Crenshaw-Prairie Corridor
Major Investment Study

Technical Memorandum
Design Issues and Constraint Analysis

Submitted to:

Los Angeles Metropolitan Transportation Authority

Submitted by:

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1.0 Introduction

The purpose of this memorandum is to update engineering design issues and physical constraints for the proposed BRT and LRT alternatives. The results of this task will guide the technology discussions and the ongoing evaluation of the investment strategy alternatives.

2.0 Transit System Design Options and Issues

2.1 Bus Rapid Transit (BRT)

BRT is a transit system that substantially upgrades bus system performance through low-cost investments in infrastructure, equipment, operational improvements, and technology. Generally speaking, BRT would provide for significantly faster operating speeds, better service reliability, and increased convenience, matching the quality of rail transit when implemented in appropriate settings. Typically, a BRT system would include the following features:

- ***Dedicated Bus Lane***: A lane on an urban arterial or city street is reserved for the exclusive use of buses, wherever possible.
- ***Transit Priority System***: A technological systems interface that enables transit vehicles to receive preferential treatment at signalized intersections.
- ***Frequent Service and Schedule Adherence:*** Providing high-speed buses with small headways jointly with the Automated Vehicle Location (AVL) system and global Positioning Satellite (GPS) technology would significantly improve travel times.
- ***Faster Boarding:*** Providing low-floor, multi-door buses and pre-paid fare collection system would significantly reduce boarding times.
- ***Improved Facilities and Amenities***: Enhanced bus stops/stations with lighting, route maps, shelter, and electronic transmitted real time schedule data.

2.1.1 Alignment

As recommended by FTA Office of Research, bus lanes for BRT should require an 11-foot cross section per direction at a minimum. The basic obstacle to creating a bus lane on Crenshaw Boulevard is the lack of an adequate cross section to separate buses from general-purpose traffic. This is especially true for the Crenshaw Corridor segment between Wilshire Boulevard and Washington Boulevard, where the existing lane configuration is only two travel lanes each direction. If one travel lane is dedicated for buses use, that will leave only one travel lane each direction for mixed flow and will produce serious adverse consequences for general-purpose traffic.

Depending upon whether a bus lane is located along the curb or the median of Crenshaw Corridor, conflicts are created with right- or left- turn vehicles. The need for general-purpose traffic to use a bus lane for turning interferes with bus operations and creates concerns of safety as well as travel time increasing.

Table 1 summarizes the advantages and disadvantages of curb running and median running alternatives.

Table 1 Comparison of BRT Alternatives

Alignment	Description	Advantages	Disadvantages
Curb Running	BRT running in existing curb-lane with bus stations on sidewalk	• Retention of landscaped median • Continued use of left-turn pockets • Convenient access to bus stations.	• Curb parking prohibited along entire service corridor • BRT intermix with local buses creating reduced timesaving • BRT experiencing possible delay from vehicles making right turns and pedestrian crossing intersections
Median Running	BRT operating in the street median with bus stations located at far side of intersection	• Exclusive lane for BRT service. • Loading/unloading may be allowed in curb lane • Existing landscaped median or two-way-left-turn-lane may remain • No right turning vehicles conflicts at intersections • No pedestrian conflicts at intersections	• Patrons must use crosswalks to access bus stations in median of roadway. • Left-turning vehicles must cross the BRT only lane. • Possible queue spillover from left turn pockets.

2.1.2 Operations

With the understanding that Metro Rapid Bus for Crenshaw Corridor will be implemented in the near future, the most critical advantage that a BRT system may bring to this corridor, in terms of travel time saving, is the dedicated bus lane. However, due to the existing physical constraints at some segments (e.g. narrow right of way between Wilshire and Washington), a 24-hour BRT system with dedicated bus lanes is not feasible. Buses mix flow with general traffic may be an alternative for these segments.

Low floor, high capacity buses such as articulated or bi-articulated buses could be used to help address crowded conditions. These buses are able to carry more customers than the regular 40-foot buses -- approximately 110 people (standing and seated).

While a 24-hour BRT operation has significant impact on existing curb parking, "peak period only" may be considered as the "Phase I" of a phased implementation strategy, which would have minimum impact on existing curb parking.

There is always a trade-off between the improvement in travel times that can be achieved by providing limited stops only, as in the case of rapid rail service, versus the convenient access made possible by frequent stops, as in conventional bus service. It has been assumed that the BRT system will provide stops at major intersections only (about one mile interval). Other means to improve overall travel time may include reducing boarding time and providing transit priority. The reduction of boarding time could be achieved by low floor, multiple entry/exit buses with prepaid bus fare system such as "Smart" card electronic system. Transit priority could be achieved by providing state-of-the-art technologies that will either hold or extend the green time in order for buses to pass through the signalized intersections without stopping.

2.1.3 Stations/Stops

Depending upon whether the BRT alignment is along the curb or in the median of Crenshaw Corridor, stations/stops should be located accordingly. The advantage of having stations/stops on sidewalks is to provide convenience access for patrons using BRT. The stations/stops should locate at the far side of the major intersections wherever possible to obtain the benefit of signal priority.

Integration of transit development with land use policies and community activities in station area should be thoroughly evaluated during the development of station concepts. The BRT and concepts of transit mall, inter-modal center, as well as pedestrian-oriented land use development are mutually supportive.

Station design could include amenities such as benches, vicinity map, printed routes and schedules or electronically transmitted real time schedule data.

2.1.4 Bus Signal Priority (BSP) Technologies

Transit signal priority systems have been shown to be an effective method of improving the operation, efficiency and attractiveness of transit. The success of the MTA/LADOT Metro Rapid Bus Demonstration Program (Wilshire Boulevard and Ventura Boulevard), showing results of a 25% travel time saving and a 26% increase in ridership, contributes to reductions in traffic congestion and environmental degradation. However, it should be noted that the signal priority contributed to about 1/3 of the total time saving while low-floor buses and limited stops contributed to the rest.

Signal priority for transit vehicles can be implemented in many ways ranging from adding a few seconds of green time to the transit phase to a complete preemption for the transit vehicle, although preemption is mainly applied in LRT. Queue Jumpers can also provide transit priority. A queue jump lane is a short stretch of bus lane combined with traffic signal priority. Although it is not favored by many jurisdictions due to the fact that either transit operators don't always take the advantage of the bus signal or buses are likely being blocked by right turn vehicles resulting in a waste of priority phase, it could still be an effective design treatment for the interface of the general traffic lanes where BRT alignment begins or ends.

Crenshaw Corridor traverses through three jurisdictions including the City of Los Angeles, City of Inglewood and City of Hawthorne. The traffic signal control systems are different between jurisdictions (Los Angeles: Type 2070/TPM; Inglewood: Bi Tran 233/170; Hawthorne: LACO-1 or 3/170). The challenges for this project will be to develop a transit priority system that could be deployed to all the jurisdictions along the corridor.

LACMTA currently has an on-going Countywide Bus Signal Priority Pilot Project, which consists of design, development, deployment, and evaluation of a BSP system that has the ability to interface with the wide variety of signal control systems that are owned and operated by various Los Angeles County jurisdictions. The technology chosen for this pilot project is a "Smart Bus" solution, which will utilize an on-bus processor to interface with a GPS receiver, and a spread spectrum radio and/or wireless subscriber service modem, to request priority at intersections. Since the signal intersection control systems differ by jurisdiction along Crenshaw corridor, different approaches must be adopted to granting priority. For example, at intersections controlled by Los Angeles County

and the City of Inglewood, priority data will be processed at the intersection level while in the City of Los Angeles; priority requests will be transmitted to the local intersection controller and passed through to the City's centralized Transit Priority Manager (TPM) system, which will be responsible for granting priority requests. If this pilot project turns out to be a success, the same technology may be applied to Crenshaw-Prairie Corridor BRT.

2.1.5 I-10 Freeway at Crenshaw Boulevard

The Santa Monica Freeway (I-10) is depressed at this location, which is also a "tight diamond" interchange, with direct ramps to and from the freeway that tie in to Crenshaw Boulevard at either end of the freeway overcrossing. Potential BRT alignment would include curb running and median running. Due to the fact that this interchange is currently operating at near capacity, taking one travel lane from each direction for the exclusive use of BRT will adverse impact the traffic capacity significantly. Therefore, a widening or total reconstruction of existing bridge would be highly desirable.

2.1.6 BNSF Right Of Way

Given the new reality of the options associated with BNSF Harbor Subdivision use, the Project Team recognizes that the BRT alternative needs to be examined in light of the new issues associated specifically with BNSF right of way usage. Although MTA owns the railroad right of way, BNSF still maintains the freight operating right in perpetuity. Based upon the subdivision maps provided by MTA, the existing right-of-way varies from 24' to 100'. The narrowest cross sections are found at Eucalyptus-San Diego Freeway-Arbor Vitae segments and they range from 24.5' to 50'. This presents a challenge to provide two BRT lanes plus a freight track without acquiring additional right of way.

