dia.	$ 218	LF	425	$ 92,650	40%	$ 129,710
	Major Utility Relocation, Aerial OH Transmission Line - Level C: ≥240kV	$ 4,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level B: <240kV	$ 1,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level A: Other OH	$ 750	LF	0		40%	
	Off-CTA					40%	
	Major Utility Relocation, Underground - Level 7: Duct banks & fiber optic lines	$ 900	LF	20	$ 18,000	40%	$ 25,200
	Major Utility Relocation, Underground - Level 6: ≥60" Dia.	$ 1,333	LF	0		40%	
	Major Utility Relocation, Underground - Level 5: ≥48" Dia. To <60" Dia.	$ 973	LF	50	$ 48,650	40%	$ 68,110
	Major Utility Relocation, Underground - Level 4: ≥36" Dia. To <48" Dia.	$ 770	LF	100	$ 77,000	40%	$ 107,800
	Major Utility Relocation, Underground - Level 3: ≥24" Dia. To <36" Dia.	$ 645	LF	400	$ 258,000	40%	$ 361,200
	Major Utility Relocation, Underground - Level 2: ≥12" Dia. To <24" Dia.	$ 390	LF	1500	$ 585,000	40%	$ 819,000
	Major Utility Relocation, Underground - Level 1: <12" Dia.	$ 218	LF	2400	$ 523,200	40%	$ 732,480
	Major Utility Relocation, Aerial OH Transmission Line - Level C: ≥240kV	$ 4,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level B: <240kV	$ 1,000	LF	0		40%	
	Major Utility Relocation, Aerial OH Transmission Line - Level A: Other OH	$ 750	LF	0		40%	
40.03	Haz. Mat'l Contaminated Soil Removal/Mitigation, Ground Water Treatments				$ 5,103,400		$ 6,889,590
	Standard	$ 680,000	RM	2.38	$ 1,618,400	35%	$ 2,184,840
	On-CTA	$ 1,700,000	RM	1.81	$ 3,077,000	35%	$ 4,153,950
	Terminals 6 - 8	$ 2,720,000	RM	0.15	$ 408,000	35%	$ 550,800
40.04	Environmental Mitigation, E.G. Wetlands, Historic/Archeological, Parks	$ 100,000	RM	4.34	$ 434,167	35%	$ 586,125
40.05	Site Structures Including Retaining Walls, Sound Walls				$ -		$ -
40.06	Pedestrian/Bike Access & Accommodation, Landscaping				$ -		$ -
40.06	Pedestrian/Bike Access & Accommodation, Landscaping: Art Work	0.5%	10-50		$ 5,650,086	35%	$ 7,627,616
40.07	Automobile, Bus, Van Access Ways Including Roads				$ -		$ -
40.07	Automobile, Bus, Van Access Ways Including Parking Lots				$ -		$ -
40.08	Temporary Facilities and Other Indirect Costs During Construction	30.0%	10-50		$ 371,761,773	35%	$ 501,878,394
50	**Systems**				**$ 42,674,167**		**$ 57,610,125**
50.01	Train Control and Signals				$ 8,012,500		$ 10,816,875
	Light Rail	$ 1,500,000	RM	5.34	$ 8,012,500	35%	$ 10,816,875
50.02	Traffic Signals and Crossing Protection				$ -		$ -
50.03	Traction Power Supply: Substations	$ 2,500,000	EA	2	$ 5,000,000	35%	$ 6,750,000
50.04	Traction Power Distribution: Catenary	$ 2,000,000	RM	4.34	$ 8,683,333	35%	$ 11,722,500
50.05	Communications	$ 2,000,000	RM	4.34	$ 8,683,333	35%	$ 11,722,500
50.06	Fare Collection System and Equipment				$ 9,690,000		$ 13,081,500
	Gates	$ 356,500	EA	20	$ 7,130,000	35%	$ 9,625,500
	Ticket Vending Machines	$ 160,000	EA	16	$ 2,560,000	35%	$ 3,456,000
50.07	Central Control	$ 600,000	RM	4.34	$ 2,605,000	35%	$ 3,516,750
10-50	**Construction Total**				**$ 1,507,429,115**		**$ 1,986,655,152**
60	**ROW, Land, Existing Improvements**				**$ 71,819,838**		**$ 89,774,798**
60.01	Purchase or Lease of Real Estate	$ 1,000,000	LS	34.519038	$ 34,519,038	25%	$ 43,148,798
60.02	Relocation of Existing Households and Businesses	$ 1,000,000	LS	37.3008	$ 37,300,800	25%	$ 46,626,000
70	**Vehicles**				**$ -**		**$ -**
80	**Professional Services**				**$ 444,868,988**		**$ 532,299,877**
80.01	AA / Draft EIS/EIR / Final EIS/EIR				$ 7,714,545		$ 7,714,545
	Alternative Analysis	$ 1,818,428	LS	1	$ 1,818,428		$ 1,818,428
	Draft EIS/EIR	$ 3,691,961	LS	1	$ 3,691,961		$ 3,691,961
	Final EIS/EIR	$ 2,204,156	LS	1	$ 2,204,156		$ 2,204,156
80.01	Preliminary Engineering	3%	10-50		$ 45,222,873	20%	$ 54,267,448
80.02	Final Design	6%	10-50		$ 90,445,747	20%	$ 108,534,896
80.03	Project Management for Design and Construction (Agency)	8%	10-50		$ 120,594,329	20%	$ 144,713,195
80.04	Construction Administration and Management (Consultants)	4%	10-50		$ 60,297,165	20%	$ 72,356,598
80.05	Professional Liability and Other Non-Construction Insurance	0%	10-50		$ -	20%	$ -
80.06	Legal; Permits; Review Fees by Other Agencies, Cities, Etc.	1%	10-50		$ 15,074,291	20%	$ 18,089,149
80.07	Surveys, Testing, Investigation, Inspection	2%	10-50		$ 30,148,582	20%	$ 36,178,299
80.08	Start Up	5%	10-50		$ 75,371,456	20%	$ 90,445,747
10-80	**Total**				**$ 2,024,117,941**		**$ 2,608,729,826**
90	**Unallocated Contingency**	37%	10-80				**$ 965,230,036**
	10-90 Total				**$ 2,024,117,941**		**$ 3,573,959,862**
100	**Finance Charges**						**$ -**
10-100	**Total**				**$ 2,024,117,941**		**$ 3,573,959,862**

