APPENDIX K

DRAFT TECHNICAL MEMORANDUM: TRAFFIC ANALYSIS FOR DETOUR - 7TH STREET GRADE SEPARATION

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Technical Memorandum - DRAFT

TO: Chuck Joseph, Jacobs

FROM: Cigdem Mulazimoglu, Jacobs

DATE: October 7, 2011

SUBJECT: 7th Street Grade Separation Traffic Analysis for Detour

COPIES: Andrea Glerum, Jacobs

1. INTRODUCTION

Jacobs is tasked to develop a set of concept plans for the 7th Street Grade Separation Project at the Port of Oakland. The phasing plan proposes to close 7th Street between Maritime Street and Bay Street during construction of Phase 1. A traffic analysis is performed to identify impacts of this proposed 7th Street closure.

7th Street is one of the three main gateways to the Port of Oakland. The other two are Maritime Street via West Grand Avenue on the north and Middle Harbor Road/Adeline Street on the south. Exhibit 1 shows the project location within the general Port of Oakland area along with the list of key intersections that would potentially be impacted due to the 7th Street closure. One or more movements at these five key intersections will need to accommodate additional traffic due to the construction detour.

The project is planned to be constructed in year 2013. The traffic operations analysis discussed in this technical memorandum reflect year 2013 conditions. Exhibit 2 illustrates the proposed detour routes due to 7th Street closure between Maritime Street and Bay Street. As shown, the majority of the traffic that is currently using 7th Street to enter and exit the Port is proposed to be moved to Adeline Street on the south. This is consistent with the detour plans shown on the as-build plans obtained from CALTRANS for the I-880 work that required closure of 7th Street at the Port entrance (CALTRANS Project ER-1505(003)N). Outbound traffic destined for northbound I-880 would likely travel north along Maritime Street to access the northern gateway at West Grand Avenue.

EXHIBIT 1: GENERAL STUDY AREA

LEGEND :

ⓧ Analyzed Intersection

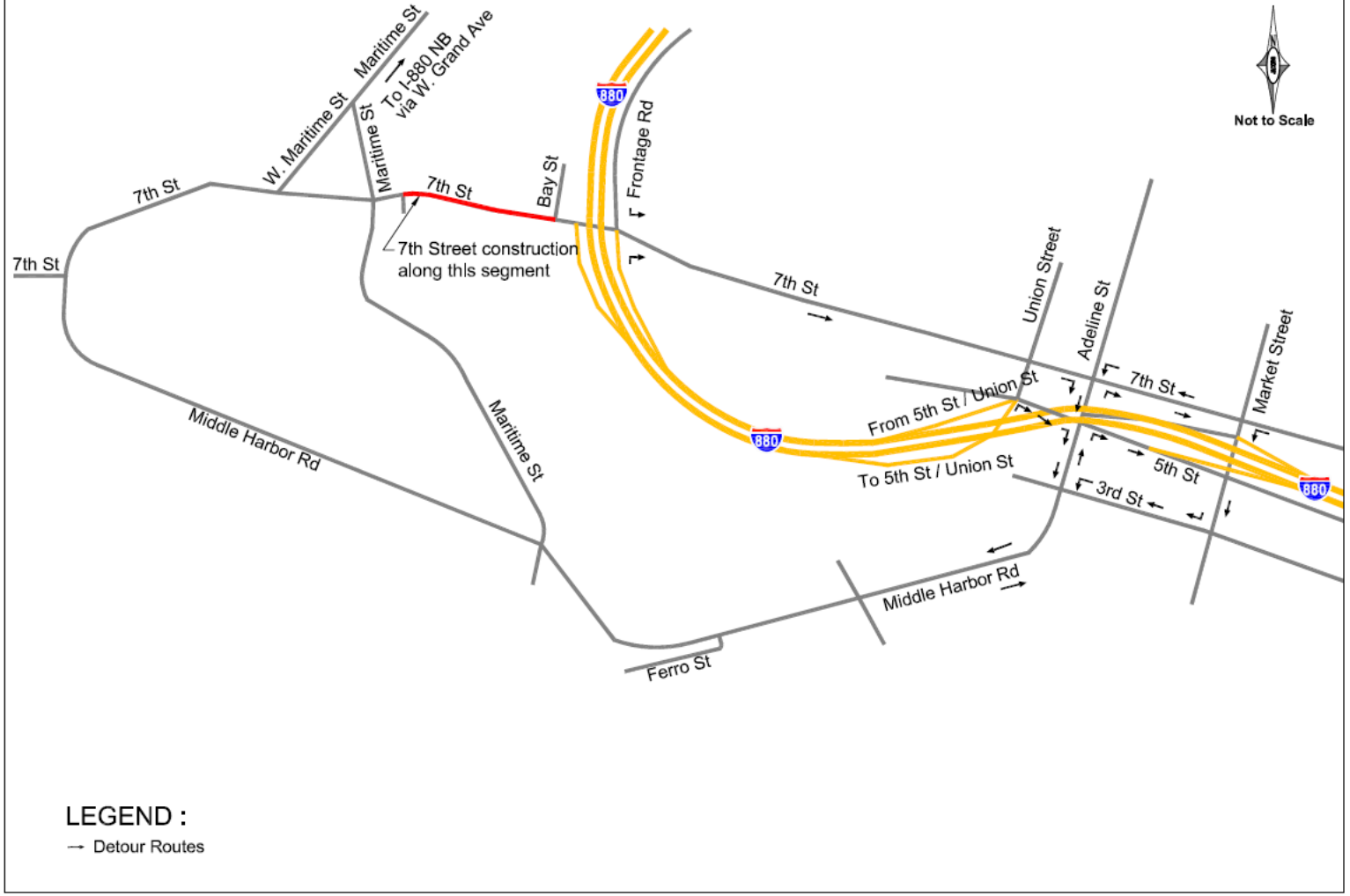
7th Street construction project limits

① I-880 Northbound Ramps/7th Street	④ Adeline Street/3rd Street
② Adeline Street/7th Street	⑤ Maritime Street/Middle Harbor Road
③ Adeline Street/5th Street	

Not to Scale

.

