TRANSIT OPERATIONS AND TRAFFIC ENGINEERING ANALYSIS FOR THE GRAND-MACARTHUR BRT PROJECT IN OAKLAND

FINAL REPORT

TRANSIT OPERATIONS ANALYSIS

Prepared for

Alameda County Congestion Management Agency

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1. INTRODUCTION

This report documents the existing conditions observed on AC Transit's Transbay Route NL. This bus route stretches from the San Francisco Transbay Terminal to the Eastmont Town Center located at 73rd Avenue and Bancroft Avenue in Oakland. Recommendations to improve the overall performance of Route NL are presented in this report.

1.1 Background

Route NL started operations in 2003, as part of a restructuring and route consolidation effort by AC Transit. With the availability of Regional Measure 2 (RM2) money, a multi-agency task force (including ACCMA, City of Oakland, AC Transit, CalTrans, and DKS Associates) was formed to investigate measures for boosting the route's utilization and performance. This project includes three major tasks – Transit Analysis, Traffic Operations Analysis, and System Engineering Analysis. This report is a product of the Transit Analysis task.

1.2 Outline

Following the introductory chapter, this report consists of several key chapters:

- The second chapter describes **general characteristics** of the route, such as its layout, service headway, bus type and capacity, bus stop information, transfer routes, and roadway layout.
- The third chapter contains **rider characteristics** from a recent on-board survey.
- The fourth chapter summarizes findings from data analysis on **bus operations**, including ridership, load profile, and run time.
- The fifth chapter presents analysis and findings from a September 2005 **ride check** to study stop and segment-specific travel delay, speed, and reliability.
- The sixth chapter present **findings and recommendations** based on the analysis in this report

1.3 General Project Goals

A set of general project goals was established for the project in October, 2005. These general goals and how this report relates to them are as follows:

- **To improve transit operations.** Improvements in transit operations first are primarily intended to provide improvements in speed and reliability. In addition, this study is intended to ways to increase ridership so that productivity gains could be achieved. Finally, this study looks at improvements from the perspective of the riders, so that the experience includes discussion of the rider experiences at the stops and on the bus.

- **To improve access to the Bay Bridge.** The westbound access to the Bay Bridge is problematic at certain times of the day if the metering lights are on and traffic is backed onto Grand Avenue. This study discusses conceptual ways to examine this particular situation, but recognizes that more detailed design studies will be required to resolve this challenge.

- **To implement signal design improvements.** Because the bus route operates in mixed flow traffic, the overall goal to implement improved signal operations would benefit buses and cars. This study examines the impact of traffic delays to buses, and recommends area where signal designs can reduce delays.

2. GENERAL CHARACTERISTICS

This chapter summarizes the overall supply components of the MacArthur corridor, focusing on Route NL. This chapter contains a detailed description of the NL's structure, bus stop locations, service frequency, revenue hours and miles, and parallel and crossing routes. For other routes, more abbreviated characteristics are provided.

2.1 Map and Route Structure

The Route NL runs between the San Francisco Transbay Terminal and Eastmont Town Center in Oakland. It generally operates along the following sections of roadway:

- Interstate 80 on the Bay Bridge between the Transbay Terminal and the Interstate 880/West Grand Avenue ramps
- West Grand Avenue between the Interstate 880/West Grand Avenue ramps and San Pablo Avenue
- San Pablo Avenue between West Grand Avenue and 20th Street
- 20th Street between San Pablo Avenue and Harrison Street
- Harrison Street between 20th Street and Grand Avenue
- Grand Avenue between Harrison Street and MacArthur Boulevard
- MacArthur Boulevard between Grand Ave and 68th Avenue
- Foothill Boulevard between 68th Avenue and Eastmont Town Center at 73rd Avenue and Bancroft Avenue

The one-way route length is 16 miles in the eastbound direction, and 16.9 miles in the westbound direction. The westbound route runs on different streets than eastbound route for two segments:

- Chatham Road from 14th Avenue to Park Avenue
- Lake Park Avenue from Athol Avenue to Grand Avenue

There are 19 bus stops in each direction. Route map is shown in Figure 2.1, bus stop locations and distances are listed in Table 2.1.

Figure 2.1 – NL Route Map

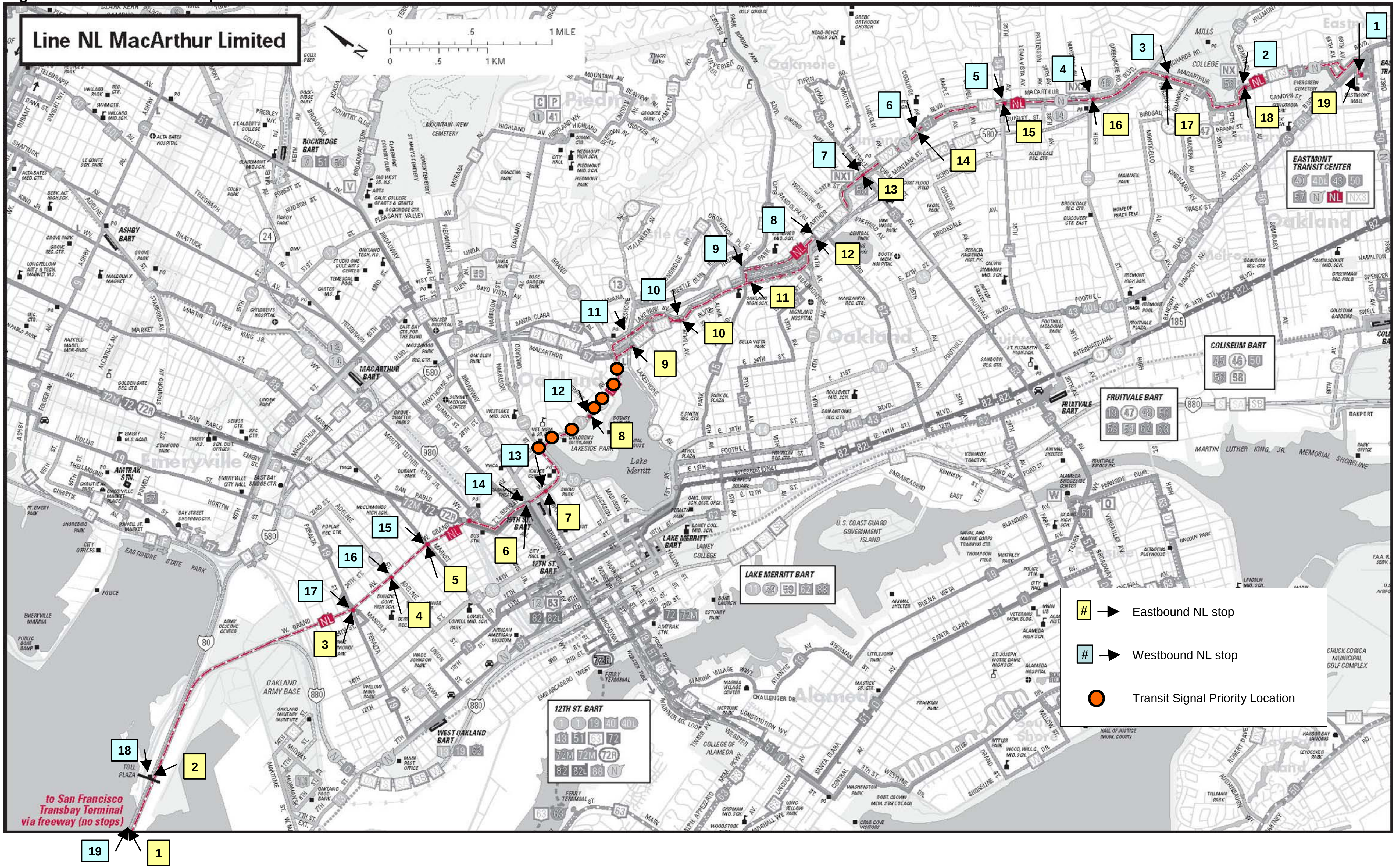


Table 2.1 – Route NL Bus Stop Locations and Distances

Stop No	Location	Distance (mile)	Other Weekday Routes at Stop
Eastbound			
1	San Francisco Terminal	0	Multiple Routes -- AC; Muni; Samtrans; Golden Gate Transit
2	Toll Plaza	6.16	
3	W Grand Av & Mandela Pkwy	1.58	AC --19
4	W Grand Av & Adeline St	0.35	AC --14
5	W Grand Av & Market St	0.30	AC -- 88
6	20th St & Broadway	0.72	AC – 11; 12; 15; 40; 40L; 43; 51; 59; 72; 72R; 59; BART
7	20th St & Webster St	0.16	AC – 11; 59
8	Grand Av & Perkins St	0.66	AC – 12
9	Macarthur Blvd & Lake Shore Ave	0.53	AC – 12; 13; 57; NX; NX1
10	Macarthur Blvd & Athol Ave	0.39	AC – 57; NX; NX1
11	Macarthur Blvd & Park Blvd	0.46	AC – 15; 57; NX; NX1
12	Macarthur Blvd & Randolph Ave	0.61	AC – 11; 57; 62; NX; NX1
13	Macarthur Blvd & Fruitvale Ave	0.53	AC – 11; 53; 57; NX; NX1; NX2
14	Macarthur Blvd & Coolidge Ave	0.42	AC – 57; NX; NX2
15	Macarthur Blvd & 35th Ave	0.58	AC – 14; 54; 57; NX; NX2
16	Macarthur Blvd & High St	0.58	AC – 48; 57; NX; NX2; NX3
17	Macarthur Blvd & Pierson St	0.52	AC – 57; NX; NX3
18	Seminary Av & Camden St	0.61	AC – 56; 57; NX; NX3
19	Eastmont Mall Transit Center	0.86	AC – 40; 40L; 43; 50; 57; NX; NX3
	Total Distance	**16.01**	
Westbound			
1	Eastmont Mall Transit Center	0	AC – 40; 40L; 43; 50; 57; NX; NX3
2	Macarthur Blvd & Seminary Ave	0.84	AC – 56; 57; NX; NX3
3	Macarthur Blvd & Pierson St	0.75	AC – 57; NX; NX3
4	Macarthur Blvd & High St	0.48	AC – 48; 57; NX; NX2; NX3
5	Macarthur Blvd & 35th Av	0.54	AC – 14; 54; 57; NX; NX2
6	Macarthur Blvd & Coolidge Ave	0.57	AC – 57; NX; NX2
7	Macarthur Blvd & Fruitvale	0.46	AC – 11; 53; 57; NX; NX1; NX2
8	Macarthur Blvd & Randolph Ave	0.50	AC – 11; 57; 62; NX; NX1
9	Chatham Rd & Park Blvd	0.51	AC – 15; 57; NX; NX1
10	Macarthur Blvd & Athol Av	0.55	AC – 57; NX; NX1
11	Lake Park Ave & Lakeshore Ave	0.41	AC – 12; 13; 57; NX; NX1
12	Grand Av & Perkins St	0.57	AC – 12
13	20th St & Webster St	0.69	AC – 11; 59
14	20th St & Broadway	0.17	AC – 11; 12; 15; 40; 40L; 43; 51; 59; 72; 72R; 59; BART
15	W Grand Av & Market St	0.71	AC -- 88
16	W Grand Av & Adeline St	0.31	AC --14
17	W Grand Av & Mandela Pkwy	0.38	AC --19
18	Toll Plaza	1.53	
19	San Francisco Terminal	6.93	Multiple Routes -- AC; Muni; Samtrans; Golden Gate Transit
	Total Distance	**16.89**	

Source: AC Transit Operations Planning

2.2 Service Headway

The line runs on 15-minute headway during weekdays and on 30-minute headway in early morning and late evening. Detailed headway information is summarized in Table 2.2.

Table 2.2 – Route NL Headway (Weekday)

	Westbound		*Eastbound*	
Time Period	**# of Buses Leaving**	**Max Scheduled Headway**	**# of Buses Leaving**	**Max Scheduled Headway**
	first bus	*5:00 AM*		
5 AM-6 AM	3	30	*first bus*	*6:00AM*
6 AM-7 AM	4	15	2	45
7 AM-8 AM	4	15	2	30
8 AM-9 AM	4	15	4	15
9 AM-10 AM	4	15	4	15
10 AM-11 AM	4	15	4	15
11 AM-12 PM	4	15	4	15
12 PM-1 PM	4	15	4	15
1 PM-2 PM	4	15	4	15
2 PM-3 PM	4	15	4	15
3 PM-4 PM	4	15	4	15
4 PM-5 PM	4	15	4	15
5 PM-6 PM	4	15	4	15
6 PM-7 PM	4	15	4	15
7 PM-8 PM	4	15	4	15
8 PM-9 PM	2	30	4	15
9 PM-10 PM	2	30	2	30
10 PM-11 PM	2	30	2	30
11 PM-12 AM	2	30	2	30
12 AM-1 AM	*last bus*	*11:30 PM*	1	n/a
			last bus	*12:30 AM*

Source: 511.org; November 2005

On weekends, the service operates on a reduced schedule. Eastbound service consists of 30-minute headways between 6:05 AM and 12:05 PM. Westbound service consists of 30-minute headways between 5:30 AM and 11:30 PM.

Owl service is provided on a related route, identified as N Route. Between 1:00 AM and 5:00 AM, this route operations with 1-hour headway, more frequent stops (38 vs. 19), and more destinations including West Oakland, Downtown Oakland, Coliseum, and the Oakland Airport.

2.3 Revenue Hours and Miles

During each weekday, Route NL makes 67 trips in the westbound directions, and 63 trips in the eastbound direction. With the current scheduled run time of 45 minutes, the route generates a total of 97.5 revenue-hours per weekday (calculation: (67 trips x 45 minutes + 63 minutes x 45 minutes)/60 minutes). For revenue miles, Route NL generates 2140 revenue-miles per weekday (calculation: 67 trips x 16.9 miles + 63 trips x 16miles).

2.4 Fleet Requirement and Dimensions

During peak service of 15-minutes headway, assuming a recovery time of 15-minutes at the terminals, the round-trip cycle time of the route was originally 120 minutes (calculation: 45 minute run time westbound +15 minutes layover + 45 run time eastbound + 15 minutes layover). Therefore, a fleet of eight buses (120 round trip /15 minute headway) should be required to provide revenue service for the route. In operating the route, the trip times have been shown to often take an additional 5 to 10 minutes, so that the round trip time has been readjusted to 135 minutes (the next fifteen minute increment) and the overall number of buses has been increased to 9.

AC currently uses Van Hool AG300 articulated buses to run on Route NL. Figure 2.2 shows the dimensions and interior layout of the bus. It has 45 seats. AC Policy 550 establishes two types of standards for the type of route that the Route NL is designed to be.

For arterial Bus Rapid Transit service, AC Transit Policy 550 directs that the loads can include up to 25 percent of standees or 11 standees (calculation: 45 seats x 25 percent = 11 standees) during peak hour at the maximum load point. This establishes the maximum bus capacity of the bus as 56 people (calculation: 45 seats + 11 standees).

For the Transbay or freeway portion of the service, Policy 550 directs that the loads include no standees during peak hour on the bridge. This establishes the maximum bus capacity of the bus as 45 people, or one per seat.

Figure 2.2 – Route NL Bus Dimensions and Interior Layout

Kleurprofiel: Niet beschikbaar
Samengesteld Standaardscherm

V:\ODB\OfferteTekeningen\offertes\OF3522B.cdr
woensdag 23 oktober 2002 15:59:33

Source: AC Transit, 2005

2.5 Parallel and Cross Routes

2.5.1 Parallel Routes

Along the Grand-MacArthur corridor, there are 5 routes that run parallel with Route NL. Routes NX, NX1, NX2, and NX3 provide Transbay services from different locations of MacArthur Boulevard to the San Francisco Transbay Terminal. Route 57 runs with Route NL on MacArthur Boulevard between Eastmont Mall and Lakeshore Avenue. Table 2.3 summarizes the transit service currently provided and ridership of Route NL and parallel routes.

Table 2.3 – Route NL and Parallel Routes

Route Name	Route Description	Service Time	Headway (minutes)	One-way Run Time (minutes)
Westbound				
NL MacArthur Limited	Eastmont->MacArthur->Grand->San Francisco	5 AM-11:30 PM	15-30	45
NX Grand Lake - Laurel	Seminary->Fruitvale->Lakeshore->San Francisco	6 AM-8:30 AM	15-20	33
NX3 Eastmont	Sheffield->Eastmont->Seminary->SF	6 AM-8:30 AM	20-30	40
57	Coliseum->Eastmont->Lakeshore->Emeryville	4:15 AM-12:15 AM	12-30	48-52
Eastbound				
NL MacArthur Limited	San Francisco->Grand->MacArthur->Eastmont	6 AM-12:30 AM	15-30	45
NX1 Grand Lake	San Francisco->Lakeshore->Fruitvale	4:15 PM-6:15 PM	20	26
NX2 Laurel	San Francisco->Fruitvale->High	4:05 PM-7:30 PM	20-30	27
NX3 Eastmont	San Francisco->Seminary->Eastmont->Sheffield	4 PM-7:30 PM	20-30	40
57	Emeryville->Lakeshore->Eastmont->Coliseum	5:15 AM-12:41 AM	12-30	49-56

Source: 511.org; November, 2005

2.5.2 Cross Routes

There are 17 AC Transit routes that cross Route NL in Oakland. The route information is listed in Table 2.4. In addition, Route NL crosses BART at the 19th Street Oakland BART Station's 20th Street entrances. At the Transbay Terminal, Route NL connects with an extensive number of transit routes provided by San Francisco Muni, Golden Gate Transit, and SamTrans; BART stations are also within walking distance of the Transbay Terminal.

In order to estimate the transfer volume from other bus lines to Route NL, the last three columns of Table 2.4 list the daily boarding and alighting volume for all the cross routes at location intersecting with the Route NL. As these data show, no major transfer patterns were found between Route NL and the cross routes.

Table 2.4 – Cross Routes

Route Name	Route	Service Time	Headway (minutes)	One-way Run Time (minutes)	Crossing Street	Direction	Boarding at NL stop	Alighting at NL stop	One-way on/off
19 Hollis	N. Berkeley -> Oakland -> Alameda -> Fruitvale	6 AM-9 PM	30	65	Mandela	eastbound	1	0	1000
						westbound	0	1	
14 East 18th St.	MacBART ->Oakland -> 38th	6 AM-7 PM	15-30	51	Adeline	eastbound	12	3	1300
						westbound	11	10	
					Mac/Loma Vista	eastbound	3	1	
						westbound	0	1	
88 Market	N. Berkeley -> Market -> 11th -> Oakland	5 AM-11 PM	15-30	33	Market/21st	eastbound	44	22	700
						westbound	15	19	
72/72M San Pablo	El Cerrito -> San Pablo -> Oakland -> Oak Amtrak	24 hrs	15-60	43-73	San Pablo	southbound	69	44	4200
						northbound	75	59	
72R San Pablo Rapid	San Pablo -> Oak Amtrak	6 AM-7 PM	12	53-63	San Pablo	southbound	72	76	3200
						northbound	95	79	
15 M L King Jr.	CAL -> Berkeley -> Ashby -> Oakland -> Oakmore	6 AM-9 PM	15	56-72	M L King	eastbound	30	35	2000
						westbound	27	16	
					Mac/Park	eastbound	20	56	
						westbound	139	22	
40/40L Telegraph	Berkeley BART -> Telegraph -> 12th -> Foothill -> Eastmont	24 hrs	15-60	46-60	Tele/W Grand	eastbound	42	10	3800
						westbound	27	29	
					EMM	eastbound	172	284	
						westbound	275	145	
59/59A Piedmont	Montclair -> Rockridge -> Piedmont -> Broadway	6 AM-7 PM	60	50	Broadway	eastbound	0	1	150
						westbound	8	6	
					20th/Web	eastbound	3	4	
						westbound	6	2	
51 Broadway	Berkeley -> College -> Broadway -> Oak -> Alameda	24 hrs	8-10,60	57-74	Broadway	eastbound	29	34	8400
						westbound	75	66	
11 Harrison	Piedmont -> Harrison -> Oakland -> Fruitvale	6 AM-7 PM	20-30	47	20th/Web	eastbound	13	21	800
						westbound	39	15	
12 Grand	MacBART -> 40th -> Linda -> Grand -> Oakland	6 AM-7 PM	20-30	41	Grand/Mac	eastbound	10	13	700
						westbound	43	16	
13 14th Street	West Oakland BART -> 14th -> Lakeshore	6 AM-10 PM	20-30	50	LakSh/LakPark	eastbound	7	58	800
						westbound	25	5	
62 San Antonio	West Oakland -> Oakland -> Mac/23rd -> Fruitvale	5:30 AM-12 AM	20-30	39	Mac/Randolph	eastbound	79	87	1800
						westbound	78	81	
53 Fruitvale	Oakmore -> Fruitvale -> Fruitvale BART	5 AM-12 PM	15-30	20	Mac/Fru	eastbound	45	3	1300
						westbound	506	2	
54 Merritt	Merritt College -> 35th -> Fruitvale BART	6 AM-10 PM	10-30	20	Mac/35th	eastbound	139	172	1200
						westbound	144	135	
48 High street	Mac/High -> High -> Fruitvale BART	5:30 AM-7 PM	30	26	Mac/High	circular	0	15	350
47 Maxwell Park	Mac/55 -> local -> International -> Fruitvale BART	6:30 AM-7 PM	30	18	Mac/55th	eastbound	29	0	240
						westbound	0	37	
56 Millsmont	Mills College -> Mountain Blvd -> Coliseum BART -> Mills College	5 AM-9 PM	15-30	40	Mac/Sem	counter-clockwise	20	40	700
						clockwise	17	39	

Note: The on/ off NL stops column does NOT represent current bus transfer to/from NL, but are listed to illustrate the potential transfer volume between NL and these cross routes.

2.6 Bus Stops

There are 19 bus stops in each direction for the Route NL. Table 2.5 documents details of each bus stop such as its location relative to the nearest intersection (nearside/farside), stop type (along curb/in an indented bay), length (linear feet along the curb), adjacent lane width, nearby widths of driveways or other openings that increase the bus stop distance, and notes on potential operational problems.

Table 2.5 – Bus Stop Inventory

Stop No	Location	Location	Type	Stop Length (feet)	Lane Width at Stop (feet)	Parking Allowed At Stop	Potential Berthing Problem
Eastbound							
1	San Francisco Terminal	covered	station			no	
2	Toll Plaza						
3	W Grand Av & Mandela Pkwy	nearside	bay	82	15	no	
4	W Grand Av & Adeline St	farside	curb	68	19	no	
5	W Grand Av & Market St	farside	curb	97	14	no	
6	20th St & Broadway	nearside	curb	60	16	yes	X
7	20th St & Webster St	farside	curb	72	19	no	
8	Grand Av & Perkins St	nearside	curb	48+18*	14	yes	X
9	Macarthur Blvd & Lake Shore	nearside	curb	no mark	12	no	
10	Macarthur Blvd & Athol Av	nearside	curb	64	26	no	
11	Macarthur Blvd & Park Blvd	nearside	curb	50+18*+52	19	no	
12	Macarthur Blvd & Randolph Av	nearside	curb	60	24	yes	
13	Macarthur Blvd & Fruitvale	nearside	curb	98	17	yes	
14	Macarthur Blvd & Coolidge Av	nearside	curb	50	12	no	
15	Macarthur Blvd & 35th Av	nearside	curb	40+29*	22	no	X
16	Macarthur Blvd & High St	farside	curb	20+40**+30	12	no	
17	Macarthur Blvd & Pierson St	farside	curb	60	14	no	
18	Seminary Av & Camden St	farside	curb	60	23	yes	
19	Foothill Blvd & Eastmont -		bay	74	22	no	
Westbound							
1	Foothill Blvd & Eastmont Tr		bay	76	n/a	no	
2	Macarthur Blvd & Seminary A	nearside	curb	66	19	no	
3	Macarthur Blvd & Pierson St	farside	curb	130	13	no	
4	Macarthur Blvd & High St	nearside	curb	35+28*+21	18	no	X
5	Macarthur Blvd & 35th Av	nearside	curb	52+12*+6	18	yes	X
6	Macarthur Blvd & Coolidge Av	nearside	curb	17+20*+31+23*	13	no	
7	Macarthur Blvd & Fruitvale	farside	curb	135	20	no	
8	Macarthur Blvd & Randolph A	nearside	curb	72	24	no	
9	Chatham Rd & Park Blvd	nearside	curb	76	19	no	
10	Macarthur Blvd & Athol Av	farside	curb	110	26	no	
11	Lake Park Ave & Lakeshore A	farside	curb	60	33	no	
12	Grand Av & Perkins St	nearside	curb	56+32*	14	no	
13	20th St & Webster St	nearside	curb	162	20	no	
14	20th St & Broadway	farside	curb	80	21	no	X
15	W Grand Av & Market St	nearside	curb	59	14	yes	
16	W Grand Av & Adeline St	nearside	curb	60	19	no	
17	W Grand Av & Mandela Pkwy	farside	bay	60	38	no	
18	Toll Plaza						
19	San Francisco Terminal -	covered	station			no	

*Length of adjacent driveways and other openings

Source: DKS Associates; October 2005

The Grand Avenue / Perkins Street eastbound stop, MacArthur Boulevard / High Street westbound stop, and the MacArthur Boulevard / 35th Street westbound stop in the table are listed as having potential berthing problems. It was observed during field visits that buses incurred delay when vehicle queue developed in front of the intersection occurred while cars were parked right behind the bus stop. These disturbances prevent the buses from berthing at the bus stop.

Broadway stops are listed as having a potential berthing problem because of the high bus volumes from multiple lines using these stops. Buses sometime have to double park because another bus already is dwelling at the stop. Double parking impacts passenger safety and convenience, while affecting other vehicles traffic flow.

Pictures of each bus stop are provided in Appendix A – Route NL Bus Stop Photos.

2.7 Roadway and Signal Configurations

2.7.1 General Description of Traffic Conditions along Route NL

Table 2.6 lists the number of traffic lanes along the route. Most portions of Route NL travel on roadways with two lanes in each direction, with the exceptions of portions of MacArthur Boulevard (one lane), the Bay Bridge (five lanes), and some highway on/off ramps (three lanes). The table also provides estimated one-way daily traffic volumes at selected locations. A detailed Traffic Analysis Report is in preparation that evaluates the performance of the route for vehicles. It should be noted that traffic volumes are relatively light on many segments, so that a significant percentage of travelers on these roads are in AC Transit buses.

Table 2.6 – Number of Traffic Lanes along Route NL

Road Segment	Number of Lanes (one direction)	Estimated One-Way Daily Traffic
Eastbound		
I-80 on the Bay Bridge	5	143,400
West Grand Ave between Maritime St and Campbell Ave	2	8,600
West Grand Ave between Campbell St and Market St	3	7,500
West Grand Ave between Market St and San Pablo Ave	2 + bike lane	7,500
San Pablo Ave between 20th St and West Grand Ave	2	5,200
20th St between San Pablo Ave and Harrison St	2	3,000
Harrison St between 20th St and Grand Ave	3	17,800
Grand Ave between Harrison St and MacArthur Blvd	2 + bike lane	13,000
MacArthur Blvd between Grand Ave and Lake Shore Ave	3	16,000
MacArthur Blvd between Lake Shore to Alma St	1 + bike lane	3,800
MacArthur Blvd between Alma Street to Park Ave	2	3,800
MacArthur Blvd between Park Ave and Fruitvale Ave	2	11,900
MacArthur Blvd between Fruitvale Ave and 35th Ave	1 + bike lane	9,100
MacArthur Blvd between 35th Ave and Seminary Ave	2	11,100
MacArthur Blvd between Seminary Ave and 68th Ave	1	4,000
Foothill Blvd between 68th Ave and Eastmont Mall	2	
Westbound		
Foothill Blvd between Eastmont Mall and 68th Ave	2	
MacArthur Blvd between 68th and Seminary Ave	1	5,100
MacArthur Blvd between Seminary Ave and 35th Ave	2	10,100
MacArthur Blvd between 35th Ave and Fruitvale Ave	1 + bike lane	8,700
MacArthur Blvd between Fruitvale Ave and 14th Ave	1	6,200
Chatham Ave between 14th Ave and Park Ave	2	10,500
MacArthur Blvd between Park Ave and Athol Ave	1 + bike lane	5,800
Lake Park between Athol Ave and Grand Ave	2	16,300
Grand Ave between MacArthur Blvd and Harrison St	2 + bike lane	11,100
Harrison St between Grand Ave and 20th St	3	12,600
20th St between Harrison St and San Pablo Ave	2	2,600
San Pablo Ave between 20th St and West Grand Ave	2	6,000
West Grand Ave between San Pablo Ave and Market St	2 + bike lane	9,700
West Grand Ave between Market St and Campbell St	3	9,700
West Grand Ave between Campbell St and Maritime St	2	12,300
I-80 on the Bay Bridge	5	139,900

Sources: Wiltec; November, 2005; Metropolitan Transportation Commission, 2003 (Interstate 80 only)

2.7.2 Signalized Intersections along Route NL

Signalized intersections along Route NL are listed in Table 2.7. Route NL buses must travel through 47 signals in the eastbound direction, and 48 signals in the westbound direction.