APPENDIX C
Operations Analysis

Appendix C:
Rail Operations Analysis

Introduction

The operations analysis conducted for the Airport Metro Connector Supplemental Analysis Report focuses on two key issues: the Redondo Beach Terminal and the feasibility of Alternative B.

Redondo Beach Terminal Analysis

A key terminal in the Metro Rail system is the Redondo Beach Station at the southern terminus of the Metro Green Line. The existing configuration at the Redondo Beach Station does not include tracks beyond the station platform, which requires trains to enter the station at reduced speeds. An operations analysis was conducted to determine whether the current terminal configuration could accommodate five minute headways on three branches as proposed as part of the Airport Metro Connector alternatives.

Train Performance Calculations (TPCs) were done to identify the runtimes at the interlocking approaching the Redondo Beach terminal to see if the existing infrastructure was sufficient to accommodate the 200 second trunk headway of Alternatives B (split service), C1, C3, & C4. A mock schedule was then created to identify the times of platform and interlocking occupancy to identify any conflicts. The timeline of the schedule is shown in Table 1. While there are no double-occupancies shown, these calculations do not account for train control system impact, interlocking realignment time, or normal daily perturbations. A typical interlocking realignment time used in simulations is 30 seconds; this would use all but a few seconds of the time between when one train arrives at Redondo Beach and the next train departs, making these operations infeasible on this infrastructure.

The addition of tail tracks to the station allows for faster inbound speeds. This means with no changes to the inbound schedule, trains will arrive earlier, thus lengthening the terminal dwell, and increasing the time from an inbound arrival to an outbound departure. The additional infrastructure allows the proposed operations to be feasible at the terminal station.