EXHIBIT 2: DETOUR ROUTES



2. EXISTING AND BACKROUND CONDITIONS

2.1. Traffic Volumes

The following traffic volume count data is obtained and used for the traffic analysis discussed in this memorandum:

- 24-hour bi-directional traffic volumes with vehicle classification for three days at 7th Street West of I-880 and at Middle Harbor Road south of 3rd Street.
- Peak hour turning movement volumes at study intersections collected from 7 to 9 AM and 4 to 6 PM. Based on previous studies performed within the vicinity of the study area and the patterns observed from the 24- hour counts, the peak hour for traffic activity at study intersections fall within these time frames.

Exhibit 3 shows the traffic volume data.

The 24-hour counts were collected for three typical weekdays (Tuesday, Wednesday and Thursday) in August 2011. Most of the intersection turning movement count data was obtained from a previous Traffic Study for 7th Street Grade Separation Project[1], and the data is for year 2007. More recent turning movement data from year 2011 was used when available. A comparison of daily and peak hour traffic volumes at 7th Street West of I-880 (i.e. along the Project area), and the peak hour total entering traffic volumes at the intersection of 7th Street and Maritime Street (just west of project the Project area) indicated that the traffic volumes did not go up since year 2007. In fact they have gone down in several instances – see Tables 1 and 2. This may be attributable to the economic downturn of the past few years. The year 2007 counts therefore continue to be relevant and are assumed to reflect existing volumes.

The traffic count data indicates that the peak direction of travel during AM peak hour is inbound; and during PM peak hour is outbound.

[1] 7th Street Grade Separation Project Traffic Operations Report, URS, February 2008.