Table 2.7 – Signalized Intersections

Route Segment	Cross Street	Route Segment	Cross Street
Eastbound & Westbound			
W. Grand Av	Maritime St	MacArthur Blvd	Lakeshore Av (EB only)
	Frontage Rd		Park Blvd (EB only)
	Mandela Pkwy		13th Av (EB only)
	Poplar St		Beaumont Av (EB only)
	Adeline St		Ardley Av
	Market St		Sheffield Av
	San Pablo Av		E 38th St / Canon St
San Pablo Av	Castro St		Fruitvale Av
	20th St		Lincoln Av
20th St	Telegraph Av		Coolidge Av
	Broadway		Maple Av
	Franklin St		35th Av
	Webster St		Loma Vista Av
	Harrison St		Patterson Av
Harrison St	Lakeside Dr		38th Av
	21st St		39th Av
	Grand Av		High St
Grand Av	Bay Pl		Mills College Entrance
	Park View Ter		55th Av
	Perkins St		Camden/Seminary (EB only)
	Staten Av		Seminary Av
	Euclid Av		64th Av
	El Embarcadero	Foothill Blvd	Church St
	MacArthur Blvd		Eastmont Transit Center
Westbound only			
Chatham Rd	Beaumont Av	MacArthur Blvd	580 MacArthur off-ramp
	13th	Lake Park Av	Lakeshore Av
	Park Blvd		Grand Av

Source: DKS Associates; November, 2005

2.7.3 Stop and Yield Signs

There are a few places where Route NL buses must travel through stop signs or yield signs. These locations are listed in Table 2.8. Three stop locations - West Grand Avenue and San Pablo Avenue (eastbound), Glen Park Avenue and 14^{th} Avenue (eastbound), and MacArthur Boulevard and the Interstate 580 off-ramp (eastbound), plus both yield signs, are locations where buses make right-turns.

Table 2.8 – Stop and Yield Sign Locations

Stop Signs	Yield Signs
MacArthur & 68th Av (EB & WB – 4-way)	West Grand and San Pablo (EB only)
MacArthur & 580 MacArthur off-ramp (EB only)	Grand and MacArthur (EB only)
MacArthur & 14th Av (EB only – 4-way)	
Glen Park & 14th Av (EB only)	

Source: DKS Associates; November, 2005

3. RIDER CHARACTERISTICS

3.1 Methodology and Data Source

AC transit commissioned Quantum Market Research Inc. to conduct a survey on Route NL riders. On June 28 and 29, 2005, 390 riders aged 13 or above were surveyed. Demographic data such as age, gender, income, ethnicity, trip purpose, trip origin-destination was collected.

3.2 Findings

Basic characteristics of the Route NL riders are summarized below; the original report is attached in Appendix B.

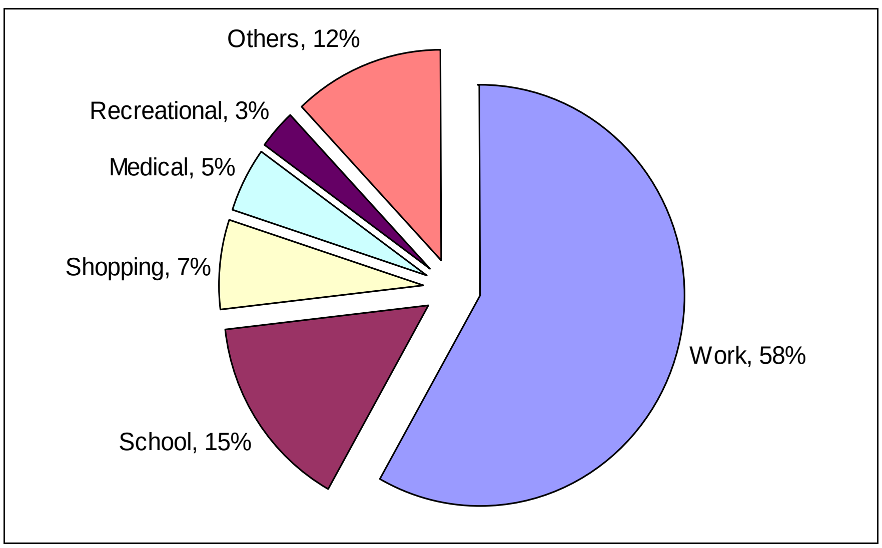
3.2.1 Trip Destination

The surveys found that 67 percent of the riders were going to East Bay destinations, while 33 percent were going across the Bay Bridge. This is consistent with the findings presented in Chapter 4 on bus loads for different roadway segments. It should be noted that the Bay Bridge segment represents only 30 percent of the entire route travel time, so that the route productivity of 33 percent is a reasonable expectation.

3.2.2 Trip Purpose and Trip Frequency

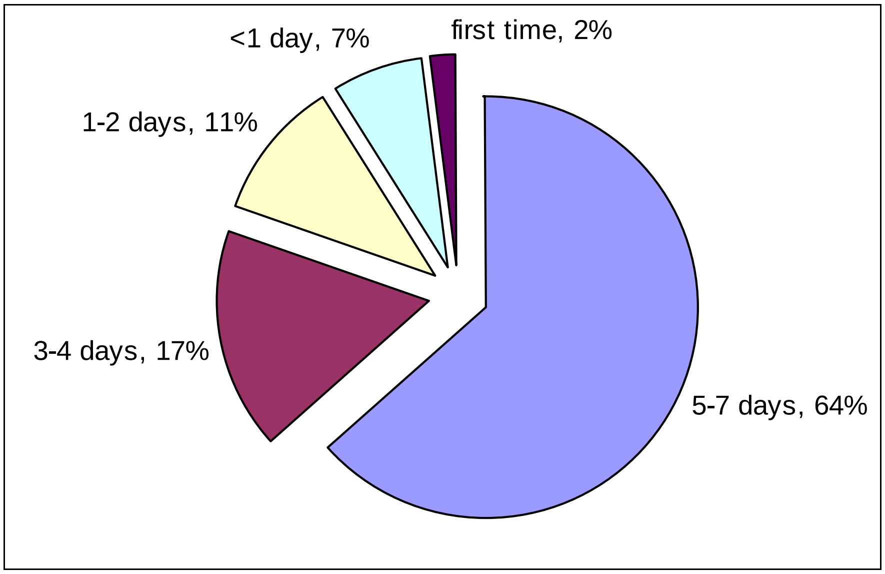
More than half of the riders surveyed were traveling for work trips, while school trips comprised another 15 percent. Similarly, 81 percent of the riders were riding the Route NL at least three days a week. Work trips dominate Route NL which distinguishes Route NL from other AC Transit routes. However, given the relatively low school enrollment and low retail activity along the Route NL path, this is expected.

Figure 3.1 – Trip Purpose



Source: Quantum Market Research, 2005

Figure 3.2 – Trip Frequency



Source: Quantum Market Research, 2005

3.2.3 Average Household Size

The average household had 2.8 persons, which is slightly above the City of Oakland average household size (2.6 from the 2000 Census).

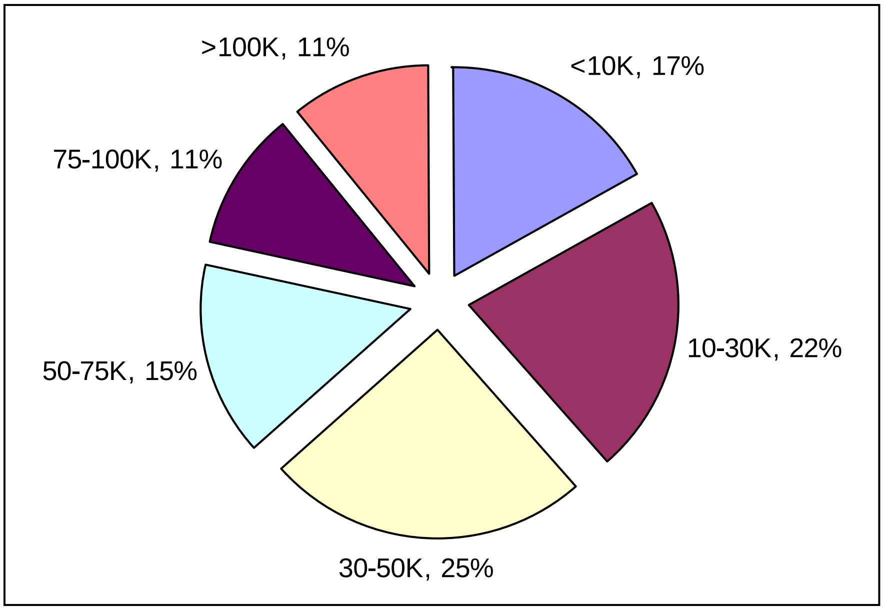
3.2.4 City of Residence

Over 90 percent of the riders surveyed reside in the City of Oakland, while less than five percent reside in San Francisco. This indicates that many in the City of San Francisco may not be aware of the existence of the Route NL, or that it does not travel to destinations that San Francisco residents may wish to travel. Instead, this route currently attracts usage similar to other peak period Transbay services, as opposed to a day-long two directional high frequency route.

3.2.5 Household Income, Car Ownership

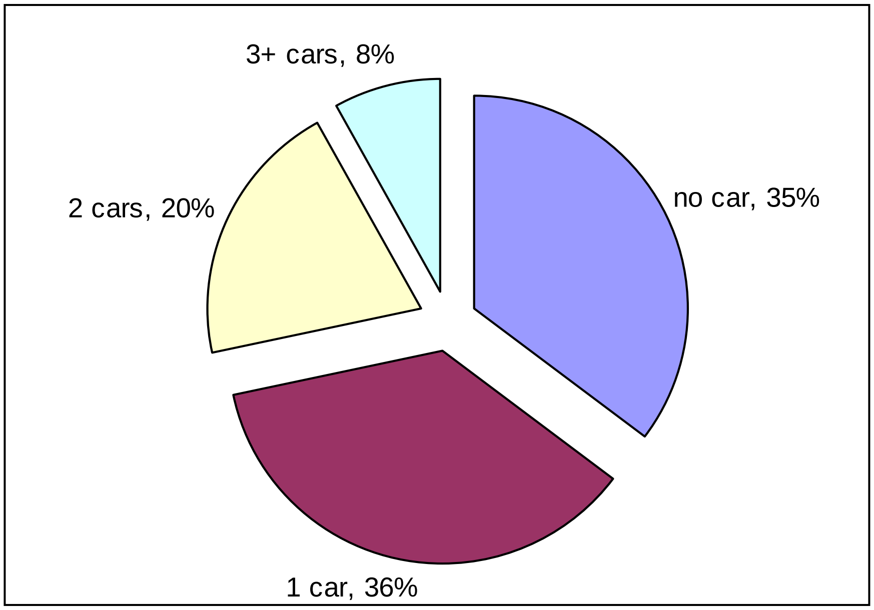
The household income mix of riders showed that persons of all categories could be found on the Route NL. As shown in Figure 3.5, thirty-seven percent of the riders with an annual income of $50,000 or more. Similarly, Figure 3.6 shows that 64 percent of riders have at least one vehicle available with their household. This demonstrates that Route NL users represent a diverse group economically, and that it does attract riders who may not be entirely transit dependent.

Figure 3.3 – Household Income



Source: Quantum Market Research, 2005

Figure 3.4 – Car Ownership



Source: Quantum Market Research, 2005

3.2.6 Internet Usage

The survey showed that 78 percent of the riders had access to the Internet. Thus, Route NL information on the internet would be accessible to most riders.

4. OPERATIONS SUMMARY (BUS OPERATIONS)

This chapter summarizes current Route NL operations, including ridership patterns, route load profile, run time, dwell time, speed, and schedule reliability.

4.1 Data Sources

All data was obtained from AC Transit during spring 2005 operations.

Ridership data and trip run times came directly from AC Transit. Bus load profile, segment run times, dwell time, speed, and schedule reliability were derived from 40 days of AC Transit Automatic Passenger Count (APC) data, recorded from April to June of 2005.

4.2 Ridership

4.2.1 Daily Ridership

In spring 2005, average weekday daily ridership on Route NL was reported to be around 2600. Fifty-five percent of the riders traveled in an eastbound direction while 45 percent traveled westbound. The lower westbound totals are most likely attributable to the occurrence of casual carpooling westbound into San Francisco in the morning.

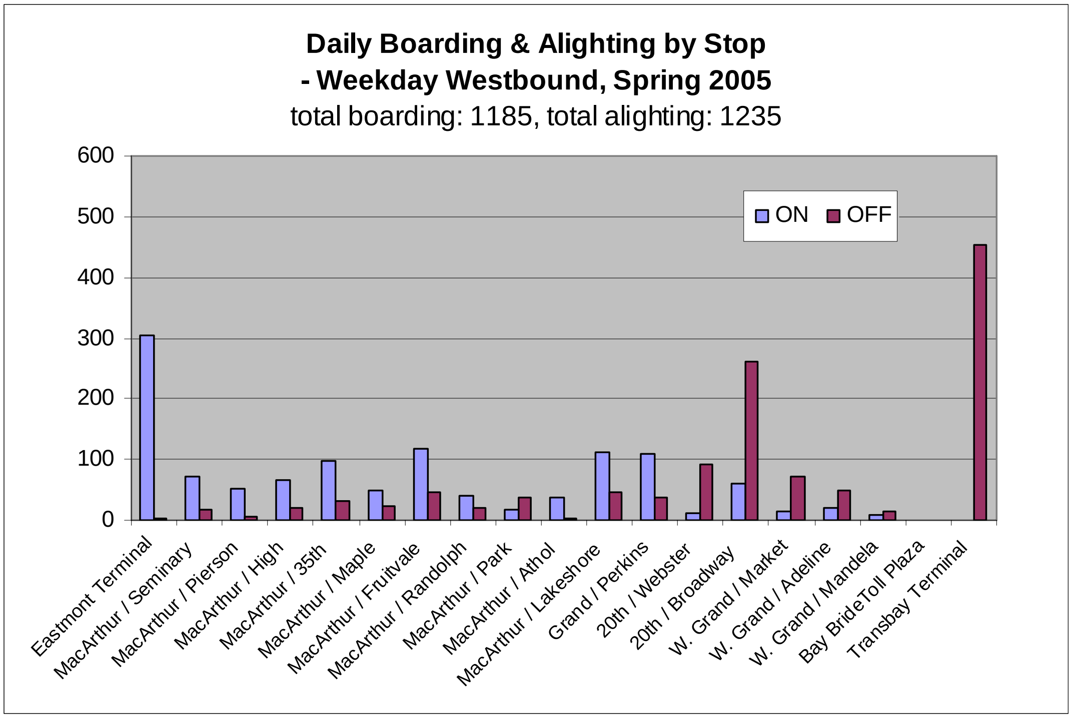
4.2.2 Stop Activity

Figure 4.1a shows the distribution of weekday boardings and alightings westbound along the route. Major westbound boarding and alighting locations include Eastmont (308 riders mostly boarding), Broadway at 20th Street (320 riders, of which 80 percent are alighting) and the Transbay Terminal in San Francisco (455 riders alighting). Locations where at least 100 passengers board or alight are: 35th Avenue (128 riders), Fruitvale Avenue (164 riders), Lakeshore Avenue (157 riders), Perkins Street (145 riders), and Webster Street (103 riders). Few persons use the Toll Plaza stop.

Figure 4.1b shows the distributions of weekday boarding and alighting eastbound along the route. Major eastbound boarding and alighting locations are located at the Transbay Terminal (574 boardings), Broadway (278 riders, of which 80 percent are boarding), and Eastmont (431 alighting). Locations with at least 100 passengers boarding or alighting are: Perkins Street (156 riders), Lakeshore Avenue (206 riders), Fruitvale Avenue (200 riders), Coolidge Avenue (170 riders), 35th Avenue (174 riders), High Street (131 riders), and Seminary Avenue (110 riders).

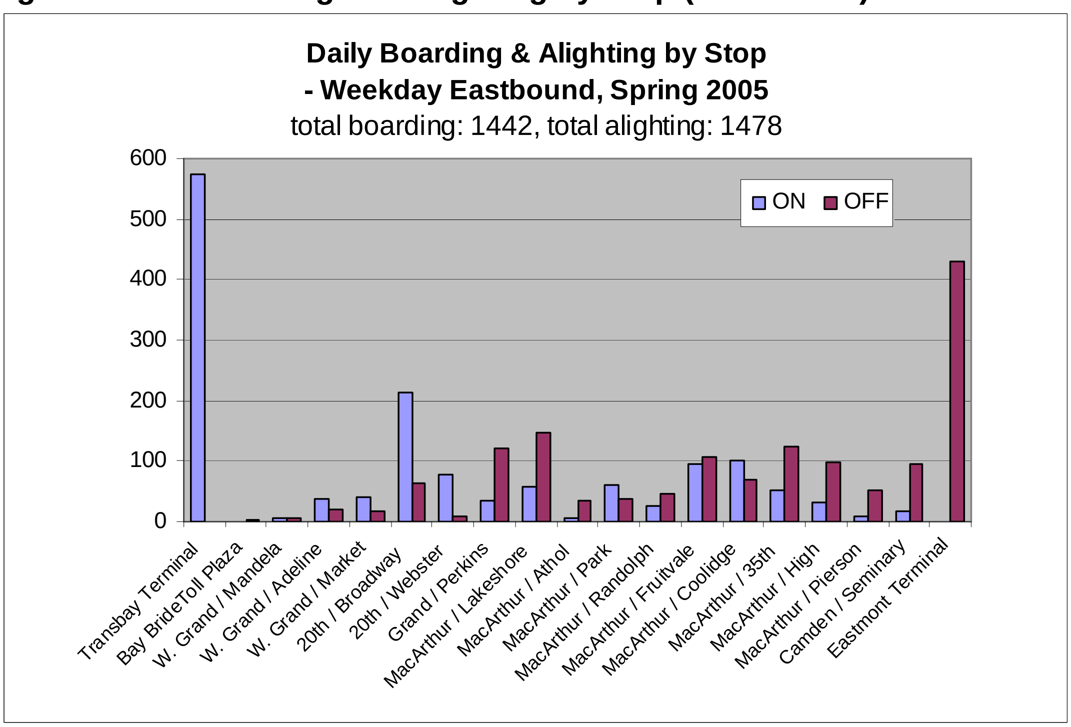
The overall ridership pattern of eastbound is fairly symmetrical to that of westbound, indicating most passengers were taking round trips on Route NL.

Figure 4.1a – Boarding and Alighting by Stop (Westbound)



Source: AC Transit, Spring 2005

Figure 4.1b – Boarding and Alighting by Stop (Eastbound)

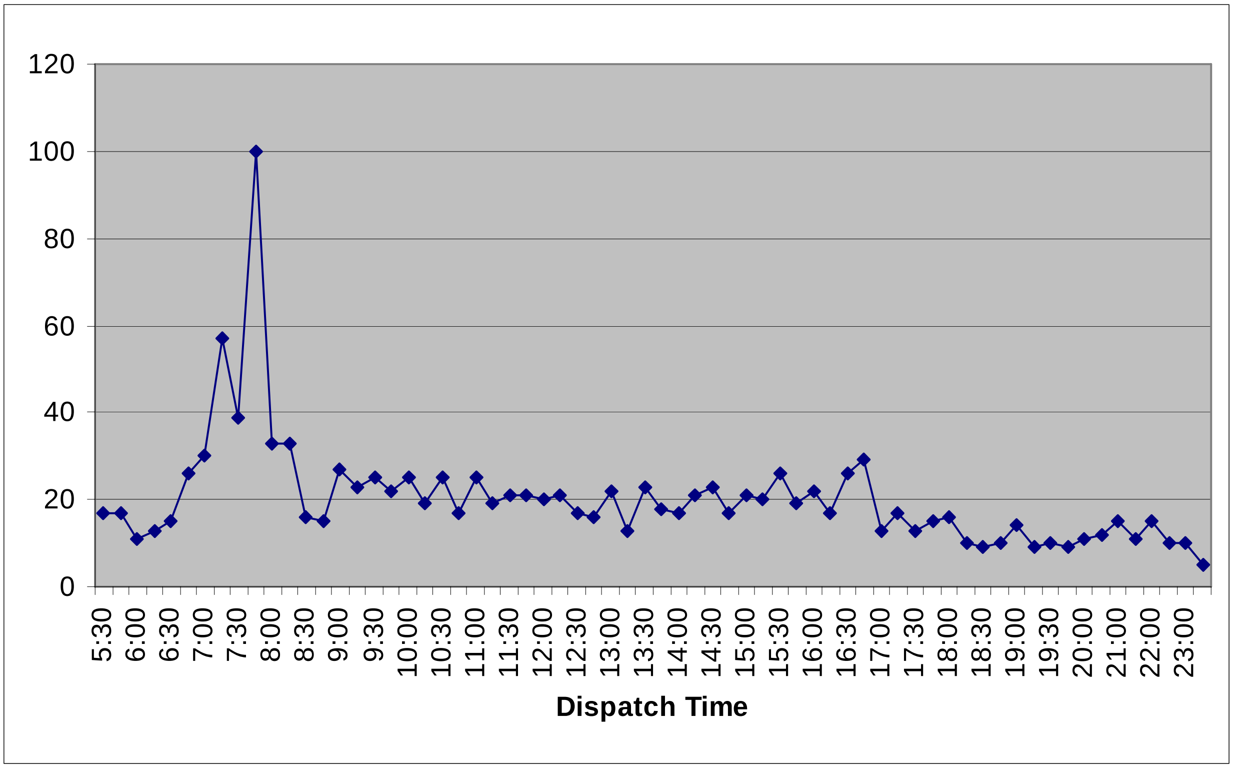


Source: AC Transit, Spring 2005

4.2.3 Time of Day Analysis

Total trip boarding by time of dispatch are provided in Figure 4.2a and 4.2b. In the westbound direction, a sharp AM peak is observed between 7:15-7:45 AM. Boardings remain constant at around 20 passengers per trip from 9 AM to 5 PM, and then drop to the 15-18 range in the evening.

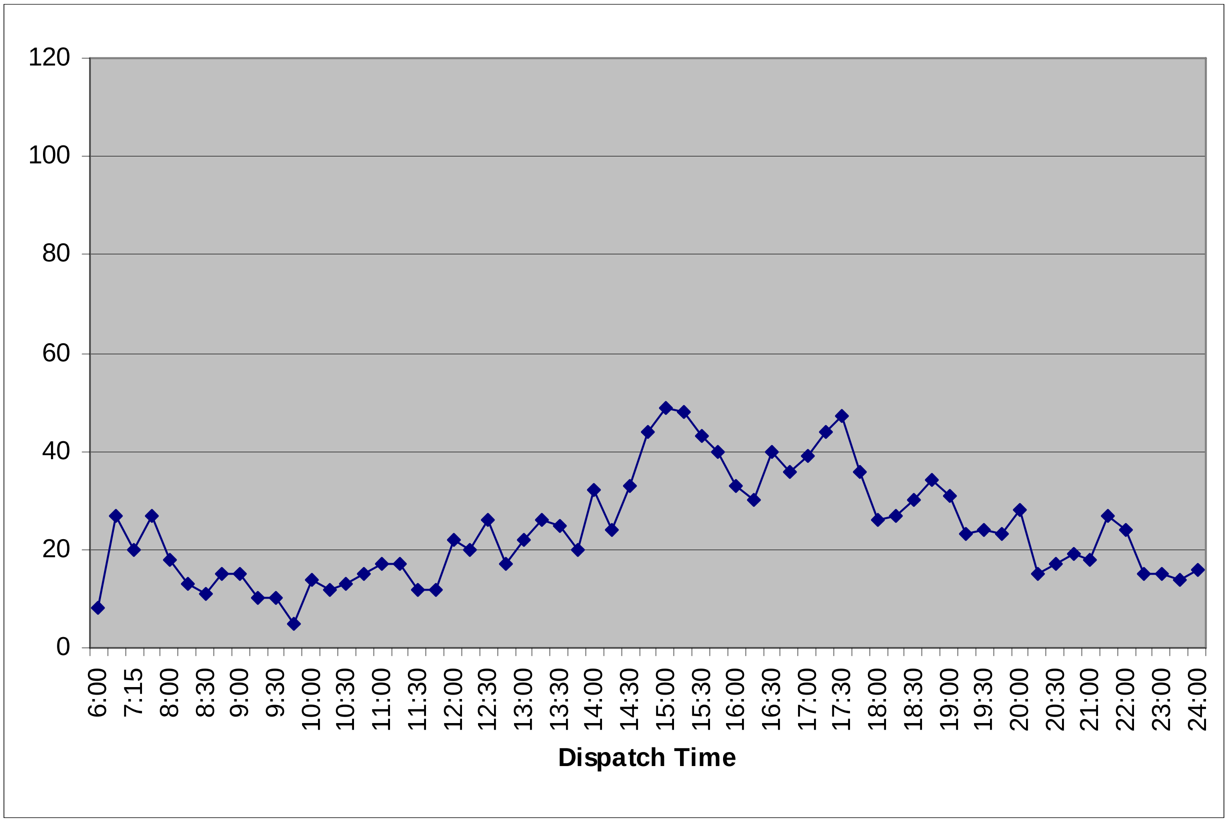
Figure 4.2a – Trip Boarding by Time of Day (Weekday Westbound)



Source: AC Transit, Spring 2005

In the eastbound direction, boardings are more spread out. A small peak is observed between 6:45 AM and 7:45 AM. Boardings gradually build up to the first peak at 2:45 PM. After that boarding falls and then comes up again in 4:30 PM before going down in the evening.

Figure 4.2b – Trip Boarding by Time of Day (Weekday Eastbound)



Source: AC Transit, Spring 2005

4.3 Load Profile and Bus Utilization

Load profile is examined to determine the utilization level of the bus throughout the route. It establishes the maximum load point, as well as describes how crowded a bus becomes during a given run. By using on/off data by stop provided by AC Transit and presented in Section 4.2, it is possible to develop a load profile for each direction – westbound and eastbound. An average of 5 to 15 days of weekday data were used to generated each load profile.

The load profile for the westbound direction is shown in Figure 4.4a. To illustrate variability during the day, the peak bus load profile is shown, as well as profiles for the AM peak period, midday, and the PM peak period. These are presented for each of the three time periods, as well as the 7:15 AM trip, which has the maximum load of the day.