Table 1: Schedule at Redondo Beach Station

Time	Service A	Service B	Service C	Clear time
0:00	Enter - normal			
1:01	Arrive - normal			
1:31	TC reset			
3:20		Enter - reverse		1:49
4:17		Arrive - reverse		
4:47		TC reset		
5:00	Depart - reverse			0:13
5:22	Exit - reverse			
5:52	TC reset			
6:40			Enter - normal	0:48
7:41			Arrive - normal	
8:11			TC reset	
8:20		Depart - normal		0:09
8:38		Exit - normal		
9:08		TC reset		
10:00	Enter - reverse			0:52
10:57	Arrive - reverse			
11:27	TC reset			
11:40			Depart - reverse	0:13
12:02			Exit - reverse	
12:32			TC reset	
13:20		Enter - normal		0:48
14:21		Arrive - normal		
14:51		TC reset		
15:00	Depart - normal			0:09
15:18	Exit - normal			
15:48	TC reset			
16:40			Enter - reverse	0:52
17:37			Arrive - reverse	
18:07			TC reset	
18:20		Depart - reverse		0:13
18:42		Exit - reverse		
19:12		TC reset		
20:00	Enter - normal			0:48
21:01	Arrive - normal			
21:31	TC reset			

Time	Service A	Service B	Service C	Clear time
21:40			Depart - normal	0:09
21:58			Exit - normal	
22:28			TC reset	
23:20		Enter - reverse		0:52
24:17		Arrive - reverse		
24:47		TC reset		
25:00	Depart - reverse			0:13
25:22	Exit - reverse			
25:52	TC reset			
26:40			Enter - normal	0:48
27:41			Arrive - normal	
28:11			TC reset	
28:20		Depart - normal		0:09
28:38		Exit - normal		
29:08		TC reset		
30:00	Enter - reverse			0:52

Alternative B Operational Feasibility Analysis

To determine the feasibility of Alternative B, an operations spreadsheet analysis was completed using simulated trip times (Figure 1 and Table 2). Due to the four different operating moves in Alternative B (split service), there are three critical junctions - the grade-separated junction north of the Aviation/Century Station, the flat junction west of the Aviation/LAX Station, and the junction south of the Hindry Station.

The three services along the branch from Mariposa to Redondo Beach require a trunk headway of 3 trains every 10 minutes, or a 200 second headway. A mock schedule was then created using the trip times from the Train Performance Calculations (TPCs) showing arrival and departure times at all the junctions and stations within the core area of the network. At Mariposa, the Crenshaw/Expo service via ITF began 200 seconds behind the Crenshaw/Expo service via Aviation/Century. Since the alignment via ITF is longer, the resulting runtime is longer, and the via ITF service was nearly 5 minutes behind the Aviation/Century service when they merged at the junction south of Hindry. The difference in the even five-minute headway was rectified by increasing the dwell time at Aviation/Century by approximately 40 seconds. The reverse calculations were performed on the two Crenshaw/LAX services, again needing to modify the dwell time at Aviation/Century to achieve the correct headway spacing at Mariposa.

The departure time at Aviation/LAX was then calculated so that the Norwalk-Redondo Beach service would arrive at Mariposa 200 seconds after the Aviation/Century Crenshaw service and 200 seconds before the ITF Crenshaw service. This provided the westbound departure times for the ITF loop service from Norwalk. Adding the runtime from Mariposa to Aviation/LAX for the Norwalk-Redondo

service allowed for determining the necessary departure time at Aviation/LAX once the loop service returned, headed for Norwalk. Similar to the Crenshaw/LAX services, the ITF loop service needed to extend its dwells at ITF and Aviation/LAX to have an even trunk headway east of Aviation/LAX. The increased dwell at ITF required another increase to the dwell at Aviation/Century.

Analysis of the junction occupation times show there are no double-occupancies of the junctions for any conflicting moves, however, there are extremely narrow clearing times, such as six seconds from one train's exit to another train's entry. These calculations do not account for impacts of train control systems and normal daily perturbations to operations, meaning that the narrow gaps between conflicting moves would be overcome in regular operations, causing trains to be delayed at the junctions. Additionally, the ITF loop service does not align close to an even five-minute headway with either the ITF Crenshaw/LAX service at the ITF station or the Aviation/Century service at Aviation/Century station, creating an additional source for likely delays. These factors will create delays and variations in train operations greater than the slim operating margin of the theoretical results, meaning this scenario will be difficult to operate in practice.

