
TRAFFIC OPERATIONAL IMPROVEMENTS AT VARIOUS LOCATIONS

H-1 OFF-RAMP RESTRIPING STUDY FOR KOKO HEAD AVENUE AND H-1 FREEWAY OFF-RAMP

Honolulu, Oahu, Hawaii

FINAL

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Prepared for:

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FINAL

H-1 OFF-RAMP RESTRIPIING STUDY FOR KOKO HEAD AVENUE AND H-1 FREEWAY OFF-RAMP Honolulu, Oahu, Hawaii

I. INTRODUCTION

This report documents the findings of a traffic study conducted by Austin, Tsutsumi and Associates, Inc. (ATA) to evaluate existing traffic conditions and potential mitigation measures at the Koko Head Avenue intersection with the H-1 Freeway Off-Ramp.

A. Background and Location

The Hawaii Department of Transportation (HDOT) has requested that traffic analysis and simulation be performed to evaluate a proposed traffic improvement at the intersection of Koko Head Avenue/H-1 Freeway Off-Ramp, herein after referred to as the "Project Intersection". The intersection will be studied due to complaints made regarding right-turning vehicles on the H-1 Freeway Off-Ramp experiencing significant queuing in the shared left-turn/right-turn lane. See Figure 1 for the project location. The proposed traffic improvement will involve one of two options below:

1. A) Restripe the eastbound shared left-turn/right-turn lane to an exclusive right-turn lane at the Koko Head Avenue/H-1 Freeway Off-Ramp intersection.

B) Restripe the eastbound shared left-turn/right-turn lane to an exclusive right-turn lane at the Koko Head Avenue/H-1 Freeway Off-Ramp intersection. In addition, at the Koko Head Avenue/Harding Avenue intersection, restripe the northbound shared left-turn/through lane to a dedicated left-turn lane.
2. Widen the existing Koko Head Avenue Off-Ramp from 2 lanes to 3 lanes to provide dedicated double left-turn lanes and a dedicated right-turn lane.



Hereinafter, the H-1 Off-Ramp Restriping study shall be referred to as “Project”.

B. Study Methodology

This study will address the following:

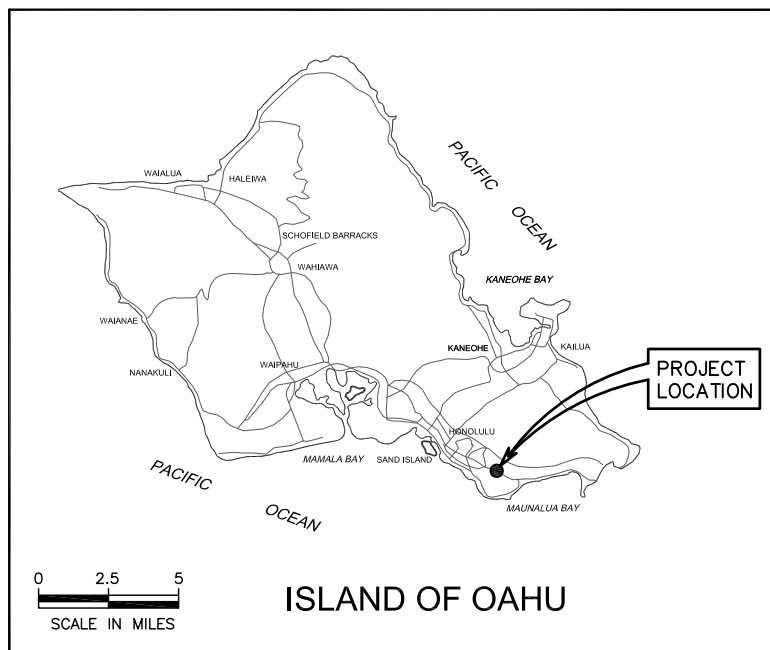
1. Assess existing traffic operating conditions at the study intersection.
2. Study the proposed traffic improvements to alleviate congestion issues.



NOT TO SCALE



STUDY
INTERSECTIONS



ISLAND OF OAHU

H-1 FREEWAY OFF-RAMP
RESTRIPING STUDY AT
KOKO HEAD AVENUE



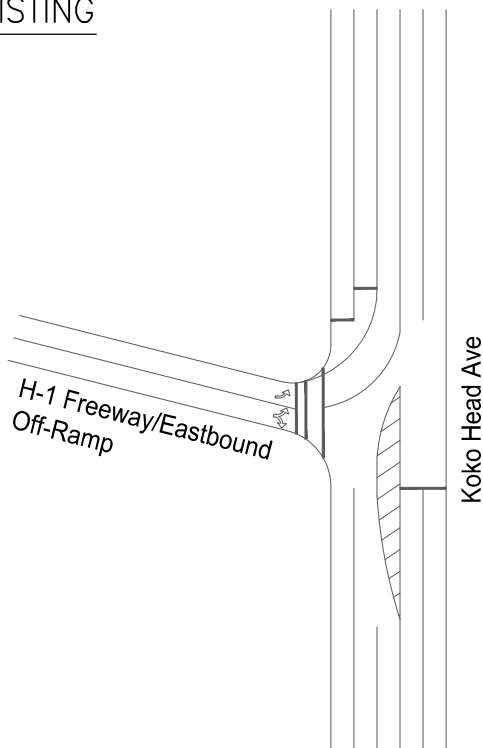
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LOCATION MAP