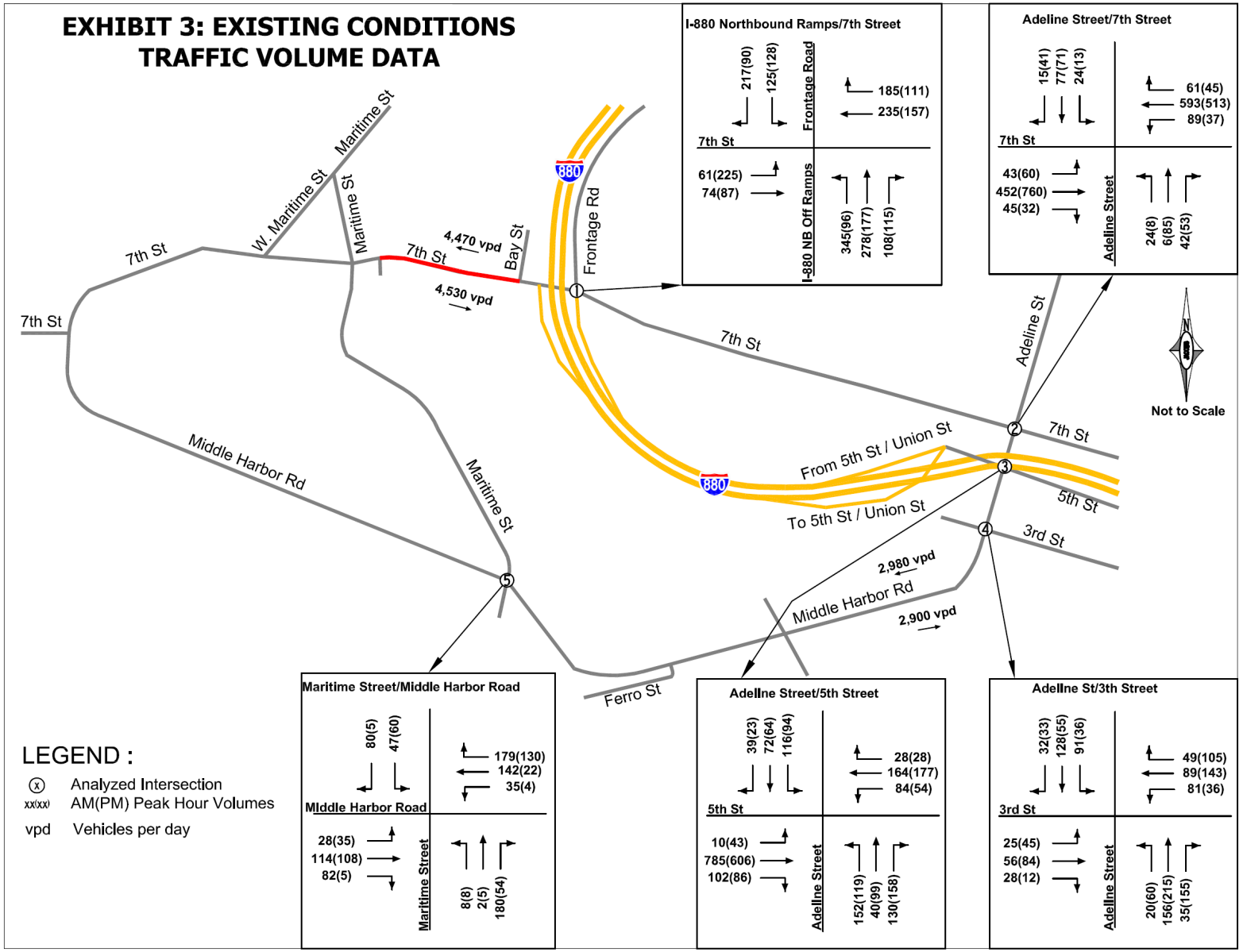


EXHIBIT 3: EXISTING CONDITIONS
TRAFFIC VOLUME DATA
I-880 Northbound Ramps/7th Street
217(90)
125(128)
Frontage Road
185(111)
235(157)
7th St
61(225)
74(87)
I-880 NB Off Ramps
345(96)
278(177)
108(115)
Adeline Street/7th Street
15(41)
77(71)
24(13)
61(45)
593(513)
89(37)
7th St
43(60)
452(760)
45(32)
Adeline Street
24(8)
6(85)
42(53)
Maritime St
W. Maritime St
Maritime St
7th St
4,470 vpd
7th St
Bay St
4,530 vpd
880
Frontage Rd
7th St
7th St
Middle Harbor Rd
Maritime St
Adeline St
Not to Scale
From 5th St / Union St
7th St
880
To 5th St / Union St
5th St
3rd St
2,980 vpd
Middle Harbor Rd
2,900 vpd
Ferro St
Maritime Street/Middle Harbor Road
80(5)
47(60)
179(130)
142(22)
35(4)
Middle Harbor Road
28(35)
114(108)
82(5)
Maritime Street
8(8)
2(5)
180(54)
Adelline Street/5th Street
39(23)
72(64)
116(94)
28(28)
164(177)
84(54)
5th St
10(43)
785(606)
102(86)
Adeline Street
152(119)
40(99)
130(158)
Adelline St/3th Street
32(33)
128(55)
91(36)
49(105)
89(143)
81(36)
3rd St
25(45)
56(84)
28(12)
Adeline Street
20(60)
156(215)
35(155)
LEGEND :
X Analyzed Intersection
xx(xx) AM(PM) Peak Hour Volumes
vpd Vehicles per day

TABLE 1: YEAR 2007 AND 2011 VOLUME COMPARISON ON 7TH STREET WITHIN THE PROJECT AREA				
Time Period	Westbound (Inbound)		Eastbound (Outbound)	
	Year 2007	Year 2011	Year 2007	Year 2011
Daily Volume	4,450	4,470	5,300	4,530
AM Peak Hour Volume*	576	455	-	-
PM Peak Hour Volume*	-	-	464	455
Note: Source for year 2007 volumes is the 7th Street Grade Separation Project Traffic Operations Report by URS dated February 2008. The counts are from month of June. Year 2011 counts are collected in August 2011. *During AM peak hour, peak direction of traffic is inbound. During PM peak hour, peak direction of traffic is outbound.				

TABLE 2: YEAR 2007 AND 2011 VOLUME COMPARISON AT 7TH STREET/MARITIME STREET INTERSECTION		
Time Period	Year 2007	Year 2011
AM Peak Hour Total Entering Volume	1,227	922
PM Peak Hour Total Entering Volume	1,077	1,074

2.2. Intersection Geometry

Existing intersection geometry data was obtained from aerial pictures and field observations. Exhibit 4 illustrates the existing lane geometries and traffic control at the study intersections. The lane geometries and control shown on Exhibit 4 were used to evaluate the background and detour conditions traffic operations at the study intersections.

