University of Hawai'i at Mānoa

INVESTIGATION OF THE EFFECTS OF LIMITED RAMP CLOSURES ALONG THE H-1 FREEWAY

VOLUME 3

WEST BOUND LUNALILO STREET ON-RAMP CLOSURE: JUSTIFICATION, DESIGN AND ANALYSIS OF RESEARCH EXPERIMENT

FINAL REPORT

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16. Abstract

The focus of the research project is the central section of the H-1 Fwy. between Koko Head Ave. and Middle St., in Honolulu, Hawaii. The objective of the project is the investigation of short-term actions to improve the flow of traffic. The project utilized FRESIM, INTEGRATION, KRONOS and TRANSYT-7F to identify ramps that impede the mainline flow and assess to the impact on both freeway and streets should the ramps be modified. AUTOSCOPE speeds were used to calibrate the base-case models.

This volume summarizes the 2-week experimental closure of the Lunalilo St. on-ramp in fall 1997. Simulation revealed that this on-ramp is the most significant bottleneck on the west bound freeway and that its morning closure would result in substantial travel time savings to freeway users. The local geometry permits traffic from the on-ramp to continue onto the Vineyard Blvd. off-ramp without entering the freeway. Overall, results showed strong promise for long-term benefit. Although speeds initially dropped, by the last (10^{th}) day of the experiment, peak morning travel time on the freeway was 15% faster than normal. Surveys were distributed to motorists at upstream on-ramps. The majority of the 1,120 respondents wanted the morning coning to continue and relatively few disliked the experiment. About ¼ of Lunalilo St. motorists liked the morning coning and ¼ were neutral. Long-term experimental closure of this ramp with automated enforcement is recommended for week days and between 6:00 and 9:30 A.M.

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Executive Summary

The focus of the overall research project is the central section of the H-1 Freeway between Koko Head Ave. and Middle St. The objective of the overall project is the investigation of short-term actions to improve the flow of traffic. The purpose of this report is to present the justification, design, execution and assessment of the experimental closure of the west bound Lunalilo St. on-ramp.

Pervasive congestion is observed on the west bound H-1 Freeway in the project area for about 1.5 to 2.5 hours every weekday morning and for 1 to 4 hours every weekday afternoon. Morning congestion typically affects the segment between 6th Ave. and Ward Ave. Afternoon congestion usually begins by the University of Hawaii, Manoa Campus and ends past the Kalihi St. overpass.

Detailed analyses of west bound H-1 Freeway flow conditions with fall 1996 data revealed that the Lunalilo St. on-ramp is the most significant bottleneck. Simulation showed that its morning closure would result in substantial travel time savings to freeway users. The local geometry permits traffic from the on-ramp to continue onto the Vineyard Blvd. off-ramp without entering the freeway. About 20% of on-ramp traffic already exits at Vineyard Blvd. The remainder could re-enter the freeway via the west bound Punchbowl St., School St. and Vineyard Blvd. on-ramps. Analysis showed that in the morning, the west bound Vineyard Blvd. off-ramp and the west bound direction of Vineyard Blvd. could handle the traffic diverted from the Lunalilo St. on-ramp.

Based on these findings, the HDOT and FHWA approved an experimental morning closure for two consecutive weeks from late October to early November, 1997. A suite of data were collected to evaluate the experiment.

The major components of the design and execution of the experiment were as follows.

- Traffic cones were placed in 20 ft. intervals to define the closure. After the first day, the density was doubled to reduce violations.
- 2 police officers were used for oversight and to discourage violations.
- 3 portable variable message signs (VMS) were used:
    - one on the freeway, about 1,500 ft. before the beginning of the coning, notifying motorists of the coning and that the off-ramp was open;
    - one at the signalized intersection of two one-way streets that feed the on-ramp, informing motorists about the detour. This VMS was placed 2 weeks in advance with an announcement of the forthcoming experiment; and,
    - one at the end of the coning notifying large vehicles to avoid a downstream on-ramp with a small turning radius.
- The state DOT issued the mandatory "Notice to Motorists" in the local press and informational press releases.
- Six locations including the experiment site were videotaped using the surveillance cameras of HDTS.

- Traffic counts were collected at all west bound on- and off-ramps from 11th Ave. to Kalihi St.
- Ten vehicles with crews of two members conducted travel time surveys along six routes, with departures every 30 minutes.
- A post-experiment questionnaire was distributed at the closed on-ramp and 7 upstream on-ramps.