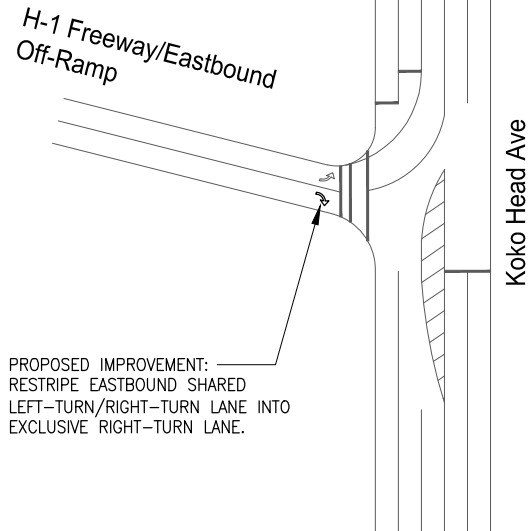
FIGURE

1

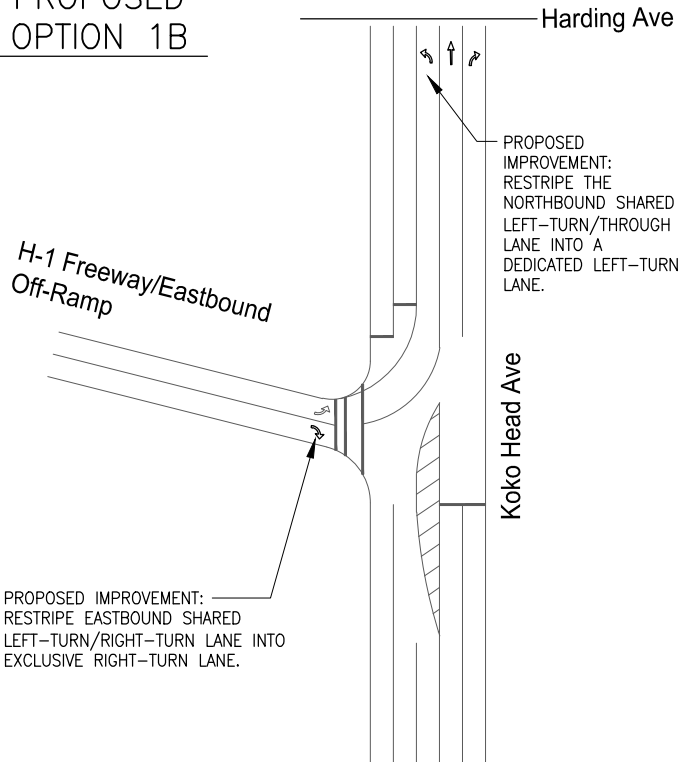
EXISTING



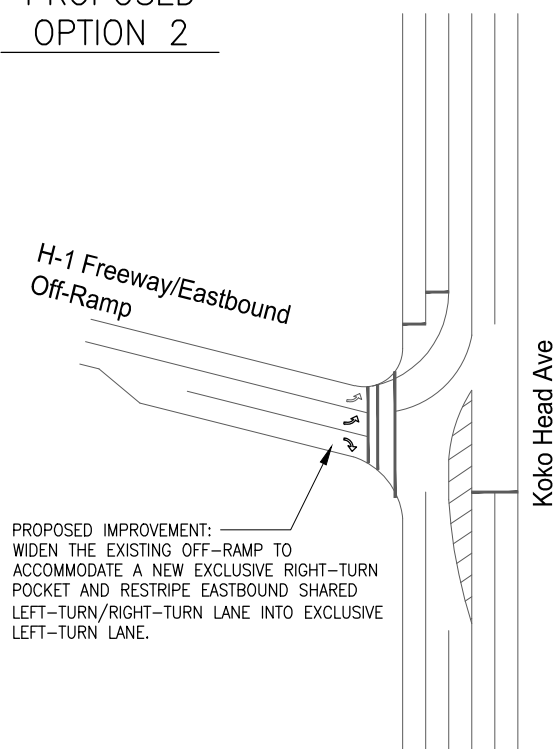
PROPOSED OPTION 1A



PROPOSED OPTION 1B



PROPOSED OPTION 2



H-1 FREEWAY OFF-RAMP
RESTRIPING STUDY AT
KOKO HEAD AVENUE



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FIGURE

2

PROPOSED OPTIONS AT
KOKO HEAD AVENUE/H-1 FREEWAY OFF-RAMP



II. EXISTING CONDITIONS

A. Roadway System

Koko Head Avenue

Koko Head Avenue is generally a north-south, two-way roadway with a posted speed limit of 25 miles per hour (mph). Koko Head Avenue begins at its intersection with Sierra Drive to the north and terminates at its intersection with 12th Avenue to the south. Between its intersection with Pahoa Avenue and Harding Avenue, it is a four-lane undivided major collector street. South of Pahoa Avenue and north of Harding Avenue, Koko Head Avenue narrows to a two-lane undivided roadway.

Koko Head Avenue provides direct access from the H-1 Freeway to residential and commercial sites in the Kaimuki area.

H-1 Freeway

The H-1 Freeway is an east-west, two-way, divided freeway which begins to the west in the vicinity of the Palailai Interchange then extends through Kapolei, Ewa, Waipahu, and Central Honolulu before terminating to the east and continuing on as Kalanianaʻole Highway.

In the vicinity of the Project the Koko Head Avenue Eastbound Off-Ramp is a two-lane ramp with an advisory speed limit of 25 mph.

B. Existing Traffic Volumes

Manual turning movement traffic counts and field observations were conducted at the following study intersections:

- Koko Head Avenue/Harding Avenue (Signalized)
- Koko Head Avenue/H-1 Eastbound Off-Ramp (Signalized)
- Koko Head Avenue/Pahoa Avenue (Signalized)

Based on the count data, it was determined that the weekday AM peak hour of traffic occurs between 7:15 AM and 8:15 AM and the weekday PM peak hour of traffic occurs between 4:45 PM and 5:45 PM. The turning movement count data is included in Figure 3.

C. Existing Traffic Conditions

Methodology

Analysis for the study intersections was performed using SimTraffic. SimTraffic is a traffic analysis software that simulates real-time travel along the studied corridors based on the Synchro model. The average field travel time data was compared to the travel time data obtained from SimTraffic reports, to ensure the network of intersections created in SimTraffic generally correlated to traffic patterns under existing conditions. Adjustments were made to Synchro input parameters until the travel time data from the SimTraffic simulation model were reasonably close to the field travel time study.

Observations and Intersection Analysis

Koko Head Avenue/Harding Avenue

In general, all approaches to this intersection experience queuing due to its proximity to high densities of residential and commercial buildings. The northbound left-turn and southbound through movements typically experience the longest queue lengths; however, the major northbound and southbound movements along Koko Head Avenue experience delay of 37 seconds or less for both peak hours.

Koko Head Avenue/H-1 Freeway Off-Ramp

During the AM and PM peak hours of traffic, eastbound right-turning vehicles experience significant queuing in the existing shared left-turn/right-turn lane on the H-1 Freeway Off-ramp. Left-turning vehicles in the shared left-turn/right-turn lane on the H-1 Freeway Off-Ramp prevent right-turning vehicles behind them from making the permissive right-turn on-red movement onto Koko Head Avenue. Additionally, queue from southbound left-turn lane at the adjacent Koko Head Avenue/Pahoa Street intersection was observed to sometimes spill out of the pocket and block progression of the high-volume right-turn movement during both peak hours.

The intersection is anticipated to experience 28 seconds of delay or less along the major Koko Head Avenue corridor and 39 seconds of delay or less on the eastbound Off-Ramp approach. SimTraffic analysis indicates that the dedicated left-turn lane experiences queue lengths of approximately 325(325) feet

and the shared eastbound left-turn/right-turn lane experiences queue lengths of 925(650) feet during the AM(PM) peak hours of traffic, consistent with field observations.

Koko Head Avenue/Pahoa Avenue

The intersection of Koko Head Avenue/Pahoa Avenue experienced queueing on the westbound approach which was occasionally observed to spill back between 13th Avenue and 14th Avenue. Although the westbound approach is striped as a single shared lane allowing left-turns, right-turns and through movements; local traffic was observed to treat it as a two-lane approach. Westbound vehicles attempting to proceed through the intersection or make a left-turn were observed to stop close to the centerline to allow right-turn vehicles enough space to pass the queue and make right-turns on red. This condition was taken into consideration and modeled in SimTraffic to accurately reflect field observations.

During both peak hours, vehicles making right-turns from the H-1 Freeway Off-Ramp and the subsequent left-turn at the Koko Head Avenue/Pahoa Avenue intersection were observed to consistently queue out of the turn pocket and block the intersection. As a result, southbound vehicles along Koko Head Avenue approaching the H-1 Off-Ramp intersection were observed to be impeded by the spillback of the left-turn queue during a portion of their green phase. With the current lagging left-turn phasing at Pahoa Avenue, typically no southbound left-turn vehicles are able to proceed initially as they are required to yield to northbound through vehicles during the permissive phase. Furthermore, during the lagging protected left-turn phase, green time associated with the movement is occasionally wasted. The southbound left-turn movement at Pahoa Avenue was observed to often have no cars in queue or on approach for up to 10 seconds.

Overall, the intersection is anticipated to experience 22 seconds of delay or less along the major Koko Head Avenue corridor.

Figure 3 shows the existing traffic volumes and associated queue lengths for the study intersections. Table 1 summarizes the simulation results at the study intersections.