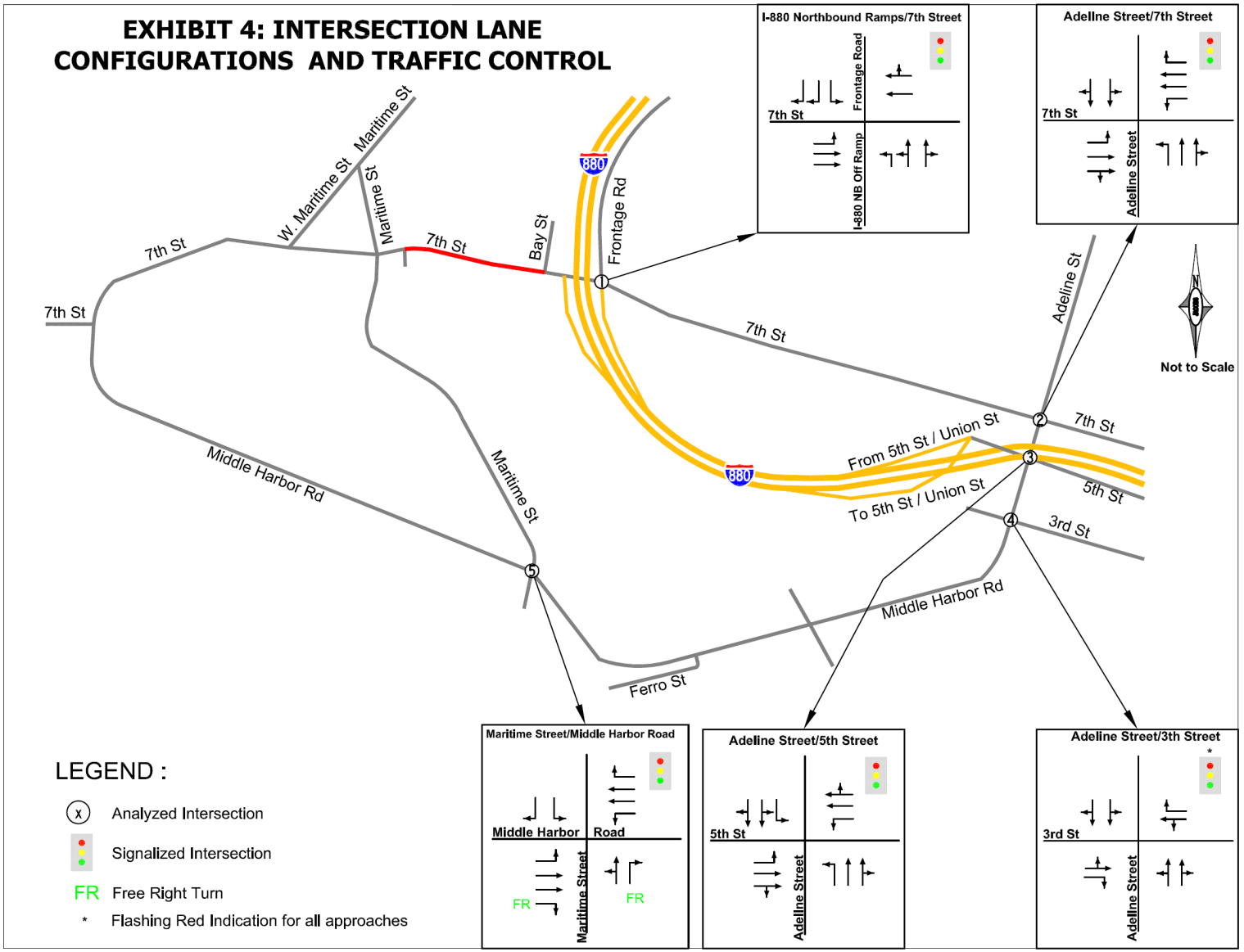


EXHIBIT 4: INTERSECTION LANE CONFIGURATIONS AND TRAFFIC CONTROL
I-880 Northbound Ramps/7th Street
Frontage Road
7th St
I-880 NB Off Ramp
Adelline Street/7th Street
7th St
Adeline Street
Not to Scale
W. Maritime St
Maritime St
Maritime St
7th St
7th St
Bay St
Frontage Rd
880
7th St
Adeline St
7th St
From 5th St / Union St
To 5th St / Union St
5th St
3rd St
Middle Harbor Rd
Maritime St
Middle Harbor Rd
Ferro St
Maritime Street/Middle Harbor Road
Middle Harbor
Road
Maritime Street
FR
FR
Adeline Street/5th Street
5th St
Adeline Street
Adeline Street/3th Street
*
3rd St
Adeline Street
LEGEND :
Analyzed Intersection
Signalized Intersection
FR Free Right Turn
* Flashing Red Indication for all approaches

2.3. Traffic Operational Analysis – Background Conditions

The traffic operational analysis in this memorandum reflects construction year conditions, which is planned to be year 2013. A two (2) percent marginal growth rate is applied to the current volumes shown on Exhibit 3 to reflect 2013 volumes. It should be noted that the year 2007 versus 2011 volume comparison indicated zero or negative growth. Instead of ignoring any growth, a two percent growth rate is deemed appropriate (and suitably conservative) to reflect traffic volumes for two years ahead.

Peak hour intersection analysis is performed at study intersections for the background conditions first. "Background" refers to the conditions without the project. Background analysis establishes a basis of comparison with detour analysis discussed in the next section.

The study intersections are analyzed using Trafficware's Synchro 7.0 software. Analysis is performed with the following assumptions. These assumptions apply to the analysis of detour conditions also:

- Analysis is performed for the year of construction – year 2013.
- Analysis periods are weekday AM and PM peak hours.
- Signal phasing and control type is based on actual field conditions.
- Optimized signal timings are used for both background and detour conditions.
- Peak hour factors are based on actual field counts for each intersection.
- Peak hour truck factors are based on field collected data as listed below:
    - 7th Street/I-880 Northbound off-ramp – 62 percent as per truck percentage data collected during 24-hour counts on 7th Street west I-880 ramps.
    - Adeline Street/7th Street; and Adeline Street/5th Street – 60 percent as per the percentage used in the 7th Street Grade Separation Project Traffic Operations Report by URS.
    - Adeline Street/3rd Street – Individual truck percentages for each movement from the intersection count data conducted in August 2011. For certain approaches, the truck percentages are as high as 90 percent.
    - Maritime Street/Middle Harbor Road – 65 percent as per truck percentage data collected during 24-hour counts on Middle Harbor Road south of 3rd Street
- Ideal saturation flow rate of 1,900 vehicles per hour per lane as per HCM Methodology
- LOS results are based on HCM criteria shown on Table 3 below.

TABLE 3: HCM INTERSECTION LOS CRITERIA		
LOS	Control Delay per Vehicle (in seconds)	
	Signalized Intersections	Unsignalized Intersections
A	0-10	0-10
B	>10-20	>10-15
C	>20-35	>15-25
D	>35-55	>25-35
E	>55-80	>35-50
F	>80	>50
Source: Highway Capacity Manual 2000, Transportation Research Board		

Below is the list of measures of effectiveness (MOEs) and the criteria used to determine the performance of an intersection:

- Level of Service (LOS): The City of Oakland's policy LOS is D. Intersections with LOS worse than D were considered unacceptable and require mitigation.
- Volume to Capacity Ratio (V/C): Intersections with V/Cs greater than 1 (i.e. volumes exceeding capacity) are considered unacceptable and requires mitigation.
- 95th percentile Queues: Queues that exceed the available turn lane storage length require mitigation.

Table 4 shows the background conditions (i.e. without the detour) intersection analysis results. As shown, all of the study intersections are projected to operate satisfactorily during both AM and PM peak hours under background conditions. One exception to this is that; the 95th percentile queue length exceeds available storage length at the southbound left turn lane at Adeline Street and 5th Street. The available storage length is 90', but the projected 95th percentile queue is 132'.