Figure 1: Alternative B Operations

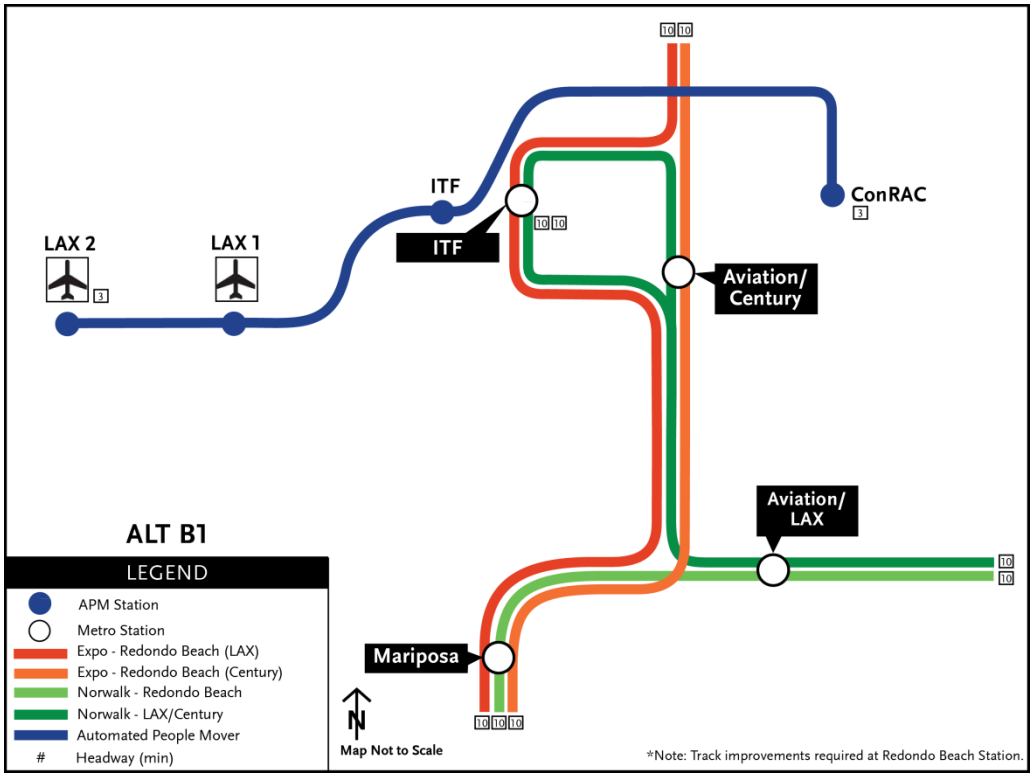


Table 2: Alternative B Operations

South/West

Route	Hindry	Hindry Jct.		ITF		Aviation/ Century		Aviation/ Century Jct.		Aviation/ LAX (WB)		Av/LAX Jct.		Aviation/ LAX (EB)		Mariposa
	Dep	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep	Arr
Crenshaw/Expo-Redondo Beach via Aviation/Century	0:00	0:54	0:59			1:56	3:07	3:37	3:57			4:31	5:19			7:04
Crenshaw/Expo-Redondo Beach via ITF	5:00	5:58	6:11	7:53	8:23			10:15	10:37			11:10	11:59			13:44
Norwalk-Redondo Beach											8:07	8:11	8:40	(8:38)	(8:58)	10:24
Norwalk-ITF loop		7:51	9:18			9:30	10:41	11:15	11:31			12:05	12:44	13:00	13:58	

North/East

Route	Mariposa	Aviation/ LAX (WB)		Av/LAX Jct.		Aviation/ LAX (EB)		Aviation/ Century Jct.		Aviation/ Century		ITF		Hindry Jct.		Hindry
	Dep	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep	Arr	Dep	Arr
Crenshaw/Expo-Redondo Beach via Aviation/Century	0:00			1:25	2:03			2:42	2:54	3:19	4:29			4:43	4:57	6:21
Crenshaw/Expo-Redondo Beach via ITF	3:20			4:45	5:23			6:05	6:20			8:02	8:32	9:08	9:49	11:21
Norwalk-Redondo Beach	6:40			8:03	8:31	8:38	8:58									
Norwalk-ITF loop			**3:07**	3:11	4:03	*(13:00)*	*(13:58)*	4:47	5:03			**6:44**	**7:14**	7:51	9:18	

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