NOT TO SCALE

LEGEND

##(##) - AM(PM) PEAK HOUR OF TRAFFIC VOLUMES

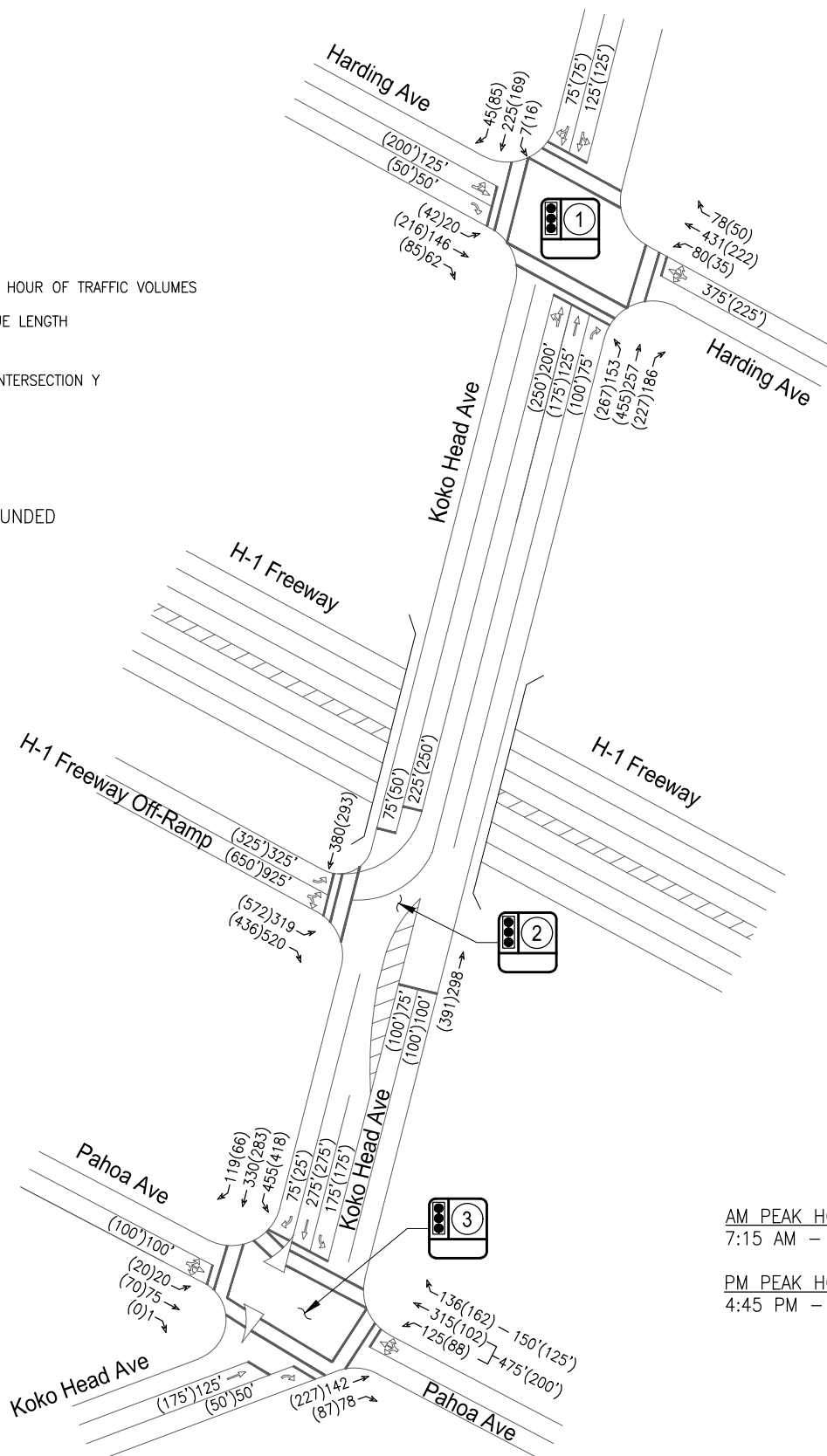
X'(X') - AM(PM) QUEUE LENGTH



- SIGNALIZED INTERSECTION Y

NOTE:

QUEUE LENGTHS ARE
APPROXIMATE AND ROUNDED
TO THE NEAREST 25'



AM PEAK HOUR:
7:15 AM - 8:15 AM

PM PEAK HOUR:
4:45 PM - 5:45 PM

H-1 FREEWAY OFF-RAMP
RESTRIPING STUDY AT
KOKO HEAD AVENUE



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EXISTING LANE CONFIGURATION, VOLUME AND
QUEUEING

FIGURE

3

Table 1
Existing Conditions Analysis

	EXISTING			
	AM		PM	
	Queuing (ft)	Delay (s)	Queuing (ft)	Delay (s)
Koko Head Avenue/Harding Avenue				
EB LT/TH	125	-	200	-
EB RT	50	-	50	-
WB LT/TH/RT	375	-	225	-
NB LT/TH	200	37	250	26
NB TH	125	37	175	26
NB RT	75	-	100	-
SB LT/TH	125	17	125	13
SB TH/RT	75	17	75	13
Koko Head Avenue/Eastbound H-1 Off-Ramp				
EB LT	325	-	325	-
EB LT/RT	925	39	650	33
NB TH Ln 1	75	4	100	2
NB TH Ln 2	100	4	100	2
SB TH Ln 1	225	17	250	28
SB TH Ln 2	75	17	50	28
Koko Head Avenue/Pahoa Avenue				
EB LT/TH/RT	100	-	100	-
WB LT/TH	475	-	200	-
WB RT	150	-	125	-
NB TH	125	22	175	22
NB RT	50	-	50	-
SB LT	175	-	175	-
SB TH	275	5	275	5
SB RT	75	-	25	-

"-" indicates approaches beyond the scope of report, no results available.



III. OPTIONS ANALYSIS

Option 1A – Restripe Existing Off-Ramp

Currently, vehicles trying to turn right at the Koko Head Avenue/H-1 Freeway Off-Ramp experiences significant queuing when attempting a right-turn on red due to eastbound left-turn vehicles queued at the front of the shared left-turn/right-turn lane. As the left-turn vehicles wait for the protected left-turn phase, right-turn vehicles behind them are unable to progress through the intersection.

In order to prevent eastbound left-turn vehicles from blocking eastbound right-turn vehicles at the intersection of Koko Head Avenue/H-1 Freeway Off-Ramp, the following improvement was studied:

- Restripe the existing eastbound shared left-turn/right-turn lane to an exclusive right-turn lane at the Koko Head Avenue/H-1 Freeway Off-Ramp intersection.

Restriping of the existing eastbound shared left-turn/right-turn lane to an exclusive right-turn lane at the Koko Head Avenue/H-1 Freeway Off-Ramp intersection is projected to allow right-turning vehicles to freely enter the intersection without left-turning vehicles blocking the lane. This improvement is also projected to provide a clean breakout on Koko Head Avenue for eastbound left-turning vehicles, and reduce eastbound right-turn queue lengths and delay. As a result of the clean breakout for left-turns onto Koko Head Avenue, there will be significantly less weaving as drivers are likely to turn directly into their desired lane without conflict. Furthermore, northbound queues at Harding Avenue are expected to be more balanced with less lane utilization disparity. Estimated costs for improvement Option 1A are approximately \$40,000 to account for new signal heads, signage and lane restriping.

Analysis Results

Queue lengths obtained were chosen as the critical consideration when assessing the benefits of the Project. The existing right-turn queue length currently extends from the Project Intersection, back past the Off-Ramp gore, and onto the freeway. The main objective of the restriping will be to mitigate the standing queue in the “exit only” lane of the H-1 Eastbound Freeway.

Based on calibration and results, the new eastbound right-turn lane queue improved to 250(275) feet down from 925(650) feet during AM(PM) peak hours. The left-



turn lane queue however worsened to approximately 500 feet, up from approximately 325 feet during PM peak period. Queue increases to the eastbound left-turn lane align with expectations and can be attributed to the reduction in left-turn storage capacity as a result of Option 1A. Despite increases to the left-turn queue length, all vehicles are anticipated to be completely contained on the Off-Ramp, and not queuing back on to the freeway.

In addition, eastbound queue lengths may further benefit from a re-optimization of existing signal timings to account for the new approach lane geometry. Intersections surrounding the Koko Head Avenue/H-1 Freeway Off-Ramp intersection remain relatively unaffected by the Project. As part of the re-optimization of existing signal timings, a change in phasing for the southbound left-turn movement at Pahoa Avenue from a lagging left-turn phase to a leading left-turn phase was also analyzed. However, the conversion to a leading left-turn phase does not show a significant and conclusive benefit to reduce queue lengths.