TABLE 4: BACKGROUND CONDITIONS OPERATIONAL ANALYSIS RESULTS						
Intersection Name and Number	AM Peak Hour			PM Peak Hour		
	HCM Delay (sec/veh)	LOS	V/C	HCM Delay (sec/veh)	LOS	V/C
1. 7th St/ I-880 NB Ramps	37.3	D	0.82	38.7	D	0.78
2. 7th St/Adeline St	14.6	B	0.40	15.3	B	0.51
3. Adeline St/5th St*	48.9	D	0.87	29.9	C	0.72
4. Adeline St/3rd St**	12.8	B	0.42	17.3	C	0.58
5. M. Harbor Rd/ Maritime St	8.8	A	0.21	11.5	B	0.24
*For the SB left turn movement, the 95th percentile queue length (132') exceeds available storage length (90')						
**Delay, LOS and V/C shown for the worst movement						

3. TRAFFIC ANALYSIS FOR DETOUR

3.1. Revised Traffic Volumes

Detour due to the proposed 7th Street closure will result in additional volumes along the detour routes. The revised intersection turning movement volumes during the detour are shown on Exhibit 5. Movements that will need to accommodate additional traffic due to detour are marked on the exhibit.

3.2. Traffic Operational Analysis – Detour Conditions without Mitigation

3.2.1. Roadway Segment Capacity Analysis

A general roadway capacity analysis was performed first to identify any major issues in moving the 7th Street traffic to Middle Harbor Road during the detour. If total roadway volume exceeds its capacity, then the full closure of 7th Street should not be recommended. To evaluate this, a volume to capacity (V/C) analysis is performed as described as follows:

As discussed earlier, 24-hour count data was collected at the gateways of the Port in August 2011. The average daily traffic and peak hour directional traffic volumes are obtained at 7th Street west of I-880 and Adeline Street/Middle Harbor Road south of 3rd Street. These volumes were used to determine daily and peak hour peak direction V/Cs on Middle Harbor Road with the additional traffic moved from 7th Street. Table 5 illustrates this analysis. The capacity of Middle Harbor Road is estimated from the roadway 'Service Volume Table' provided in HCM 2010[2]. To allow for a conservative analysis, the lowest capacity value from this HCM Table was selected to reflect the capacity of Middle Harbor Road and was adjusted (i.e. reduced) to account for high truck percentages observed on Middle Harbor Road (70% daily and 65% peak hour truck percentage). The HCM Table assumes some percentage of trucks, but this was not adjusted for to allow for a conservative estimate. Furthermore, it should be noted that, some traffic will be using W. Grand Avenue via Maritime Street to access northbound I-880. This was also neglected in the calculations.

[2] Highway Capacity Manual 2010, Exhibit 16-14.