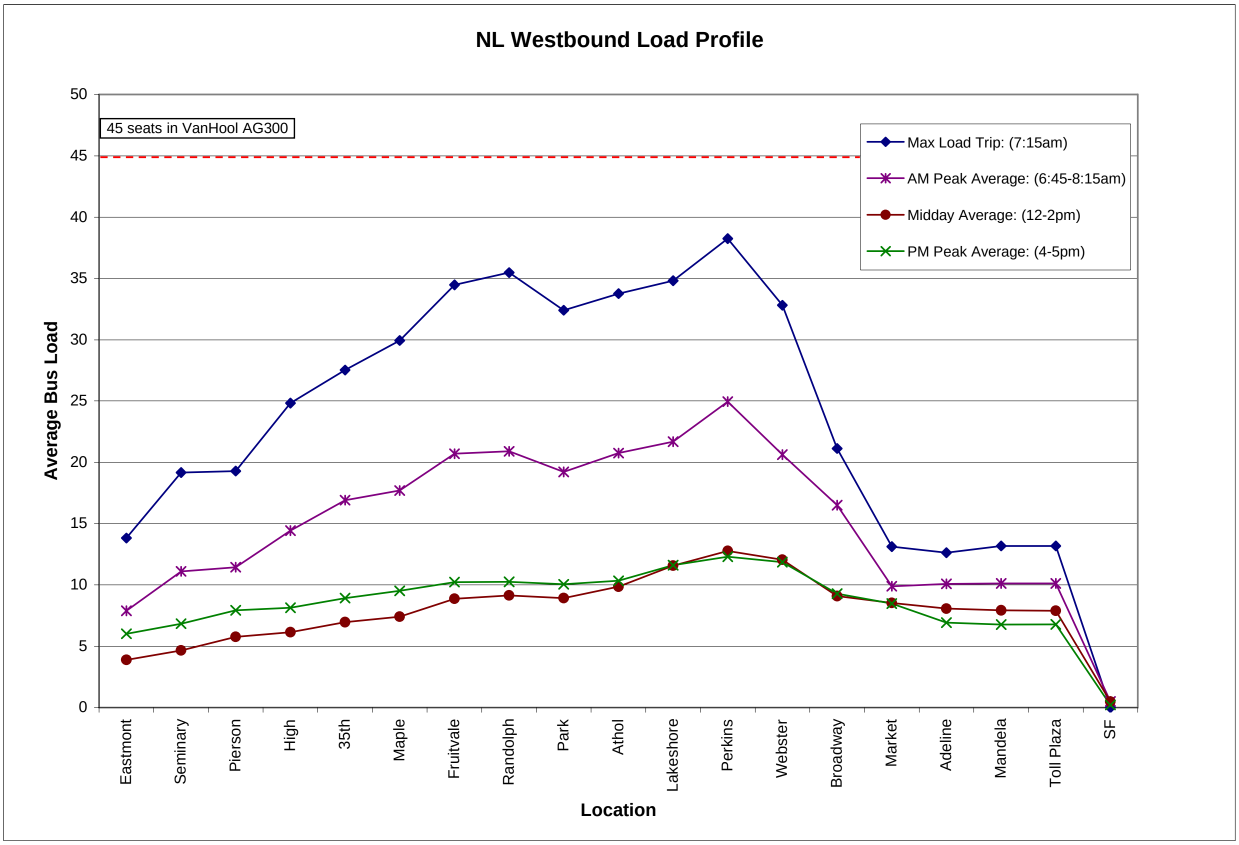
The dots in the figure represent average bus loads leaving each bus stop. As seen in the figure, load builds up from Eastmont terminal to Park Boulevard stop, then drops slightly before increasing until Webster Street in downtown Oakland. Then the load starts to drop until the bus reaches Market Street on West Grand Avenue, after that the load maintains at a constant level going into the San Francisco terminal.

The westbound load profile of the route shows that the highest utilization segments are found between High Street and Broadway. The highest segment is between Perkins Avenue and Harrison Street on Grand Avenue. There is a secondary peak in the Fruitvale area. The utilization of the route in West Oakland is low, relative to other parts of the city.

The AM peak period buses are more utilized than at other times. The peak loads are found on the bus leaving Eastmont Mall at 7:15 AM and arrives at the Transbay Terminal approximately 8 AM. Sufficient seating capacity is available to accommodate all passengers throughout the day.

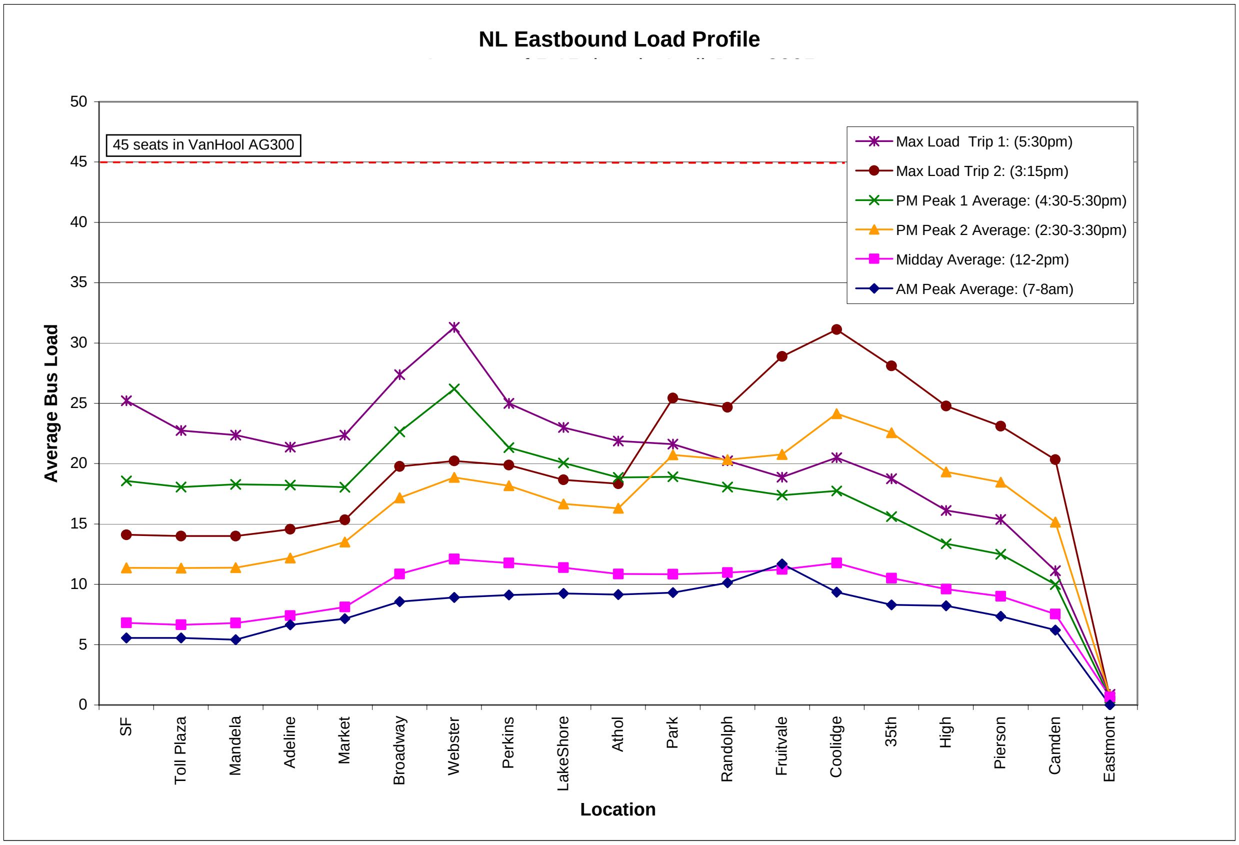
As shown by the dotted lines, the use of the Van Hool AG300 articulated bus on Route NL has provided excess capacity for the current ridership. All passengers were able to get a seat even in the most crowded bus. Except for the most crowded bus, AC could use the Van Hool A330 bus to serve the existing ridership.

Figure 4.4a – Bus Load Profile (Westbound)



Source: AC Transit. Average of 5-15 days, April-June 2005

Figure 4.4b – Bus Load Profile (Eastbound)



Source: AC Transit. 5-15 days in April-June, 2005

In the eastbound direction, as discussed in Section 5.1.3 - Boarding by Time of Day, there are two peaks. To illustrate the slightly more complex time-of-day patterns, Figure 4.4b has two more lines than Figure 5a shows: the load profile for the second PM peak, and its maximum loaded bus.

As seen in the figure, bus loads remain fairly constant from the San Francisco Transbay Terminal through West Grand Avenue. Then they increase at Broadway and Webster Street and stop in Downtown Oakland. This pattern illustrates the two major markets of Route NL: transbay riders who board at San Francisco, and local riders which board at Downtown Oakland.

For AM, midday, and PM peak (1), bus loads start to reduce after passing downtown Oakland, in a very mild and even manner (except Perkins), indicating that riders spread evenly throughout the route. The larger drop of load at Perkins from PM peak (1) bus indicates a significant amount of Transbay riders live in the Perkins/Adams Point area.

For PM Peak 2 (2:30 to 3:30 PM), there was another increase in bus load from Fruitvale stop to Coolidge stop, indicating midday local boardings in the Fruitvale/Coolidge area.

4.4 Run Time Analysis

An evaluation of the travel speed and delay for AC Transit buses is critical to understanding how to improve bus speed and reliability. Documenting travel time components to identify lengthy signal delay, boarding problems and other operational issues is important so that the most effective investments in corridor operations can be determined.

The trip time analysis is performed using two methods of ride check sampling – Automated Passenger Count and Transit Speed/Delay Manual Rider Check.

AC Transit collected information through their **Automated Passenger Count** systems for runs in each direction. With the automated ride check, items such as overall travel speeds, schedule adherence and other items can be sampled throughout the day. For the APC ride check, about 5 to 15 days of detailed bus run times data were obtained. Results are shown in this section.

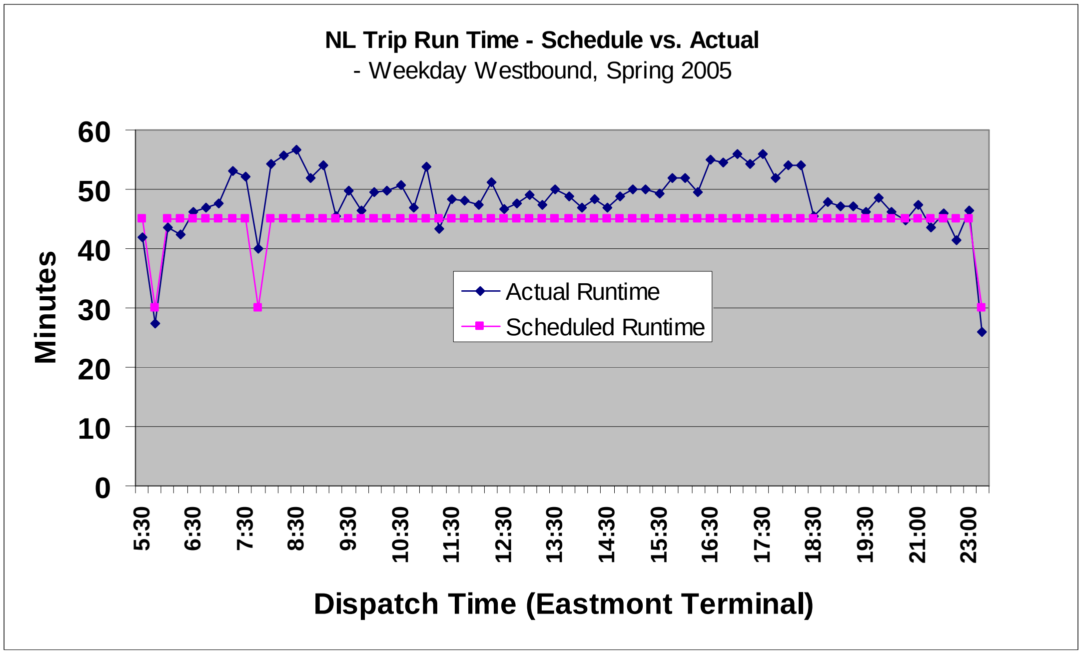
In addition, DKS collected a **Transit Speed/Delay Manual Ride Check** to determine the details of why delay occurs. This information provides specific reasons why bus speed deteriorates at particular locations. For the manually collected ride check data, laptop computers were used with a clock running that records the various components of delay at each intersection and stop. A total of 25 round trips data sets were collected, which will be used to identify operational problems and opportunities associated with specific improvements on the corridor. Transit Speed/Delay Manual Ride Check results will be discussed in Section 5.

4.4.1 Bus Trip Run Time

The analysis of overall run time was obtained through data developed by AC Transit.

Figure 4.5a shows the results of the analysis in the westbound direction. The scheduled vs. actual westbound trip run time in Spring 2005. The result shows that actual run times are longer than the scheduled 45 minutes, especially during the AM peak (8 to 9 AM) and PM peak (4 to 6 PM) in the westbound direction, and during the PM peak (3-6PM) in the eastbound direction.

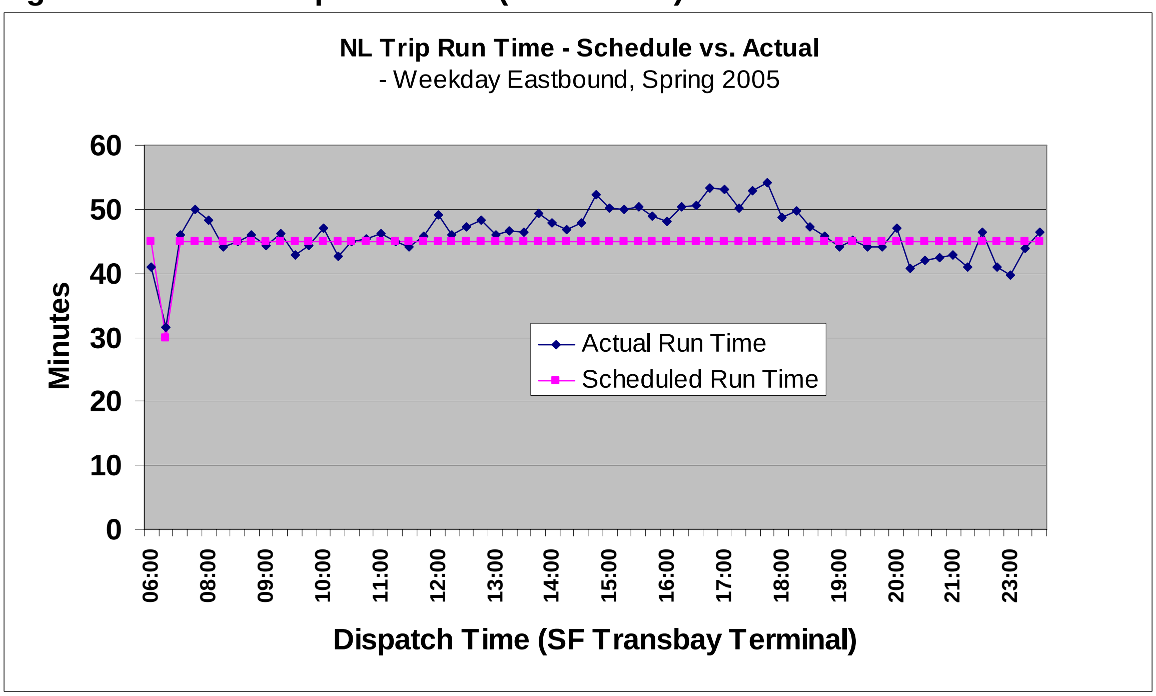
Figure 4.5a – Bus Trip Run Time (Westbound)



Source: AC Transit, Spring 2005

Figure 4.5b shows the results of the analysis in the eastbound direction. The research shows that actual run times are often slightly longer than the scheduled 45 minutes, especially during the PM peak (3 to 6 PM).

Figure 4.5b – Bus Trip Run Time (Eastbound)



Source: AC Transit, Spring 2005

4.4.2 Segment Run Time

In order to identify the source of run time variability, the entire Route NL is divided into 9 segments in both directions for analysis. These segments represent distances of one-half to two miles (except for the Bay Bridge) and generally represent segments where the buses operate at a comparable moving speed. The segments are:

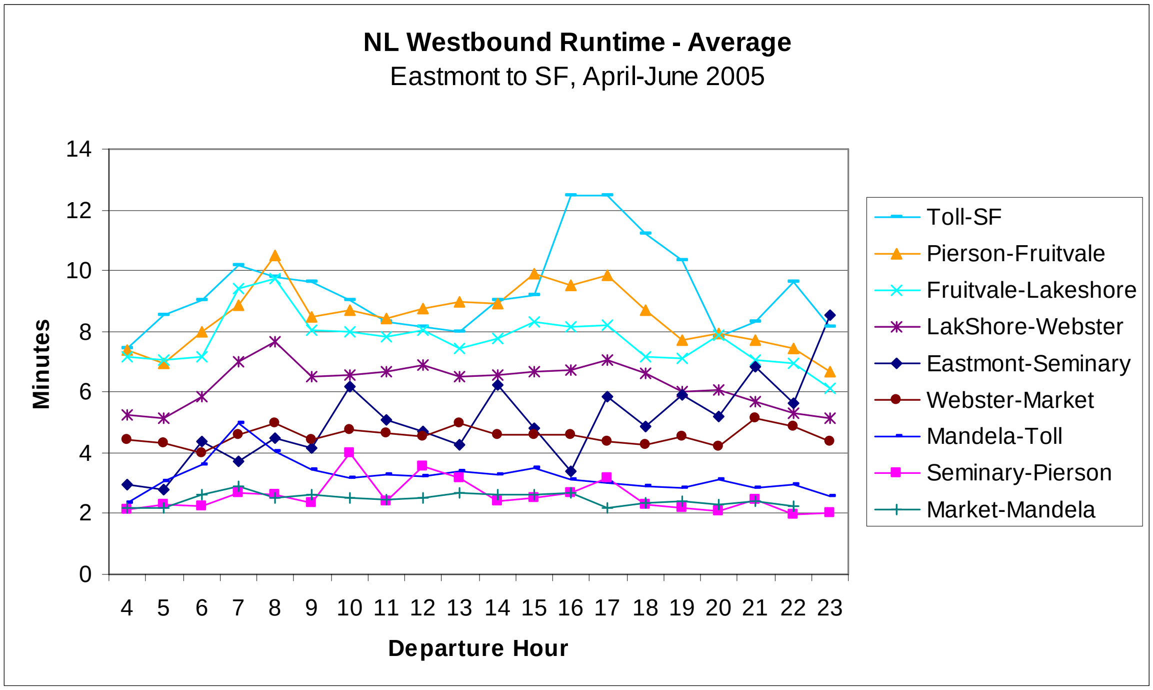
- Eastmont Terminal to Seminary Avenue (Eastmont-Seminary)
- Seminary Avenue to Pierson Street (Seminary-Pierson)
- Pierson Street to Fruitvale Avenue (Pierson-Fruitvale)
- Fruitvale Avenue to Lakeshore Avenue (Fruitvale-Lakeshore)
- Lakeshore Avenue to Webster Street (Lakeshore-Webster)
- Webster Street to Market Street (Webster-Market)
- Market Street to Mandela Parkway (Market-Mandela)
- Mandela Parkway to Toll Plaza (Mandela-Toll)
- Toll Plaza to San Francisco Terminal (Toll-SF)

4.4.2.1 Segment Run Time - Westbound

The run times to travel from the beginning to the end of each segment were recorded in the sampling. Figure 4.6a shows the average run times for each of the nine segments in the westbound direction.

Several of the roadway segments show significant increases in run time during peak periods. The specific segments are sorted by peak time period in Table 4.1. In both cases, the Bay Bridge and the Pierson-Fruitvale segments show longer run times as a result of congestion.

Figure 4.6a – Segment Run Time (Westbound)



Source: AC Transit, Spring 2005

Table 4.1 – Segments with Run Time Increases During Peak Hours (Westbound)

AM Peak	PM Peak
Toll Plaza-San Francisco (Bay Bridge) Pierson-Fruitvale Fruitvale-Lakeshore Lakeshore-Webster Mandela-Toll (I-80 on-ramp)	Toll Plaza-San Francisco (Bay Bridge) Pierson-Fruitvale

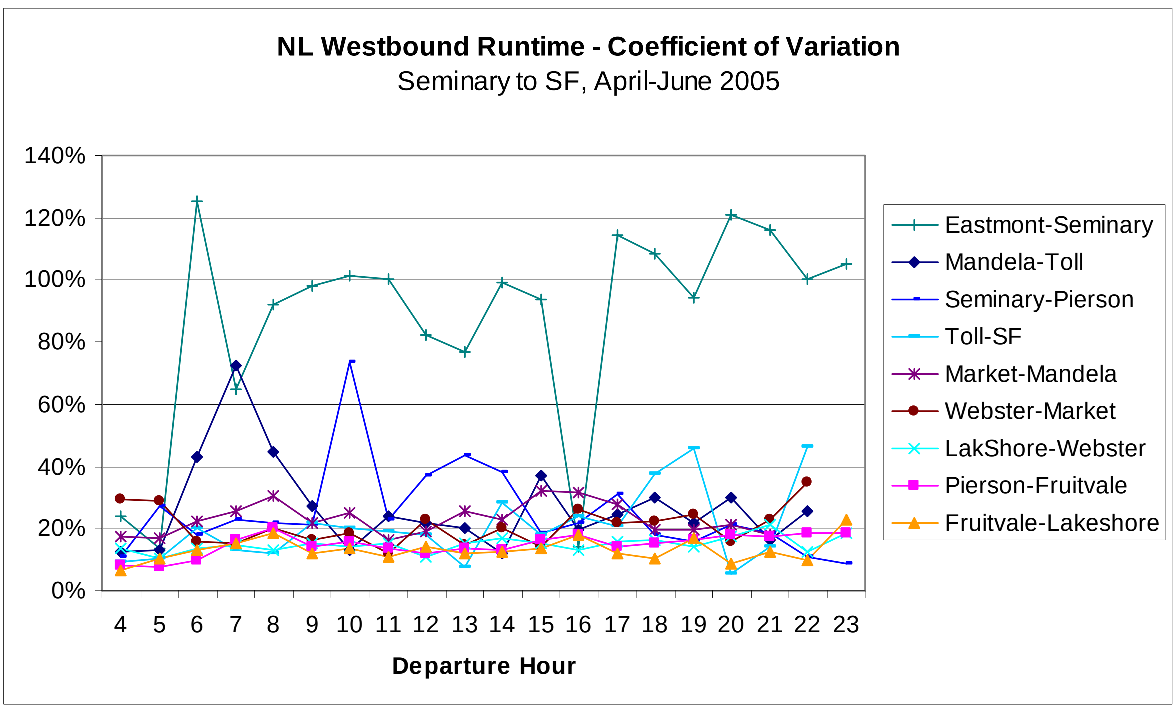
Source: DKS Associates; November, 2005

The measurement of transit reliability is determined by looking at the variability of travel times for each segment. Figure 4.6b displays the coefficient of variation (CV) of the segment run time. CV is standard deviation divided by average, illustrating the degree of variation of the sampled run times. In the westbound run time sample, most segments have a fairly small coefficient of variation, around 10 to 30 percent, indicating that the run times for these segments are fairly uniform across different runs.

The exceptions are the Mandela-Toll Plaza segment in the AM peak, Seminary-Pierson segment during midday, and Toll Plaza- San Francisco in the PM peak.

The 100 percent CV reflected in the Eastmont Mall-Seminary segment reflect the effect of mid-route crew change at the Seminary bus stop for some runs, creating widely different operating speeds for this segment.

Figure 4.6b – Coefficient of Variation of Segment Run Time (Westbound)

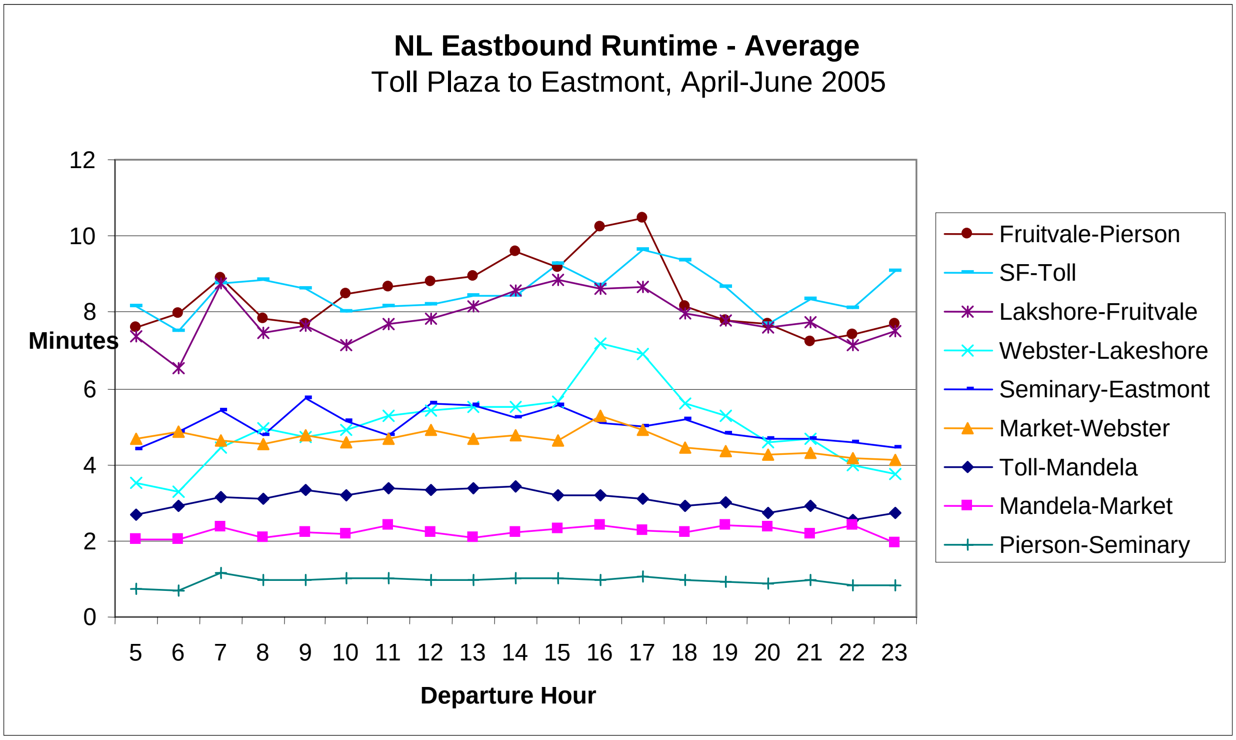


Source: AC Transit, Spring 2005

4.4.2.2 Segment Run Time - Eastbound

As in the westbound direction, the same segment-by-segment analysis was performed in the eastbound direction. In the eastbound direction, there were less delays in both AM and PM peak. Figure 4.7a shows the average run times for each of the nine segments in the westbound direction.

Figure 4.7a – Segment Run Time (Eastbound)



Source: AC Transit, Spring 2005

Based on the results shown in Figure 4.8a, some increases in travel time occur during peak periods. Table 4.2 lists the segments that registered significant increase in run times.

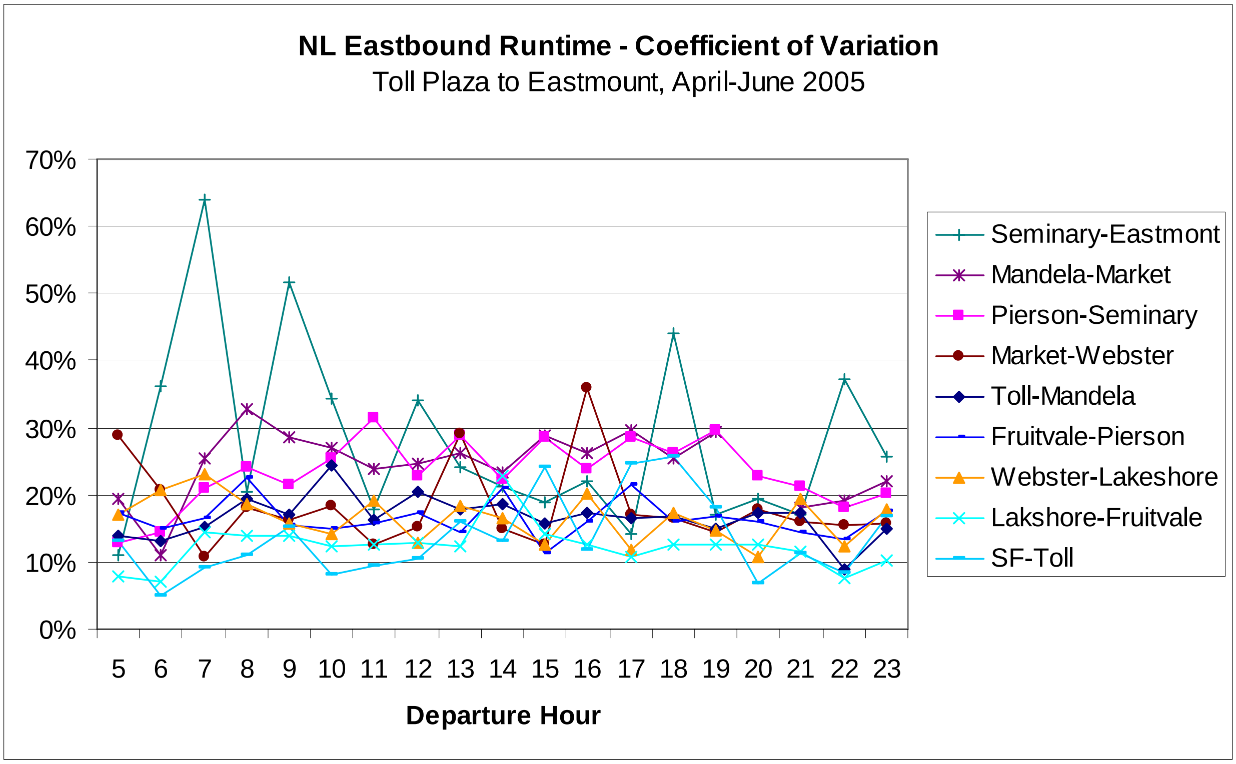
Table 4.2 – Segments with Run Time Increases During Peak Hours (Eastbound)

AM Peak	PM Peak
Fruitvale-Pierson Lakeshore-Fruitvale San Francisco-Toll Plaza (Bay Bridge) Seminary-Eastmont Mall	Fruitvale-Pierson Lakeshore-Fruitvale San Francisco -Toll Plaza (Bay Bridge) Webster-Lake Shore Market –Webster

Source: DKS Associates; November, 2005

To examine reliability, the variability of Coefficient of Variation (CV) was examined in the eastbound direction. Figure 4.7b displays the CV of the segment run times, most routes have CV in the 10-30 percent range. The larger CV observed at the Seminary-Eastmont Mall segment is likely related to the unscheduled crew change near the Seminary bus stop.