Figure 4a shows the Project volumes and queue lengths for the study intersections. Table 2 summarizes the Project simulation results at the study intersections. Figure 6 shows a comparison figure illustrating expected before and after queue lengths as a result of the Project.



NOT TO SCALE

LEGEND

##(##) - AM(PM) PEAK HOUR OF TRAFFIC VOLUMES

X'(X') - AM(PM) QUEUE LENGTH

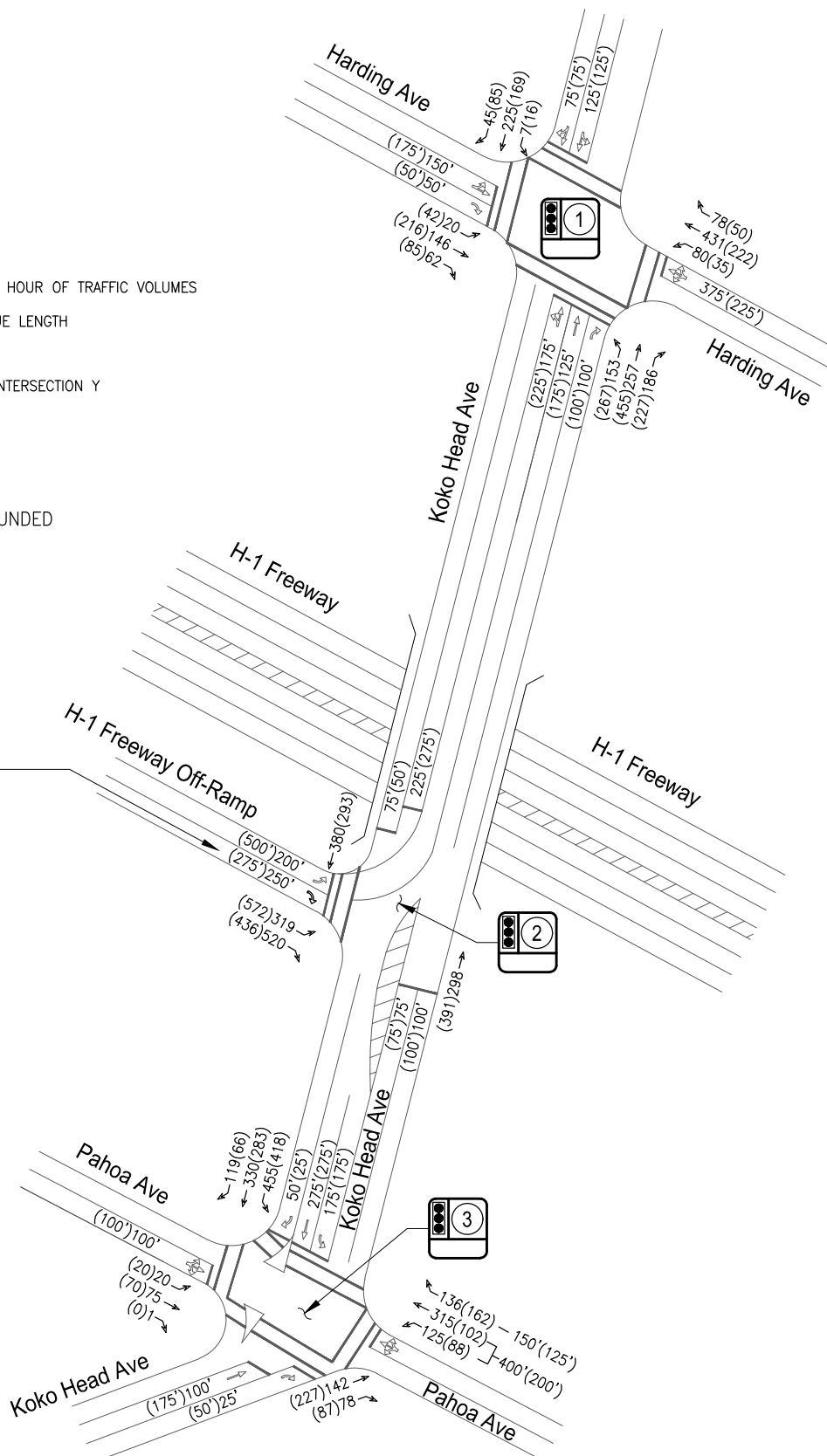


- SIGNALIZED INTERSECTION Y

NOTE:

QUEUE LENGTHS ARE
APPROXIMATE AND ROUNDED
TO THE NEAREST 25'

**New Dedicated
Right-Turn Lane**



H-1 FREEWAY OFF-RAMP
RESTRIPIING STUDY AT
KOKO HEAD AVENUE



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OPTION 1A - PROJECT LANE CONFIGURATION,
VOLUME AND QUEUING

FIGURE

4A

Table 2
Existing and Option 1A Conditions Analysis Comparison

	EXISTING			
	AM		PM	
	Simulation		Simulation	
	Queuing (ft)	Delay (s)	Queuing (ft)	Delay (s)
<u>Koko Head Avenue/Harding Avenue</u>				
EB LT/TH	125	-	200	-
EB RT	50	-	50	-
WB LT/TH/RT	375	-	225	-
NB LT/TH	200	37	250	26
NB TH	125	37	175	26
NB RT	75	-	100	-
SB LT/TH	125	17	125	13
SB TH/RT	75	17	75	13
<u>Koko Head Avenue/Eastbound H-1 Off-Ramp</u>				
EB LT	325	-	325	-
EB LT/RT	925	39	650	33
NB TH Ln 1	75	4	100	2
NB TH Ln 2	100	4	100	2
SB TH Ln 1	225	17	250	28
SB TH Ln 2	75	17	50	28
<u>Koko Head Avenue/Pahoa Avenue</u>				
EB LT/TH/RT	100	-	100	-
WB LT/TH	475	-	200	-
WB RT	150	-	125	-
NB TH	125	22	175	22
NB RT	50	-	50	-
SB LT	175	-	175	-
SB TH	275	5	275	5
SB RT	75	-	25	-

	OPTION 1A			
	AM		PM	
	Simulation		Simulation	
	Queuing (ft)	Delay (s)	Queuing (ft)	Delay (s)
<u>Koko Head Avenue/Harding Avenue</u>				
EB LT/TH	150	-	175	-
EB RT	50	-	50	-
WB LT/TH/RT	375	-	225	-
NB LT/TH	175	34	225	28
NB TH	125	34	175	28
NB RT	100	-	100	-
SB LT/TH	125	15	125	15
SB TH/RT	75	15	75	15
<u>Koko Head Avenue/Eastbound H-1 Off-Ramp</u>				
EB LT	200	21	500	40
EB RT	250	21	275	40
NB TH Ln 1	75	4	75	1
NB TH Ln 2	100	4	100	1
SB TH Ln 1	225	13	275	31
SB TH Ln 2	50	13	75	31
<u>Koko Head Avenue/Pahoa Avenue</u>				
EB LT/TH/RT	100	-	100	-
WB LT/TH	400	-	200	-
WB RT	150	-	125	-
NB TH	100	19	175	22
NB RT	25	-	50	-
SB LT	175	-	175	-
SB TH	275	5	275	5
SB RT	50	-	25	-

"-" indicates approaches beyond the scope of report, no results available.

Option 1B – Restripe Existing Off-Ramp and Left-Turn at Harding Avenue

In addition to Option 1A discussed above, an additional restriping improvement was explored at the Koko Head Avenue/Harding Avenue intersection. Existing northbound vehicles attempting to turn left at the intersection currently share a lane with the through movements along Koko Head Avenue. As the left-turn vehicles yield to on-coming traffic, through vehicles behind them are unable to progress through the intersection. Furthermore, parking is permitted on Koko Head Avenue north of Harding Avenue, which may discourage drivers from using the exclusive northbound through lane as drivers would need to merge within a short distance if parked vehicles are present.