EXHIBIT 5: PEAK HOUR TURNING MOVEMENT VOLUMES ADJUSTED FOR DETOUR

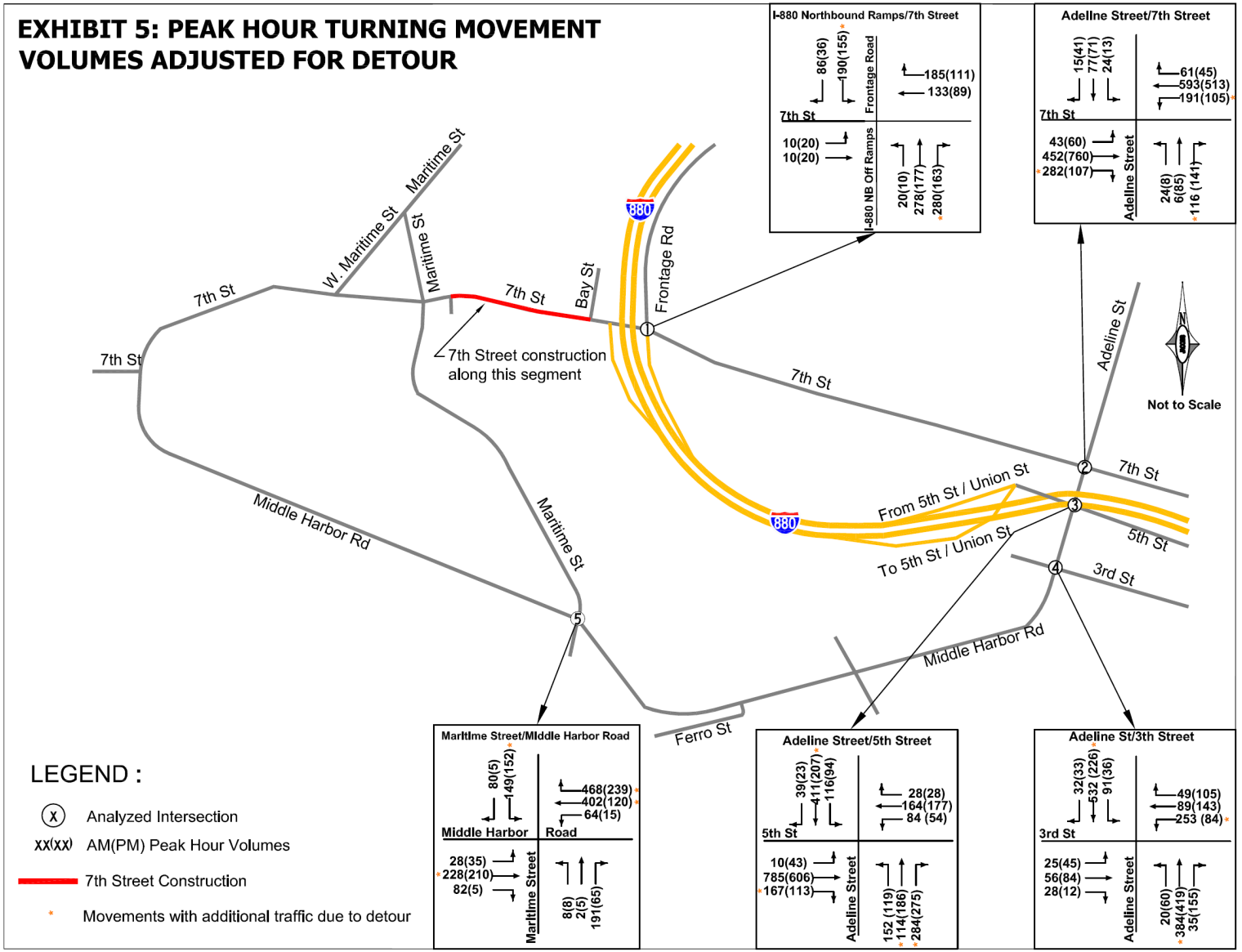


TABLE 5: VOLUME TO CAPACITY ANALYSIS FOR MIDDLE HARBOR ROAD		
Analyzed Roadway Location	**Daily Volumes**	**Peak Hour Peak Direction Volumes**
7th Street west of I-880	9,010	455
Middle Harbor Road South of 3rd Street - Before Construction	5,880	345
Middle Harbor Road South of 3rd Street - During Construction*	14,890	800
Lowest Capacity from HCM 2010 for a four-lane roadway **	28,400	1,560
Adjusted Capacity to account for trucks***	16,710	950
Volume to Capacity Ratio	0.89	0.84
*During construction, 7th Street Traffic is added to Middle Harbor Road		
**Capacity of a roadway segment is assumed to be LOS E traffic volumes shown in HCM Exhibit 16-14		
***Daily truck percentage is70%; and peak hour truck percentage is 65%		

As shown in Table 5, even with the conservative approach, the projected V/Cs on Middle Harbor Road are less than 1.0, meaning volumes do not exceed capacity. This analysis indicates that routing 7th Street traffic to Middle Harbor Road during construction would not create significant impacts; therefore full closure of 7th Street is feasible. However, a detailed intersection analysis is still necessary to identify impacts of the detour on the individual intersections/movements. Even though the Middle Harbor Road would accommodate the additional traffic, individual intersections along the detour route may need improvements to continue to operate at acceptable levels of service.

3.2.2. Intersection Capacity Analysis

Study intersections are analyzed with the revised volumes (i.e. volumes during detour) shown on Exhibit 5. The first tier of analysis assumed no lane geometry and control changes from the background scenario. The objective was to identify potential operational issues due to the detour. Table 6 reports the results of this Tier 1 analysis.

TABLE 6: OPERATIONAL ANALYSIS RESULTS WITHOUT MITIGATION						
Intersection Name and Number	**AM Peak Hour**			**PM Peak Hour**		
	HCM Delay (sec/veh)	**LOS**	**V/C**	**HCM Delay (sec/veh)**	**LOS**	**V/C**
1. 7th St/ I-880 NB Ramps	31.5	C	0.75	22.8	C	0.58
2. 7th St/Adeline St	18.4	B	0.71	17.5	B	0.59
3. Adeline St/5th St	92.5	F	1.05	38.7	D	0.76
4. Adeline St/3rd St*	77.0	F	1.01	51.7	F	0.92
5. M. Harbor Rd/ Maritime St	16.4	B	0.56	16.7	B	0.53
*Delay, LOS and V/C shown for the worst movement						

As shown in Table 6, two intersections are projected to operate poorly due to the impact of detour traffic – see results in red in Table 6. With the existing lane geometry and traffic control (signal), the LOS at the intersection of Adeline Street and 5th Street is projected to be F with a V/C greater than 1. The Adeline Street and 3rd Street is projected to operate unacceptably during both peak hours with the existing flashing red (i.e. all-way stop) operation.

The next table (Table 7) shows the 95th percentile queues from the Synchro analysis for the movements that are impacted by the detour. The values in red indicate queues that exceed available storage length. Two intersections have issues with the queue spillback: At the 7th Street/Adeline Street, the projected 95th percentile queue for westbound left turn lane is 252' which is longer than the available 140'. At the intersection of 5th Street/Adeline Street, southbound and northbound left turns are projected to have longer queues than the available storage lengths.

TABLE 7: 95TH PERCENTILE QUEUE LENGTHS WITHOUT MITIGATION

Intersection Name and Number	Turn Lane	Available Storage	AM Peak Hour Queue	PM Peak Hour Queue
1. 7th St/ I-880 NB Ramps	SB Left	190'	183'	97'
2. 7th St/Adeline St	WB Left	140'	252'	138'
	NB Left	80'	30'	12'
3. Adeline St/5th St	SB Left	90'	182'*	110'
	NB Left	230'	282'	135'
4. Adeline St/3rd St*	WB Thru/Left	270'	N/A**	N/A**
5. M. Harbor Rd/ Maritime St	WB Right	750'	159'	51'
	SB Left	1000'	110'	80'

*Without construction (i.e. no detour), the 95th percentile queue is 132', which is still longer than the available storage
**HCM methodology does not provide 95th percentile queues for all-way stop intersections.

For the 7th Street/Adeline Street, the queuing issue may be resolved without implementing an improvement. As illustrated on Exhibit 6 below, this intersection has an exclusive right turn lane, two through lanes and an exclusive left turn lane on the westbound approach. When and if the queue for westbound left turn movement exceeds the storage lane limits, the back up will be handled with the inner through lane. The blockage of through traffic due to this back-up is not expected to reduce the LOS to unacceptable levels. Analysis of a single westbound through lane scenario indicates that the intersection operates at LOS C.

EXHIBIT 6: ILLUSTRATION OF ADELINE ST/7TH ST

The intersections of Adeline Street with 5th Street and 3rd Street, however, will require some mitigation to continue to operate at acceptable levels of service during the planned detour. Next section discusses the recommended mitigation measures.