The experiment period consisted of a base week (first week in October 1997) and the two experiment weeks (last week in October and first week in November 1997). These were selected so that school, State and federal holidays were minimized. The coning and portable VMS, the travel time surveys and the post-experiment survey were handled by HDOT contractors. HDOT was responsible for traffic counts and overall coordination. The City provided police, helicopter and camera surveillance.

Overall, results showed strong promise for long-term benefit. Speed dropped in the vicinity of the traffic cones, then gradually increased through the end of the experiment. By the last (10th) day of the experiment, peak morning travel time on west bound H-1 Freeway between 6th Ave. and Ward Ave. was 15% faster than normal. Based on NCHRP 431 and actual statistics collected during this experimental closure, travel time savings and a reduction in travel time variation valued at $11,000 can be achieved on typical week days. This amount is a conservative estimate: It accounts for the losses of rerouted traffic but excludes savings in fuel consumption and pollution.

A week after the experiment was completed, surveys were distributed to motorists at upstream on-ramps. The majority of the 1,120 respondents wanted the morning coning to continue and relatively few disliked the experiment. Equal attention was given to the impacts on motorists using the Lunalilo St. on-ramp. Although it was assumed that most users of the Lunalilo St. on-ramp would dislike the experiment, about ¼ liked the morning coning and ¼ were neutral. As anticipated, the normal freeway-bound queue on Piikoi St. and Lunalilo St. was replaced with queuing on the Vineyard Blvd. off-ramp. Travel time increased for drivers rerouted to the Vineyard Blvd. on-ramp. However, the closure reduced travel time for reaching the Lunalilo St. on-ramp and did not significantly increase travel time for those rerouted to the Punchbowl St. on-ramp.

During the brief (10 days) period of the experiment, better results could not be achieved given the presence of:
- cones, hesitant motorists and "rubbernecking"
- breaches of coning and the fact that cones spilled across the freeway daily
- variable message signs, police and cone truck, and
- brief but systematic overflow of the west bound Vineyard Blvd. off-ramp.

The experimental Lunalilo St. on-ramp closure could not offer the simulated benefits because it did not become a "normal" traffic phenomenon, which is what the simulations represented. Six incidents during the experiment also had a negative effect on the outcomes.

Based on findings from the short-term experiment, a long-term experimental closure of the Lunalilo St. on-ramp is recommended for week days and between 6:00 and 9:30 A.M. Recommended elements of the long-term closure include a variable message sign over the Lunalilo St. on-ramp, fixed signs on the approaches to this ramp and automated enforcement. The purpose of the signs is to inform motorists about the prohibition on lane changing (e.g., *no merge onto the freeway*), their options for reaching the freeway, and the presence of automated enforcement. Consideration should be given to installation of in-pavement LED lights along the line on which the cones were set during the short-term experiment. These in-pavement lights could be similar to those used at unsignalized pedestrian crosswalks. These lights could be a significant aid for guiding Lunalilo St. on-ramp motorists to the right lane of the Vineyard Blvd. off-ramp as well as for guiding freeway motorists to the left lane of the Vineyard Blvd. off-ramp.

Automated, non-intrusive enforcement is recommended. Automated enforcement of lane changing violations and ticket-by-mail were authorized by Act 263, Session Laws of Hawaii 1999. Thus, a system using video surveillance and off-the-shelf license recognition technology and mailed citations is proposed. Enforcement for this site requires license plate monitoring at the Lunalilo St. on-ramp (entry) and at the Vineyard Blvd. off-ramp (exit). All vehicles identified at the entry but not identified at the exit are presumed to have illegally merged onto the freeway. Potential errors by the system (e.g., contested tickets) can be resolved by manually comparing the entry and exit tapes.

Several options are available for reducing delays for traffic rerouted onto the Vineyard Blvd. off-ramp. As part of the Queens Medical Center expansion, a left turn lane on south bound Punchbowl St. will be constructed. This will reduce queues on Vineyard Blvd. and permit a more balanced use of the twin left turns. (Presently, motorists tend to avoid the left of the two left turning lanes.) It also is recommended that HDOT ban the east bound left turns from Vineyard Blvd. to north bound Punchbowl St. while the Lunalilo St. on-ramp is closed. This will displace fewer than 150 vehicles in the morning peak hour, but will increase west bound left turn green time by about 60%, and west bound through and right turn green time by more than 30%. HDOT also should encourage the City to proceed with plans to improve the geometry of the (tight) right turn from Vineyard Blvd. to north bound Punchbowl Blvd.