The possible options would include:

- Acquire additional right of way where necessary
- Limit freight operations to a time window in which BRT would not operate.

On November 2, 2001, the Consultant Team has been instructed by MTA in assuming that BNSF will abandon its operations when this project begins construction and therefore the conflicts with freight train operations is no longer an issue.

2.1.7 At-Grade Crossing/Intersection Treatment

There are currently 18 at-grade crossings along BNSF right of way within the project limits and they may have to be converted to regular signalized or stop sign controlled intersections due to the fact that preemption and gated crossings may not be feasible for the proposed busway.

The types of treatment for each crossing/intersection will depend upon the traffic characteristics, lane configuration and current crossing locations. Table 2 identifies the potential treatment for each crossing. Every designated pedestrian crossing and every public roadway crossing

must be controlled by traffic signals. Private crossings (access roads) along the route may be controlled by 2-way stop signs.

BRT signals and vehicles must be placed at each crossing to control both the bus and vehicle traffic at the crossing. Typically the BRT crossings would be two-phased (BRT phase & vehicle phase) with the exception of the crossings where pre-signals are being installed.

Table 2

Location	Recommended Intersection Treatments
Crenshaw/BRT	Remove existing gates and install new traffic signal with BRT phasing; provide bus signal priority for southbound right turn and eastbound left turn movements; coordinate signal timing with adjacent intersections.
S. Victoria/BRT	Remove existing gates and install new traffic signal with BRT phasing.
Brynhurst/BRT	Remove existing gates and install new traffic signal with BRT phasing.
West/W. 71st St/BRT	Modify traffic signal and install BRT phasing.
Redondo/BRT	Remove existing gates and install pre-signal with BRT phasing.
Centinela/BRT	Remove existing gates and install pre-signal with BRT phasing.
La Brea/BRT	Remove existing gates and install pre-signal with BRT phasing.
Ivy/BRT	Remove existing gates and install pre-signal with BRT phasing.
Eucalyptus/BRT	Remove existing gates and install new traffic signal with BRT phasing; coordinate signal timing with adjacent intersections.
Cedar/BRT	Remove existing gates and install stop signs.
Oak/BRT	Remove existing gates and install pre-signal with BRT phasing.
Hyde Park/BRT	Remove existing gates and install pre-signal with BRT phasing.
La Cienega/BRT	Remove existing gates and install pre-signal with BRT phasing.
Hindry/BRT	Remove existing gates and install pre-signal with BRT phasing.
Manchester/BRT	Remove existing gates and install new traffic signal with BRT phasing; coordinate signal timing with adjacent intersections.
Arbor Vitae	Remove existing gates and install new traffic signal with BRT phasing.
104th Street/BRT	Remove existing gates and install pre-signal with BRT phasing.
111th Street/BRT	Remove existing gates and install pre-signal with BRT phasing.

2.2 Light Rail Transit (LRT)

According to FTA, Light Rail Transit (LRT) has the following characteristics:

- A system of electrically propelled passenger vehicles with steel wheels that are propelled along a track constructed with steel rails.
- Propulsion power is drawn from an overhead distribution wire by means of a pantograph and returned to the electrical substations through the rails.
- The tracks and vehicles must be capable of sharing the streets with rubber-tired vehicular traffic and pedestrians. The track system may also be constructed within exclusive rights-of-way.
- Vehicles are capable of negotiating curves as sharp as 82 feet and sometimes even sharper, in order to traverse city streets.

The design issues associated with LRT are summarized in the following sections.

2.2.1 Alignment

The alternatives adopted from the Crenshaw/Prairie Corridor Route Refinement Study are Maximize At-Grade Operations and Minimize At-Grade Operations. The following at-grade operational issues should be considered before a final alternative is selected.

- An at grade rail alternative is feasible in wide Crenshaw and Hawthorne Boulevard section with parking removal and on the BNSF right-of-way; street widening is needed elsewhere, but this could be done given much of the land use along the corridor and redevelopment potential.
- It should be noted that an at-grade alternative would be slower. Very few at-grade systems adjacent to or within roadway attain 55 mph operation (requires gated crossings and fenced right-of-way); expect 35 mph between stations, and much lower average speeds due to conflicts with traffic.
- There could be more stations since they are cheaper with at-grade operation – even though these stations would slow down the transit, they could provide more economic development opportunities. However, overall potential is limited and may need to be focused in relatively few locations.
- The ultimate decision therefore involves a complex trade-off between transit service (speed), coverage (number of stops), right-of-way take (cost) and economic benefit (redevelopment) and traffic service impact.
- Short sections of at-grade are not desirable, due to complexity, cost, and poor train operations on transition sections resulting in 'roller coaster' vertical alignment.
- A median running alignment is preferred to a side running alignment because of factors related to motorist behavior and motorist expectancy. Although Manual on Uniform Traffic Control Devices (MUTCD) does not designate a safer alternative, TCRP Report 17 designates the median running alignment as a preferred alignment type.

2.2.2 LRT Vehicle Maintenance Yard

The Preliminary Planning Study estimated that on the order of 14 transit (rail) vehicles would be needed in the Crenshaw-Prairie Corridor. While the obvious approach to the vehicle and maintenance issue is for the Crenshaw Line to have its own storage and maintenance facility, this approach further complicates the LACMTA's organizational approach to a coordinated and efficient rail system vehicle maintenance plan.

A stand alone Crenshaw-Prairie Facility ignores the obvious long term labor and material inventory savings potential realized by economics of scale and only serves to create more needless duplication of reoccurring rail vehicle maintenance tasks throughout the entire LAMTA rail system.

A decision regarding the final specifics of the approach to Crenshaw-Prairie LRT maintenance is best made as a integral element of the development of a total system maintenance strategy regarding LACMTA rail vehicles given the forthcoming Pasadena, Claremont, and East Line extensions of rail service. To design Crenshaw-Prairie as a stand alone facility only serves to further complicate and replicates the complex rail vehicle maintenance coordination issues that the LACMTA is currently faced with.

2.2.3 Station Access

In order to enhance convenient accesses to transit, it is recommended that every station along the corridor should have a kiss-and-ride facility where feasible. This will also help minimize station impacts on traffic flows/operations on adjacent arterials.

Certain stations should also have park-and-ride facilities. These should be locations where high drive-in patronage is expected (e.g. via major east-west arterials), where right-of-way or space is available to provide parking, and where opportunities exist for sharing parking with adjacent land uses. On a preliminary basis, park-and-ride facilities might be expected at the following potential station locations.

- Crenshaw/Exposition
- Crenshaw/Martin Luther King
- Crenshaw/Vernon
- Crenshaw/Slauson
- Florence/West
- Florence/La Brea
- Prairie/Manchester
- Prairie/Hollywood Park
- Prairie/I-105
- Hawthorne/El Segundo (Hawthorne Plaza)
- Aviation/Century (Future Intermodal Transit Center)
- Aviation/I-105

Availability of space for park-and-ride lot locations has not yet been confirmed at all these locations, nor has the potential size of park-and-ride lots been defined. Nevertheless, there does seem to be a significant potential for providing park-and-ride lots along the corridor.

Bus intercept facilities should be provided where key bus routes or a number of bus routes cross or meet the rail alignment. This will provide integrated bus access to the rail system, as well as improving coordination between bus routes. While bus routings in the corridor may be reorganized with introduction of a rail line, the following locations appear to be potential sites for bus intercept facilities.

- Future Expo/Crenshaw LRT Station
- Crenshaw Plaza area
- Leimert Park area
- Crenshaw/Slauson
- Downtown Inglewood
- Forum/Hollywood Park
- Hawthorne/Green Line Station
- Hawthorne Plaza
- LAX Lot C

Bus intercept facilities may be provided either on-street or off-street, depending upon the scale of facility, traffic conditions, and the availability of land. Certain of these sites could also be more substantial and function as intermodal transit facilities when demand would warrant or significant opportunities exist.

2.2.4 Freeway Crossing

The alignments under consideration include a number of potential freeway crossings, including:

- Glenn M. Anderson Freeway (I-105), between Prairie Avenue and Hawthorne Boulevard;
- San Diego Freeway (I-405) along Florence Avenue

The design would vary depending upon whether the rail alignment would be constructed on aerial structure, at-grade, or in subway as well as whether the freeway section being crossed is raised or depressed.

- *Glenn M. Anderson Freeway (I-105)* – Two alignments are under preliminary consideration – one would be an aerial alignment parallel to the freeway from Prairie Avenue to Hawthorne Boulevard with an angled crossing immediately east of Hawthorne Boulevard; the other would be an at-grade alignment along Hawthorne Boulevard. The aerial alternative would involve construction of a bridge across the freeway, which is depressed at Hawthorne Boulevard. The freeway median is wide enough to accommodate a column, which would allow use of a two-span structure. While such a structure would be more costly than

typical aerial sections, it would be feasible. With an at-grade solution, it may be possible to install tracks on the existing bridge, which is a new structure in good condition. Some strengthening of the bridge may be necessary.