Figure 4.7b – Coefficient of Variation of Segment Run Time (Eastbound)



Source: AC Transit, Spring 2005

4.5 Dwell Time

A significant component of transit travel time is the dwell time, which is the time it takes to unload and board riders. Table 4.3 provides the dwell time statistics for each of the 19 stops along the NL line. Numbers are derived from approximately 500 data points obtained during spring 2005 weekday operations. As the table shows, the highest dwell times are at the Transbay Terminal and Eastmont Mall; these are layover points for drivers. Among the interim stops, the longest dwell times are at Broadway, because these are the stops with the highest number of boarding passengers.

Table 4.3 – Average Dwell Time by Stop

Stop	Average (seconds)	Standard Deviation (seconds)	Stop	Average (seconds)	Standard Deviation (seconds)
Eastbound			*Westbound*		
Transbay Terminal	764	507	Eastmont	886	497
Toll Plaza	0	2	Seminary	26	61
Mandela	2	7	Pierson	8	12
Adeline	8	32	High	17	20
Market	7	11	35th	20	26
Broadway	34	34	Maple	9	14
Webster	11	14	Fruitvale	20	21
Perkins	13	15	Randolph	7	9
Lakeshore	18	19	Park	5	9
Athol	5	9	Athol	3	7
Park	11	17	Lakeshore	18	22
Randolph	9	14	Perkins	19	24
Fruitvale	28	33	Broadway	22	28
Coolidge	10	17	Webster	9	13
35th	22	31	Market	8	17
High	12	18	Adeline	7	14
Pierson	6	6	Mandela	6	35
Seminary/Camden	20	50	Toll Plaza	0	2
Eastmont	867	459	Transbay Terminal	715	526

Source: DKS Associates; November, 2005

A time-of-day analysis for dwell time helps to explain how these vary through the day. Figure 4.8a and 4.8b illustrate dwell time variations over the course of a day for major stops that have dwell times over 30 seconds. Each data point in the figures represents the average dwell time of a bus stop over the sampled hour.

In the westbound direction, as seen in Figure 4.8a, the average dwell remains fairly constant for most stops throughout the day, except for the Seminary bus stop, which shows increase in dwell times at 10 AM, 12 noon, 1 PM, and 5 PM. It is suspected that the increase in dwell reflects the unscheduled crew change at the stop.

In the eastbound direction, shown in Figure 4.8b, the Seminary stop shows an increase at 12 noon. The Broadway stop has a peak at 5 PM, where people depart from downtown Oakland traveling east. Fruitvale, Lakeshore, 35th, and Webster have longer dwell times from noon until commencement of the PM peak period. This indicates there are substantial local riders boarding in those stops during the midday to PM peak period.

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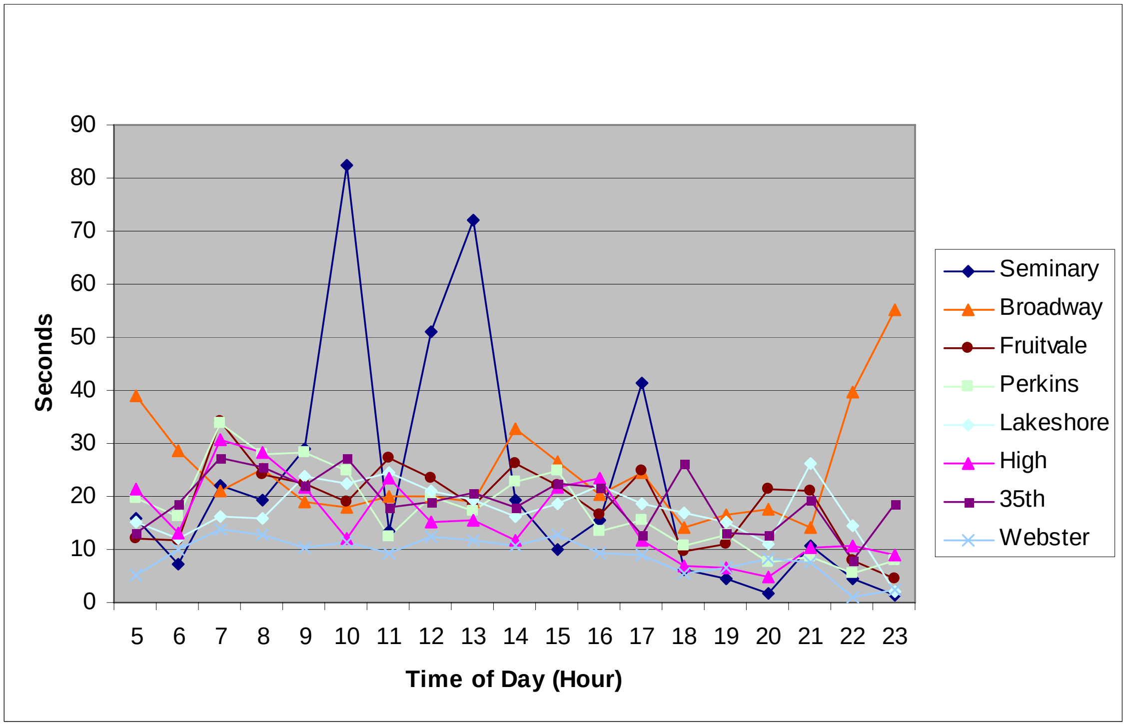
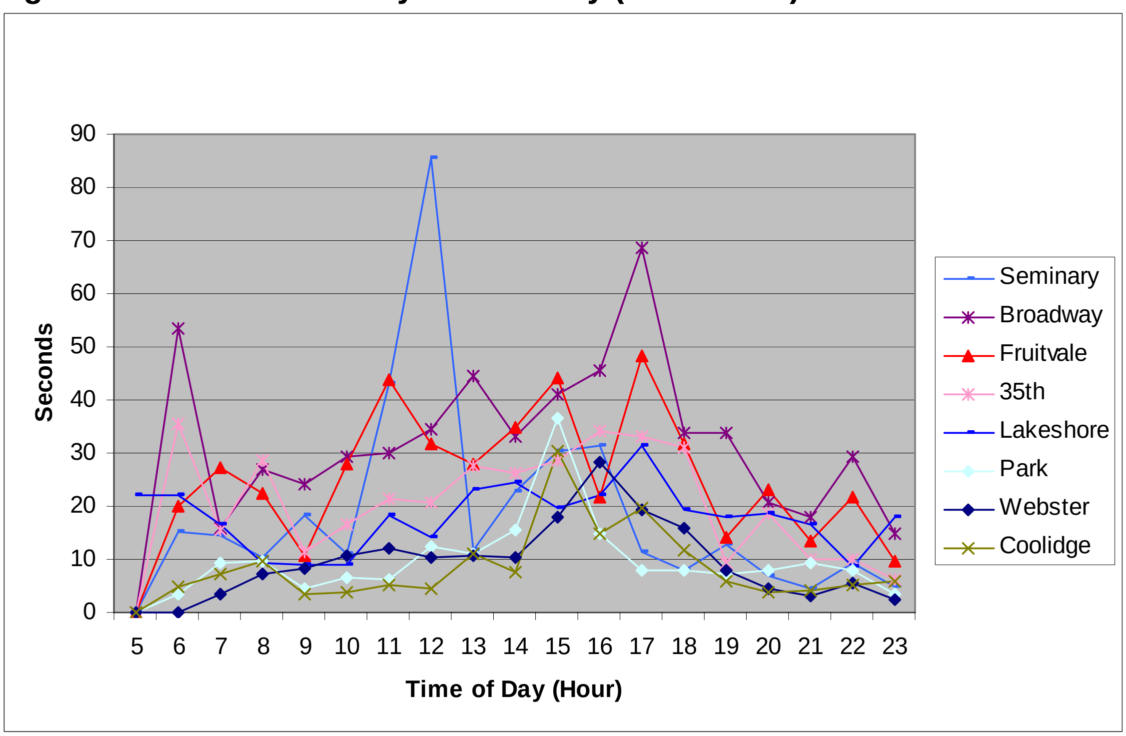
Figure 4.8a – Dwell Time by Time of Day (Westbound)



Source: AC Transit, Spring 2005

Figure 4.8b – Dwell Time by Time of Day (Eastbound)



Source: AC Transit, Spring 2005

4.6 Speed

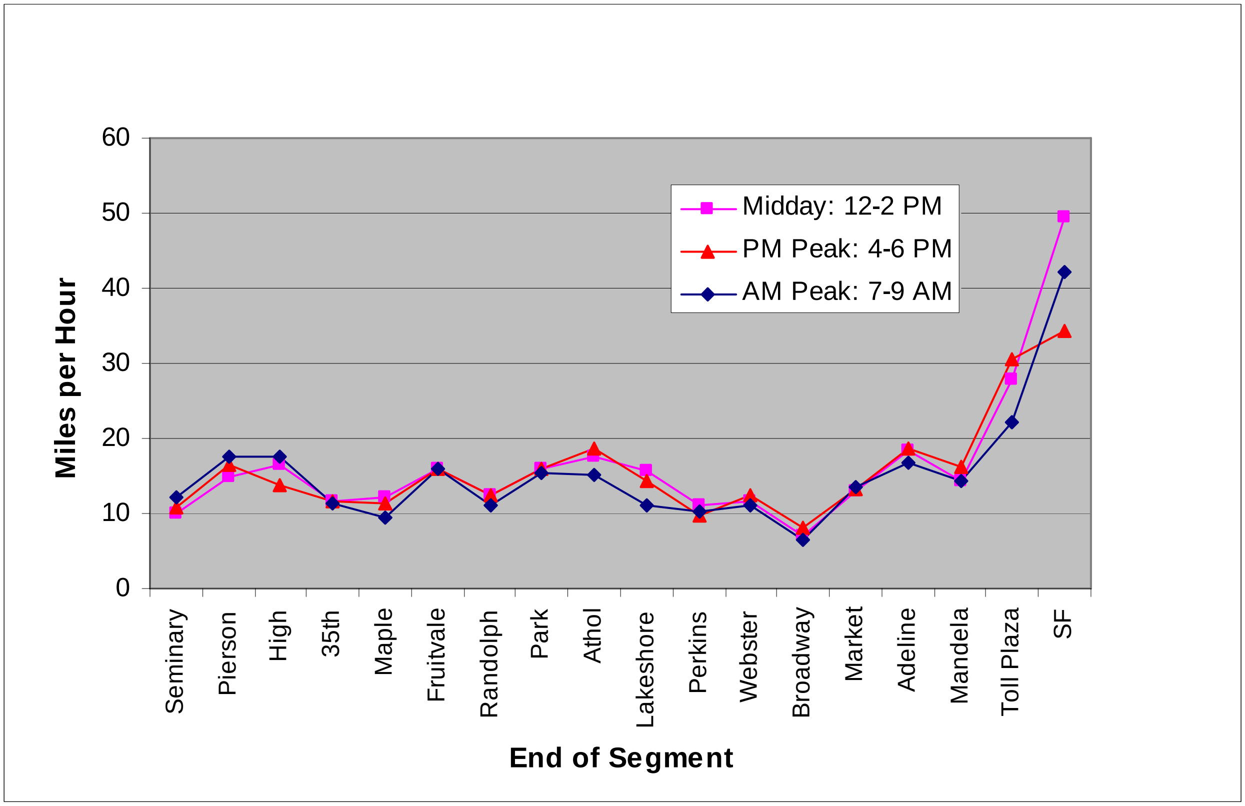
Transit operating speeds are examined in order to evaluate the competitiveness of bus transit relative to private automobiles. Typical travel speeds include dwell times, signal delay and other types of transit operations factors. As a result, most transit lines that operate on arterial roadways operate at 14 to 20 miles per hour. Because the Bay Bridge portion of the route operates without stopping, the travel speed is entirely dependent on the flow of traffic.

4.6.1 Average Bus Speed

Figures 4.9a and 4.9b show the average bus speeds by segment in the AM peak, midday, and PM peak. The speeds were calculated by dividing stop distance with run times (i.e. speed = distance/run time). Run times between stops were derived from the same APC data used in Section 5.4.2 – Segment Run Time. The average speed for the whole route was 21 miles per hour in the eastbound direction, and 20 miles per hour in westbound direction.

Among the specific eastbound segments being analyzed, the 20th Street segment operates the slowest. Other segment that operate slower include those on Grand Avenue, the MacArthur Boulevard segments around High Street/35th Avenue and the beginning of the route near Eastmont Mall.

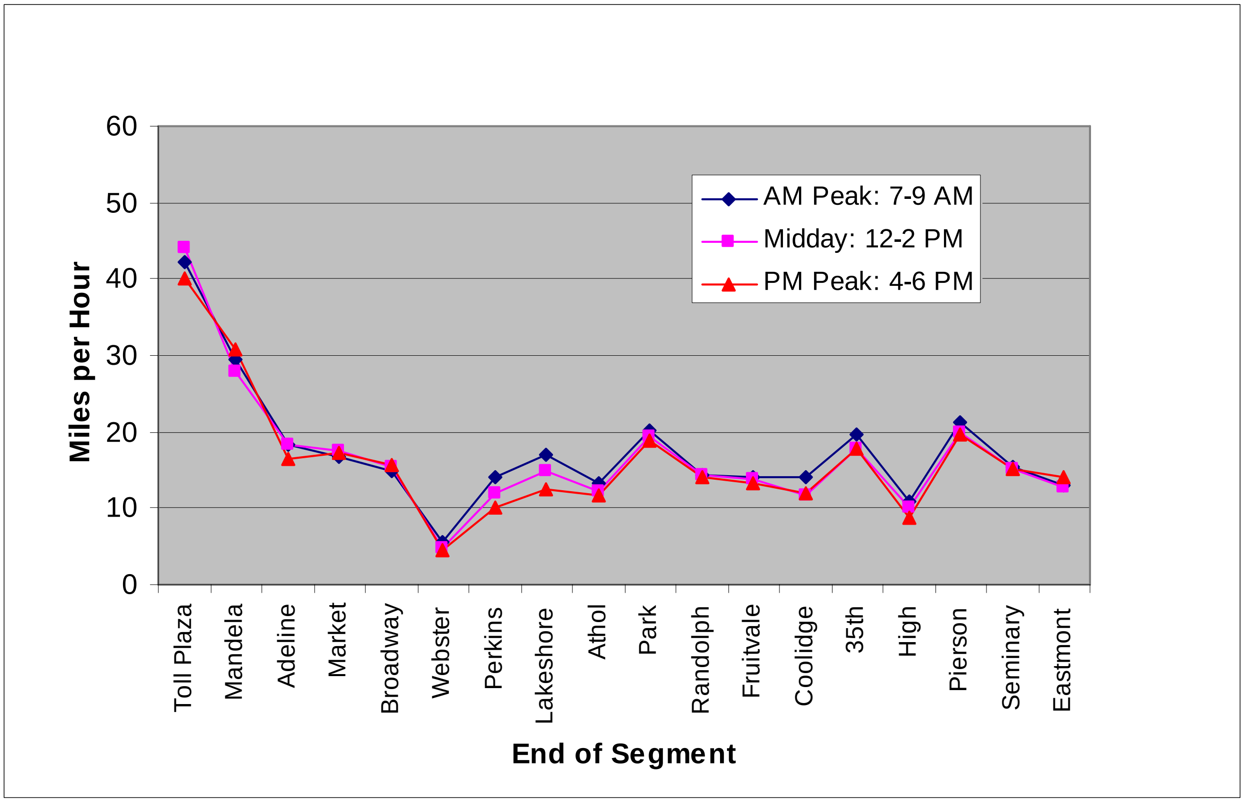
Figure 4.9a – Average Bus Speed (Westbound)



Source: AC Transit, Spring 2005

Among the specific westbound segments being analyzed, the 20th Street segment also operates the slowest. Other segments that operate slower include those around the Grand/Lakeshore district, segments around High Street/35th Avenue.

Figure 4.9b – Average Bus Speed (Eastbound)



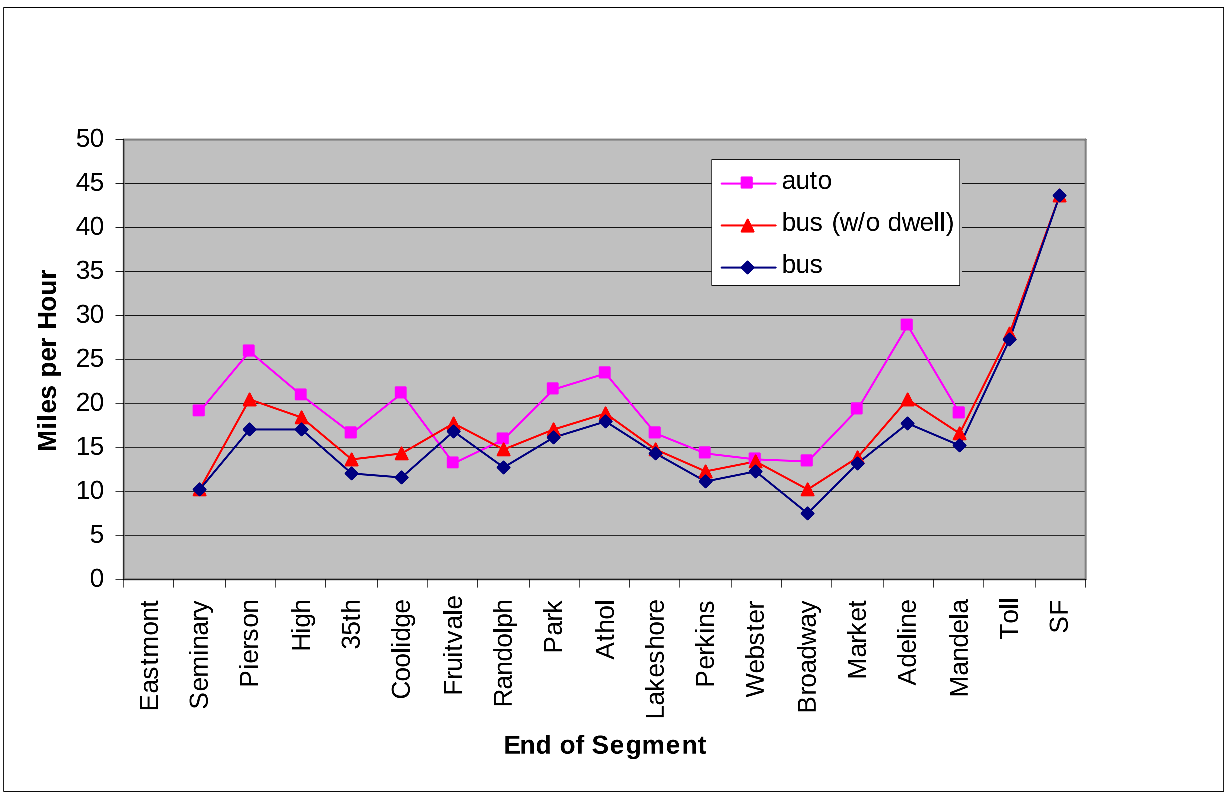
Source: AC Transit, Spring 2005

4.6.2 Auto vs. Bus Speed

Automobile travel time runs were conducted along Route NL to compare speed of automobile versus buses. 12 runs were conducted in the eastbound direction from Mandela Parkway bus stop to Eastmont Transit Terminal, and 13 runs were conducted in the westbound direction from Eastmont Transit Center to Mandela Parkway stop. Figure 4.10a and 4.10b show the average speed for bus versus auto along Route NL, with each point in the figures represents the average speed of bus/auto approaching each bus stop, regardless of time period. Bus speed without dwell time was obtained by subtracting average dwell times from average run times in the calculation. It should be noted that the auto travel times were collected on different days than the bus travel times, and that one segment westbound from Coolidge Avenue to Fruitvale Avenue resulted in faster sampled bus travel times than auto travel times.

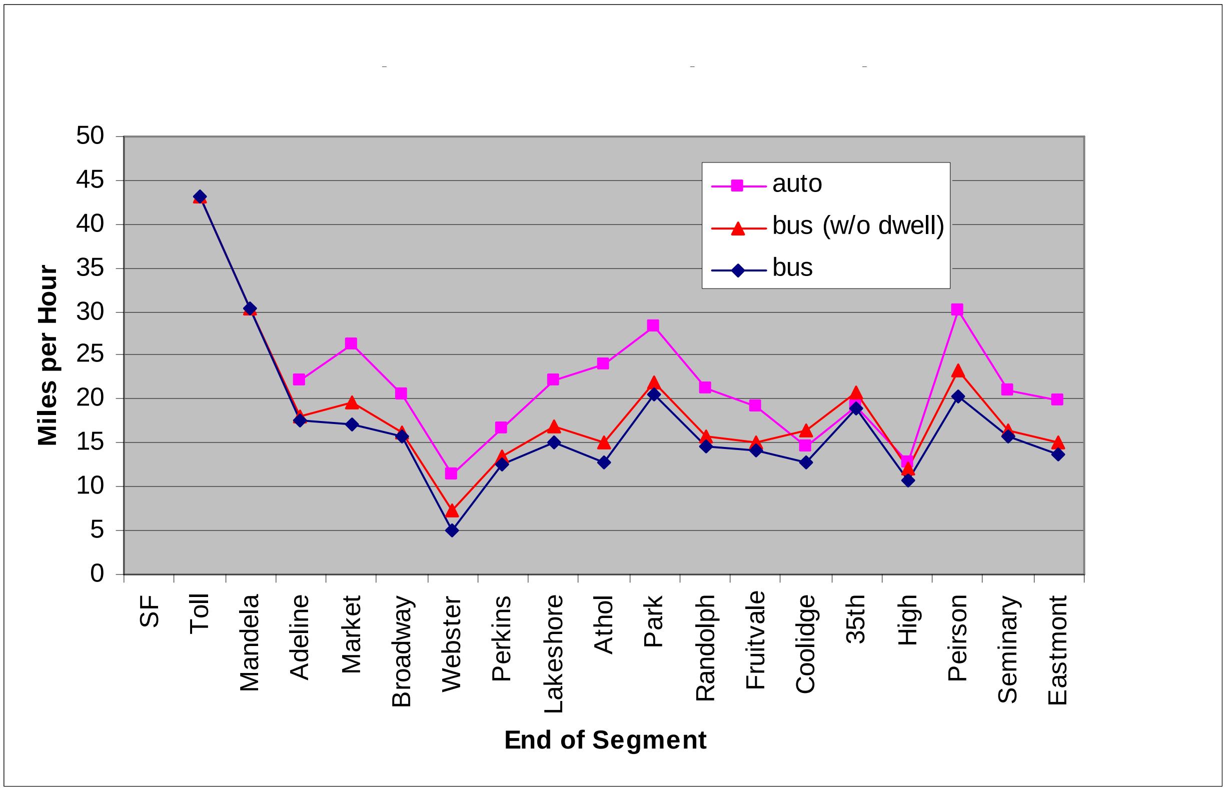
As shown in the figures, auto and bus speeds generally share the same pattern along the route, with automobiles traveling 4-9 mph faster than buses on most segments. The lower auto speed observed at westbound Fruitvale was due to left turn traffic congestion at the intersection during auto runs. The speed difference between automobiles and buses was higher in the eastbound direction than westbound.

Figure 4.10a – Auto vs. Bus Speed (Westbound)



Source: DKS Associates, November 2005

Figure 4.10b – Auto vs. Bus Speed (Eastbound)



Source: DKS Associates, November 2005

4.7 Schedule Reliability

In addition to examining the travel times and speed by segment, it is important to see if the sampled time points (except at the end point) match those in published schedules. This section summarizes the reliability of the Route NL in terms of schedule adherence, and headway adherence.

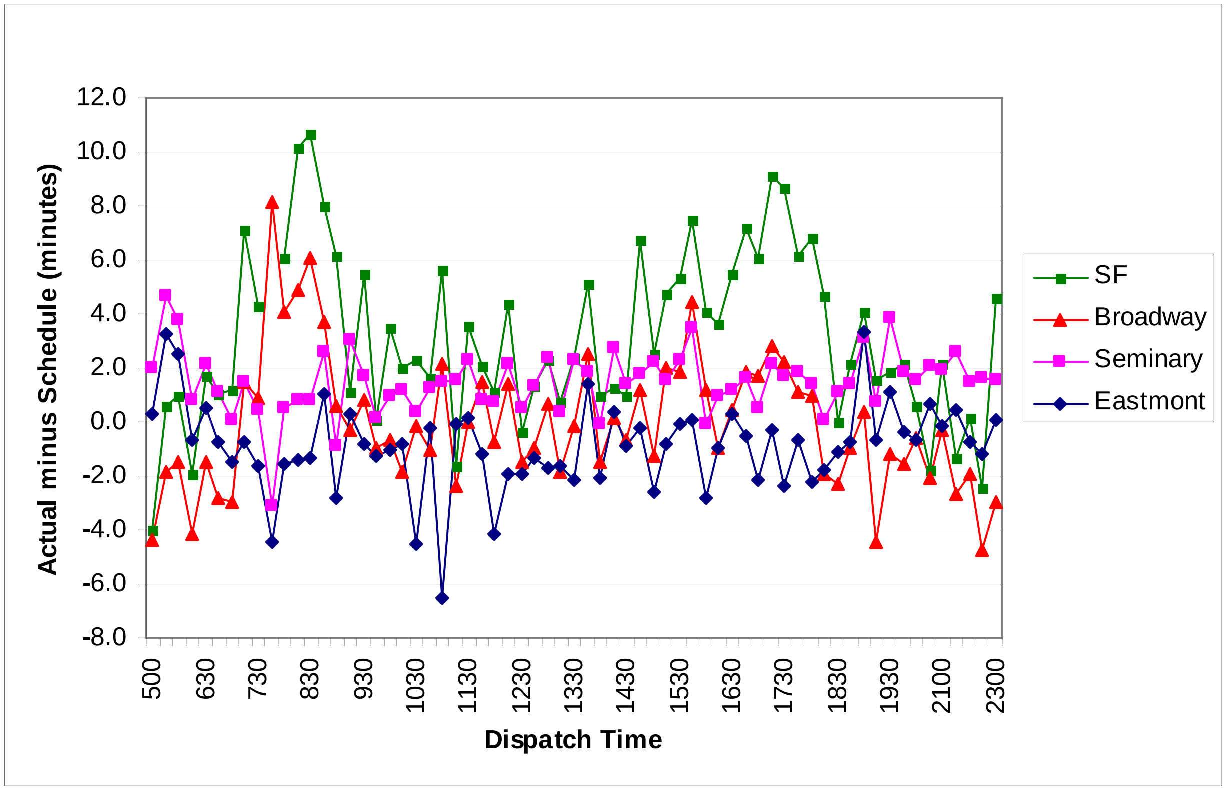
4.7.1 Schedule Adherence

A comparison of the difference between scheduled and actual arrival time at time points is used to show the schedule reliability. Figure 4.11a and 4.11b show the schedule deviation for Route NL at each of the four time points: Eastmont Mall Transit Center, Seminary Avenue, 20th/Broadway, and the Transbay Terminal. Each dot in the figures represents the average schedule reliability for runs at each time point. About 5 to 15 days of schedule deviation data were used to generate these results.

In the westbound direction (shown in Figure 4.11a), most of the buses started between two minutes ahead to one minute behind at the Eastmont Mall departure point, then arrived two minutes behind schedule at the Seminary time point. By the time buses arrived at the 20th/Broadway time point, most buses were able to get back on schedule, with the exception of the morning peak period (7:45 AM – 8:30 AM) and afternoon peak (3:00 PM – 6:00 PM), where buses were one to eight minutes behind schedule. This suggests that local traffic in Oakland had impacted Route NL in the morning peak by four to eight minutes and the afternoon peak by 2 to 4 minutes. When buses arrived at the Transbay Terminal; they incurred another two to six minute delay in the Bay Bridge segment.

The uniformity of late arrivals at the Seminary time point suggests that actual run time is about two minutes longer than the current schedule allows.