4. PROPOSED MITIGATION MEASURES

4.1. Traffic Operational Analysis – Detour Conditions with Mitigation

Based on the detour conditions analysis discussed in the previous section, mitigation is recommended at the following two intersections:

- Adeline Street and 5th Street
- Adeline Street and 3rd[h] Street

The operational analysis results with the proposed mitigation are shown in Tables 8 and 9 and are discussed below:

Adeline Street and 5th Street: As reported in the previous section this intersection is projected to be negatively impacted by the detour. The projected LOS is F with a V/C greater than 1.0 during the AM peak hour. Queuing issues are also expected for the northbound and southbound left turn movements. The intersection currently operates with protected only left-turn phasing for the east/west direction; and split phasing for the north/south direction. The existing signal equipment does not allow for permissive phasing. The split phasing for the north/south direction contributes to the unacceptable LOS, however has to be in place due to shared left/through lane on the southbound approach. Re-striping this shared lane to an exclusive through lane and providing protected only phasing instead of the split phasing reduces the delay; however the LOS still remains F. Furthermore, this modification results in longer southbound left turn queues.

The recommended mitigation for this intersection is illustrated on Exhibit 7. Traffic signal modification is needed to allow for permissive-protected phasing. Additionally, the southbound shared left/through lane should be converted to exclusive through lane to eliminate the split phasing. With this mitigation, the projected LOS is D with V/C less than 1.0 – See Table 8. The projected left turn lane 95th percentile queue (113') is still longer than the available storage length of 90', but only slightly longer. It is much lower than the projected queue without mitigation (182') and lower than the projected queue for the background (without detour) conditions (132') – See Table 9.

EXHIBIT 7: MITIGATION FOR ADELINE ST/5TH ST

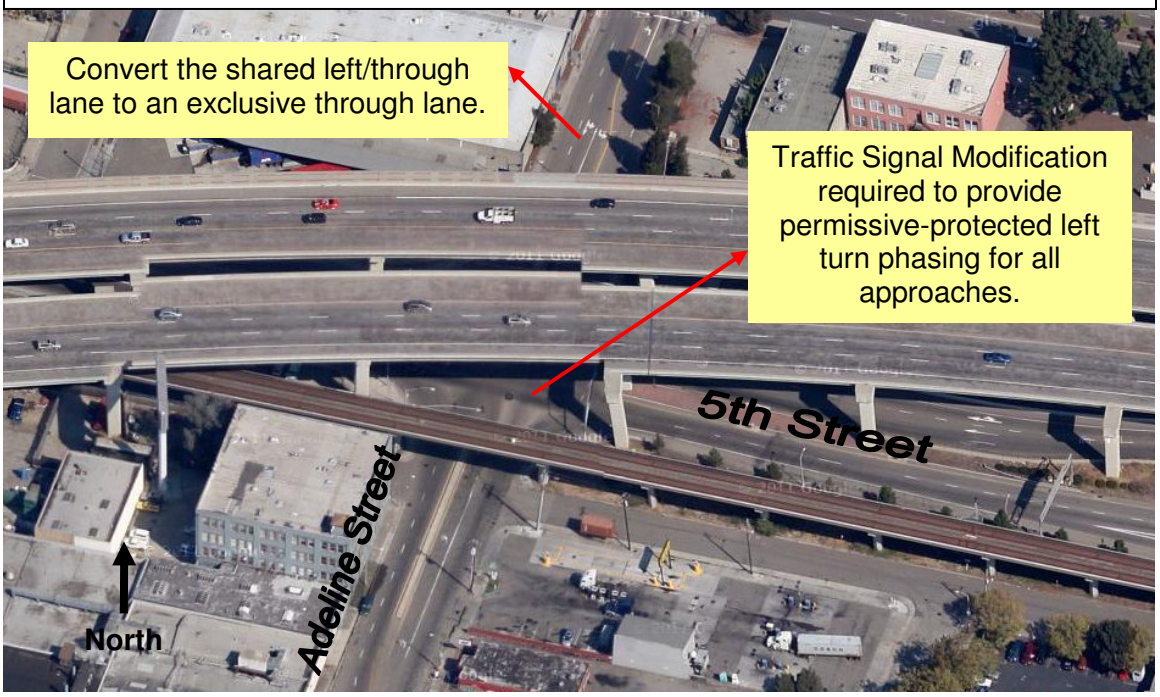


TABLE 8: OPERATIONAL ANALYSIS RESULTS AFTER MITIGATION

Intersection Name and Number	AM Peak Hour			PM Peak Hour		
	HCM Delay (sec/veh)	LOS	V/C	HCM Delay (sec/veh)	LOS	V/C
2. 7th St/Adeline St	23.9	C	0.71	21.1	B	0.63
3. Adeline St/5th St	53.4	D	0.96	24.5	C	0.77
4. Adeline St/3rd St*	19.7	B	0.85	13.3	B	0.68

*Delay, LOS and V/C shown for the worst movement

TABLE 9: 95TH PERCENTILE QUEUE LENGTHS AFTER MITIGATION

Intersection Name and Number	Turn Lane	Available Storage	AM Peak Hour Queue	PM Peak Hour Queue
2. 7th St/Adeline St	WB Left	>252'	252'	138'
	NB Left	80'	30'	12'
3. Adeline St/5th St	SB Left	90'	113'*	66'
	NB Left	230'	220'	151'
4. Adeline St/3rd St*	WB Thru/Left	270'	258'	132'

*Without construction (i.e. no detour), the 95th percentile queue is 132', which is longer than both the projected queue length of 113' and the available storage length of 90'. No further mitigation is proposed to lower the 113' shown.