In order to improve the lane utilization at the Koko Head Avenue/Harding Avenue intersection and, as mentioned above, prevent the eastbound left-turn vehicles from blocking eastbound right-turn vehicles at the intersection of Koko Head Avenue/H-1 Freeway Off-Ramp, the following improvements were studied:

- Restripe the eastbound shared left-turn/right-turn lane to an exclusive right-turn lane at the Koko Head Avenue/H-1 Freeway Off-Ramp intersection. In addition, at the Koko Head Avenue/Harding Avenue intersection, restripe the northbound shared left-turn/through lane to a dedicated left-turn lane.

Restriping of the existing northbound shared left-turn/through lane to an exclusive left-turn lane at the Koko Head Avenue/Harding Avenue intersection is projected to further improve the balance between the northbound lane utilization. As mentioned above, the restriping improvements at the Koko Head Avenue/H-1 Freeway Off-Ramp intersection will provide a clean breakout on Koko Head Avenue for eastbound left-turning vehicles, which will result in significantly less weaving as drivers are likely to turn directly into their desired lane without conflict. Exclusive northbound left-turn and through lanes will further simplify lane assignments.

In addition, less weaving on Koko Head Avenue north of Harding Avenue is expected as northbound through drivers will be traveling through the intersection in one lane. Estimated costs for improvement Option 1B are approximately \$45,000 to account for new signal heads, signage and lane restriping.

Analysis Results

Queue lengths obtained were chosen as the critical consideration when assessing the benefits of the Project. The existing right-turn queue length currently extends from the Koko Head Avenue/H-1 Freeway Off-Ramp intersection, back past the Off-Ramp gore, and onto the freeway. The northbound left-turn queue at the Koko Head Avenue/Harding Avenue intersection also experiences long vehicle queue. The main objective of the restriping will be to mitigate the standing queue in the “exit only” lane of the H-1 Eastbound Freeway and balance the queues between the northbound lanes at the Koko Head Avenue/Harding Avenue intersection.

Based on calibration and results, the new eastbound right-turn lane queue at the Koko Head Avenue/H-1 Freeway Off-Ramp intersection improved to 250(225) feet down from 925(650) feet during AM(PM) peak hours. The left-turn lane queue however worsened to approximately 575 feet, up from approximately 325 feet during PM peak period. Queue increases to the eastbound left-turn lane align with expectations and can be attributed to the reduction in left-turn storage capacity as a result of Option 1B. Despite increases to the left-turn queue length, all vehicles are anticipated to be completely contained on the Off-Ramp, and not queuing back on to the freeway.

In addition, eastbound queue lengths at the Koko Head Avenue/H-1 Freeway Off-Ramp intersection may further benefit from a re-optimization of existing signal timings to account for the new approach lane geometry. As part of the re-optimization of existing signal timings, a change in phasing for the southbound left-turn movement at Pahoa Avenue from a lagging left-turn phase to a leading left-turn phase was also analyzed. However, the conversion to a leading left-turn phase does not show a significant and conclusive benefit to reduce queue lengths.

Based on calibration and results, the new dedicated left-turn lane queue at the Koko Head Avenue/Harding Avenue intersection improved to 150(200) feet down from 200(250) feet during the AM(PM) peak hours. Although the northbound through queue increased to 175(225) from 125(175) feet during the AM(PM) peak hours, vehicle queues are not expected to spill back to the upstream intersection.

Figure 4B shows the Project volumes and queue lengths for the study intersections. Table 3 summarizes the Project simulation results at the study



intersections. Figure 6 shows a comparison figure illustrating expected before and after queue lengths as a result of the Project.



NOT TO SCALE

LEGEND

##(##) - AM(PM) PEAK HOUR OF TRAFFIC VOLUMES

X'(X') - AM(PM) QUEUE LENGTH

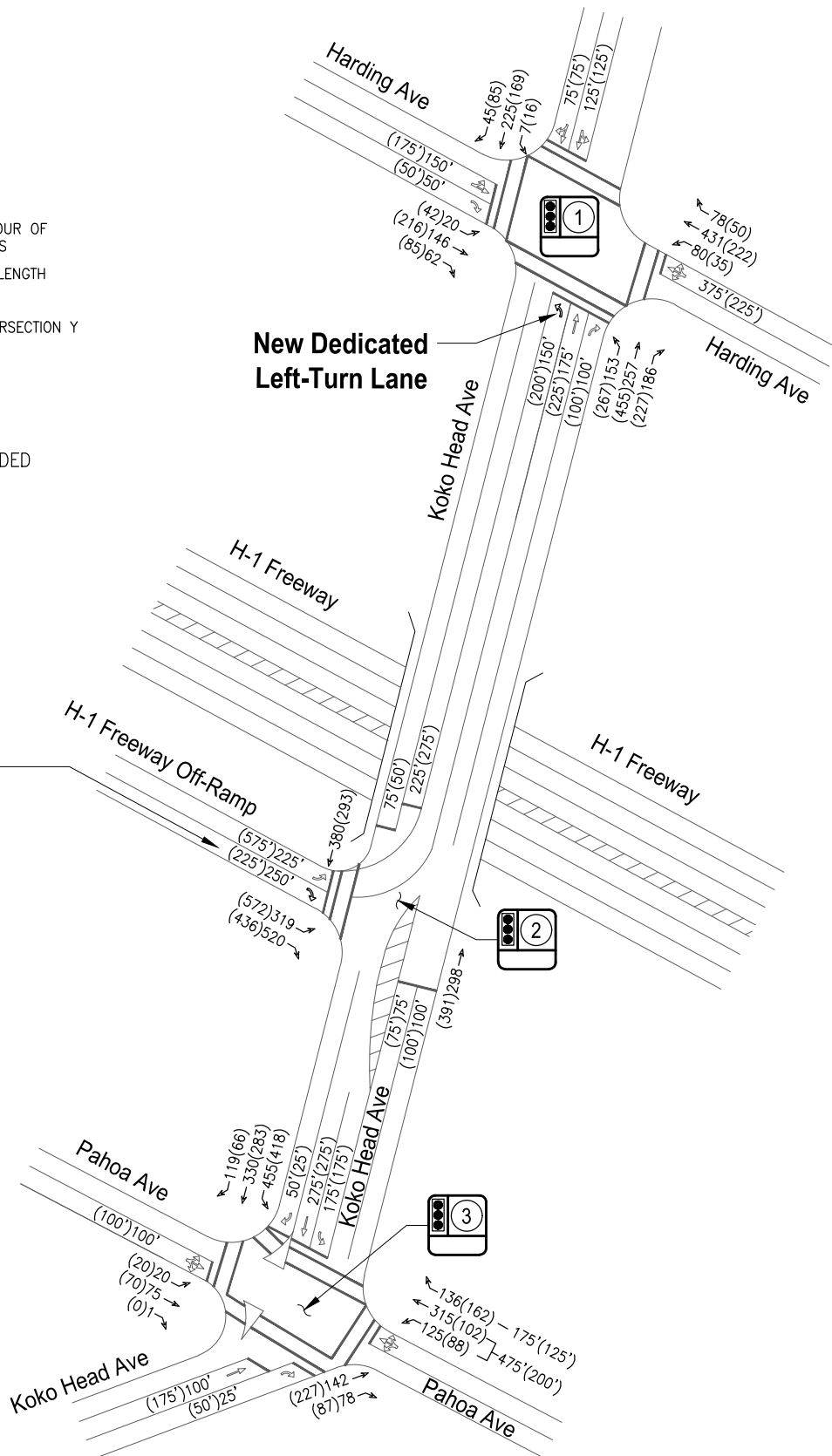


- SIGNALIZED INTERSECTION Y

NOTE:
QUEUE LENGTHS ARE
APPROXIMATE AND ROUNDED
TO THE NEAREST 25'