Figure 4.11a – Schedule Deviation by Time of Day (Westbound)

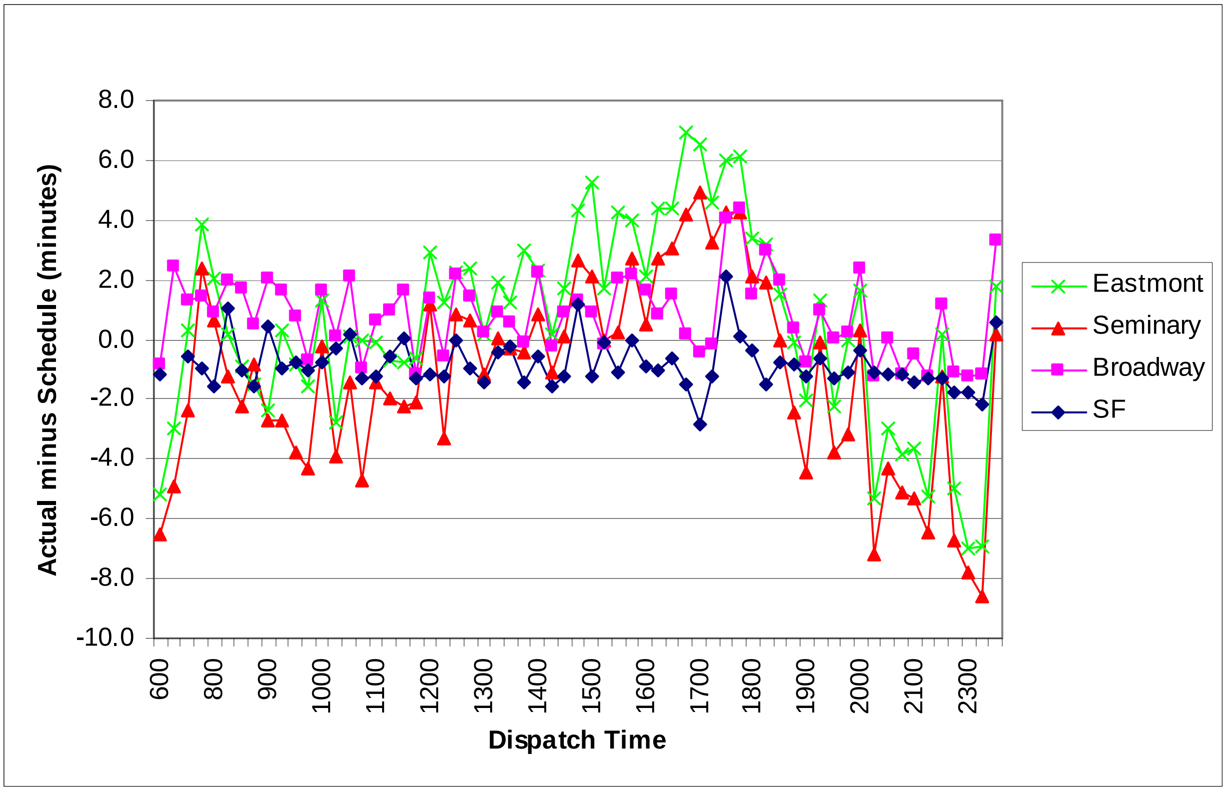


Source: AC Transit, Spring 2005

In the eastbound direction (shown in Figure 4.11b), most of the buses left between one minute ahead to on time at the Transbay Terminal departure. By the time buses arrive the 20th/Broadway time point, most buses were on schedule to two minutes behind, with slightly more delay (up to four minutes behind) during the evening peak at around 5:30 PM – due mostly to Bay Bridge congestion. By the time buses reach the Seminary time point, buses in the morning and evening were anywhere between on-time to four minutes ahead of schedule, whereas buses in the afternoon were two to four minutes behind schedule, which indicates heavier traffic in the Broadway-to-Seminary segment in the afternoon period. By the time buses arrive the Eastmont Mall terminal point, they incurred another two minutes of delay. This confirms a prior observation in the westbound direction that the actual run time between Eastmont and Seminary is two minutes longer than set in the current schedule.

Overall buses incurred less delay in the eastbound direction, partly because they do not have a sharp morning traffic peak as in the westbound direction, and also there is a milder congestion in the Bay Bridge. This results in overall shorter run time and more recovery (slack) time in the eastbound runs.

Figure 4.11b – Schedule Deviation by Time of Day (Eastbound)



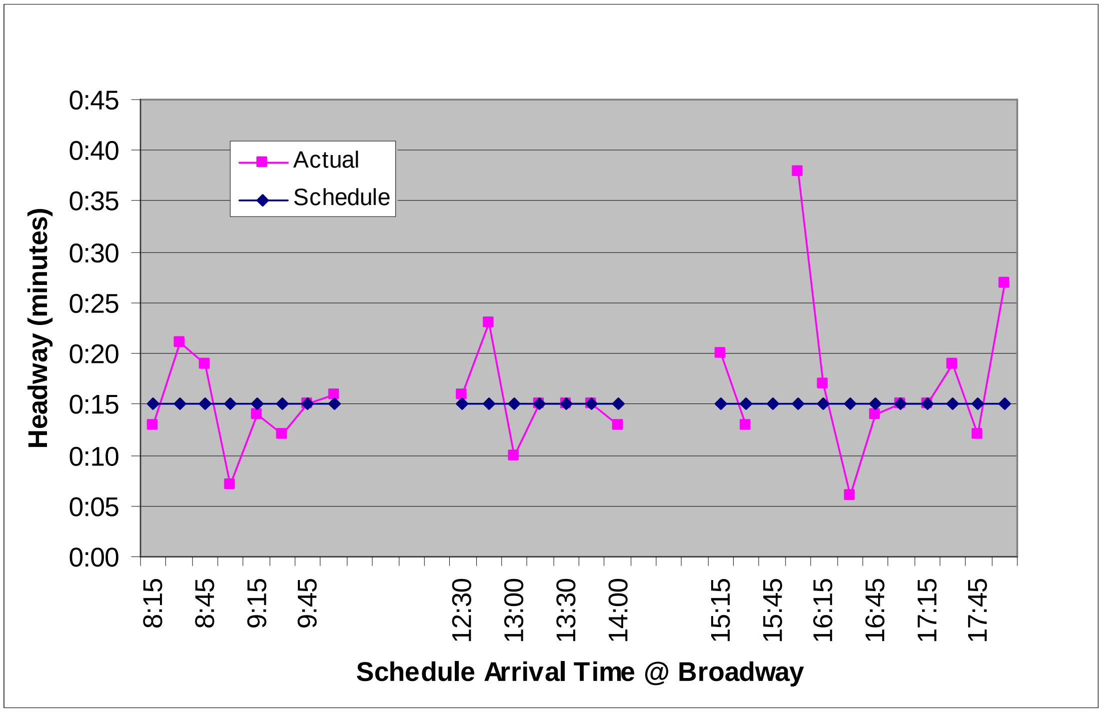
Source: AC Transit, Spring 2005

4.7.2 Headway Adherence

A point check was conducted on November 7th, 2005; actual bus arrival time was recorded at the Broadway/20th Street bus stop during AM peak (8-10 AM), midday (12-2 PM), and PM peak (3-6 PM). Figure 4.12a and 4.12b shows the schedule versus actual headway arriving at the Broadway bus stop.

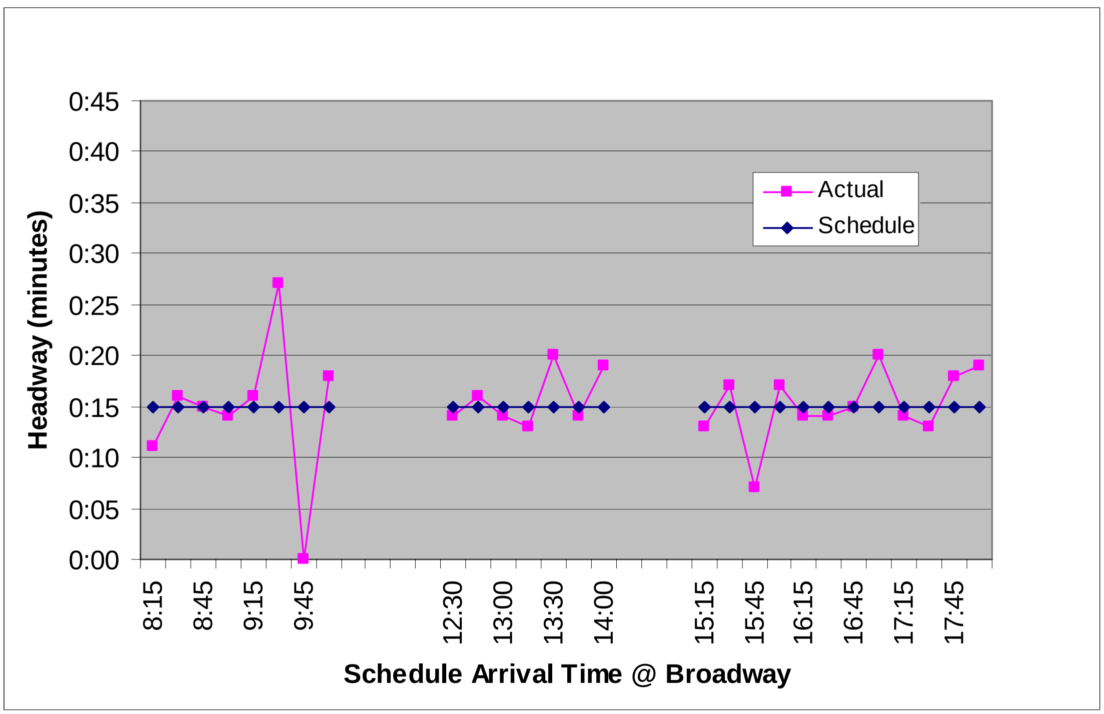
As seen in the figures, except for the 4PM westbound bus and the 9:45 AM eastbound bus, most buses arrived with 10-20 minute headway. "Bus bunching" was not observed. The delay observed in the eastbound 9:45 AM bus was probably due to delay in previous westbound trips at the Bay Bridge section.

Figure 4.12a – Schedule vs. Actual Headway Arriving Broadway (Westbound)



Source: DKS Associates, November 2005

Figure 4.12b – Schedule vs. Actual Headway Arriving Broadway (Eastbound)



Source: DKS Associates, November 2005

4.8 Summary of Operations Findings

4.8.1 Ridership and Market

- Route NL ridership consists of Transbay (33 percent) and local trips (67 percent).
- Riders are diverse in terms of household income, trip purpose, and ethnicity.
- Passengers are disturbed fairly evenly along the route.

4.8.2 Bus Load and Utilization

- Articulated buses have excess capacity to serve the current load.
- Single bus can be used to serve current load.

4.8.3 Run Time Variability

- Run time increased observed at the Westbound I-80 on-ramp in the morning peak period.
- Westbound segment run times recorded higher increase during morning peak than the rest of the day (except Bay Bridge segment). Eastbound run time increases in the afternoon-PM peak period.
- Seminary-Eastmont segment shows large run time variability, suspected to be caused by unscheduled crew change.

4.8.4 Schedule Reliability and Service Planning

- Route NL incurred more delay in the westbound direction than eastbound.
- Current schedule trip run time of 45 minutes is on average 5-10 minutes shorter than actual during the peak periods: AM peak in the westbound direction, PM peak in both westbound and eastbound direction.
- Scheduled run time between Seminary and Eastmont is 2-minutes shorter than the actual run time.

4.8.5 Traffic Condition, Auto versus Bus Speed

- Auto and bus speeds generally share same pattern along the route, with auto travels 4-9 mph faster than bus on most segments. This indicates that bus operations are fairly efficient compared with the general traffic.
- Speed difference between automobiles and buses were higher in the eastbound direction than westbound.

5. RIDE CHECK ANALYSIS

5.1 Purpose and Outline

DKS conducted a ride check analysis as part of the detailed transit vehicle delay study, focusing on the different causes and significance of delays occurring on Route NL. This chapter contains a run time summary and overall breakdown into run time, dwell time, and delay time. The chapter also includes a delay analysis, which summarizes sources and durations of delays. Signal delays and dwell times and other items such as fare payment boarding time and on-board observations are documented to complete this analysis of the bus route. It should be noted that delays are instances when buses are stopped, and that slow-moving bus occurrences are not registered in this analysis. Finally, the chapter concludes with a summary of findings.

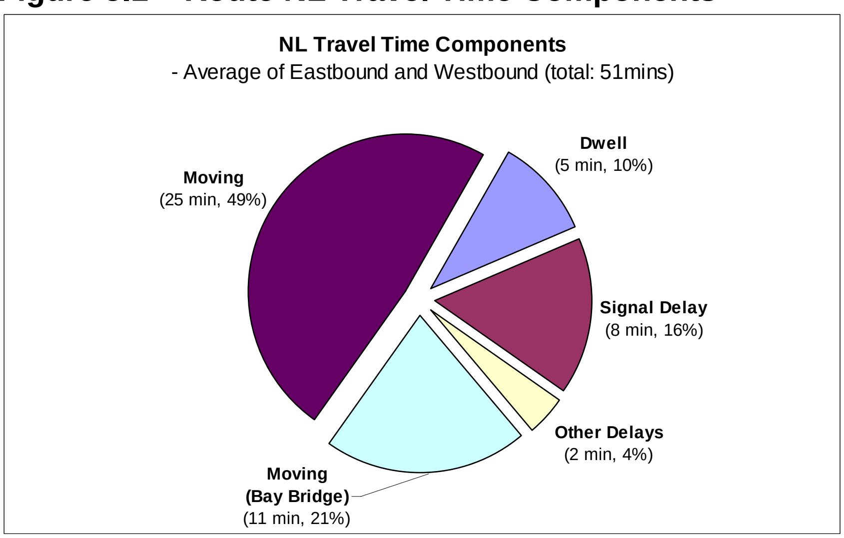
5.2 Data Collection

Ride checks were conducted on five mid-week days during the latter part of October 2005. A total of 48 travel time runs (one-way) were conducted on board using laptop computers. Detailed run time information such as run time by intersection, dwell time, and delay data, were recorded.

5.3 Run Time Components

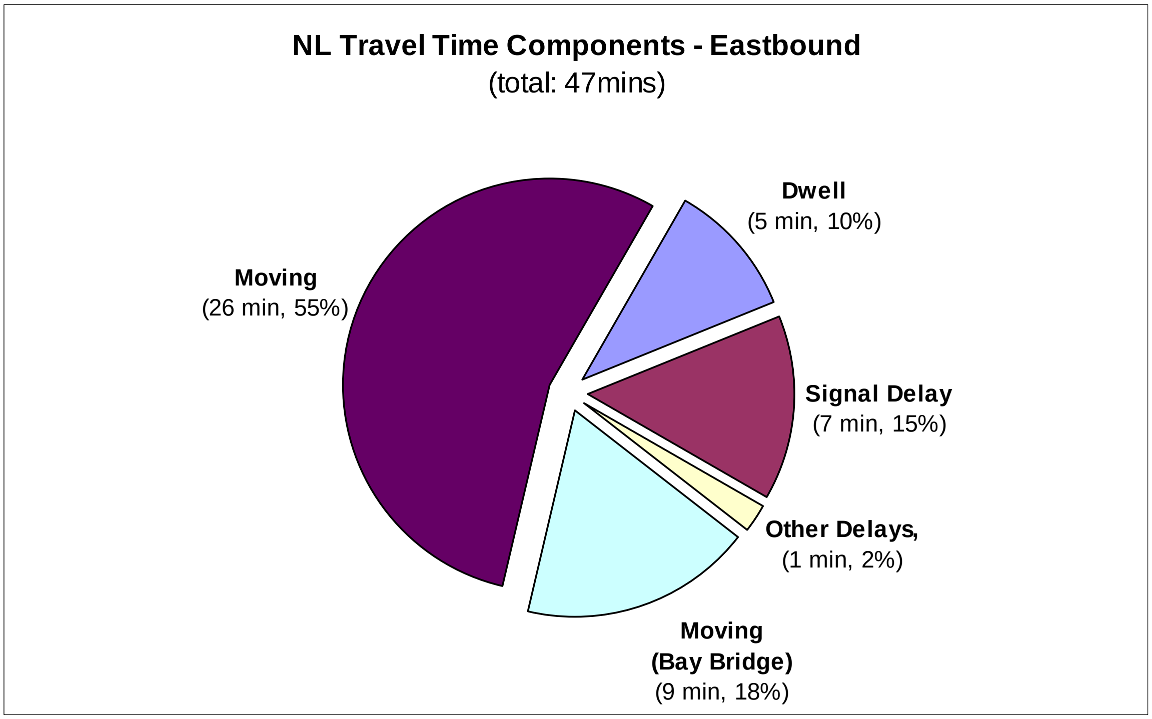
An understanding of run time components is essential to estimate potential improvement of various solutions. Figure 5.1 shows the run time components of current Route NL. The figures represent the average for eastbound and westbound runs. On average, buses were moving 70 percent of the total run time, with 21 percent on Bay Bridge and 49 percent on local roads. Dwell time contributed ten percent while signal delay added another 16 percent. Other delays such as bicycle loading/unloading, pedestrian crossings, and slow vehicular moving traffic amounted to four percent. Figures 5.2a and 5.2b shows the run time components for eastbound and westbound separately. Westbound trips had longer run times on the Bay Bridge (4 minutes), and more signal delay (3 minutes).

Figure 5.1 – Route NL Travel Time Components



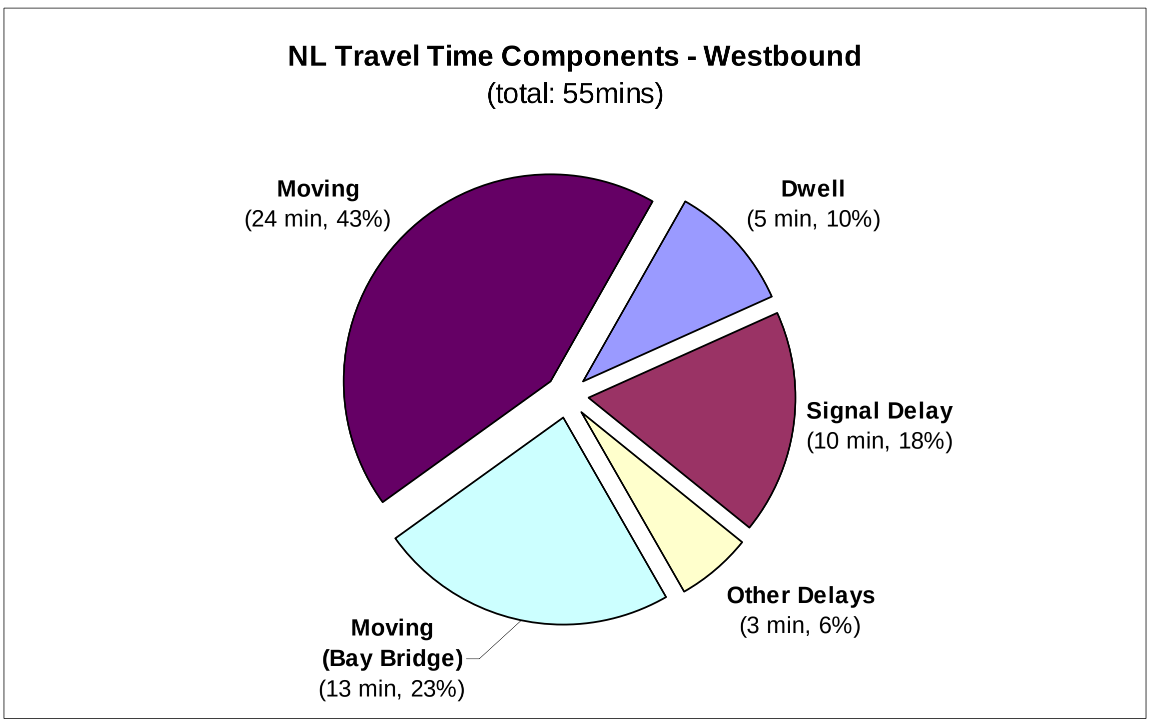
Source: DKS Associates, November 2005

Figure 5.2a – Run Time Component (Eastbound)



Source: DKS Associates, November 2005

Figure 5.2b – Run Time Component (Westbound)



Source: DKS Associates, November 2005

Table 5.1 lists the detailed run time component statistics by time period for each direction. In the eastbound direction, the average end-to-end run time was 47 minutes, with a longer run time (50 minutes) in the PM peak period. The total dwell time averaged five minutes, representing 10 percent of total run time. The average signal delay was seven minutes, or about 15 percent of total run time. There was one minute of other delay.

In the westbound direction, the average end-to-end run time was 55 minutes, with a longer run time in both AM peak (59 minutes) and PM peak (55 minutes) period. The total dwell time averaged five minutes. The average signal delay was ten minutes. There was an average three minutes of other delay. The components of delays for each type are discussed in detail separately.

Table 5.1 – General Run Time Statistics

	Number of Runs Conducted	Average Travel Time (minutes)	Average Travel Time on Bay Bridge (minutes)	Average Dwell Time (minutes)	Average Signal Delay (minutes)	Average of Other Delays (minutes)	Percent of Total Travel Time		
							Dwell Time	Signal Delay	Other Delay
Eastbound									
AM	10	44.7	8.0	5.0	6.8	0.7	11%	15%	2%
MD	4	44.8	9.0	4.1	6.3	1.6	9%	14%	4%
PM	9	49.7	8.8	5.1	7.0	1.0	10%	14%	2%
Total	**23**	**46.7**	**8.5**	**4.9**	**6.8**	**1.0**	**10%**	**15%**	**2%**
Westbound									
AM	10	58.6	13.6	6.8	8.5	2.8	12%	15%	5%
MD	6	47.4	7.5	4.6	9.8	1.0	10%	21%	2%
PM	9	55.1	15.1	4.6	10.7	5.1	8%	19%	9%
Total	**25**	**54.6**	**12.7**	**5.5**	**9.6**	**3.2**	**10%**	**18%**	**6%**

Source: DKS Associates; November, 2005

5.4 Delay Analysis by Type

As shown earlier in Figure 5.1, about 20 percent of Route NL total run times are categorized as signal and other delays. This section presents the detail break down of these delays, including their statistics, their nature, and any potential solutions for mitigation.

Table 5.2 tabulates the statistics of the delays by type. The count, total delay, and average duration for each delay type are shown.

In the eastbound direction, delay types that contribute two or more percent to total delay are: signals (87 percent), boarding/alighting difficulty (4 percent), construction (2 percent), and traffic queued in front of bus stops (2 percent), and crew shift (2 percent).

In the westbound direction, delay types that contribute two or more percent to total delay are: signals (74 percent), traffic congestion (13 percent), accidents (4 percent), and traffic queued in front of bus stops (2 percent).

A more detailed discussion on each type of delay is included in the next section.

Table 5.2 – Bus Delays by Type

Type	Average Occurrence / Trip	Average Delay / Trip (seconds)	Percent of Total Delay
Eastbound			
Signal	19.4	409	87%
Boarding/alighting difficulty	0.2	17	4%
Construction	0.3	11	2%
Queue in front of stop	0.4	8	2%
Crew shift	0.1	7	2%
Yield	0.4	5	1%
Right turn vehicle	0.1	2	1%
Transit info	0.1	2	0%
Traffic congestion	0.0	2	0%
Bicycle loading/unloading	0.1	1	0%
Parking vehicle	0.2	1	0%
Left turning vehicle	0.0	1	0%
Total	**21.6**	**468**	**100%**
Westbound			
Signal	22.4	545	74%
Traffic congestion	0.9	96	13%
Accident	0.0	31	4%
Queue in front of stop	0.4	11	2%
Bus congestion	0.2	10	1%
Lefting turn vehicle	0.2	6	1%
Parking vehicle	0.1	5	1%
Crew shift	0.0	5	1%
Transit info	0.2	4	0%
Yield	0.1	2	0%
Bicycle loading/unleading	0.2	2	0%
Pedestrian crossing	0.2	1	0%
Boarding/alighting difficulty	0.0	1	0%
Truck	0.0	1	0%
Extra stop	0.0	1	0%
Right turn vehicle	0.1	1	0%
Construction	0.0	0	0%
Total	**25.2**	**736**	**100%**

Source: DKS Associates; November 2005

5.5 Signal Stop Delays

As discussed in the previous section, signal stop delays account for about 80 percent of total delay, or 16 percent (8 minutes) of total run time. In addition to the stopped delay recorded here, each stop at a signal increases overall travel time through bus deceleration and acceleration. Table 5.3 lists the top twenty signal delay intersections, sorted by overall average delay per run. They represent data from AM, Midday, and PM peak periods, and data are listed by the occurrence, the average duration of the delay when occurring, and the average delay when applied to all bus runs (whether or not the bus has stopped).

Table 5.3 – Top 20 Signal Stop Delay Locations

	Count	% Runs When Bus Stopped	Average Duration / Delay (seconds)	Average Delay / Run (seconds)
Eastbound (23 Runs)				
MacArthur Blvd & High St	19	83%	33	28
Seminary Av & Camden St	16	70%	37	26
MacArthur Blvd & 35th Av	20	87%	29	25
MacArthur Blvd & E 38th St (Canon)	20	87%	27	24
W Grand Av & Frontage Rd	14	61%	32	19
MacArthur Blvd & Lakeshore Av	13	57%	32	18
MacArthur Blvd & Park Blvd	15	65%	27	18
MacArthur Blvd & Fruitvale Av	18	78%	21	17
20th St & Harrison St	16	70%	24	17
Harrison St & 21st St	20	87%	19	16
20th St & Webster St	15	65%	20	13
San Pablo Av & 20th St	11	48%	26	12
20th St & (Franklin St + Broadway)	17	74%	15	11
W Grand Av & Poplar St (+ Mandela Pkwy)	11	48%	23	11
Grand Av & Perkins St	10	43%	22	10
Foothill Blvd & Church St	8	35%	27	10
San Pablo Av & Castro St	13	57%	16	9
MacArthur Blvd & Lincoln Av	13	57%	16	9
W Grand Av & Maritime St	12	52%	16	8
Grand Av & Harrison St	10	43%	19	8
Westbound (25 Runs)				
MacArthur Blvd & High St	23	92%	39	36
Chatham Rd & Park Blvd	21	84%	41	34
Lake Park Av & Lakeshore Av	14	56%	38	21
Chatham Rd & Beaumont Av	14	56%	37	21
Lake Park Av & Grand Av	13	52%	39	20
MacArthur Blvd & Fruitvale Av	14	56%	35	20
W Grand Av & Frontage Rd	12	48%	41	20
Harrison St & Grand Av	17	68%	27	18
MacArthur Blvd & Canon Av (E 38th)	14	56%	31	18
Chatham Rd & 13th Av	9	36%	48	17
MacArthur Blvd & Seminary Av	19	76%	22	17
Eastmont Terminal	16	64%	26	17
W Grand Av & Maritime St	13	52%	32	16
MacArthur Blvd & 35th Av	16	64%	25	16
MacArthur Blvd & Lincoln Av	11	44%	35	16
20th St & (Franklin St + Webster St)	18	72%	21	15
20th St & Harrison St	12	48%	28	13
MacArthur Blvd & Coolidge Av	9	36%	35	13
Harrison St & 21st St	11	44%	28	13
20th St & Broadway	15	60%	19	12

Source: DKS Associates; November 2005

The top 20 intersections account for 76 percent of total signal delay in the eastbound direction, and 68 percent of total signal delay in the westbound direction.

This suggests that signal delays occurred at dispersed locations along the entire route, that signal delay is a wide spread phenomena along the route, and that route-wide improved signal coordination with transit signal priority could significantly reduce bus travel delays.

The average signal delay by segment is listed in Table 5.4. This shows the potential travel time saving through signal improvement along the route.

Table 5.4 - Signal Delay by Segment

	Average Signal Delay / Run (seconds)
Eastbound	
Toll Plaza - Mandela	31
Mandela - Market	21
Market - Webster	58
Webster - Lakeshore	67
Lakeshore - Fruitvale	74
Fruitvale - Pierson	104
Pierson - Seminary	30
Seminary - Eastmont	24
Westbound	
Eastmont - Seminary	28
Seminary - Pierson	29
Pierson - Fruitvale	126
Fruitvale - Lakeshore	132
Lakeshore - Webster	102
Webster - Market	60
Market - Mandela	31
Mandela - Toll Plaza	37

Source: DKS Associates; November 2005

5.6 Other Delays

Other delays contributed two minutes or four percent of total run time. This section documents their sources, their impact to overall run time, and their locations of occurrence.