Adeline Street and 3rd Street: Without improvements, this intersection is projected to be negatively impacted by the detour with the current flashing red (i.e. all-way stop) operation. The projected LOS is F with a V/C greater than 1.0 during both the AM and PM peak hours.

This intersection has signal equipment in place for a future conversion to full signal operation. The geometry of the intersection is shared left/through and through/right lanes on the northbound/southbound approaches; and shared left/through and a short exclusive right turn lane on the eastbound/westbound approaches.

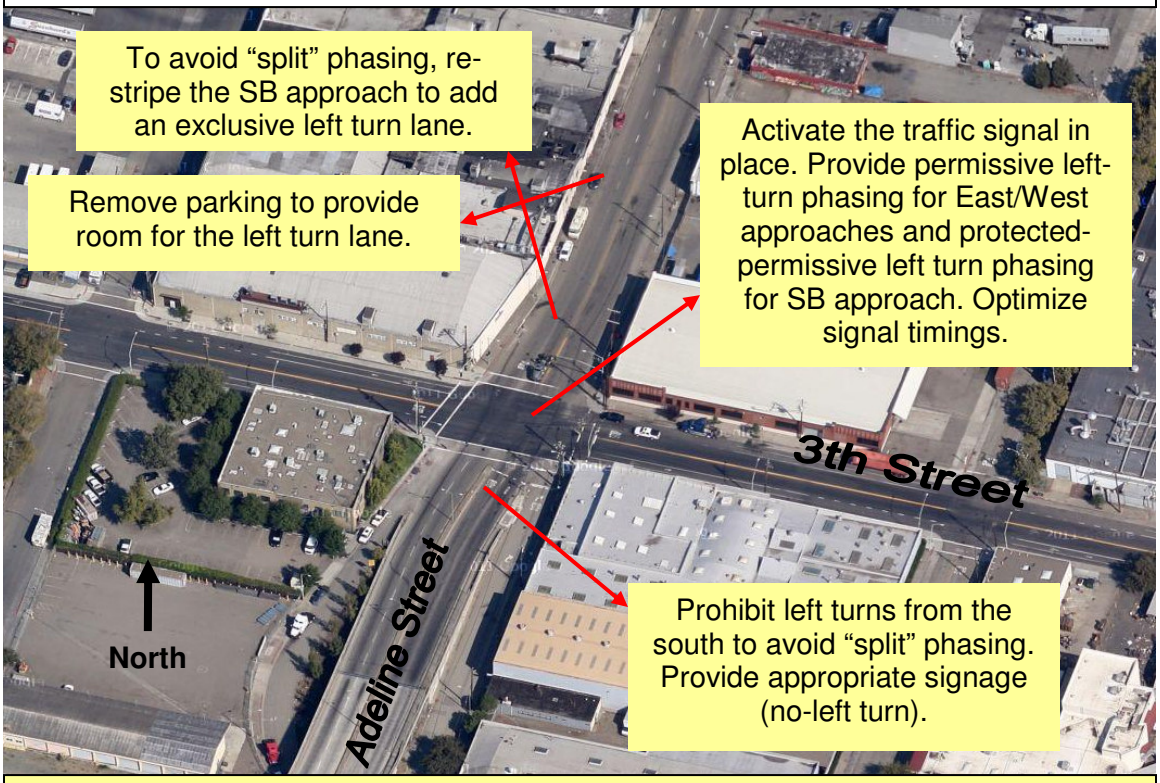
Two separate mitigation options are illustrated on Exhibit 8 – Preferred Option (Option 1) and Option 2. Both options require activating the existing signal in place to provide full signal operation. With the current intersection geometry (shared left/through lanes); the ideal (and safer) signal phasing would be splitting the northbound and southbound movements. However, the analysis shows that split phasing results in LOS F conditions with the additional detour traffic. 'Permissive only' left-turn phasing for all approaches could also work, but is not preferred (see Option 2). Exclusive left-turn lanes are required to avoid split phasing or 'permissive only' phasing. The preferred mitigation option (Option 1) is described below:

- Re-stripe the **southbound approach** to add an exclusive left turn lane. The width of the approach is adequate for an additional lane; however existing parking will need to be removed on the southbound approach.
- Providing an exclusive left-turn lane for the **northbound approach** requires widening of the roadway. Widening is not possible for the temporary detour conditions. In order to eliminate split or 'permissive only' phase, the northbound left-turn movement is proposed to be prohibited during detour. The northbound left-turn traffic is not significant at this intersection and can be accommodated at the upstream intersection of 5th Street. With the Adeline Street/5th Street mitigation (discussed above) in place, this additional left turn volume does not degrade the operations of that intersection. Proper signage (no-left turn) is required. The signs should be redundant - one on the signal mastarm and one ground posted sign.
- With the above two improvements, the signal should be activated to operate on permissive-protected left-turn phasing for northbound/southbound; and permissive left-turn phasing for eastbound/westbound. The existing signal heads allow for a green left-turn arrow. The controller settings should be set such that the green arrow would be inactive for the signal heads facing south, east and west. With these improvements, an LOS of B can be achieved at this intersection – see Table 8. The

available storage lengths are also adequate to accommodate the projected 95th percentile queues – see Table 9.

A second mitigation option – Option 2 - is to activate the traffic signal to provide 'permissive only' left-turn phasing for all approaches. With this option, an exclusive left turn lane for the southbound approach and prohibition of northbound left-turn movement will not be necessary. However, it is noted that the permissive operation in the north/south direction may be problematic with left turners blocking the through traffic; and with the inner lane traffic blocking the view of the outside lane through traffic for opposing left-turners. Therefore, Option 1 is preferred over Option 2.

EXHIBIT 8: MITIGATION FOR ADELINE ST/3RD ST



Option 2: A second mitigation option is to activate the traffic signal to provide permissive left turn phasing for all approaches.