**New Dedicated
Right-Turn Lane**

**New Dedicated
Left-Turn Lane**



H-1 FREEWAY OFF-RAMP
RESTRIPING STUDY AT
KOKO HEAD AVENUE



AUSTIN, TSUTSUMI & ASSOCIATES, INC.
ENGINEERS, SURVEYORS

HONOLULU, HAWAII

OPTION 1B - PROJECT LANE CONFIGURATION,
VOLUME AND QUEUING

FIGURE

4B

Table 3
Existing and Option 1B Conditions Analysis Comparison

	EXISTING			
	AM		PM	
	Simulation		Simulation	
	Queuing (ft)	Delay (s)	Queuing (ft)	Delay (s)
<u>Koko Head Avenue/Harding Avenue</u>				
EB LT/TH	125	-	200	-
EB RT	50	-	50	-
WB LT/TH/RT	375	-	225	-
NB LT/TH	200	37	250	26
NB TH	125	37	175	26
NB RT	75	-	100	-
SB LT/TH	125	17	125	13
SB TH/RT	75	17	75	13
<u>Koko Head Avenue/Eastbound H-1 Off-Ramp</u>				
EB LT	325	-	325	-
EB LT/RT	925	39	650	33
NB TH Ln 1	75	4	100	2
NB TH Ln 2	100	4	100	2
SB TH Ln 1	225	17	250	28
SB TH Ln 2	75	17	50	28
<u>Koko Head Avenue/Pahoa Avenue</u>				
EB LT/TH/RT	100	-	100	-
WB LT/TH	475	-	200	-
WB RT	150	-	125	-
NB TH	125	22	175	22
NB RT	50	-	50	-
SB LT	175	-	175	-
SB TH	275	5	275	5
SB RT	75	-	25	-

	OPTION 1B			
	AM		PM	
	Simulation		Simulation	
	Queuing (ft)	Delay (s)	Queuing (ft)	Delay (s)
<u>Koko Head Avenue/Harding Avenue</u>				
EB LT/TH	150	-	175	-
EB RT	50	-	50	-
WB LT/TH/RT	375	-	225	-
NB LT	150	32	200	28
NB TH	175	32	225	28
NB RT	100	-	100	-
SB LT/TH	125	17	125	19
SB TH/RT	75	17	75	19
<u>Koko Head Avenue/Eastbound H-1 Off-Ramp</u>				
EB LT	225	22	575	38
EB RT	250	22	225	38
NB TH Ln 1	75	4	75	2
NB TH Ln 2	100	4	100	2
SB TH Ln 1	225	11	275	35
SB TH Ln 2	50	11	75	35
<u>Koko Head Avenue/Pahoa Avenue</u>				
EB LT/TH/RT	100	-	100	-
WB LT/TH	475	-	200	-
WB RT	175	-	125	-
NB TH	100	21	175	23
NB RT	25	-	50	-
SB LT	175	-	175	-
SB TH	250	4	275	5
SB RT	50	-	25	-

"-" indicates approaches beyond the scope of report, no results available.



Option 2 – Widen the Off-Ramp to Provide a Double Left-Turn and Single Right-Turn

In order to prevent eastbound left-turn vehicles from blocking right-turn vehicles at the intersection of Koko Head Avenue/H-1 Freeway Off-Ramp, the following improvement option was also studied:

- Widen the existing Koko Head Avenue Off-Ramp and restripe the existing eastbound shared left-turn/right-turn lane to an exclusive left-turn lane and provide a new dedicated right-turn lane at the Koko Head Avenue/H-1 Freeway Off-Ramp intersection.

The addition of an exclusive right-turn lane as well as restriping the existing shared left-turn/right-turn lane at the Koko Head Avenue/H-1 Freeway Off-Ramp intersection is projected to allow right-turning vehicles easier progression through the intersection during red lights without left-turning vehicles blocking the lane.

Site restrictions as a result of nearby homes adjacent to the existing Koko Head Off-Ramp limit the length of the widening for the dedicated right-turn lane to approximately 250' which would equate to a storage capacity of 10-12 vehicles.

It should be noted that the total expected cost to construct this alternative is estimated at \$7 million which includes costs for the widening, striping and traffic signal modifications as needed.

Analysis Results

The new eastbound right-turn lane queue improved to approximately 275(200) feet down from 925(650) feet during AM(PM) peak hours. With a dual dedicated left-turn movement, left-turn lane queues improved to 225(200) feet from 325(325) feet during the AM(PM) peak periods. Option 2 queue reductions to the eastbound left-turn lanes align with expectations and can be attributed to the increase in left-turn capacity when compared to both existing and Option 1 conditions. As a result, Off-Ramp queues are anticipated to be completely contained on the Koko Head Off-Ramp, and not queuing back past the Off-Ramp gore.

In addition, a change in phasing for the southbound left-turn movement at Pahoa Avenue from a lagging left-turn phase to a leading left-turn phase was also analyzed. However, the conversion to a leading left-turn phase does not show a significant and conclusive benefit to reduce queue lengths.



Figure 5 shows the Project volumes and queue lengths for the study intersections. Table 4 summarizes the Project simulation results at the study intersections. Figure 6 shows a comparison figure illustrating expected before and after queue lengths as a result of the studied options.