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CHAPTER ONE: INTRODUCTION

The primary objective of the INVESTIGATION OF THE EFFECTS OF LIMITED RAMP CLOSURES project is to identify potential ramps on the segment of the H-1 freeway between Koko Head Ave. and Middle St. which, if closed would cause a significant improvement of the flow conditions on the freeway without causing major adverse effects on the surface street network. The documentation of the report consists of two basic volumes. Volume 1 introduces the project, methodology, data and details the west bound analyses. Volume 2 details east bound analyses. Subsequent volumes summarize real-world experiments. This document is Volume 3; it summarizes the 2-week experimental "closure" of the west bound Lunalilo St. on-ramp in the fall of 1997. It is referred to as a "closure" because in effect the ramp was open and all its traffic was rerouted to the west bound Vineyard Blvd. off-ramp. Merge into the freeway was prohibited with the use of traffic cones.

This report is structured as follows: The methodology is summarized below including highlights of the results of the simulation of existing conditions on west bound H-1 Freeway. Chapter 2 details the morning and afternoon analyses of the Lunalilo St. on-ramp closure in three parts: 1) Freeway, 2) Piikoi St. and Lunalilo St. Arterials, and 3) Vineyard Blvd. Arterial. Chapter 3 presents the design of the experiment and Chapter 4 presents the evaluation of the experiment. The evaluation consists of traffic volume analysis, AUTOSCOPE speeds analysis, KRONOS simulation of experiment conditions, travel times analysis, and motorists perceptions analysis from a post-experiment survey conducted at the Lunalilo St. on-ramp and several upstream on-ramps. Chapter 5 presents an overall summary including the lessons learned from this short-term experiment, a proposed design for a long-term experimental deployment and other recommendations.

The methodology of analysis is outlined in Figure 1.1. Initial stages include literature review for software selection and identification of past experiences with ramp closures. In parallel, data are collected and sample-tested for accuracy. Once software have been selected[1] and the data have been inspected, freeway simulations commence. A field-validated base case (separate for morning and afternoon conditions) is followed by the analysis of several alternatives and combinations of alternatives. Some alternatives have a considerable potential for improving traffic flow and may be practical for implementation. These are analyzed further with network simulation to assess the impact of the proposed change on both freeway and surface street traffic flow.

In some cases, a real-world experimentation of an alternative with a high potential for improving traffic flow may be feasible. In this a case, requests for approvals and funding commence. Once approval and funding are secured, a detailed design (physical, organizational and analytical) commences. The physical design addresses all the requirements for the safe and efficient execution of the experiment in the field. Organizational design addresses the roles of all the partners and stake-holders which included the Hawaii Department of Transportation (HDOT), the City and County of Honolulu Department of Transportation Services (HDTS), the Police Department (HPD) and the Federal Highway Administration (FHWA). In addition, the neighborhood boards and a number of contractors are likely to be involved. Analytical design addresses the collection of data for the proper evaluation of the outcomes of the experiment and the comparison with normal conditions.

[1] KRONOS v.8 was selected for freeway simulations. It was developed at the University of Minnesota with support from Minnesota DOT and FHWA. INTEGRATION v.2 was selected for network simulations. It was developed at the Queen's University in Canada and has been used in many applications world-wide. (See Volume 1 for references to these software and review of many other traffic software.)