- *San Diego Freeway (I-405)* – The alignment being considered is parallel to Florence Boulevard along the BNSF right-of-way. The freeway is depressed and there is an existing ballasted Rail Bridge that could be used with an at-grade alignment. An aerial alignment may be necessary in order to grade separate the trackway at La Cienega, which parallels the freeway immediately to the west. If so, a new bridge would need to be constructed across the freeway.

2.2.5 Connection to Future Exposition LRT

In June 2001, MTA adopted LRT as the Locally Preferred Alternative (LPA) for Exposition Corridor from downtown LA to Venice/Robertson. With a probable transfer at Exposition Station, the Crenshaw Corridor LRT would provide direct connections between downtown Los Angeles, downtown Inglewood, LAX and the Green Line. Since the segment between Wilshire Boulevard and Exposition Boulevard has issues of constrained right-of-way, underground hydrogen sulfite gas and freeway interchange reconstruction; it was decided that the intersection of Crenshaw/Exposition the northern terminus point for the corridor connecting to Metro/7th Street Station ultimately. In this case, the segment between Wilshire and Exposition could be served by Metro Rapid Buses.

2.2.6 BNSF Right of Way

Our initial investigations have revealed new unanticipated study implications with respect to the impacts of the Burlington Northern Santa Fe (BNSF) and MTA Agreements regarding right of way usage from Crenshaw Boulevard south to the Metro Green Line. These right of way usage issues are different than those assumptions made by MTA and Project Team staff in the 1995 study when LRT alternatives were defined, designed and cost assigned. Additionally, when the current MIS Contract was negotiated in December 2000-January 2001, the assumption was made to use the majority of the previous engineering work.

Given the fact that BNSF still maintains the operating rights in perpetuity and it presents a challenge at locations on the right of way, which can are as narrow as 24 feet in width, making it impossible to provide two LRT tracks plus a freight track with some type of design or right of way accommodation. The following options in Table 3 should be assessed resulting from the continuation of BNSF freight service.

Table 3 Crenshaw LRT Operating Scenarios in the BNSR Right-of-Way

Option	Relative Cost	BNSF Track Relocation	Additional ROW Needs	Remarks
1. Single Track & BNSF freight (Segregated operation)	Low to Moderate	Entire segment	Nominal (Needed at passing sidings and stations)	Permanent LRT single track operation
2. Double Track with segregated BNSF freight operation	High	Entire segment	Moderate (Continuous narrow take)	Additional ROW at stations
3. Double Track LRT with time shared BNSF	Moderate	Entire Segment	Nominal (Needed at passing sidings and stations)	Unknown cost for restricting BNSF operations
4. Double Track LRT on aerial structure	Very High	Minimal	None (potential some at stations)	Aerial stations required
5. Double Track LRT (BNSF operation abandoned) – previously studied.	Low to Moderately High	(See Note 1)	None for typical alignment	Unknown cost for BNSF abandonment. Additional ROW at stations.

Note 1: All options would involve an agreement with BNSF with the following possibilities:

- Reroute BNSF freight traffic via UPRR El Segundo branch (allowing the segment between LAX and Crenshaw to be abandoned).
- Restrict BNSF freight traffic between midnight and 5am. Negotiate shared trackage agreement.
- Negotiate shared ROW agreement, but with segregated operation.
- Buy out entire railroad and force shippers to use trucks.

On November 2, 2001, the Consultant Team has been instructed by MTA in assuming that BNSF will abandon its operations when this project begins construction and therefore the conflicts with freight train operations is no longer an issue.

2.2.7 LRT System Safety

Safety of light rail system is one of the major concerns from the community. Special attention needs to be focused on the following safety issues:

Alignment Type

Two semi-exclusive LRT alignment types are possible for two-way, street running, at-grade LRT systems; 1) median running and 2) side running. A median running alignment is preferred to a side running alignment because of factors related to motorist behavior and motorist expectancy. Typical problems associated with two-

way, side-aligned LRT operations on one way or two-way street include the following:

- Pedestrian and motorists are confused as to which way the light rail vehicle (LRV) is approaching.
- Driveway access across LRT tracks conflict with LRV operations
- Two two-way street couplets are effectively formed when a two-way LRT is side aligned on a two-way street. This type of geometry, especially when turning traffic is involved, forces the motorist to make complicated decisions. Drivers may be especially confused at night, when the headlights of an LRV appear on the right hand side of the road.

Trackway and Roadway Separation

The delineation of the trackway between at-grade crossings creates a roadway/trackway separation. For a semi-exclusive right of way, where pedestrians and motorists cross at designated locations only, the trackway can be delineated through various techniques including the use of pavement striping, textured pavement treatment, non-mountable curbs, mountable curbs, or fencing.

California safety regulations governing light rail transit (GO 143-B) do not require a fence where the LRV maximum operating speed does not exceed 35 mph. The operating speed for Crenshaw LRT should not exceed street speed limit of 35 mph for the alignment in semi-exclusive right of way.

Sight Distance

Sight distance is a critical element in LRT grade crossing design for both motorist and pedestrian safety. The Crenshaw LRT alignment between Exposition Boulevard and Florence Avenue does not have substantial vertical or horizontal curves that impede adequate sight lines for motorists, pedestrians or LRV operators down the trackway. Since this LRT segment between Exposition Boulevard and Florence Avenue will be operated in semi-exclusive right of way, all the crossings will have to be signalized providing a greater level of control and safety for the motorists and pedestrians that must cross the trackway.

For the alignment utilizing existing BNSF right-of-way, a diagnostic team field review will have to be conducted in preliminary engineering stage to ensure the ultimate safety measures are implemented to comply with the CPUC and industry standards.

Gated Crossings

The MUTCD states, "highway-light rail transit grade crossings in semi-exclusive alignments should be equipped with traffic gates and flashing light signals (R/R flashers) where light rail transit speeds exceed 35 mph." (Section 10D.2) In addition, GO 143-B

requires the use of gates at all at-grade crossings where maximum LRV operating speed exceeds 35mph. A major portion of the proposed Crenshaw LRT will utilize existing BNSF right of way therefore the maximum LRV operating speed is likely to be greater than 35 mph in these segments. However, all the existing grade crossing warning devices and safety treatment serving the BNSF freight trains may not comply with the latest LRT at-grade crossing design standards. A diagnostic field review addressing the following safety issues has to be conducted before the project design is initiated.

- Inadequate/inconsistent grade crossing warning devices
- Vehicle queuing across railroad tracks
- Vehicle driving around automatic gates
- False/inconsistent activation of automatic gates and warning systems
- Poor sight distance/grade crossing conditions
- Poor pedestrian conditions

An initial set of recommendations for the existing grade crossing safety upgrades is summarized in Table 4.

Table 4 Initial Recommendations for At-Grade Crossing Improvement

Improvement / Crossing*	Re-Profile	Upgrade flashing lights	Install/Modify Median Island	Install pre-signal	Traffic Signal Coordination Upgrades	Street Improve-ment	Update Signage and Pavement Marking	Install railroad concrete panels	Grade Separation
Crenshaw/LRT			X			X	X	X	
S. Victoria/LRT		X	X				X	X	
Brynhurst/LRT	X	X	X			X	X	X	
West/W. 71st St/LRT		X	X		X		X	X	
Florence/Redondo/LRT		X	X	X	X		X	X	
Florence/Centinela/LRT									X
Florence/La Brea/LRT									X
Ivy/LRT		X	X				X	X	
Eucalyptus/LRT		X				X	X	X	
Cedar/LRT		X				X	X	X	
Florence/Oak/LRT		X	X	X			X	X	
Florence/Hyde Park/LRT		X	X			X	X	X	
Florence/La Cienega/LRT									X
Florence/Hindry/LRT	X	X					X	X	
Florence/Manchester/LRT		X			X		X	X	
Arbor Vitae/LRT		X				X	X	X	
104th Street/LRT		X				X	X	X	
111th Street/LRT		X				X	X	X	

*Photos of existing crossings are included in the Appendix.

2.2.8 Green Line Extension to LAX

A conceptual design was done for the Metro Green Line Northern Extension as supplemental EIR from Aviation Station to Westchester Station in 1993. This design included a combination of aerial/tunnel structures between Aviation Station and Century Boulevard connecting with future LAX people mover. Since tunneling generally imposes high construction cost comparing to other construction methods and is not absolutely required for this segment, an alternative of aerial/trench structures is being considered under this study. The proposed alternative will clear the LRT from the flight path as well as pose no confusion to airplane pilots at night since they will not see the lights of LRT.