NOT TO SCALE

LEGEND

##(##) - AM(PM) PEAK HOUR OF TRAFFIC VOLUMES

X'(X') - AM(PM) QUEUE LENGTH

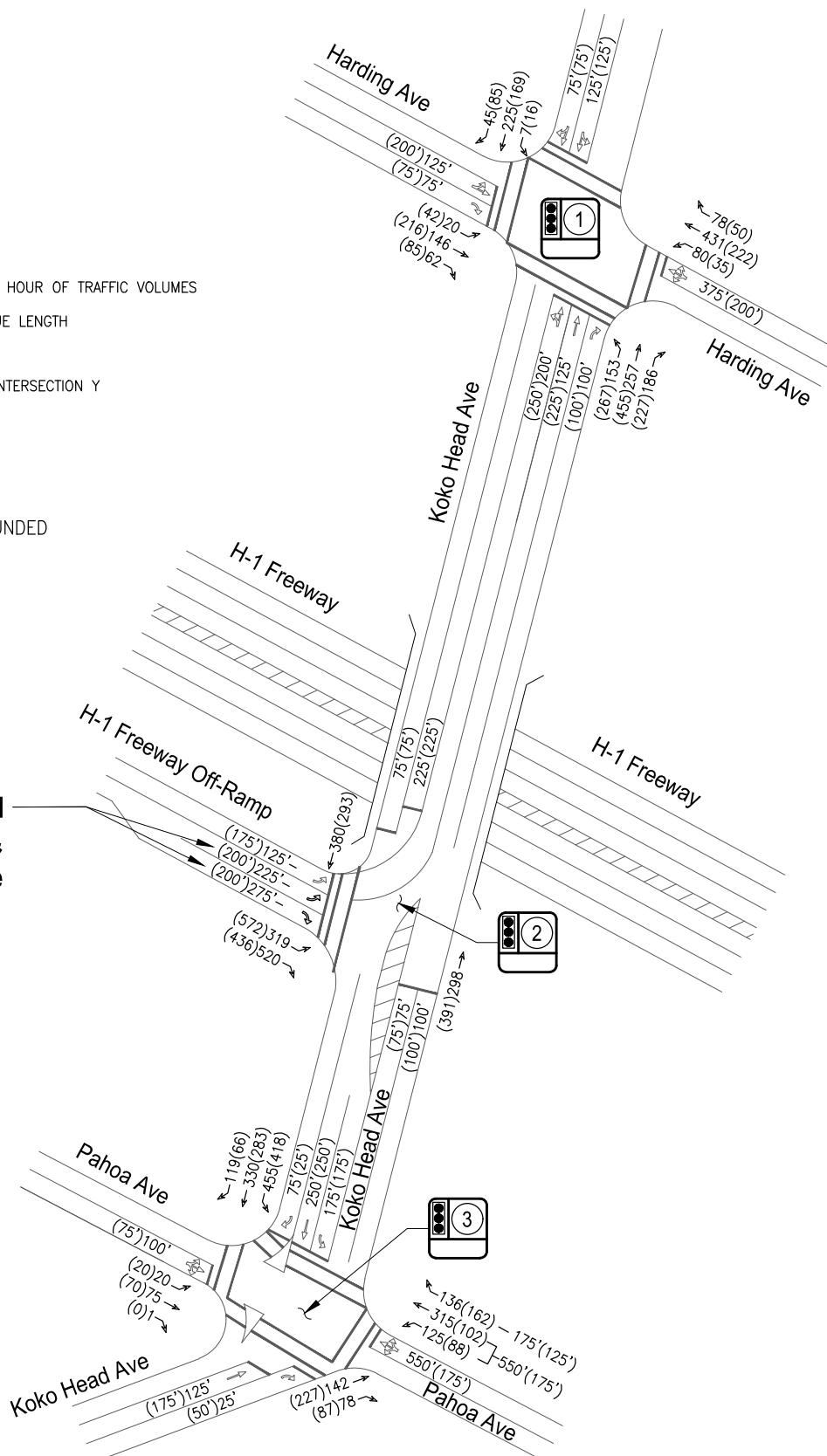


- SIGNALIZED INTERSECTION Y

NOTE:

QUEUE LENGTHS ARE APPROXIMATE AND ROUNDED TO THE NEAREST 25'

**New Dedicated
Left-Turn Lane &
Right-Turn Lane**



H-1 FREEWAY OFF-RAMP
RESTRIPING STUDY AT
KOKO HEAD AVENUE



AUSTIN, TSUTSUMI & ASSOCIATES, INC.
ENGINEERS, SURVEYORS

HONOLULU, HAWAII

**OPTION 2 - PROJECT LANE CONFIGURATION,
VOLUME AND QUEUING**

FIGURE

5

Table 4
Existing and Option 2 Conditions Analysis Comparison

	EXISTING			
	AM		PM	
	Simulation		Simulation	
	Queuing (ft)	Delay (s)	Queuing (ft)	Delay (s)
Koko Head Avenue/Harding Avenue				
EB LT/TH	125	-	200	-
EB RT	50	-	50	-
WB LT/TH/RT	375	-	225	-
NB LT/TH	200	37	250	26
NB TH	125	37	175	26
NB RT	75	-	100	-
SB LT/TH	125	17	125	13
SB TH/RT	75	17	75	13
Koko Head Avenue/Eastbound H-1 Off-Ramp				
EB LT	325	-	325	-
EB LT/RT	925	39	650	33
NB TH Ln 1	75	4	100	2
NB TH Ln 2	100	4	100	2
SB TH Ln 1	225	17	250	28
SB TH Ln 2	75	17	50	28
Koko Head Avenue/Pahoa Avenue				
EB LT/TH/RT	100	-	100	-
WB LT/TH	475	-	200	-
WB RT	150	-	125	-
NB TH	125	22	175	22
NB RT	50	-	50	-
SB LT	175	-	175	-
SB TH	275	5	275	5
SB RT	75	-	25	-

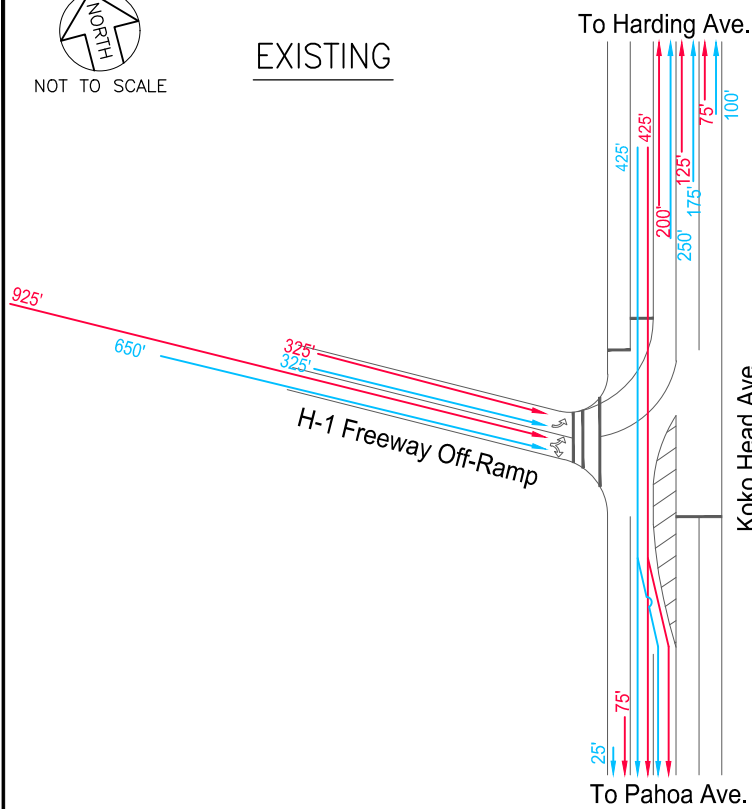
	OPTION 2			
	AM		PM	
	Simulation		Simulation	
	Queuing (ft)	Delay (s)	Queuing (ft)	Delay (s)
Koko Head Avenue/Harding Avenue				
EB LT/TH	125	-	200	-
EB RT	75	-	75	-
WB LT/TH/RT	375	-	200	-
NB LT/TH	200	34	250	28
NB TH	125	34	225	28
NB RT	100	-	100	-
SB LT/TH	125	15	125	15
SB TH/RT	75	15	75	15
Koko Head Avenue/Eastbound H-1 Off-Ramp				
EB LT Ln 1	125	21	175	40
EB LT Ln 2	225	21	200	40
EB RT	275	-	200	-
NB TH Ln 1	75	4	75	1
NB TH Ln 2	100	4	100	1
SB TH Ln 1	225	13	225	31
SB TH Ln 2	75	13	75	31
Koko Head Avenue/Pahoa Avenue				
EB LT/TH/RT	100	-	75	-
WB LT/TH	550	-	175	-
WB RT	175	-	125	-
NB TH	125	19	175	22
NB RT	25	-	50	-
SB LT	175	-	175	-
SB TH	250	5	250	5
SB RT	75	-	25	-

"-" indicates approaches beyond the scope of report, no results available.