5.6.1 Traffic Congestion (13 percent of total delay in westbound)

Traffic congestion was recorded to be the second largest delay source in the westbound direction, which constitutes thirteen percent of westbound total delays (equivalent to 1.3 minute run time). Of this traffic congestion delay, about 50 percent occurred on Bay Bridge, 15 percent occurred between Maritime Street and Toll Plaza, and 30 percent occurred in front of the Maritime Street Signal.

This suggests that exclusive treatment for buses on westbound from West Grand Avenue to the Bay Bridge on ramp could reduce time lost from traffic congestion by 45 percent, equivalent to an average run time reduction of 35 seconds (10 minutes x 13 percent x 45 percent).

5.6.2 Queue in Front of Stops (2 percent of total delay in westbound and eastbound runs)

Queues in front of stops were recorded when a bus arrived near a stop but could not berth to the bus stop due to traffic queuing in front of the stop. These delays usually occurred at nearside bus stops located near intersections with major cross street traffic. The situation worsened when parked cars were present right behind the bus stop, which prevents a bus from "jumping" the queue to the stop. Locations affected by this type of delay are listed below:

Eastbound:
- MacArthur Boulevard at Park Street (three occurrences, averaging 34 seconds)
- Grand Avenue at Perkins Street (one occurrence, 26 seconds)
- MacArthur Boulevard at Lakeshore Avenue (one occurrence, 21 seconds)

Westbound:
- MacArthur Boulevard at High Street (six occurrences, averaging 28 seconds)
- MacArthur Boulevard at 35th Avenue (two occurrences, averaging 41 seconds)

Strategies that could relieve delays of this kind include: extending bus stop length by removing parking, changing the roadway configuration (such as a bus-only lane) for bus to reach stops without delays, changing a bus stop location from nearside to farside, and implementing Transit Signal Priority (TSP) to clear traffic when buses approach stop.

5.6.3 Boarding/Alighting Difficulty (4 percent of total delay in eastbound runs)

Our field observations recorded four instances of passengers with boarding/alighting difficulty on Route NL eastbound and one observation westbound during the survey period. These were passengers with walking aids (walker, cane, etc.). Their average boarding/alighting time was 96 seconds in the eastbound runs, and 22 seconds in the westbound runs.

5.6.4 Crew Shift (2 percent of total delay in eastbound runs, 1 percent of total delay in westbound runs)

Unscheduled crew shifts were observed at the Seminary bus stop. There were three shift changes observed on the eastbound runs, and one observed on the westbound run.

5.6.5 Yield Delays (1 percent of total delay in eastbound runs, minimal in westbound)

Yield delays happen when buses must wait until traffic has cleared to proceed. In the ride check sample, nine counts of yield delays were recorded in the eastbound runs, with delays averaging 6 to 21 seconds. In the westbound runs, three counts of yield delay were observed, ranging from 10 to 30 seconds. Locations and duration of yield delays are listed below:

Eastbound:
- Grand Avenue at MacArthur Boulevard (four counts, average delay 18 seconds)
- MacArthur Boulevard at I-580 MacArthur off-ramp (three counts, average delay 7 seconds)
- Foothill Boulevard at Church Street (one count, 21 seconds)

Westbound
- Lake Park Avenue at Grand Avenue (one count, 30 seconds)
- W. Grand Avenue at San Pablo Avenue (one count, 22 seconds)

To eliminate yield delays, traffic signals can be installed or modified to provide right of way to buses.

5.6.6 Bicycle Loading

Bicycle loading times for both boarding and alighting were minimal compare to other delay sources. A total of seven counts of bicycle delays were recorded, with an average delay of 10 to 15 seconds.

5.6.7 Turning Vehicles (less than 1 percent of total delay)

Delay occurred when buses were stopped behind vehicles making left turns and right turns. The locations of these days are listed as follows:

Eastbound:
- Right turn, 33 seconds, Grand Avenue at MacArthur Boulevard

Westbound:
- Left turn, 58 seconds, MacArthur Boulevard at Alma Avenue (Oakland High vehicles)
- Left turn, two counts averaging 40 seconds, Lake Park Avenue at Grand Avenue

Strategies that can mitigate these delays include imposing turning restrictions, adding left turn pockets, or adding signal phases for left turns (e.g. Lake Park Avenue at Grand Avenue).

5.6.8 Transit Information

Six delays were recorded when passengers asked drivers for transit information. The average delay for transit information was 21 seconds.

5.6.9 Bus Congestion (1 percent of total delay in westbound runs)

Bus congestion is caused when one bus occupies or blocks the bus stop or roadway. Bus congestion was observed at the San Francisco Transbay Terminal (two counts, average delay 57 seconds), MacArthur Boulevard at Canon Avenue (one count, 81 seconds), MacArthur Boulevard at 35th Avenue bus stop (one count, 37 seconds), and 20th Street at Broadway (one count, 18 seconds).

5.7 Dwell Time

Average dwell times are summarized in Table 5.5. Dwell times at Eastmont Mall and the Transbay Terminal are not recorded, as they are layover points where drivers hold open doors for periods that are longer than normal. At the beginning stop of a run, most drivers did not allow boarding until two or three minutes before scheduled departure. Dwell times are usually less than 20 seconds at the ending stop. In most cases buses were able to depart on-time, unless there is significant delay in the immediate previous run.

Table 5.5 – Ride Check Dwell Time

	AM	MD	PM	Whole Day
Eastbound				
San Francisco Transbay Terminal		*layover point*		
I-80 Fwy & Toll Plaza	3	0	1	2
W Grand Av & Mandela Pkwy (Nearside) Bus Stop	6	18	13	11
W Grand Av & Adeline St (Farside) Bus Stop	14	1	8	9
W Grand Av & Market St (Farside) Bus Stop	22	29	34	28
20th St & Broadway (Nearside) Bus Stop	31	26	59	41
20th St & Webster St (Farside) Bus Stop	11	8	19	14
Grand Av & Perkins St (Nearside) Bus Stop	13	18	16	15
MacArthur Blvd & Lakeshore Av (Nearside) Bus Stop	20	11	16	17
MacArthur Blvd & Athol Av (Nearside) Bus Stop	4	20	6	8
MacArthur Blvd & Park Blvd (Nearside) Bus Stop	37	14	13	23
MacArthur Blvd & Randolph Av (Nearside) Bus Stop	14	10	11	12
MacArthur Blvd & Fruitvale Av (Nearside) Bus Stop	29	21	25	26
MacArthur Blvd & Coolidge Av (Nearside) Bus Stop	23	4	20	18
MacArthur Blvd & 35th Av (Nearside) Bus Stop	23	21	30	25
MacArthur Blvd & High St (Farside) Bus Stop	23	3	17	17
MacArthur Blvd & Pierson St (Farside) Bus Stop	14	6	8	10
Seminary Av & Camden St (Farside) Bus Stop	17	38	14	20
Eastmont Transit Center		*layover point*		
Total	**302**	**247**	**310**	**295**
Westbound				
Eastmont Transit Center		*layover point*		
MacArthur Blvd & Seminary Av (Nearside) Bus Stop	34	36	21	30
MacArthur Blvd & Pierson St (Farside) Bus Stop	9	13	27	16
MacArthur Blvd & High St (Nearside) Bus Stop	31	27	17	26
MacArthur Blvd & 35th Av (Nearside) Bus Stop	38	28	29	32
MacArthur Blvd & Coolidge Av (Nearside) Bus Stop	23	30	8	19
MacArthur Blvd & Fruitvale Av (Farside) Bus Stop	49	22	34	37
MacArthur Blvd & Randolph Av (Nearside) Bus Stop	14	3	9	9
Chatham Rd & Park Blvd (Nearside) Bus Stop	25	13	7	16
MacArthur Blvd & Athol Av Bus Stop	18	1	4	9
Lake Park Av & Lakeshore Av (Farside) Bus Stop	22	17	23	21
Grand Av & Perkins St (Nearside) Bus Stop	47	29	13	31
20th St & Webster St (Nearside) Bus Stop	24	13	16	19
20th St & Broadway (Farside) Bus Stop	31	19	34	29
W Grand Av & Market St (Nearside) Bus Stop	12	8	13	12
W Grand Av & Adeline St (Nearside) Bus Stop	17	12	13	14
W Grand Av & Mandela Pkwy (Farside) Bus Stop	6	4	8	6
I-80 Fwy & Toll Plaza Bus Stop	8	0	6	6
San Francisco Transbay Terminal		*layover point*		
Total	**409**	**274**	**283**	**332**

Source: DKS Associates; November 2005

5.8 Fare Payment Time

Fare payment time data was collected for all runs. A total of 705 and 780 samples were collected in the eastbound and westbound runs respectively. Table 5.6 shows basic statistics of the fare payment time. Average time for a passenger to pay was ten seconds in the eastbound direction, and nine seconds for a westbound passenger. The large range of actual payment shows that there is great variation in fare payment time. It took less than one second for someone to “flash” their ride passes to board, while it took up to 133 seconds when someone did not have their exact fare in hand, and had to spend time looking for cash.

Several instances of confusion were observed regarding the new fare starting in mid-September when the ride checks were conducted.

Since the current ridership does not require standees, dwell times were not severely impacted by the large variation of fare payment. However, if ridership increases substantially in the future, measures should be taken to prevent dwell time from impacting overall run time. Use of a smart card fare payment or a fare machine would mitigate this affect.

Table 5.6 – Fare Payment Time

Measure	Eastbound	Westbound
Sample	705	780
Average	10	9
Minimum	0	2
Maximum	92	133

Source: DKS Associates; November 2005

5.9 Summary of Ride Check Findings

5.9.1 Run Time Distribution for Route NL:

- Moving (70 percent, 35 minutes)
- Dwell (10 percent , 5 minutes)
- Signal Delay (16 percent, 8 minutes)
- Other Delay (4 percent, 2 minutes)

Westbound and eastbound travel had similar run time distributions. Westbound travel has a longer run time on the Bay Bridge, and more signal delay, resulting in a longer end-to-end run time.

5.9.2 Signal Delay Distributed Evenly Across the Entire Route:

- The top 20 intersections account for 76 percent of total signal delay in the eastbound direction, and 68 percent of total signal delay in the westbound direction.

- Signal delay is a wide spread phenomena along the route and route-wide improved signal coordination with transit signal priority could significantly reduce bus travel delays

5.9.3 Other Delays are Minimal Compared to Signal Delay. Specific Recommendations to Reduce Other Delays:

- **Traffic congestion at the I-80 on ramp** accounted for 6 percent of westbound total delay. Exclusive treatment for buses on the I-80 on ramp could save 35 seconds on average trip run time.

- **Queues in front of stops** induce secondary delay to buses. Strategies to relieve this kind of delay include extending length of bus stop, changing roadway configuration (e.g. add bus only lane), changing bus stop location from nearside to farside, and adopt Transit Signal Priority (TSP) to clear traffic queue when bus approach stop.

- **Unscheduled crew shifts** contributed an average delay of 56 seconds and 119 seconds for eastbound and westbound respectively. These delays can be eliminated if AC Transit enforces scheduled crew shift at the Eastmont Terminal.

- **Yield and turning** delays can be reduced by modifying traffic operations at busy intersections.

5.9.4 Average Fare Payment Time was 9-10 Seconds per Passenger

Average fare payment time was 9-10 seconds per passenger, with a large variation around the average. Since the current ridership is low, dwell time were not severely impacted by the large variation of fare payment. However, if ridership increases substantially in the future, measures should be taken to prevent dwell time from impacting overall run time. For example, smart card fare payment should be adopted and encouraged.

5.9.5 On board Observations:

- Route NL is a diverse route in terms of its riders and drivers.

- Route NL **route and service information** should be provided at bus stops, and on-board buses.

- Transit information can be enhanced with **automatic stop announcements** and/or electronic bus location display.

- **Rear door operations** needed to be modified and encouraged.

- Traffic in general was light except at highway access points during peak periods.

- Traffic intersection improvements at specific locations can positively impact bus and general traffic flow.

5.9.6 List of locations with signal and other delays:

- Signal delay (8 minutes, 16 percent of total run time): – refer to Table 5.3

- Other delay (2 minutes, 4 percent of total run time):

    - Queue in front of stop: Eastbound: MacArthur Boulevard at Park St, Grand Avenue at Perkins Street, MacArthur Boulevard at Lakeshore Avenue; Westbound: MacArthur Boulevard at High Street, MacArthur Boulevard at 35th Avenue

    - Driver relief: at Seminary bus stop

    - Yield: Eastbound: Grand Avenue at MacArthur Boulevard, MacArthur Boulevard at I-580 MacArthur off-ramp, Foothill Boulevard at Church Street; Westbound: Lake Park Avenue at Grand Avenue, West Grand Avenue at San Pablo Avenue

    - Left/Right turn vehicle: Eastbound: Grand Avenue at MacArthur Boulevard; Westbound: Alma Avenue at MacArthur Boulevard (Oakland High vehicles), Lake Park Avenue at Grand Avenue

    - Bus congestion: San Francisco Transbay Terminal, MacArthur Boulevard at Canon Avenue, MacArthur Boulevard at 35th Avenue bus stop, 20th Street at Broadway

- Other potential delay:
  - MacArthur Boulevard / 68th Avenue narrow intersection and street
  - MacArthur Boulevard / Fruitvale Avenue intersection (westbound), traffic flow limited on singe lane with left turn traffic and street parking
  - Left turn intersection with no designated left turn phrase (Lake Park Avenue at Grand Avenue, San Pablo Avenue at West Grand Avenue)

6.0 FINDINGS AND RECOMMENDATIONS

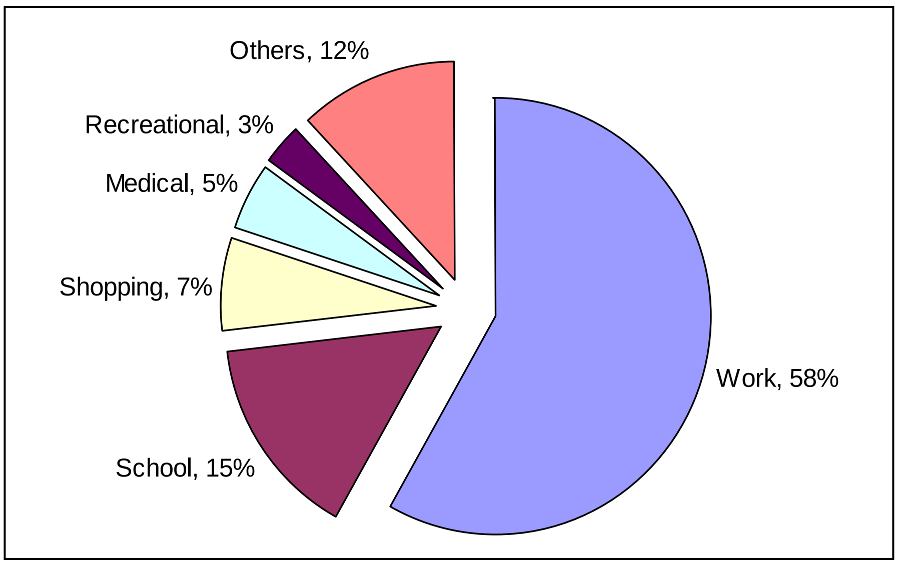
6.1 Findings

6.1.1 Route NL serves many diverse roles during the day

Being a hybrid transbay/local route, Route NL serves as a unique transportation link in the Bay Area, linking 16 miles of neighborhoods and activity centers between Oakland and San Francisco, along the Grand Avenue and MacArthur Boulevard corridor. The route serves diverse destinations, from traditional residential areas such as Millsmont, Laurel, Grand/Lake, to job centers in downtown Oakland and San Francisco, to activity centers such as Oakland High School, Mills College and Eastmont Town Center, to developing areas such as West Oakland, Lakeshore, and Fruitvale. As a result, Route NL is used by a diverse group of riders in terms of trip purpose, ethnicity, and household income.

Figures 6.1 through 6.3 (discussed in Chapter 3 – Rider Characteristics) illustrate the many trip purposes, ethnicity and household incomes among the riders.

Figure 6.1 – Trip Purpose



Source: DKS Associates, November 2005

Figure 6.2 – Ethnicity

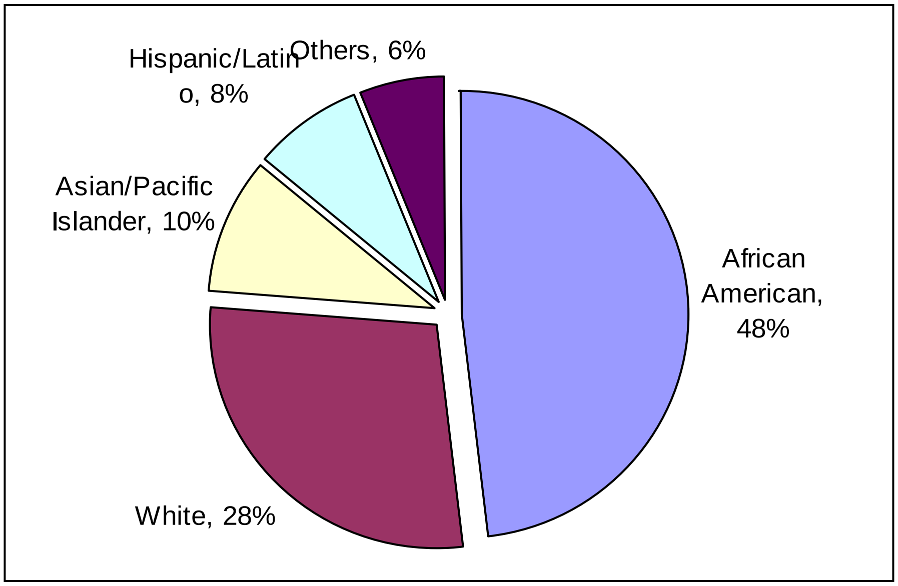
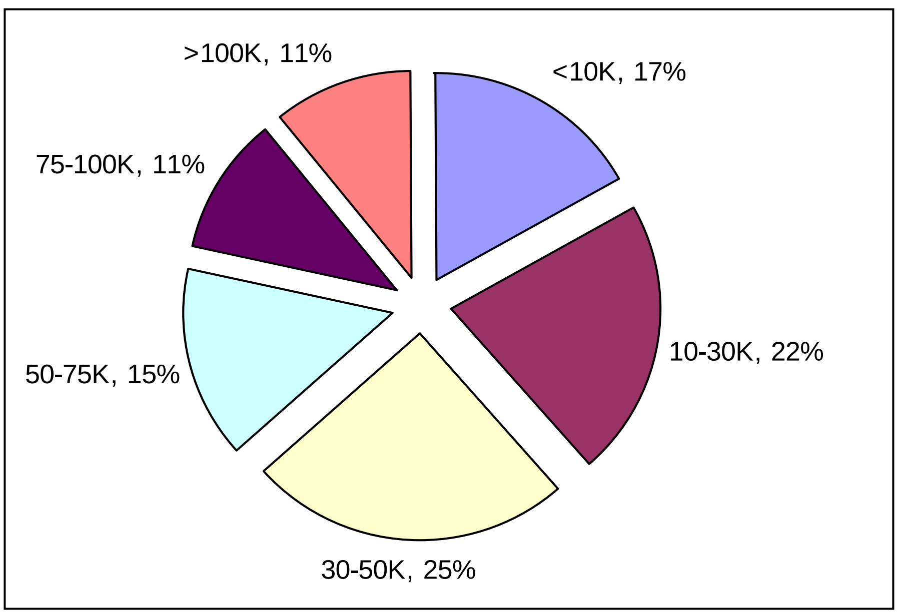


Figure 6.3 – Household Income



Figures extracted from Section 3 – Rider Characteristics

6.1.2 Ridership has not yet realized the Route NL service

Compared to other AC Transit trunk routes that run frequent services (such as routes that run on Broadway, International, and San Pablo), Route NL also provides frequency service 15 minutes with articulated buses, but has much lower ridership. Weekday ridership averaged at 2,600 in spring 2005. This has resulted in low utilization of bus capacity during most times of the day. According to spring 2005 ridership data, a single bus would be able to provide enough capacity for Route NL. However, given the recent rise of gas prices and the recent focus from the region to focus on smart growth that focuses around transit usage, there is potential for Route NL's ridership to increase in both the short-term and long term.

6.1.3 Schedule adherence is currently satisfactory but it can be improved

Buses in general are able to maintain their schedules, as concluded from the analysis of both AC Transit operations data and independently conducted rider check data. Dwell times were short and consistent, and bus speeds correspond to the speed of general traffic along the route. However, there is room for fine tuning current operations to match the current operating environment. Candidates for fine tuning measures include: actual end-to-end run time exceeds scheduled run time in peak directions during peak periods by 5-10 minutes; crew shifts at Seminary stop had induced variability to segment and overall run time, and westbound buses incur delays at the I-80 on ramp during the morning peak period. Figures 6.4 and 6.5 (discussed in Chapter 5) illustrate the overall average route speeds and their relationship to auto travel speeds

Figure 6.4 – Speed – Bus vs. Auto Westbound

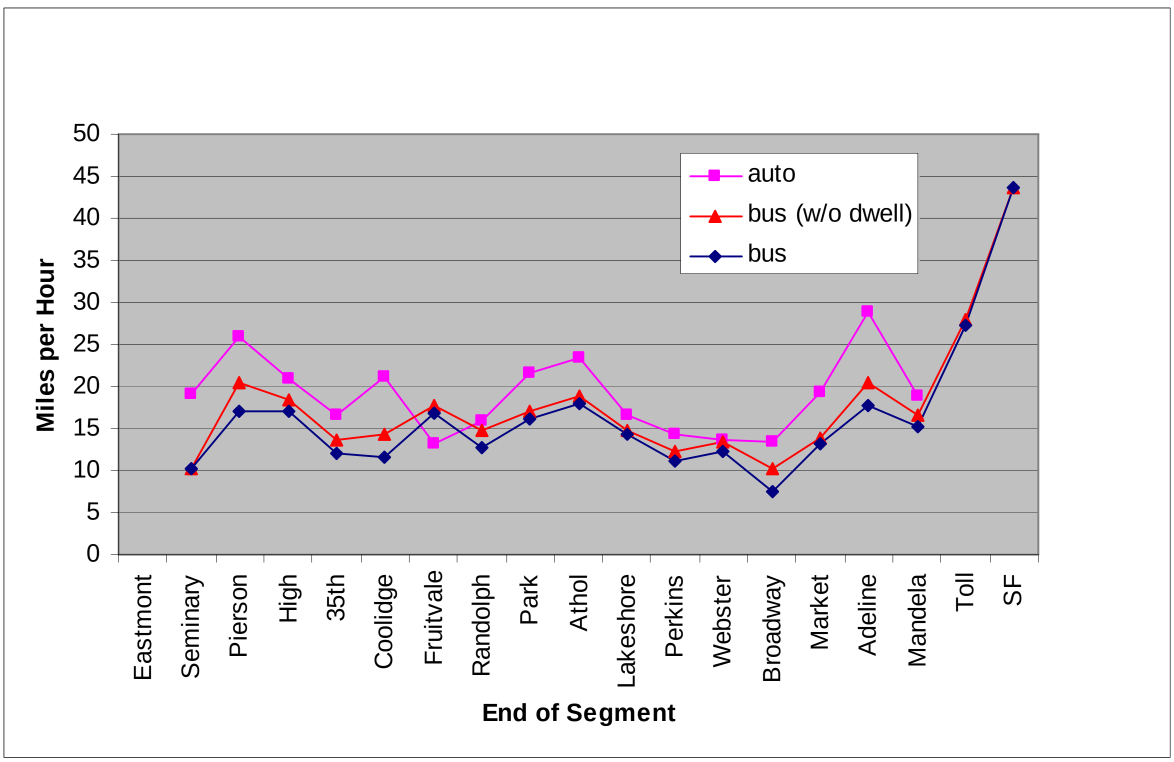
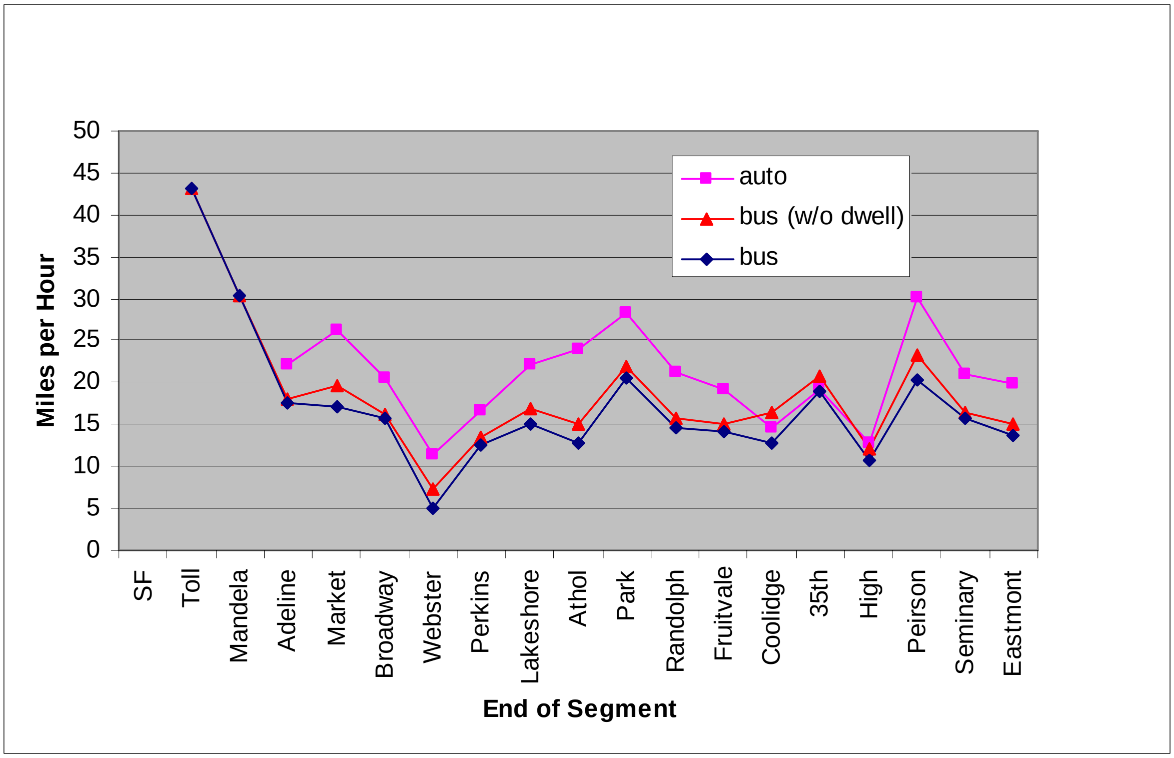


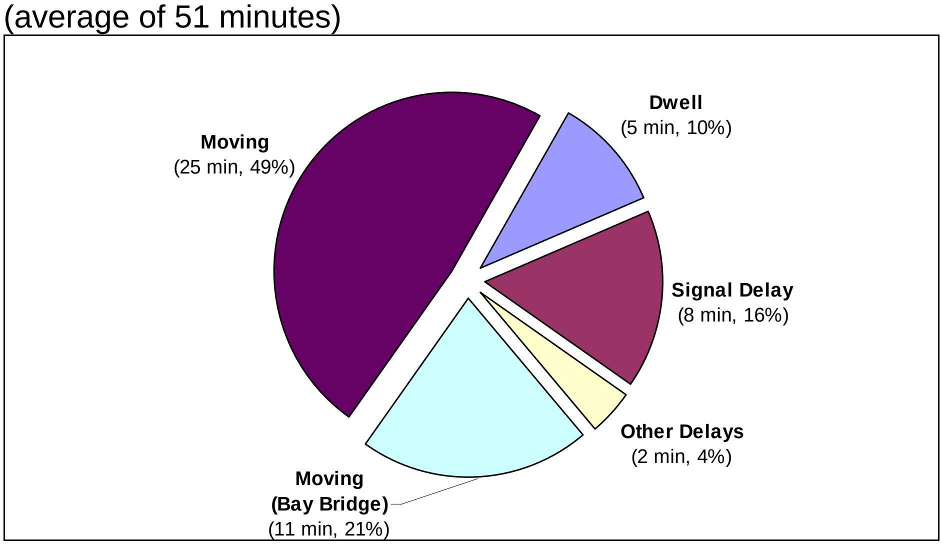
Figure 6.5 – Speed – Bus vs. Auto Eastbound



6.1.4 Signals are the greatest source of delay

Signal delay was biggest source of delay along Route NL, contributing an average of 8 minutes to end-to-end run time (16 percent). A typical run encountered about 20 signal delays for 20 to 25 seconds each, which happened randomly along the entire route. Signal delay also slowed down the bus with deceleration and acceleration for each stop. Therefore, it appears that traffic intersection and signal improvements along the entire route could yield significant run time saving for the Route NL. Figure 6.6 illustrates how signal delays affect the overall bus run times.