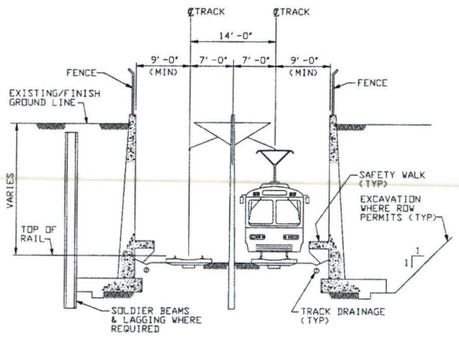
The MTA Design Criteria for LRT calls for a maximum of 5% vertical grades for short sustained grade from 500' up to 1000' between vertical points of intersections (VPIs) of vertical curves. However, as shown in the attached Figure 1 sheet 3 of 3, in order not to affect the entrance of 104th Street and still maintain the existing aerial structure at Century Boulevard, a sub-standard grade of 6% had to be utilized.

2.2.9 Grade Separation Analysis

It is recommended in the Initial Screening Report that three existing at-grade crossings, namely, Centinela Avenue, La Brea Boulevard and La Cienega Avenue should be considered as possible grade separation locations for the benefits of LRT travel time saving as well as traffic impact mitigations.

Existing traffic counts were collected on for both AM and PM peak hours. An Intersection Capacity Analysis was also conducted to assess the existing and future (year 2015) levels of service. Table 5 summarizes the volume/capacity ratios and levels of service of the intersections immediately adjacent to the grade crossings.

In addition, an evaluation of the Centinela, La Brea and La Cienega grade crossings by following the ITE Light Rail Transit Grade Separation Guidelines was conducted. As indicated in Figure 2 for the current condition, La Cienega should be feasible for at-grade operations whereas La Brea and Centinela may attain possible traffic solutions if LRT delay is acceptable. As shown in Figure 3 for year 2025, La Cienega would remain as at-grade feasible while La Brea may attain possible traffic solutions if LRT delay is acceptable. However, Centinela would have to be grade-separated.



SECTION A
RETAINED CUT SECTION

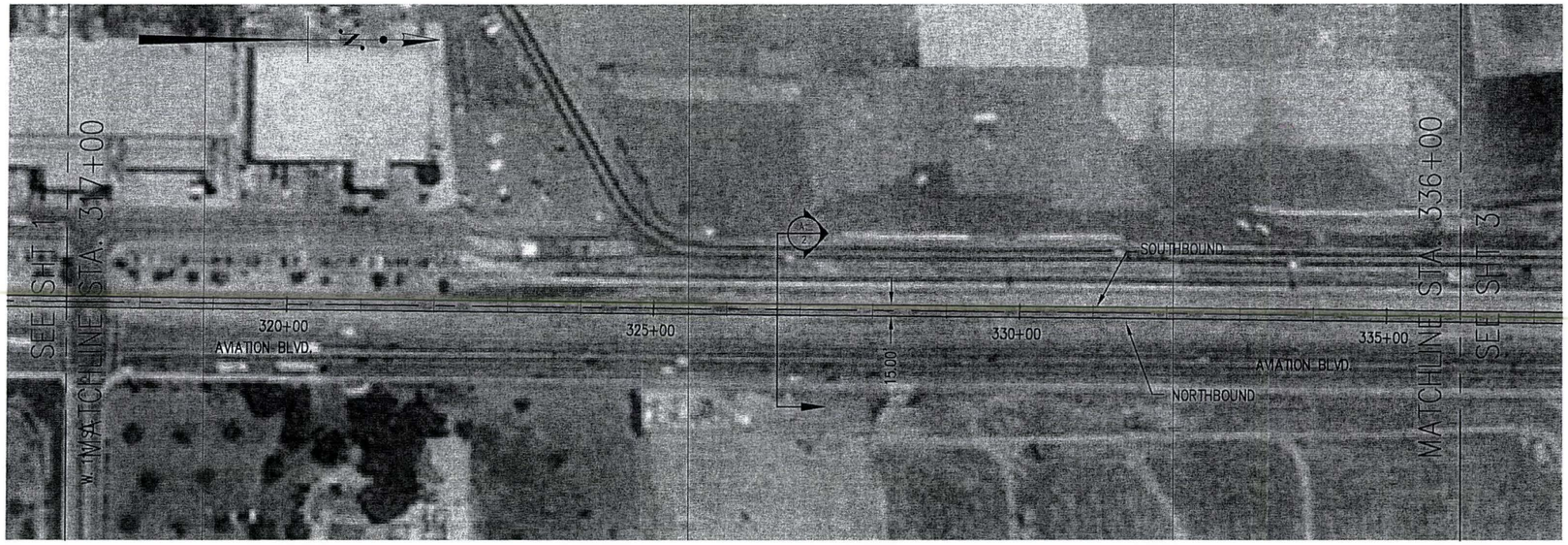
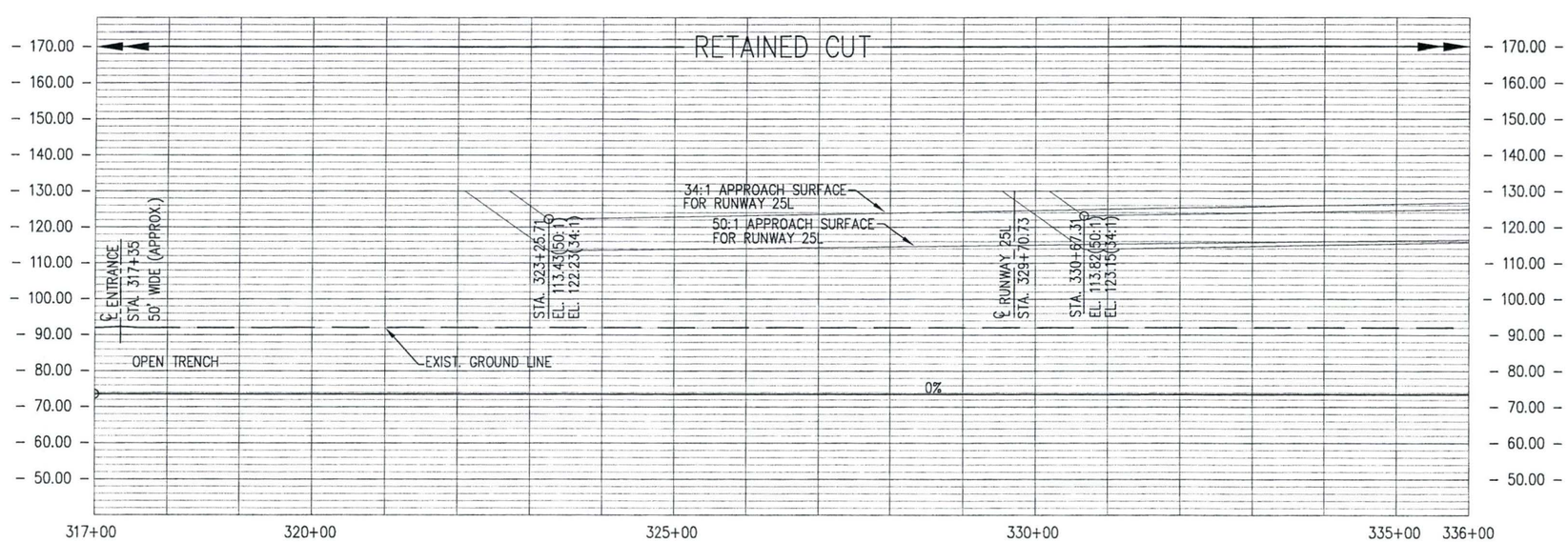


Image courtesy of the US Geological Survey Aerial Photograph 1994 http://terraserver.homeadvisor.msn.com



HORIZONTAL SCALE: 1"=200'
50 0 100 200 300

VERTICAL SCALE: 1"=40'
10 0 20 40 60

CRENSHAW TRANSPORTATION CORRIDOR PRAIRIE

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY
DRAWN BY
CHECKED BY
IN CHARGE
DATE

LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY
CRENSHAW/PRAIRIE CORRIDOR PROJECT

KORVE ENGINEERING / RAW ARCHITECTURE
725 S. Figueroa St., Suite 2350
Los Angeles, CA 90017
(213) 486-6578
(213) 486-6533 fax