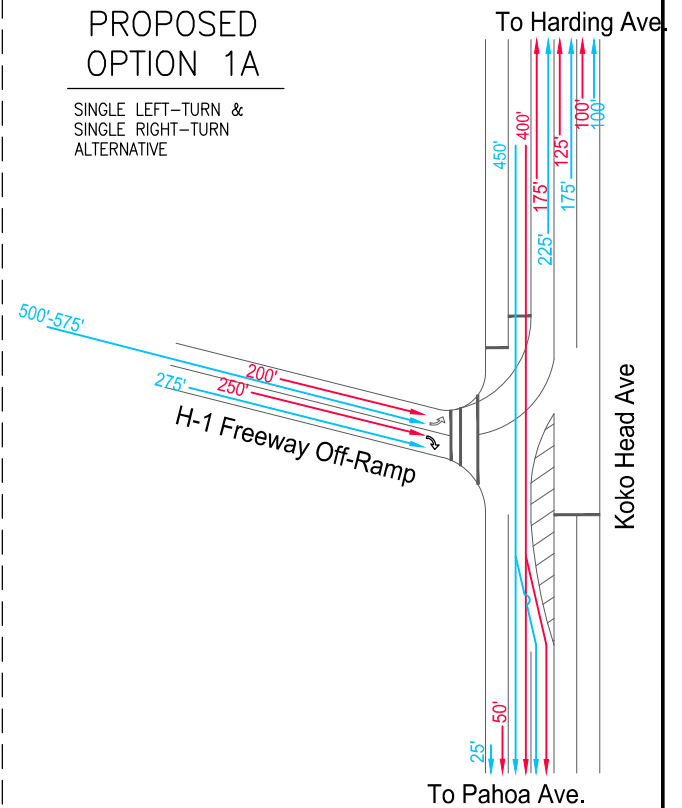
NOT TO SCALE

EXISTING



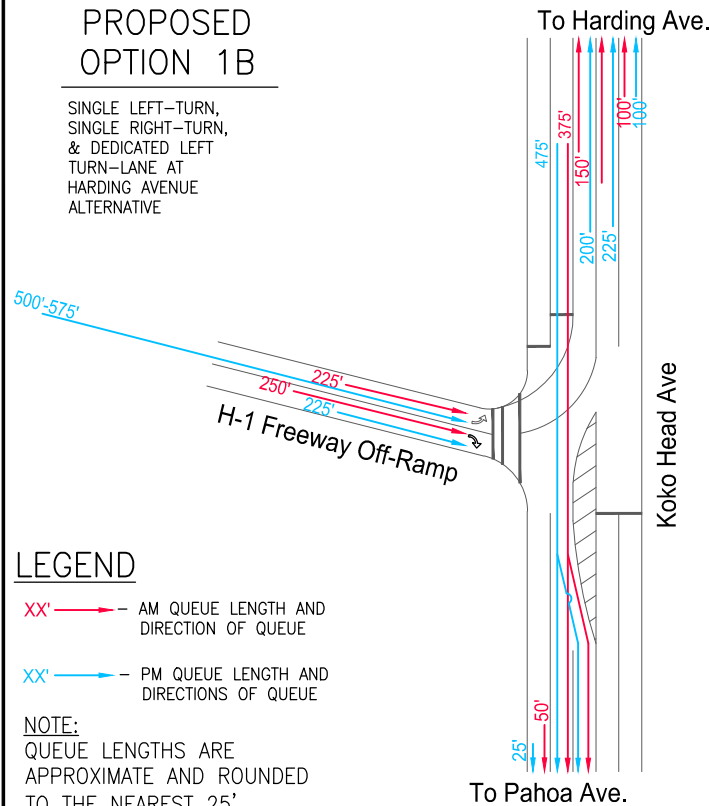
PROPOSED OPTION 1A

SINGLE LEFT-TURN &
SINGLE RIGHT-TURN
ALTERNATIVE



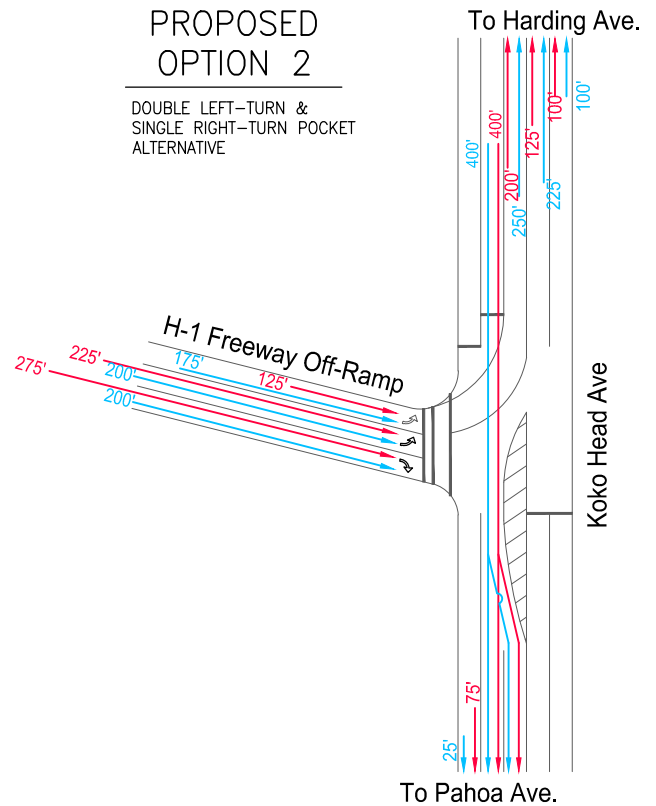
PROPOSED OPTION 1B

SINGLE LEFT-TURN,
SINGLE RIGHT-TURN,
& DEDICATED LEFT
TURN-LANE AT
HARDING AVENUE
ALTERNATIVE



PROPOSED OPTION 2

DOUBLE LEFT-TURN &
SINGLE RIGHT-TURN POCKET
ALTERNATIVE



LEGEND

XX' — AM QUEUE LENGTH AND
DIRECTION OF QUEUE

XX' — PM QUEUE LENGTH AND
DIRECTIONS OF QUEUE

NOTE:
QUEUE LENGTHS ARE
APPROXIMATE AND ROUNDED
TO THE NEAREST 25'

H-1 FREEWAY OFF-RAMP
RESTRIPING STUDY AT
KOKO HEAD AVENUE



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COMPARISON FIGURE FOR EXISTING AND
PROJECTED QUEUE LENGTHS

FIGURE

6



IV. CONCLUSIONS

The Koko Head Avenue/H-1 Freeway Off-Ramp intersection was studied due to complaints made regarding right-turning vehicles on the H-1 Freeway Off-Ramp experiencing significant queuing in the shared left-turn/right-turn lane. The proposed traffic improvement will involve restriping the eastbound shared left-turn/right-turn lane as an exclusive right-turn lane at the Koko Head Avenue/H-1 Freeway Off-Ramp intersection.

Existing Conditions

Currently, the eastbound left-turn lane queues to approximately 325(325) feet and the left-turn/right-turn movement queues to approximately 925(650) feet during the AM(PM) peak hours of traffic. All other movements across the study intersections operate under capacity and vehicles typically clear in a single cycle with the only queuing issues occurring at the Koko Head Avenue/Harding Avenue intersection during the AM and PM peak hours of traffic.

Proposed Improvement Options

Option 1A

With the proposed restriping, queuing in the existing eastbound left-turn lane will worsen during the PM peak hour of traffic. However, the new eastbound right-turn queue will greatly decrease from approximately 925(650) to 250(275) feet during the AM(PM) peak hours of traffic. All other movements across the study intersections will operate similar to existing conditions during the AM and PM peak hours of traffic.

Option 1B

With the proposed restriping at the Koko Head Avenue/H-1 Freeway Off-Ramp intersection, queuing in the existing eastbound left-turn lane will worsen during the PM peak hour of traffic. However, the new eastbound right-turn queue will greatly decrease from approximately 925(650) to 250(225) feet during the AM(PM) peak hours of traffic. All other movements across the study intersections will operate similar to existing conditions during the AM and PM peak hours of traffic.

With the proposed restriping at the Koko Heave Avenue/Harding Avenue intersection, queuing in the new dedicated left-turn lane will decreased from 200(250) to 150(200) during the AM(PM) peak hours, while the northbound through queue will increase from 125(175) to 175(225) during the AM(PM) peak hours.



Option 2

With the proposed widening and restriping, the new eastbound right-turn queue will greatly decrease from approximately 925(650) to approximately 275(200) feet during the AM(PM) peak hours of traffic. Additionally, queue lengths for the new dedicated double left-turn would improve from approximately 325(325) to 225(200) feet. All other movements across the study intersections will operate similar to existing conditions during the AM and PM peak hours of traffic.



REFERENCES

1. Transportation Research Board, Highway Capacity Manual – HCM 2000.