Figure 6.6 – NL Travel Time Components (averaged eastbound and westbound)
(average of 51 minutes)



6.1.5 Dwell time delay is minimal but can become a bigger problem when ridership increases.

Average fare payment time was 9-10 seconds per passenger, with large variation around the average. Since the current ridership is low, dwell times were not severely impacted by the large variation of fare payment. However, if ridership increases substantially in the future, measures should be taken to prevent dwell time from impacting overall run time. For example, smart cards and prepaid fare payments should be adopted and encouraged to riders.

6.1.6 Solutions are readily available to reduce delays and improve operations

Upon quantitative and qualitative assessment, multiple solutions are available to mitigate delays and improvement operations. Corridor-wide and segment specific recommendations are presented in the sections 6.2 and 6.3.

6.2 Corridor-wide Recommendations

This section outlines recommendations to improve performance of Route NL. General recommendations are presented first in the Corridor-wide recommendations, followed by a list of issues and recommendations to each segment of the route.

6.2.1 Bus Route Visibility

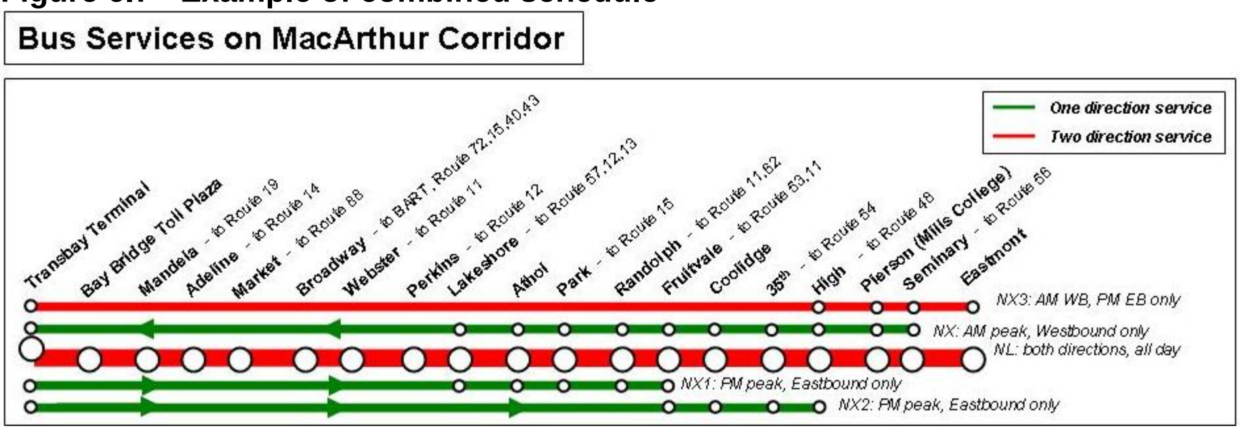
Issue. The Route NL is somewhat hidden today. The legacy of the route as a Transbay Route (as opposed to the local Route 58) prevents casual users from fully accepting the route as a "viable" service for local trips. Finally, route information is often distributed for only the Route NL, so that the parallel benefits of other routes is not explained to the user.

Recommendations. Possible solutions to this problem are:

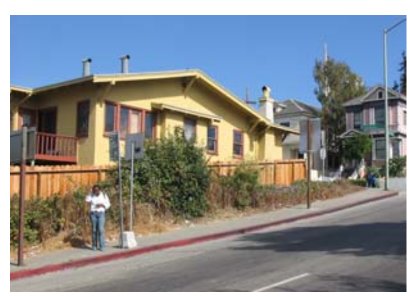
- **Recommendation G-1: Renaming route.** Renaming the route that establishes it as a new service. The use of the term NR is one option. Another would be to more prominently announce the key destination points at stops (for example: Westbound Buses in East Oakland could say "Route NR – Downtown Oakland and San Francisco").
- **Recommendation G-2: Pavement and curb treatments.** The use of pavement treatments to improve the pavement at the Route NL stops and to improve identity at the stops, would greatly improve the understanding of where stops are located and the quality of the roadway. Colored pavement treatments are endorsed in FTA's *Characteristics of Bus Rapid Transit (*August 2004). Currently, most stops are on asphalt pavement; national practices also encourage the use of concrete "bus pads" to ensure that stopped buses do not damage the street pavement; this also provides some identity for bus stop locations. Red aggregate concrete is emerging as a new BRT treatment; bus stop curbs could be replaced with dyed concrete to delineate the bus stop location to riders, and to discourage from using the bus stop for double parking and other items. Many other transit properties place pronounced pavement markings on the street, delineating areas for bus stops only, as the photo below shows. Some coordination with the City of Oakland to approve, design, and fund pavement striping on the route would be needed.

- **Recommendation G-3: Well-lit shelters.** Shelters with good lighting would provide a point of refuge for users, as well as provide some protection from inclement weather. The improved shelter environment could also include trash receptacles, security cameras, and other features to improve the passenger waiting experience.
- **Recommendation G-4: Peak hour NX service explanations.** Route explanations and schedules should include information for the peak hour NX services on the corridor. These routes would also benefit from improvements to the Route NL in the corridor, and a coordinated explanation of the entire route package would assist in showing both riders and policy makers that the MacArthur transit services carry thousands of people each day and offer excellent frequencies. Ideally, express and Route NL arrivals would be provided, so that users can choose the most appropriate service. Figure 6.7 is an example of how the information can be communicated to riders graphically.

Figure 6.7 - Example of combined schedule



- **Recommendation G-5: "Bulb-out" stops.** Sidewalks in portions of the route are very narrow, making it difficult for walking pedestrians and waiting bus riders to share the same sidewalk space. A contributing issue is that many parking lanes on the corridor are too narrow for buses to completely pull out of traffic for boarding. Depending on neighborhood preferences and roadway cross sections, some areas could have larger bus stop areas created by widening the sidewalk into the street (also known as "bulb out" stops) with shelters. These may be designed so that could remain in the full traffic lane, or that the buses could pull partially out of the lane so that traffic could pass by the buses. If a bus stops while in a full lane of traffic and no additional lane or width is available, traffic vehicles could be queued behind a stopped bus. In some cases, moving the stop may be appropriate to enable a larger waiting area. In some locations, standard 60-foot farside bulbs may not be adequate due to the aggregate hourly volume of transit vehicles from different routes that may use the stop; careful assessment of appropriate lengths should be made during design of the bulb.



6.2.2 Route Information

Issue. Information at the Route NL stops generally consists of the letters NL being added to existing bus stops in red. This does not suggest any special recognition of enhanced service beyond the red lettering of "NL". This is something which has been overcome in the San Pablo Corridor with the introduction of the "Rapid" service.

Recommendations. Several items can improve distribution of route information:

- **Recommendation G-6: Signature Identification.** The development of signature identification for the Route NL would assist in defining the route for more people. Currently, the NL route is colored red on bus stops, but it is not distinguished in prominence from other bus routes. The presence of a single symbol would more identify the route within the community. The 72 R Rapid service is an example of this. Another area of confusion is that Route "N" operates only at night, while other single letter routes are commute routes; nighttime routing definitions should also be revisited for consistency.

- **Recommendation G-7: Bus Stop Shelter Information.** On bus stop shelters, a schematic diagram indicating the list of stops and transfer points is useful for bus riders. This makes it clear for bus riders to fully understand the number of stops anticipated if they are on the bus. An example of this is shown in Figure 6.8.

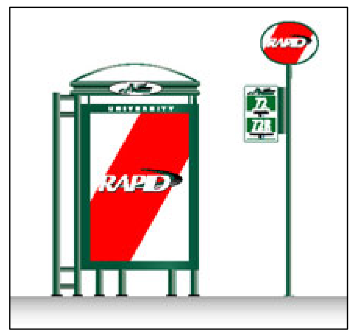
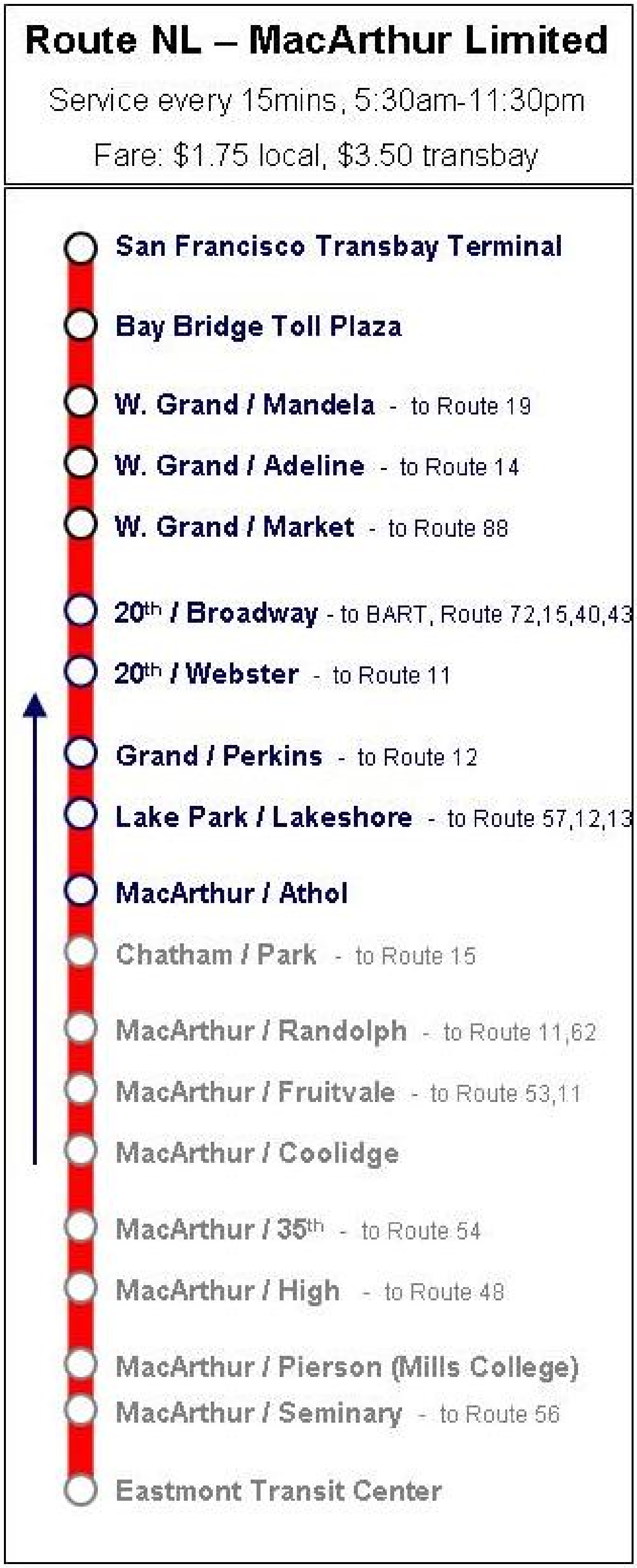
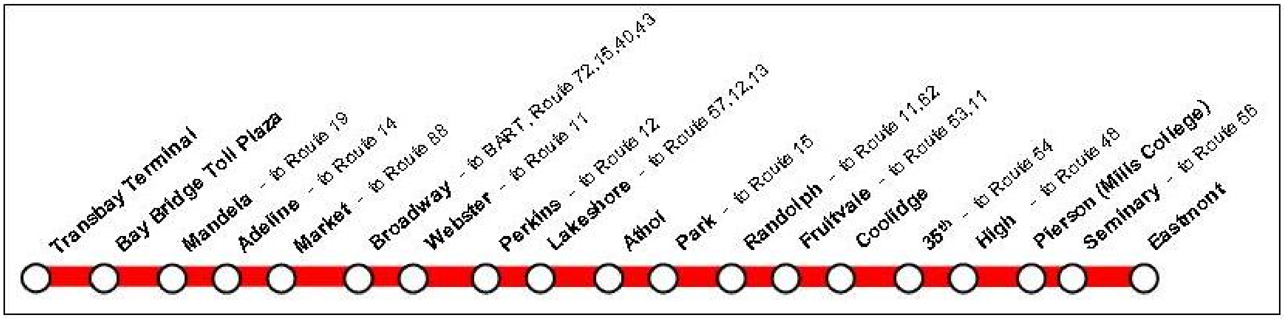


Figure 6.8 – Westbound Bus Stop Sign

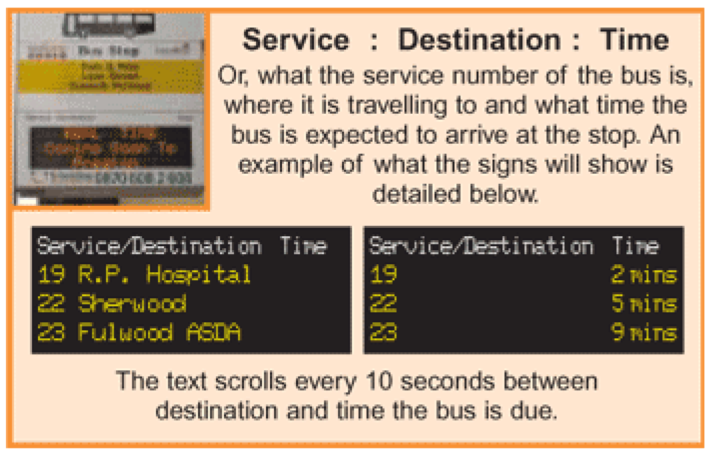


- **Recommendation G-8: Schematic route diagrams.** The identity of the Route NL could be further improved through the wider use of schematic route diagrams inside the bus to provide passenger information. Possible locations include above the doors. An example diagram is shown below. Because bus stop spacing is far, audible announcements of the next bus stop would let riders know when to get off the bus and would encourage riders to approach the doors before the bus reaches the next stop. An example of this is shown in Figure 6.9.

Figure 6.9 – Bus Stop Schematic Diagram



- **Recommendation G-9: Real-time bus arrival systems.** The installation of real-time bus arrival systems would provide great advantage for the route. With real-time arrival information, the waiting rider may be more inclined to board a bus rather than join a casual carpool, or the rider may be willing to wait for the bus at other times of the week when frequencies are not as known. Ultimately, the real-time arrival system would be most beneficial if it would also estimate end time arrivals, such as arrival times at Eastmont Mall, 20th and Broadway or the Transbay Terminal. Some transfer locations may benefit from real-time arrival information on crossing routes. This is more information than is currently enabled on the Route 72R real-time bus arrival signs. An example from Presonbus.co.uk is shown here. These signs can also be used to provide information in other languages if needed.



6.2.3 Attracting Additional Riders

Issue. A number of available seats on the Route NL are not filled, and the loads do not approach the levels that a BRT service could carry. Attracting additional riders not only requires disseminating more information and other marketing strategies, but also making targeted efforts to attract other segments of the potential riding populace.

Recommendations. Several targeted markets have been identified:

- **Recommendation G-10: "Trunk route" for bicyclists.** Because BART has a prohibition on bicycles in the Transbay Tube at commute hours, providing alternative bicycle service could be very marketable. The Bay Bridge bicycle shuttle ends at MacArthur BART and runs at a lower frequency than does the Route NL, so that the Route NL could become the "trunk route" for bicyclists. To attract this market, boarding alternatives may need to be offered to bicyclists –

such as on-board bicycle storage (rather than on racks outside of the bus) and bicycle parking at key bus stops.

- **Recommendation G-11: Casual carpoolers.** Parts of the corridor experience casual carpooling at commute hours. These users could be bus riders, and the ability of a person to choose whether to be a rider or a casual carpooler is a function of the anticipated wait and arrival times. Thus, the provision of real time information could help attract more casual carpoolers to the bus. Casual carpoolers are often found on West Grand Avenue at Perkins.

- **Recommendation G-12: Park-and-ride commuters.** Although most riders typically walk to the bus today, the bus could be used to attract persons who would view the service as a "parking shuttle system" to reach locations in San Francisco or Oakland with expensive or limited parking. First, most persons do not realize that this route offers a very wide span of service. The location of park-and-ride lots near the Bay Bridge would help to augment ridership on this segment of the route, as the service could be marketed as an alternative to being stopped at the metering lights. While no specific new lots are identified here, the opportunity to add park-and-ride spaces in West Oakland should be considered if land becomes available.

6.2.4 Route Changes

Issue. Some questions about the relevancy of the Route NL have been raised. The route operates along a busy corridor, yet there are no major all-day trip attractions on the corridor. Certainly, the corridor travels through heavily developed residential areas and commercial districts, but there is no single major location on the corridor that attracts all-day riders (such as a major university or regional shopping center). The result is that the service cannot focus its operations to service a single area

Recommendations. A number of possible recommendations can be made to enhance the attraction of the service to all-day trip attractions.

- **Recommendation G-13: Schedule Coordination**. Better linkage to other bus routes and/or transit modes by coordinating schedules to optimize the opportunities for cross connections.

- **Recommendation G-14: Better Linkages to Major Trip Attractions**. There are several locations on the corridor which are potentially strong all-day trip attractions. The major one is Highland Hospital. The difficulty in serving the hospital is the connectivity dilemma one faces if one is trying to stay on a timely route while service this area. Specific recommendations for Highland Hospital access is discussed below.

- **Recommendation G-15: Route Extension to 106th Avenue**. Portions of East Oakland beyond Eastmont Mall are some of the areas where the transit dependency is high. Castlemont High School and Foothill Square Shopping Center are major trip attractions located along this segment. Service to these major trip attractions could increase corridor ridership. This area has also had new residential development along the corridor. Still, planning efforts along this part of the corridor have been focusing on traffic calming measures, and Route NL may not be able to attain the travel speeds on this segment as they currently enjoy west of Eastmont Mall.

- **Recommendation G-16: Planning for New Major Attractions along the Corridor.** Additional use of the corridor could be increased through redevelopment to encourage major attractions along the corridor. Several large developments are currently in development on parts of the corridor. For example, several parcels of land available in West Oakland are underutilized; these could be potential destinations for high activity nodes.

- **Recommendation G-17: Providing Bus Stops Near to New High-Density Residential Development.** In some cases, the addition or relocation of bus stop may be a successful strategy to attract new riders. Within various segments of the corridor, strategies to relocate or add bus stops are more fully explained.

6.2.5 Overall Vehicle Travel Speeds

Issue. As shown in Section 4.6.2, there is a direct correlation between bus travel speeds and auto travel speeds. If autos are slowed, then buses are as well. While the arterial roads on this route serve many functions, the provision of transit service represents a sizeable daily public investment in the corridor that is affected by vehicle speeds. This is a substantial daily public investment in the corridor. Improving bus speeds improves productivity and encourages riders, resulting in the need to provide less public subsidy per rider in order to operate the route.

Recommendations.

Recommendation G-19: Bus Operations in Narrow Lane Areas. In some isolated cases, the removal of a through travel lane combined with a left turn pocket could assist in the operation through commercial districts with high activity. Several intersections experience inordinate amounts of delay because there is only one lane for all turning movements; these generally should be avoided.

Recommendation G-20: Prioritizing of Intersection Level of Service for Approaches with Bus Routes First. Intersection level of service evaluation on the route should require that the level of service be presented by approach, and that in places where level of service deficiencies occur, that the level of service standard be achieved for the Route NL path approaches first.

Recommendation G-21: Packaging of Improvements. To obtain improved overall speed and reliability, a package of improvements would need to be implemented. The specific segment improvements discussed later in this chapter have benefit for the route as a whole in travel speed, reliability and productivity. Thus, the improvements should be viewed as a package, and not mere individual recommendations.

6.2.6 Transit Signal Priority Treatments

Issue. When buses must operate within general vehicular traffic, bus travel is often at a disadvantage. Since buses must yield to cars when merging back into traffic (waiting for an acceptable gap), design and operation of the bus often requires transit priority measures that need to be implemented. Specific issue and recommendations presented here are operational improvements which can benefit buses.

Recommendations. In order to achieve transit signal priority, an upgrading of signal systems would be required. Key elements of this upgrade would include:

- **Recommendation G-22: Traffic Controller Hardware Upgrade to Permit Transit Signal Priority Programming.** Installation of new, more modern traffic controller hardware and signal interconnects would allow the City of Oakland to establish traffic coordination plans whereby platoons of traffic move through a group of signals with decreased stops and delay. The installation of vehicle detectors for side streets and pedestrian push buttons (PPBs) can also enable longer green times on routes that carry transit vehicles. These same traffic controllers (such as Type 170E) are also capable of supporting Transit Signal Priority programming which results in decreased signal delay for the transit vehicle. With upgrades, Pedestrian Push Button (PPB) functionality should also be implemented for optimized signal operations in concert with pedestrian behaviors (such as calling pedestrian phases only when required). Most PPBs in Downtown Oakland already operate on recall from 6 AM to 6 PM.
- **Recommendation G-23: Transit Priority Detectors.** The installation of transit priority detectors at the main approaches to traffic intersections allow the traffic signal controller to sense the arrival of transit vehicles and react appropriately to extend the green phases on the BRT route and to decrease signal delay. The placement of these detectors may require the replacement of existing poles or the installation of new poles and mast arms. The Alameda County Congestion Management Agency (CMA) currently employs transit signal priority (TSP) detectors for the East Bay SMART Corridors program using the 3M OPTICOM emergency vehicle pre-emption (EMP)

units. The units provide high priority for emergency vehicles as well as low priority for transit vehicles.

With an upgraded signal system, Transit Signal Priority (TSP) strategies can assist in reducing the additional delay created by giving buses priority in particular circumstances. Some examples include:

- **Signal coordination**. Overall signal coordination for all of the signalized intersections located between two bus stops enables buses to move with the flow of traffic, reducing unnecessary stopping between each stop. Use of detectors on side streets also contribute to longer green times on streets where bus routes operate.

- **Extended green phases**. Utilization of extended green phases on the BRT route if a bus is approaching so that the bus would not have to wait.

- **"Queue jump".** The phasing of through movements and protected left-turn movements can be changed or switched if buses are approaching an intersection, which could reduce the aggregate wait time of buses at signals.

  Installation of a "queue jump" signal phase where bus stops are near side and re-entering traffic is difficult. If given an early phase, buses can re-enter traffic in front of the platoon of vehicles. This way, a bus would not have to wait until the platoon of vehicles pass before re-entering a traffic lane. However, such a phase may require that right-turns be prohibited or controlled by a separate signal phase.

6.2.7 Fare Collection

Issue. There are a large number of fare payment options that a rider can use. This creates delay, as some persons are prone to need clarification on what the fare should actually be. The large percentage of both local and Transbay riders further complicates this delay.

Recommendations. There are several ways that AC Transit could address this. The options include:

- **Recommendation G-24: Translink.** The ability to create faster boarding and unloading would help to reduce the overall dwell times during the course of the route. While a number of options could be considered (such as fare machines and proof-of-payment), the fastest way to achieve quick boarding without a significant investment would be through the Translink card program. Another advantage to the Translink program is that the Transbay versus local fare issue would be automatically handled without complicating the purchase of various types of fares.

- **Recommendation G-25: Pre-paid fare area (proof of payment).** Time associated with boarding activity at the Transbay Terminal is high. This is a location where proof-of-payment could speed boarding. The ability to install pre-paid fare areas would need to occur in concert with an overall AC Transit strategy to introduce pre-paid treatments. Establishing pre-paid fare areas in other portions of the route will not significantly speed boarding due to low boarding volumes.

6.2.8 Bicycle Treatments

Issue. MacArthur Boulevard through the study area is a bicycle route recognized in a number of bicycle plans. In the adopted 1999 City of Oakland Bicycle Master Plan, the corridor is designated as a special study corridor from 14th Avenue eastward to the City limits. Bicycle lanes have already been installed between 35th Avenue and Lincoln Avenue, and Park Boulevard to Lakeshore Avenue.

In the 2006 update to this plan (proposed but not yet approved), the segment of MacArthur Boulevard between the Grand Lake district and Seminary Avenue is proposed for completion of a bicycle lane except for the portion between 35th Avenue and High Street. Current proposals are to reduce two traffic lanes to one for some segments (totaling 0.6 miles) to accommodate the bicycle lanes, while lane removal is not required for others. The Alameda Countywide Bicycle Plan, proposed for adoption in May 2006 contains a similar recommendation. Also, an additional segment of MacArthur Boulevard between Lakeshore Avenue and 14th Avenue is included in the bicycle lane network in both plans.

The reconfiguration of roadway striping to include bicycle lanes is a complex topic that affects both safety and overall traffic flow. For transit operations, bicycle lanes present several additional challenges which could result in decreases in bus speeds in two key ways:

- The addition of a bicycle lane creates additional distance between travel lanes and the curb (because of the added presence of a bicycle lane). Buses need adequate room to pull out of a travel lane to reach a curb where curbside stops are located. Bus riders may experience uncomfortable sideways movement if the lane shifting is abrupt. The location and length of a bus stop must be examined carefully so that the additional sideways distance could be facilitated.

- Some new bicycle lane segments may require the removal of a travel lane. The removal of a travel lane generally would result in less maneuverability and speed for bus operations. It could likely result in additional queue lengths at signalized intersections as vehicle through movements would need to be channelized into one lane rather than two, which then results in delays as buses must wait in longer queues. Buses should be able to move around a queue of vehicles waiting at an intersection to reach a nearside stop, so that the longer queues may require any affected nearside stops to be lengthened (through the removal of parking) to enable the bus to more quickly reach a stop.

It is recognized that a reduction in lanes along the corridor in order to provide a bicycle lane would result in slower traffic platoons and would increase delays at intersections due to longer queues, thus reducing transit speed and reliability. Decisions on the most appropriate treatment for bicycles should require careful consideration on a segment-by-segment and even an intersection-by intersection basis. Changes to roadway striping should be made in a manner that allows for both safety and operational merits to be balanced for all users of the street including bicycles, pedestrians, drivers and passengers, bus drivers, and passengers and persons who live or operate businesses on the street.

Recommendations. To minimize the impact of decreased speeds and reduced reliability as a result of installing a bicycle lane on additional segments of MacArthur Boulevard, key recommendations are made here:

- **Recommendation G-26: Detailed analysis where lane removals are proposed.** The introduction of a bicycle lane on some of the roadway segments may require reducing the number of travel lanes from two to one. Any slower general traffic flow will also generally reduce bus travel speeds because buses share the roadway with vehicles. Similarly, buses may not be able to re-enter traffic easily if there is a longer platoon of cars created by the removal of a traffic lane. Any effort to remove traffic lanes should be done with careful analysis of how AC Transit buses would operate and whether there would be any additional approach delay for buses. Specific configurations at signalized intersections should be scrutinized closely to minimize the length of vehicle-bus queues; in instances where increases in approach queue lengths occur, discontinuing a bicycle lane should be given strong consideration to minimize this delay.

- **Recommendation G-27: Roadway markings where bicycle lanes are not appropriate.** The addition of roadway markings may improve improved awareness of where bicycles and vehicles belong on a roadway where bicycle lanes are not appropriate. One option is to provide "sharrows" to indicate the existence of a bicycle route.

- **Recommendation G-28: Sufficient lane width in single lane segments.** In instances where bicycle lanes would require the reduction from two to one traffic lane, overall vehicle travel speeds could be reduced, which would then reduce bus travel speeds. Many areas of the corridor contain places where lanes are narrow so that when a vehicle is moving slow or blocking the roadway (such as a parallel parking maneuver) the bus has no alternative path available. Providing a wider single lane is important should the number of lanes be reduced from two to one in a single direction to maximize bus maneuverability around instances of delay. A minimum of 12 feet is recommended for these sections, with greater cross-section widths more desirable in commercial areas, where parking maneuvers and driveway activity are greater.

- **Recommendation G-29: Installation of reversible left-turn lanes or left-turn pockets in single-lane segments.** In areas where left-turning traffic movements are frequent and only one travel lane would exist, left-turning vehicles would create additional delay for buses behind them. In situations where the installation of a bicycle lane would result in only a single travel lane, a left turn pocket or a reversible left-turn lane should be strongly considered to reduce possible bus and vehicle operational delays, minimizing impacts to bus speed and reliability.

6.2.9 Pedestrian Access

Issue. All bus riders are pedestrians at some point during their journey. Thus, the careful layout of pedestrian paths and waiting areas is important for rider safety and for attracting new riders. Some of the corridor issues include these:

- The sidewalks along many segments of the MacArthur Boulevard portion of the corridor are very narrow. The result is that the pedestrian waiting environment is not comfortable, and can quickly become overcrowded. In some locations, the stops are inter-mingled with driveway traffic from adjacent businesses, and this again creates a less than desirable waiting environment.