CRENSHAW/PRAIRIE CORRIDOR
CONCEPTUAL ENGINEERING
LRT ALIGNMENT-MAXIMIZE AT-GRADE
PLAN AND PROFILE

Figure 1
SCALE AS NOTED
2 OF 3

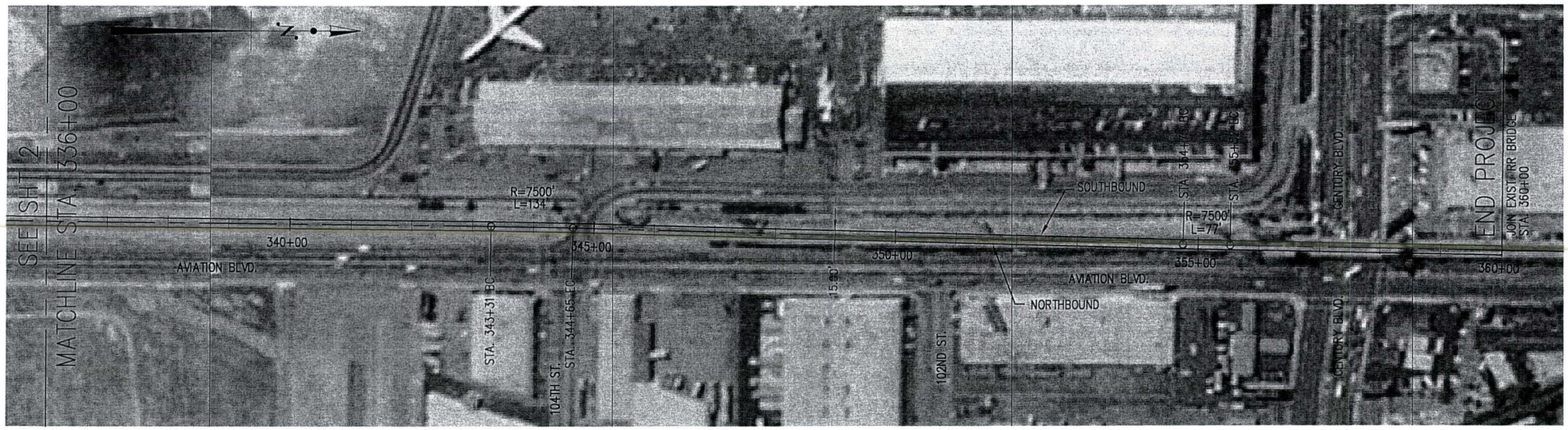
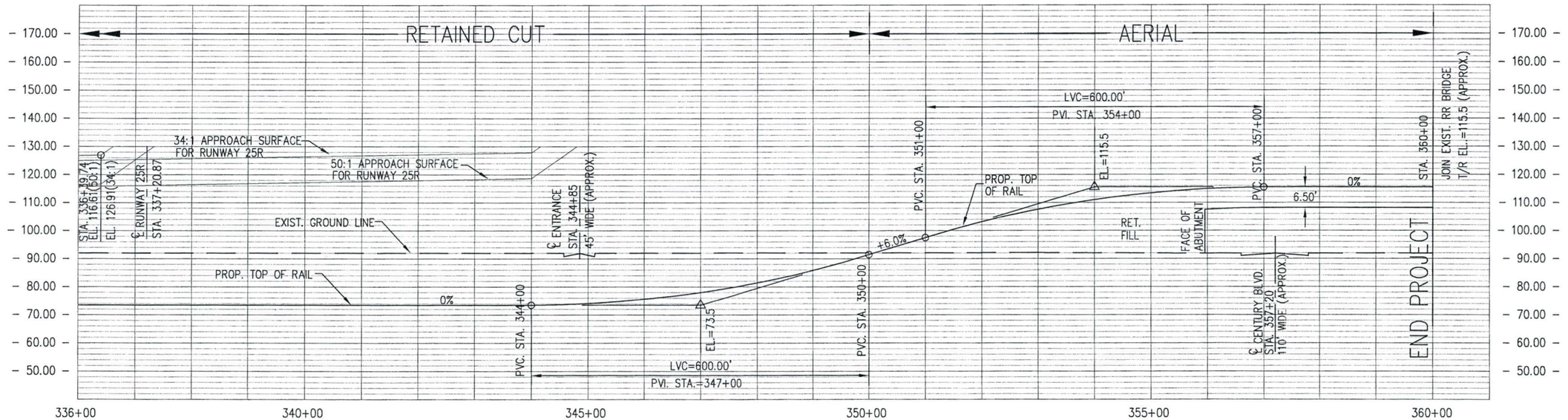


Image courtesy of the US Geological Survey Aerial Photograph 1994 http://terraserver.homeadvisor.msn.com



HORIZONTAL SCALE: 1"=200' 50 0 100 200 300

VERTICAL SCALE: 1"=40' 10 0 20 40 60

CRENSHAW TRANSPORTATION CORRIDOR PRAIRIE

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

DESIGNED BY
DRAWN BY
CHECKED BY
IN CHARGE
DATE

LOS ANGELES COUNTY METROPOLITAN TRANSPORTATION AUTHORITY
CRENSHAW/PRAIRIE CORRIDOR PROJECT

KORVE ENGINEERING RAW ARCHITECTURE

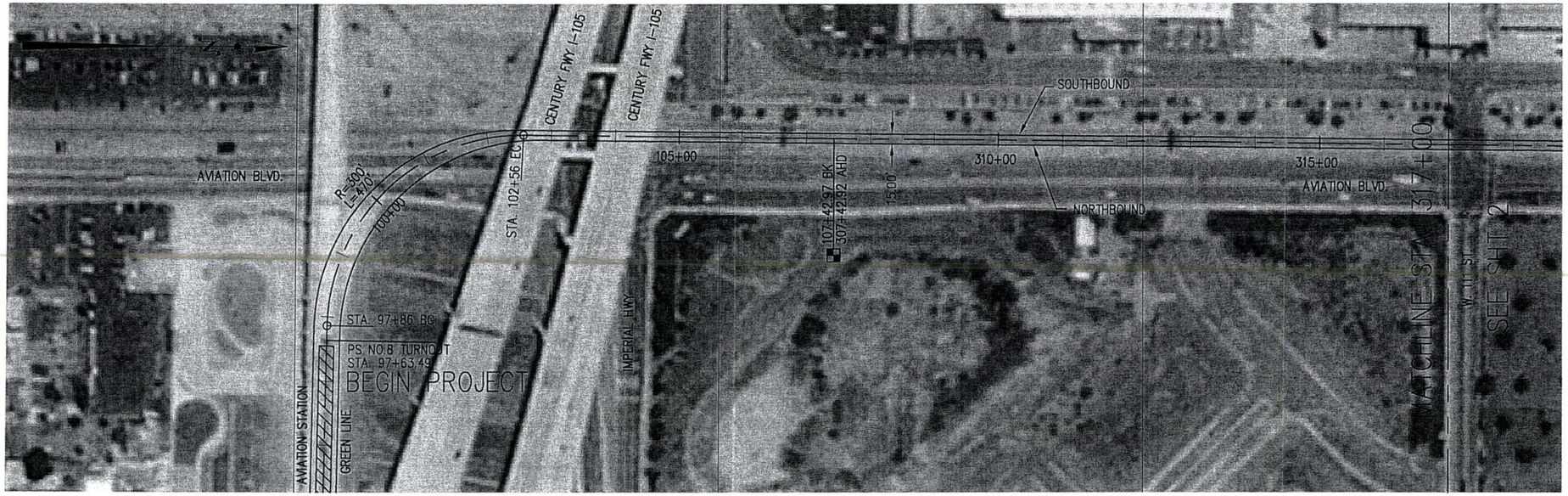
725 S. Figueroa St., Suite 2350
Los Angeles, CA 90017
(213) 486-6578
(213) 486-6533 fax

CRENSHAW/PRAIRIE CORRIDOR CONCEPTUAL ENGINEERING
LRT ALIGNMENT-MAXIMIZE AT-GRADE PLAN AND PROFILE

Figure 1

SCALE: AS NOTED

3 OF 3



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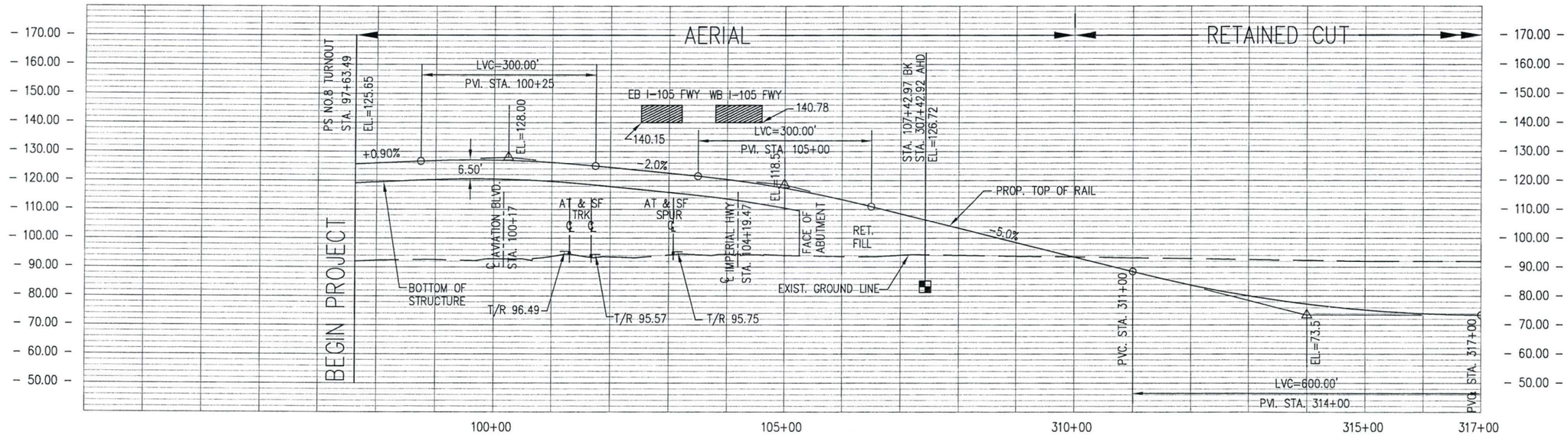

HORIZONTAL SCALE: 1"=200' (50 0 100 200 300)

VERTICAL SCALE: 1"=40' (10 0 20 40 60)

CRENSHAW TRANSPORTATION CORRIDOR PROJECTS PRAIRIE

REV	DATE	BY	APP	REG NO	EXPIRES	SEAL HOLDER	DESCRIPTION

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CRENSHAW/PRAIRIE CORRIDOR CONCEPTUAL ENGINEERING
LRT ALIGNMENT-MAXIMIZE AT-GRADE PLAN AND PROFILE

Figure 1

SCALE: AS NOTED

1 OF 3

Table 5: Intersection Capacity Analysis

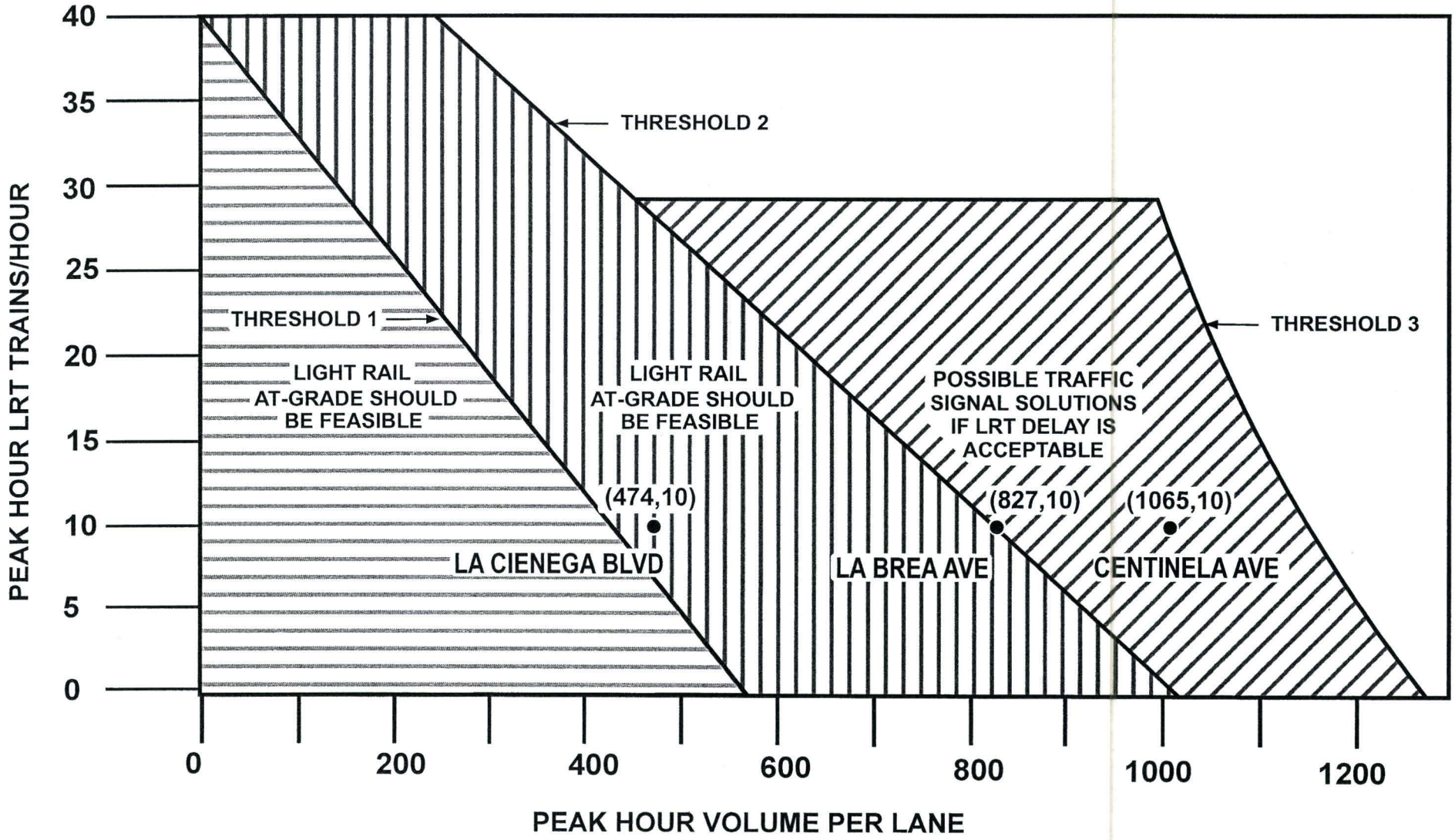
	YEAR 2001				YEAR 2025*			
	AM		PM		AM		PM	
	V/C	LOS	V/C	LOS	V/C	LOS	V/C	LOS
Centinela Avenue at Florence Aveneue	1.53	F	1.28	F	1.90	F	1.59	F
La Brea Boulevard at Florence Avenue	1.09	F	0.93	E	1.35	F	1.15	F
La Cienega Avenue at Florence Avenue	0.59	A	1.03	F	0.74	C	1.28	F

Peak Hour Volume per Lane

	YEAR 2001		YEAR 2025	
	AM	PM	AM	PM
Centinela Avenue	1065	838	1320	1039
La Brea Boulevard	827	642	1025	795
La Cienega Avenue	177	474	219	587

Level Of Service Computation by Circular 212 Planning Method
*Assume 1% growth per year

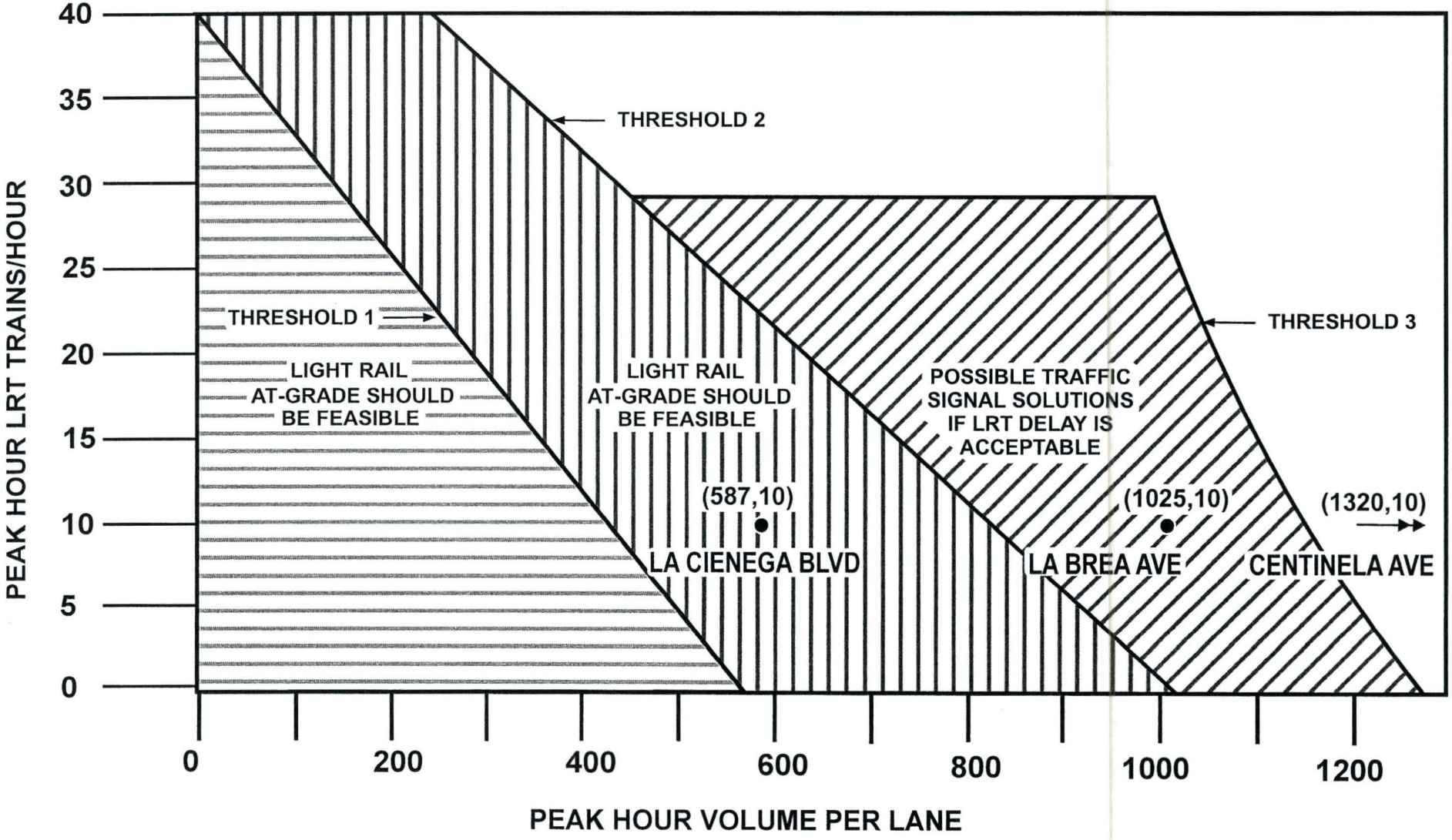
FIGURE 2
EVALUATION OF THREE CRENSHAW/PRAIRIE LRT CROSSINGS CENTINELA AVENUE, LA BREA AVENUE, AND LA CIENEGA BOULEVARD EXISTING CONDITION - YEAR 2001