  The challenge is whether or not there are viable options to relocate bus stops. This is particularly difficult where there are intersecting routes – about half of the total number of stops for the Route NL. Furthermore, several stops are not located near signalized intersections, and some stops do not have crosswalk markings.

- Crossings at signalized intersections can become difficult for pedestrians at locations that have not been upgraded to be more pedestrian friendly. For example, some persons may choose to cross the street and be stranded on a median if they are not prepared for signal phase changes. Also, many of the crossings currently do not accommodate wheelchairs and other ADA-friendly features.

Recommendation G-30: Improved Pedestrian Circulation. Pedestrian environment issues are localized issues that must be addressed on a stop-by-stop basis. Still, improvements should be programmed as much as possible to create a unified identity to the route operation.

The City of Oakland typically includes features to improve pedestrian crossings as part of the City's current traffic signal design standards. Although these features will not directly impact transit performance, they should improve pedestrian access and safety. These features include:

- Installation of “count-down” pedestrian signal heads; and
- PPB poles, ADA-compliant PPB, ADA-compliant curb ramps and sidewalk improvements along all approaches of an intersection.

6.2.10 Web Interface

Issue. As technology advances, riders will expect to have the ability to obtain bus location information prior to leaving their home or workplace. Technology solutions that would answer questions about bus stop arrival will increasingly be something that bus users could be interested in using.

Recommendation G-31. Web Interface Technologies. As AC Transit continues to implement new technologies that offer more reliable and attractive service, the ability to establish real time bus arrivals through an interface with the internet will become more important. A systems strategy to allow for individuals to have a direct feed announcing the arrival of buses at the nearest stop would be attractive to residents who would be able to leave their homes in time to catch the bus. The dissemination of information can take several avenues ranging from Internet web sites to voice and text messaging to mobile telephone users.

Web interfacing can be accomplished within Alameda County CMA web site (www.smartcorridors.com). This web site which provides CCTV camera feeds and traffic congestion information for the existing East Bay SMART Corridors. In addition, this web site provides links to other pertinent transportation web sites in the Bay Area such as 511, AC Transit, BART, Amtrak, Caltrans, and CHP. This web site can be updated to include Grand-MacArthur information as field devices are deployed.

6.2.11 Traffic Operations Monitoring and Integration

Issue. Chapter 4 of the report documents a direct relationship between bus travel speeds and overall traffic speeds. Improving overall traffic speeds can be achieved through better traffic operations monitoring and integration.

Recommendations. As part of a program to improve traffic operations, specific elements should be included to optimize the traffic flow. These include:

- **Recommendation G-32: System Detectors.** System detectors allow traffic data to be detected in real-time and congestion levels to be identified. This information is currently collected for other corridors. A variety of technologies can be used for this; the CMA currently uses radar and microwave vehicle detection systems. (It should be noted that this information can also be integrated into traffic information systems on the Web.)
- **Recommendation G-33: Vehicle Detection at Signalized Intersections.** The installation of general vehicle detection at the minor approaches of a traffic intersection allows the traffic signal controller to serve the side-streets only in cases when there is demand. This results in a maximum amount of green time for the primary approaches to intersections (such as MacArthur Boulevard and Grand Avenue) and thus decrease in traffic signal delay experienced by transit vehicles. Because the City of Oakland prefers to use video detection, the system will likely require the replacement of existing poles or the installation of new poles and mast arms to accommodate the video cameras.

6.2.12 SMART Corridor Integration

Issue. Reliable communications are needed in order to accomplish many of the recommendations identified in this report. The concept behind this coordination and its related components is generally known across Alameda County as the East Bay SMART Corridor Program.

Recommendations.

Recommendation G-34: SMART Corridors Program. The Grand-MacArthur corridor should be incorporated into the East Bay SMART Corridors Program. This will enable transportation management staff and transit vehicle patrons to know about existing travel conditions. SMART Corridor enhancements may include dynamic message signs, information dissemination via the Internet, transit priority detectors, traffic signal upgrades/transit signal priority software. pedestrian push button systems, and Type III signal hardware service cabinets. This may also include video detection for vehicles and bicycles, pedestrian push buttons, and emergency vehicle preemption for all approaches/legs of an intersection to improve overall operations and safety at an intersection.

Recommendation G-35: Communications System. To enable coordination, a communications system must also be provided. Communications between controllers, to a central signal system, and between other ITS field devices and a Transportation Management Center (TMC) would allow for traffic signal coordination plans to remain calibrated, and to respond quickly to unusual traffic flows. The City of Oakland has a central traffic control system. Alameda County CMA has employed Digital Subscriber Lines (DSL) for field-to-center communications at other locations. Communications between traffic controllers will be accomplished using the most cost effective means since no existing copper twisted pair is present along the corridor.

Recommendation G-36: Real-Time Monitoring. A final element is the installation and use of monitoring cameras. Cameras can be used to monitor traffic conditions at key locations, such as the Eastmont Mall Transit Center and Transbay Terminal. The video feed from these cameras can be made available to AC Transit dispatch as well as the public over the Internet. AC Transit could use the video to verify traffic conditions as well as the presence and severity of traffic related incidents along the corridor in order to quickly respond to unusual traffic conditions.

6.2.13 Schedule Adjustments

Issue. Given the operational conditions on the route and driver layover requirements, it is sometimes difficult to maintain the round trip travel time with layovers using eight buses.

Another issue is that there are occasional driver reliefs that occur at the Seminary stop. This operation results in a longer trip time for users as well as reduces the arrival predictability downstream on the route. AC Transit would have to determine how to implement this change, if possible.

Recommendations. Possible solutions to these issues are:

- **Recommendation G-37: Addition of Ninth Bus.** In the interim, the addition of a ninth bus would continue to allow for adequate recovery time at the Transbay Terminal during peak hours, when bridge congestion slows bus travel times. This would improve on-time departure of the subsequent trips as well as provide time for a driver break. In the long run, the number of buses assigned to the existing route could be reduced back to eight if speed enhancements are realized through transit signal priority.
- **Recommendation G-38: Route Extension.** A route extension to 106th Avenue could provide an opportunity to serve more people using the same number of buses as are in use today. Any route extension must look carefully at the resulting round-trip travel times.
- **Recommnedation G-39: End of Route Driver Reliefs.** Driver reliefs should be made at the end of the route instead of intermediate points. This will reduce on-board trip times for riders as well as improve schedule reliability for the entire run.

6.3 Specific Recommendations by Route Segment

Detailed recommendations are made for various locations. It should be noted that these are conceptual recommendations; any recommendations for signalization, signal phasing changes, lane reconfigurations and parking removal could require additional technical studies including, but not limited to, warrant evaluation, level of service analyses, and parking surveys. Some of these will be addressed in traffic studies related to this corridor.

Segment 1: Eastmont Mall to West of Seminary

Issue. Operations are hampered by slow, congested, and unsignalized intersections located between 68th Avenue/MacArthur Boulevard and Eastmont Mall. In particular, the all-way stop at 68th Avenue/MacArthur Boulevard results in bus operational difficulties and occasional travel time delays as the approaches are narrow and all buses must turn at this location.

Recommendation S1-1 (Implemented in advance of final report). Route NL could be rerouted onto Camden Street rather than using MacArthur Boulevard between Foothill Boulevard and Seminary Avenue. This change requires relocating stops at Seminary Avenue. Stops at Camden Street pose operational problems as noted below. The rerouting would significantly reduce the turning movements required to negotiate this portion of the route. Camden Street has been recently identified as a street suitable for bicycle lanes; consideration of the street cross-sections and intersection operations could affect the desirability of using Camden Street.

Issue. The westbound stop on MacArthur at Seminary Avenue is a badly sited bus stop location. The waiting area is small, and the stop is placed between driveways of a service station/convenience store. The bus also has signal delays that occur at this intersection, averaging 17 seconds per run.

Recommendation S1-2. Assuming the route segment is relocated from MacArthur Boulevard to Camden Street west of Seminary Avenue, this stop could possibly be moved to a far side stop using the right turn island of MacArthur Boulevard if adjustments to striping and the right-turn island are made. This would also allow the introduction of TSP measures at the Camden/Seminary/MacArthur intersection. Detailed analysis would be required to make this design change.

Issue. The eastbound stop on Seminary Avenue is awkwardly sited as a mid-block stop and is deficient in length (60 feet). There are no crosswalks for alighting passengers. Also, the waiting area is not desirable, yet there is little boarding activity at this stop today. A route extension could change that level of activity.

Recommendation S1-3. Assuming the route is relocated to Camden Street, this stop could be moved to a far side stop on Camden Street. This would also allow the introduction of TSP measures at the Camden/Seminary/MacArthur intersection for the eastbound route.

Issue. The intersection of Seminary Avenue and MacArthur Boulevard/Camden Street has signalized delays for eastbound buses. Westbound buses have no delay as this is a free right turn.

Recommendation S1-4. The intersection could be modified for transit priority treatments. Possible treatments include a swap of the left-turn phase from eastbound MacArthur Boulevard to be after the through movement phase if an eastbound Route NL bus is approaching. If the route is revised to proceed through to Camden Avenue, other TSP measures for buses in both directions can be introduced.

Segment 2: West of Seminary Avenue to East of High Street

Issue. The stop at Pierson Street is not very visible and the sidewalks are narrow for waiting passengers.

Recommendation S2-1. The stop could be given greater prominence, as discussed in the General Recommendations.

Issue. The eastbound buses must stop at a stop sign located where traffic leaves the frontage road and continues down MacArthur Boulevard.

Recommendation S2-2. An introduction of a signal control for this stop sign for both lanes of eastbound traffic would facilitate safety and improve bus and traffic operations at this intersection. This intersection should be monitored for possible signal installation. Coordination with Caltrans is required.

Segment 3: Laurel District -- East of High Street to West of 35th Avenue

Issue. The westbound nearside stop on High Street is poorly sited. The stop conflicts with adjacent driveway traffic, and the sidewalk is narrow. Finally, buses become queued behind cars as the westbound approach to the High Street intersection becomes delayed with a high volume of left turning vehicles.

Recommendation S3-1. Several operational strategies could be studied to identify how to improve bus operations. First, realign the lanes on the east side of this intersection to enable a larger bus stop; this would require shifting the lane striping south about three feet (eliminating parking on the south side of the street). If additional width was provided, a queue jump phase could be installed for westbound buses to allow them to get in front of the traffic platoon, although this may prove to be a problem for right-turning vehicles. Another option is to explore the channelization of westbound right-turning traffic, and install a near-side bus stop island adjacent to the through-movement lane or a far-side stop.

Issue. The Laurel Business district is congested, and the streetscape has recently been upgraded. There is some interest in removing a lane of traffic for bicycles in this area; this could create a situation where buses would need to trail vehicles driving on this segment. Observations are that some specific locations exist where parking or left-turn activity result in periodic delays to the bus, such as traffic near Albertson's.

Recommendation S3-2. Transit travel speeds through the Laurel District should be considered when studying changes to the commercial district cross-section. Further technical studies are recommended, and a dialogue to make improvements in coordination with local merchants should continue.

Issue. Local transit routes accessible through Laurel Business district are discontinuous. The operation of both Route 48 and Route 14 are such that transfers are required and access to local businesses is somewhat difficult because riders must walk from their stops.

Recommendation S3-3. AC Transit could examine the reasonableness of through-routing Routes 14 and 48. This would not only improve access between the Laurel District, Chinatown and Fruitvale Districts, but would also minimize transfer activity at 35th Street and High Street – places where transit vehicles experience operational challenges.

Issue. The eastbound and westbound bus stops at 35th Avenue are located to the near side of the intersection, and significant delays were identified in both directions. This is a major intersection and transit transfer point.

Recommendation S3-4. In situations where an intersection with a high percentage of turning movements is congested, It is preferable to relocate bus stops to the far sides of intersections. If bus stops are relocated to the far sides, new transit signal priority (TSP) techniques could be introduced to speed operation of the buses such as extended green or early red phases. Because a driveway blocks the far side site for westbound buses, some coordination with the adjacent property owner would be needed to relocate this driveway. (It is noted that this relocation is already planned once a guide wire is moved.) If bus stops are left on the near-side, it may be necessary to explore parking removal for a distance far enough from the signal to allow AC Transit buses to travel around queued cars in order to reach the stop.

Segment 4: West of 35th Avenue to east of Lincoln Avenue

The Issue. The near side bus stops at Coolidge Avenue have narrow waiting areas and are not designed well for transit signal priority. There was some traffic signal delay noted at this location. Westbound buses have an average delay of nine seconds.

Recommendation S4-1. Although not critical for travel time savings, enhancements at this stop would provide for improved waiting and crossing conditions (especially associated with the large number of students that use this stop). A far-side stop would be more operationally desirable, but the positioning of the driveways and buildings does not easily allow for this. The most logical strategy would be to develop a signal timing plan for Coolidge Avenue to provide an extended green phase for buses on MacArthur.

The Fruitvale Alive! Master Transportation Plan includes improvements at this intersection. These would provide additional pedestrian safety and would not compromise the operation of this bus stop in either direction.

Segment 5: Fruitvale District – east of Lincoln Avenue to east of 14th Avenue

Issue. The intersection at Lincoln Avenue experiences vehicle delays associated with the high percentage of turning movements and the long green phase for Lincoln Avenue traffic. This delay averages nine seconds in the eastbound direction, and 16 seconds in the westbound direction.

Recommendation S5-1. Installation of TSP to reduce the long green phases for Lincoln Avenue when a Route NL bus is approaching would provide improved travel times for the buses.

Issue. The westbound traffic at intersection of Fruitvale Avenue and MacArthur Boulevard experiences significant delays because one lane serves all movements. The westbound buses have an average of 20 seconds of delay.

Recommendation S5-2. A reevaluation of the turning movement and channelization at this intersection could improve transit operations. This could be accomplished by adding a separate left-turn lane and removing parking on one side of the street for a short distance. This improvement was also identified in the Fruitvale Alive! Master Transportation Plan.

Issue. The eastbound stop at Fruitvale Avenue and MacArthur Boulevard is located to the near side of the intersection. There is an average of 17 seconds of signal delay for Route NL buses at this intersection.

Recommendation S5-3. The stop could be relocated to a far side location, and a larger waiting area could be constructed by increasing the radius at Champion Street. The long diagonal crosswalk on the south side of MacArthur Boulevard across Champion Street could also be reduced, improving crossing safety. This improvement was also identified in the Fruitvale Alive! Master Transportation Plan.

Issue. The multi-phased intersection at Canon Avenue/East 38th Avenue/Excelsior Avenue with MacArthur results in signal delays to the Route NL. This delay is 24 seconds eastbound and 18 seconds westbound.

Recommendation S5-4. Ideally, this intersection is a candidate for reevaluation of the approaching traffic. If the current intersection remains unchanged, the sequence of side street green phases could be overridden through transit signal priority if a bus was approaching, or a green time extension could be implemented. This Fruitvale Alive! Master Transportation Plan identified this intersection as a candidate for improvements.

Issue. The bus stops at Randolph Avenue are located in areas with narrow sidewalks.

Recommendation S5-5. As discussed in the General Recommendations section, improved amenities at this location would increase bus visibility.

Segment 6: East of 14th Avenue to West of Lakeshore Avenue

Issue. The intersection of 14th Avenue/Glen Park Road and MacArthur Boulevard is not signalized. Therefore all eastbound buses must stop. Pedestrian crosswalks and overall traffic operations at this location are awkward.

Recommendation S6-1. This intersection is a candidate for signalization. There are no apparent improvements that could be safely introduced to improve bus travel speeds and reliability here.

Issue. The intersection of MacArthur Boulevard/14th Avenue and 33rd Street is an all-way stop, so that every eastbound bus must stop at this intersection.

Recommendation S6-2. This intersection should be studied to see if signals are warranted. If signalized, this intersection would become a TSP candidate to assist eastbound buses.

Issue. The current one-way couplets are inconvenient for transit users generally (and also confusing), and make the connection between Highland Hospital and westbound buses difficult. Also, improving one set of two-directional traffic signals can result in lower implementation and maintenance costs than if improvements are required on two separate streets.

Recommendation S6-3. Eastbound and westbound bus stops would ideally be located on the same street for route accessibility and clarity. This can be accomplished through development of an eastbound travel lane (contra-flow for buses only) between Park and 14th Avenue. Because this would a significant change to the street network, further study (including level of service and collision analyses) would be needed.

Issue. The intersection of Beaumont Avenue and westbound MacArthur Boulevard/Chatham Road experiences long delays (average of 21 seconds) due to the multiple phasing and high volumes of traffic at this location.

Recommendation S6-4. This would be alleviated if Recommendation S6-3 is implemented, which would then reroute westbound buses to MacArthur Boulevard. This frontage road could be exclusively for buses in the westbound direction, enabling buses to miss this intersection.

If the bus service remains on Chatham Road, the signal priority techniques could be introduced to swap the MacArthur Boulevard phase with other approach phases if a westbound Route NL bus is approaching.

Issue. The traffic signals on 13th Avenue need coordination with upstream and downstream signals to provide smooth flow of traffic for the Route NL buses, especially in the westbound direction (Chatham Road). The delays here are 17 seconds for westbound buses and seven seconds for eastbound buses, and a significant percentage of buses must stop at these signals.

Recommendation S6-5. Implementation of the contra-flow bus lane (Recommendation S6-2) would eliminate the need to coordinate signals along Chatham Road. If the buses remain on Chatham Road, the overall signal coordination here should be adjusted through a signal interconnect to coordinate vehicle and bus operations with upstream and downstream signals.

Issue. The westbound bus stops near Park Boulevard are awkwardly placed, and buses must turn left from the right lane after boarding passengers. Westbound buses are experiencing an average of a 34 second delay at this intersection.

Recommendation S6-6. The bus stop could possibly be relocated to the south side of Interstate 580 (closer to Oakland High School). If the stop is relocated just west of the Park Street intersection, then signal priority techniques could be introduced to reduce the average delay for Westbound Route NL buses. Improvements to pedestrian connectivity would be needed if the relocation occurs.

Issue. The eastbound buses experience an average of 18 seconds of delay at the intersection of MacArthur Boulevard and Park Boulevard next to the Oakland High School bus stop. Much of this is due to the long green phase for Park Boulevard.

Recommendation S6-7. The current stop is sited well next to a major trip generator. Some limited transit signal priority techniques could assist with reducing this delay, although implementation may be difficult given the siting of the bus stop on the near side of the intersection.

Issue. The eastbound and westbound stops at Athol Avenue are not clearly visible.

Recommendation S6-8. As discussed in the General Recommendations, an enhanced bus stop treatment could improve route visibility and attract more riders. This intersection has also been tentatively identified as a place where a signal may be warranted in the future.

Segment 7: Grand Lake District -- Lakeshore Avenue to El Embarcadero

Issues. Route NL buses experience an average delay of 21 seconds at the intersection of Lakeshore Avenue and Lake Park Avenue due to multiple traffic signal phases.

The current westbound bus stop is an awkward location for bus operations. The buses must merge right to stop, and then must merge left to make a left turn onto Grand Avenue.

There is no separate left turn phase for traffic from Lake Park Avenue to Grand Avenue.

The eastbound stop is located in a site that encourages jaywalking from people who are north of Interstate 580.

The eastbound Route NL buses experience an 18 second delay, on average, at the Lakeshore Avenue intersection following the bus stop. The cause of this delay is due to high volumes of traffic and multiple phases of the signal.

The recent design of Splash Pad Park does not provide an easy solution for possible relocation of various bus stops.

In addition to these general bus operations comments, there are heightened sensitivities to business access, parking and vehicular traffic, as well as storm drainage. Furthermore, this area is viewed as a pedestrian-friendly transit hub.

Recommendation S7-1. Some transit signal priority techniques could be introduced for various intersections. However, the complexities and sensitivity of this area do not lend themselves to an easy solution. These issues will need to be addressed with a detailed circulation analysis involving the entire commercial district as a whole and the City of Oakland CEDA, City of Oakland County Public Works Agency, and Caltrans in particular.

Segment 8: Grand Avenue – El Embarcadero to Harrison Street

Issue. The close proximity of traffic signals along this section of Grand Avenue frequently results in buses having to experience delays in the corridor. Because no single signal is the cause of the delay, the survey results did not show delays from one place. However, as shown in Table 5.4, an aggregate signal delay of 74 seconds occurs between El Embarcadero and 20th/Webster Street.

Recommendation S8-1. Introduction of a coordinated signal system would greatly enhance operations on this segment of roadway for both vehicles and buses. This would reduce some signal delays that occur for not only the Route NL buses, but also AC Transit Route 12.

Issue. The near side stop for eastbound Route NL buses at Perkins Street is often difficult to reach, as queuing traffic at the intersection often prevents buses from being able to pull into the stop.

Recommendation S8-2. Two strategies could relieve this situation. The first is to remove parking upstream from the bus stop so that buses can get around the queue. The second is to consider a far side bus stop, although the current stop location is well sited in relation to the nearby land uses. Detailed evaluation is needed on the impacts to parking and delay of any improvement.

Issue. Westbound buses turning at Harrison Street experience an average of 18 seconds of delay as they turn left from Grand Avenue to Harrison Street. This is due to the long cycle and multiple phases here.

Recommendation S8-3. A possible transit signal priority for westbound buses would be to change the phasing for this movement to allow for an earlier left turn in the signal if a westbound bus is waiting.

Segment 9: Downtown Oakland -- Harrison Street/Grand Avenue to 20th/Broadway

Issue. The overall traffic operation around the 20th Street/Harrison Street intersection is problematic. There are complex signal coordination and phasing systems that operate here due to the roadway geometrics. This stop is closest to Chinatown and is an important destination.

Recommendation S9-1. Reconfiguration of the roadway geometrics and installation of Pedestrian Push Buttons in this area would assist with the operation of Route NL buses. The 20th Street/Harrison Street intersection has been preliminarily redesigned in Lake Merritt Master Plan concepts; continued work to redesign this intersection could result in improved operations for vehicles, buses, and pedestrians.

Issue. The Webster Street and Broadway stops on 20th Street are sited very close to one another. The Webster Street stop could be easily served by the Broadway stop. The Broadway stop is also going to be significantly improved in the near-term, so this will become the boarding point for the Route NL in this area. Also, nearby attractions to the stop are also within walking distance to BART.

Recommendation S9-2. With careful design to accommodate surrounding land uses, the Webster Street stop could be relocated westward. Relocating this stop eastward to be near the 21st Street and Harrison intersection (in front of the Kaiser Center) would better stop spacing and a closer bus stop for Lake Merritt district residents. Improving the walking path from this area to Chinatown may need to be addressed.

Issue. Signal delays at the closely-spaced signals at Webster Street, Franklin Street, and Broadway were observed in both directions.

Recommendation S9-3. Improved signal coordination here would benefit Route NL buses. The combination of pedestrian and traffic volumes make specific recommendations for transit signal priority difficult. Once the 20th Street project is implemented, a reexamination of the signal coordination and installation of pedestrian push buttons at these locations would be appropriate. As Downtown Oakland signals are on automatic recall from 6 AM to 6 PM, the buttons would only be required at other times.

Segment 10: 20th/Broadway to San Pablo/West Grand Avenues

Issue. The stop at 20th and Broadway has a high volume of riders. Many of these are transferring from other AC Transit buses or from BART. This segment is also the segment that the San Pablo Rapid Bus (Route 72R) uses.

Recommendation S10-1. This stop is currently being redesigned. This redesign will impact area traffic flow and transit travel time. Once the redesign is implemented, further measures to create appropriate transit signal priority should be considered as well as special signage for the Route NL line.

Issue. Eastbound Route NL buses have signal delay and turning difficulties on San Pablo Avenue between West Grand Avenue and 20th Street.

Recommendation S10-2. In coordination with the San Pablo Rapid Bus program and the completion of the 20th and Broadway project, signal treatments and lane striping should be reevaluated to reduce delay and improve overall bus operations here.

Issue. The process of transferring between the Route NL and the Route 72 RAPID is not easy. Further, the Greyhound Bus Depot, the Uptown Development, and other recent investments have created a market for an additional stop in this area.

Recommendation S10-3. If the current Route 72R stop is relocated in front of the Greyhound Bus Terminal as a signature stop, then both the Route 72R and this route could benefit from a same-platform loading area. In order to do this, the stop may have to be placed in the median with loading islands to allow for signal priority for the left-turning vehicles southbound (both routes) as well as northbound (Route NL). A comprehensive study (including level of service and collision analyses) would be needed.

The Issue. Westbound Route NL buses have minor delays when turning from San Pablo Avenue onto West Grand Avenue, and the shortness of the turn bay sometimes creates operational problems.

Recommendation S10-4. Potential transit priority treatments for left turning buses may need to be introduced at this intersection, and the turn bay may need to be lengthened.

Segment 11: West Grand Avenue – San Pablo Avenue to Maritime Street

Issue. Two westbound bus stops are all near side – at Market and Adeline Streets, as well as the eastbound stop at Mandela Parkway. Although this is not demonstrated as contributing to an operational delay, the near side stops are potential problem areas.

Recommendation S11-1. These stops should be monitored to see if it is more appropriate to move them to a far side location.

Issue. This area of Oakland is experiencing significant redevelopment, so that new riders can be attracted to the system. This is especially true for recent developments that are underway at the Wood Street station site, the Grand-Mandela residential project site, and the Oakland Army Base Auto Mall plan.

Recommendation S11-2. An active role in urban design on this roadway would help to increase Route NL ridership (through increased population density) and improve pedestrian safety and attractiveness. Careful consideration of improved Route NL operations and a possible improved connection for westbound Route NL buses to Bay Bridge should be made as review and refinement of these projects continues.

Issue. The intersection of the Frontage Road and West Grand Avenue experiences long delays, as this intersection contains many phases.

Recommendation S11-3. This intersection contains heavy vehicle movements (including many truck movements), so that treatments to speed up buses here could be difficult and expensive. This intersection should be regularly monitored to see if transit signal priority measures could be implemented here.

Issue. The westbound buses experience an average of 16 seconds of delay at Maritime Street, while eastbound buses experience an average of eight seconds. This is due to the actuated signal timing installed at this location.

Recommendation S11-4. This signal is a candidate for transit signal priority, such as extended green signals for approaching buses in either direction. The adjacent Oakland Army Base Auto Mall project may affect solutions at this location. Careful consideration of improved Route NL operations and a possible improved connection for westbound Route NL buses to Bay Bridge should be made in coordination with development plans near this intersection.

Segment 12: Bay Bridge -- Maritime Street to Transbay Terminal

Issue. The ramp from Grand Avenue to the HOV/bus lane at the Bay Bridge toll plaza has historically been queued (due to metering lights) to a point where Route NL buses cannot reach the bus lane easily. Restriping of the overpass is not possible for various reasons. The result of this problem is not apparent across a full day (average of 35 seconds), but the AM peak hour delays are up to several minutes.

Recommendation S12-1. Improvements to this situation will require the construction of new ramp structures, as restriping cannot solve this problem with input from Caltrans. Stakeholders should continue to work together to define a suitable design solution. Any design solution would provide AC Transit with an additional Bay Bridge access point that could be used by other routes (such as Route C and CB). Possible design solutions include:

- The removal of mixed-flow traffic from the on-ramp. If the ramp is converted to a HOV/Bus-only ramp, an alternative access for the Bay Bridge would be required. This access could occur through a number of paths, including a possible loop ramp that would be placed just before the Maritime intersection. This would also allow for Port of Oakland traffic to not be delayed when traffic backs up from the Toll Plaza onto West Grand Avenue.

- The removal of westbound left-turning traffic at Maritime Street, and installation of a queue jump lane for buses. The elimination of this movement would allow for the left-turn lane to be used as a through lane, and the right-most lane to be for exclusive use of buses and HOVs. In order to provide for access onto Maritime Street, a loop access (commonly known as a "jughandle") could be installed on the north side of the roadway.

Any solution will need to be coordinated with the Oakland Army Base Auto Mall project.

Issue. The Bay Bridge metering lights do not appear to prevent congestion on the Bay Bridge. However, congestion observed in recent surveys are somewhat related to Central Skyway reconstruction in San Francisco. The completion of this project along with the new East Span may reduce bridge congestion.

Recommendation S12-2. Bridge congestion should continue to be monitored, and real-time coordination with Caltrans on metering light operations will help to optimize traffic flow on this overly-congested facility.

Issue. The Transbay Terminal operation is an excellent layover point for drivers, however boarding passengers may take several minutes. Transbay Terminal redevelopment will require close coordination in the future.

Recommendation S12-3. The Transbay Terminal boarding times can be reduced through use of a proof of payment system or encouragement of Translink use. In particular, the ability to load from multiple doors could significantly reduce boarding times.