ASSUMPTIONS:

- DOUBLE TRACK LRT, WITH EQUAL FREQUENCY IN EACH DIRECTION
- CONFLICTING TRAFFIC INTERSECTION LOS NOT TO EXCEED "D"
- THRESHOLDS 1 AND 2 SPAN LIKELY RANGE OF URBAN CAPACITY, ASSUMING TRAFFIC SIGNAL PRE-EMPTION

FIGURE 3
EVALUATION OF THREE CRENSHAW/PRAIRIE LRT CROSSINGS
CENTINELA AVENUE, LA BREA AVENUE, AND LA CIENEGA BOULEVARD
FUTURE CONDITION - YEAR 2025



ASSUMPTIONS:

- DOUBLE TRACK LRT, WITH EQUAL FREQUENCY IN EACH DIRECTION
- CONFLICTING TRAFFIC INTERSECTION LOS NOT TO EXCEED "D"
- THRESHOLDS 1 AND 2 SPAN LIKELY RANGE OF URBAN CAPACITY, ASSUMING TRAFFIC SIGNAL PRE-EMPTION

3.0 Constraints Analysis

The following tables summarize the initial analysis of the existing physical constraints and potential impacts on traffic and parking for the two build alternatives (BRT and LRT). Further analyses should be conducted at the stage of draft EIR/EIS and preliminary engineering.

CRENSHAW/PRAIRIE CORRIDOR MIS
DESIGN ISSUES AND CONSTRAINTS ANALYSIS
BRT BUILD ALTERNATIVES

Alignment Segment	Class	ADT	ROW	Curb to Curb	L/T(Y/N)	Lane	Typical Exist. Parking Restrictions	Current V/C	Lane Drop V/C	BRT Curb Lane	
										Prop. Operations	Design Issues and Impacts
BRT Crenshaw Branch											
Crenshaw/Wilshire to Crenshaw/Olympic	Major	33,900	70	56	Y	4	TYP (NO PKG 10-12 THUR)	1.06	1.06	Mixed Flow	No surface street impact
Crenshaw/Olympic to Crenshaw/Venice	Major	40,000	90	56	Y	4	TYP(TANS 7-9AM,4-6PM X-S/S), (NO PKG 10-12 THUR)	1.25	1.25	Mixed Flow	No surface street impact
Crenshaw/Venice Crenshaw/Washington	Major	43,600	90	56	Y	4	TYP(TANS 7-9AM,4-6PM X-S/S)	1.36	2.73	Mixed Flow	No surface street impact
Crenshaw/Washington to Crenshaw/Adams	Major	50,700	100	80	Y	6	TYP(TANS 7-9AM,4-7PM X-S/S); SOME (TANSAT)	1.06	1.58	Dedicated Lane	NO WIDENING : station on sidewalk+ loss of street parking on both sides+ loss of one thru lane each way(from 6 to 4)
Crenshaw/Adams to Crenshaw/Jefferson	Major	47,300	100	75-70	Y	6	TYP(TANS 7-9AM,4-7PM X-S/S), (1 HR. PKG. 9AM-4PM, X-SUN)	0.99	1.48	Dedicated Lane	NO WIDENING:10.5' BRT lane+station on sidewalk+loss of street parking on both sides+loss of one thru lane each way(reduce from 6 to 4)
Crenshaw/Jefferson to Crenshaw/Exposition	Major	47,300	100	70	Y	6	TYP(TANS 7-9AM,4-7PM X-S/S), (1 HR. PKG. 9AM-4PM, X-SUN)	0.99	1.48	Dedicated Lane	NO WIDENING:10.5' BRT lane+station on sidewalk+loss of street parking on both sides+loss of one thru lane each way(reduce from 6 to 4)
Crenshaw/Exposition to Crenshaw/Coliseum	Major	47,500	100	74	Y	6	TYP(TANS 7-9AM,4-7PM X-S/S), (1 HR. PKG. 9AM-4PM, X-SUN); SOME (TANSAT),(1 HR. PKG. 9AM-4PM, X-SUN)	0.99	1.48	Dedicated Lane	NO WIDENING:station on frontage road median+loss of street parking on both sides+loss of one thru lane each way(reduce from 6 to 4)
Crenshaw/Coliseum to Crenshaw/39th		47,500	200	74	Y	6	TYP(TANS 6P SUN-6A MON); SOME(TANSAT)	0.99	1.48	Dedicated Lane	NO WIDENING: station on frontage road median+loss of one thru lane each way (reduce from 6 to 4)+loss of street parking on both sides
Crenshaw/39th to Crenshaw/MLK		48,200	174	80	Y	6	TYP (TANSAT)	1.00	1.51	Dedicated Lane	NO WIDENING: station on frontage road median+loss of one thru lane each way (reduce from 6 to 4)
Crenshaw/MLK to Crenshaw/Vernon		48,200	117-100	78-70	Y	6	TYP(TANS 6P SUN-6A MON),(TANS 7-9A, 4-6P,X-S/S),(PMZ 2HR. PKG 9A-4P,X-SUN); SOME(TANSAT)	1.00	1.51	Mixed Flow	No surface street impact
Crenshaw/Vernun to Crenshaw/Slauson	Major	35,800	100-70	70-84	Y	6	TYP (PMZ 2HR PKG. 8A-6P X-SUN, TANS 9P SUN-6A MON); SOME (TANS SAT & SUN)	0.75	1.12	Dedicated Lane	NO WIDENING: loss of street parking on both sides+loss of one thru lane each way(reduce from 6 to 4)
Crenshaw/Slauson to Crenshaw/BNSF ROW (67th)	Major	32,000	180-100	130-80	Y	6	TYP (2HR PKG. 5AM-6PM,X-SUN, TANO 6PM SUN TO 6AM MON), TYP (TANS 6P SUN -6A MON, TANS 4-6PM,X S/S, 1HR PKG 8A-4P, X-SUN)	0.67	1.00	Dedicated Lane	NO WIDENING : station on frontage road median or sidewalk+ loss of street parking on both sides+loss of one thru lane each way(from 6 to4)

CRENSHAW/PRAIRIE CORRIDOR MIS
DESIGN ISSUES AND CONSTRAINTS ANALYSIS
BRT BUILD ALTERNATIVES

Alignment Segment	Class	ADT	ROW	Curb to Curb	L/T(Y/N)	Lane	Typical Exist. Parking Restrictions	Current V/C	Lane Drop V/C	BRT Curb Lane	
										Prop. Operations	Design Issues and Impacts
BRT LAX Branch											
Crenshaw/BNSF ROW to BNSF ROW/La Brea			50' (some 100')							Exclusive ROW	LACMTA property; install new signals at grade crossings
BNSF/La Brea to BNSF/Eucalyptus			50'							Exclusive ROW	LACMTA property; install new signals at grade crossings
BNSF/Eucalyptus to BNSF/San Diego Fwy (I-405)			var. 35' to 54'							Exclusive ROW	LACMTA property; install new signals at grade crossings
BNSF/San Diego FWY (I-405) to BNSF/Arbor Vitae			var. 54' to 24.5'							Exclusive ROW	LACMTA property; install new signals at grade crossings
BNSF/Arbor Vitae to BNSF/Century			var. 60' to 56'							Exclusive ROW	LACMTA property; install new signals at grade crossings
BNSF/Century to Metro Green Line Aviation Station			56'							Exclusive ROW	LACMTA property; install new signals at grade crossings
BRT Hawthorne Branch											
Crenshaw/BNSF ROW to BNSF ROW/La Brea (via BNSF ROW)		None	50' (some 100')	None	None	None				Exclusive ROW	LACMTA property; install new signals at grade crossings
BNSF ROW/La Brea to La Brea/Market (via La Brea)			95' to 100'	75' to 80'	Y	4				Mixed Flow	No surface street impact
La Brea/Market to La Brea/Arbor Vitae			112' to 120'	92'	Y	6				Dedicated Lane	NO WIDENING : station on sidewalk+ loss of street parking on both sides+ loss of one thru lane each way(from 6 to 4)
La Brea/Arbor Vitae to La Brea/Century			120'	105'	Y	6				Dedicated Lane	NO WIDENING : station on sidewalk+ loss of street parking on both sides+ loss of one thru lane each way(from 6 to 4)
La Brea/Century to La Brea/104th			130'	110'	Y	6				Didicated Lane	NO WIDENING : station on sidewalk+ loss of street parking on both sides+ loss of one thru lane each way(from 6 to 4)
La Brea/104th to Hawthorne/Imperial										Dedicated Lane	
Hawthorne/Imperial to Hawthorne/El Segundo										Dedicated Lane	

Notes:

1. **Table originally created for Censhaw/Prairie MIS 1999. Table modified accordingly with latest information obtained from LADOT traffic counts and geometric plans.**
2. **No existing street conditions available for BRT Hawthorne Branch.**
3. **Land acquisition may be needed along LAX Branch for widening of ROW (depending on design criteria)**
4. **10' minimum width for BRT stations**
5. **11' minimum BRT lane unless noted otherwise**
6. **Minimum of 4 thru lanes (2 each way) for general traffic**
7. **L/T = Left Turn**

CRENSHAW/PRAIRIE CORRIDOR MIS
DESIGN ISSUES AND CONSTRAINTS ANALYSIS
LRT BUILD ALTERNATIVES

Alignment Segment	Class	ADT	ROW	Curb to Curb	L/T(Y/N)	Lane	Typical Exist. Parking Restrictions	Current V/C	Lane Drop V/C	LRT Maximize At-Grade	
										Prop. Operations	Design Issues and Impacts
LRT Crenshaw Branch											
Crenshaw/Exposition to Crenshaw/Coliseum	Major	47,500	100-200	70-74	Y	6	TYP(TANS 7-9AM,4-7PM X-S/S), (1 HR. PKG. 9AM-4PM, X-SUN); SOME (TANSAT),(1 HR. PKG. 9AM-4PM, X-SUN)	0.99	1.48	Street median. At grade	Loss of street parking(56)+loss of one thru lane each way(reduce from 6 to 4)+ loss of median and/or center L/T lane *WIDENING at station depending on station design
Crenshaw/Coliseum to Crenshaw/39th		47,500	200	74	Y	6	TYP(TANS 6P SUN-6A MON); SOME(TANSAT)	0.99	1.48	Street median. At grade	Frontage road reduced by 20'+loss of parking on frontage road (54)+loss of center L/T lane, no loss of thru lane (6) *WIDENING at station depending on station design
Crenshaw/39th to Crenshaw/MLK		48,200	174	80	Y	6	TYP (TANSAT)	1.00	1.51	Street median. At grade	Loss of median and eastern frontage road+loss of parking along frontage road(32)+loss of center L/T lane, no loss of thru lane (6) *WIDENING at station depending on station design
Crenshaw/MLK to Crenshaw/Vernon		48,200	117-100	78-70	Y	6	TYP(TANS 6P SUN-6A MON),(TANS 7-9A, 4-6P,X-S/S),(PMZ 2HR. PKG 9A-4P,X-SUN); SOME(TANSAT)	1.00	1.51	Mixed Flow	No surface street impact
Crenshaw/Vernun to Crenshaw/Slauson	Major	35,800	100-180	70-84	Y	6	TYP (PMZ 2HR PKG. 8A-6P X-SUN, TANS 9P SUN-6A MON); SOME (TANS SAT & SUN)	0.75	1.12	Street median. At grade	Loss of street parking (232) +loss of Median and/or center L/T lane+ loss of one thru lane each way(reduce from 6 to 4) *WIDENING at station depending on station design
Crenshaw/Slauson to Crenshaw/BNSF ROW (67th)	Major	32,000	180-100	130-80	Y	6	TYP (2HR PKG. 5AM-6PM,X-SUN, TANO 6PM SUN TO 6AM MON), TYP (TANS 6P SUN -6A MON, TANS 4-6PM,X S/S, 1HR PKG 8A-4P, X-SUN)	0.67	1.00	Street median. At grade	Loss of street parking(160)+loss of Median and/or center L/T lane+loss of one thru lane each way(from 6 to 4) *WIDENING at station depending on station design

CRENSHAW/PRAIRIE CORRIDOR MIS
DESIGN ISSUES AND CONSTRAINTS ANALYSIS
LRT BUILD ALTERNATIVES

Alignment Segment	Class	ADT	ROW	Curb to Curb	L/T(Y/N)	Lane	Typical Exist. Parking Restrictions	Current V/C	Lane Drop V/C	LRT Maximize At-Grade	
										Prop. Operations	Design Issues and Impacts
LRT LAX/Metro Green Line Branch											
Crenshaw/BNSF ROW to BNSF ROW/La Brea			50' (some 100')							Exclusive, At grade	LACMTA property; upgrade/install new signals at grade crossings; consider grade seperation at Centinela
BNSF/La Brea to BNSF/Eucalyptus			50'							Exclusive, At grade	LACMTA property; upgrade/install new signals at grade crossings; consider grade seperation at La Brea
BNSF/Eucalyptus to BNSF/San Diego Fwy (I-405)			var. 35' to 54'							Exclusive, At grade	LACMTA property; upgrade/install new signals at grade crossings
BNSF/San Diego FWY (I-405) to BNSF/Arbor Vitae			var. 54' to 24.5'							Exclusive, At grade	LACMTA property; upgrade/install new signals at grade crossings; consider grade seperation at La Cienega (parallel to FWY I-405)
BNSF/Arbor Vitae to BNSF/Century			var. 60' to 56'							Exclusive, Aerial	LACMTA property; upgrade/install new signals at grade crossings; use existing aerial structure over Century
BNSF/Century to Metro Green Line Aviation Station			56'							Exclusive, Aerial & Trench	LACMTA property; upgrade/install new signals at grade crossings; construct open trench from 104th St. to 111th St.; construct aerial structure to interface with Metro Green Line Aviation Station
LRT Prairie/Hawthorne Branch											
Crenshaw/BNSF to BNSF/Prairie (via BNSF ROW)			50'(some 100')							Exclusive, At grade	LACMTA property; upgrade/install new signals at grade crossings
BNSF/Prairie to Prairie/Manchester			66-94	48-75						Mixed Flow/ or Subway	No surface street impact
Prairie/Manchester to Prairie/Century		34,900	90	76		6		0.73	1.09	Street median, At grade	Loss of street parking+loss of Median and/or center L/T lane+ loss of one thru lane each way(reduce from 6 to 4) *WIDENING at station depending on station design
Prairie/Century to Prairie/112th		34,900	100	76		6		0.73	1.09	Street median, At grade	Loss of street parking+loss of Median and/or center L/T lane+ loss of one thru lane each way(reduce from 6 to 4) *WIDENING at station depending on station design
Prairie/112th to Metro Green Line Hawthorne Station			100	76						Aerial	Coordination with Cal Trans for aerial structure over I-105
Metro Green Line Hawthorne Station to Hawthorne/118th	Major		178	154		8				Aerial	Median is reduced to 14ft-No widening needed midblock. At intersections median must be 8ft or less to avoid widening.
Hawthorn/118th to Hawthorne/El Segundo	Major		94-100	75-84		8				Street median, At grade	Loss of street parking+loss of Median and/or center L/T lane+ loss of one thru lane each way(reduce from 6 to 4) *WIDENING at station depending on station design

Notes:

1. **Table originally created for Censhaw/Prairie MIS 1999. Table modified accordingly with latest information obtained from LADOT traffic counts and geometric plans.**
2. **No existing street conditions available for LRT Prairie/Hawthorne Branch**
3. **Land acquisition may be needed along LAX Branch for widening of ROW (depending on design criteria)**
4. **L/T = Left Turn**

APPENDIX

(photos of existing at-grade crossings)

CRENSHAW BLVD/BNSF FACING NORTH

VICTORIA FACING NORTH

BRYHURST NORTH

BRYHURST SOUTH

WEST FACING NORTH

WEST SOUTH

REDONDO-FLORENCE

CENTINELLA SOUTH

LA BREA SOUTH

IVY-FIR

EUCALYPTUS NORTH

EUCALYPTUS SOUTH

CEDAR

OAK SOUTH

HYDE PARK SOUTH

LA CIENAGA NORTH

HINDRY SOUTH

MANCHESTER EAST

ARBOR VITAE

104th STREET/AVIATION BLVD. FACING EAST

111th STREET/AVIATION BLVD. FACING EAST