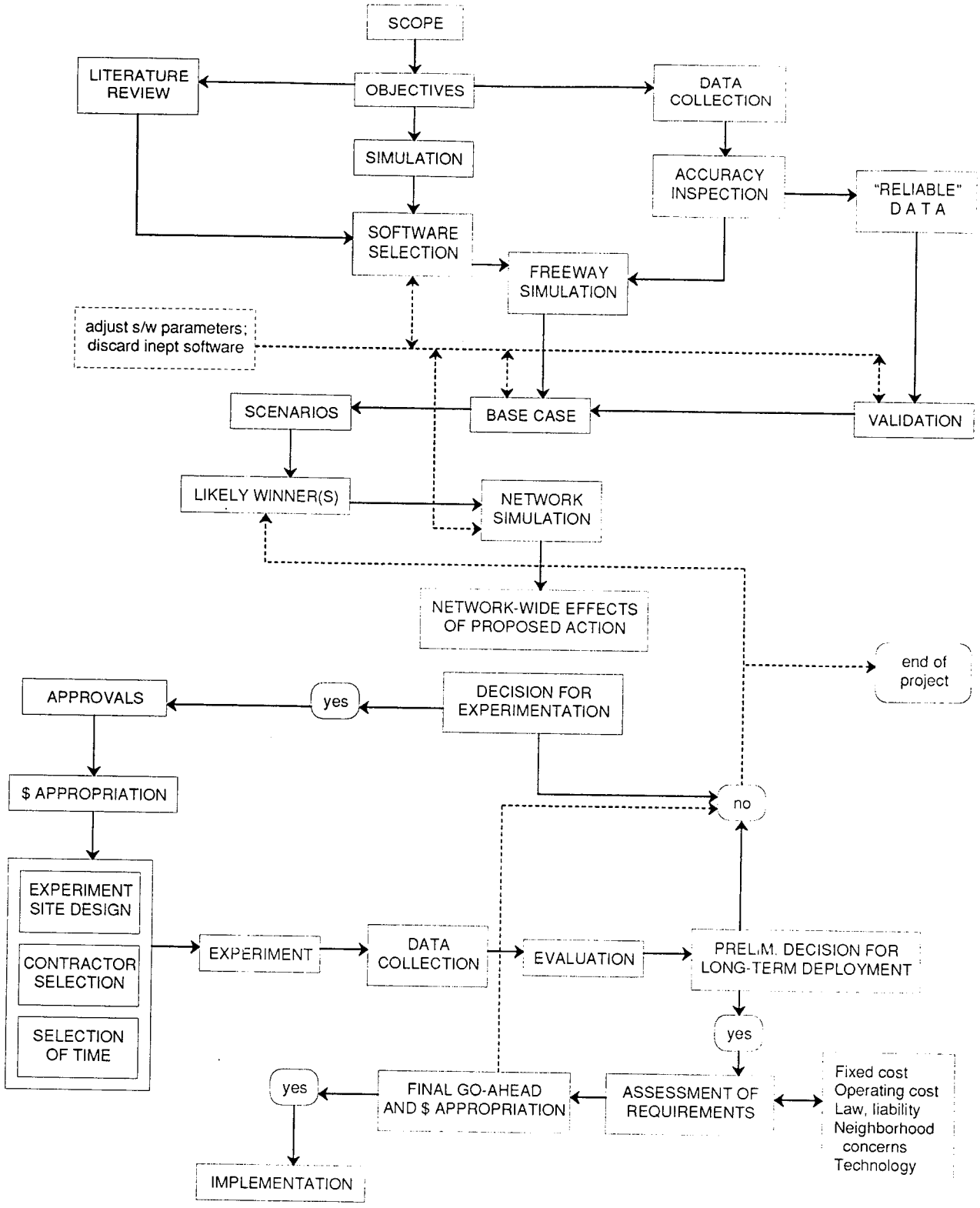


FIGURE 1.1. Main elements of methodology an basic interactions.

Analysis of the flow of traffic on west bound H-1 Freeway (base case) is detailed in Volume 1. It was conducted using the KRONOS software which analyzes freeway flow at a macroscopic scale and accounts for weaving, lane changing and shockwave propagation from multiple bottlenecks. The basic required data are freeway geometry and freeway volumes (mainline, entry and exit points). Fall 1996 data were provided by HDOT. In addition, speeds derived by the AUTOSCOPE at several cross-section (using video tapes from the HDTS freeway surveillance cameras) were used for fine-tuning the capacity and other parameters in KRONOS for the establishment of representative base cases for morning and afternoon conditions. The various data used in this project are detailed in Volume 1. Data used for the evaluation of Lunalilo St. on-ramp "closure" experiment are detailed in section 3.4, Chapter 4 and Appendices A and B.

Figures 1.2 and 1.3 summarize the morning and afternoon period simulation results in terms of delay (in vehicle-hours). Figure 1.2 shows that in the morning period long delays accumulate upstream of the Lunalilo St. on-ramp. The effect of this bottleneck is compounded by the Alexander St. on-ramp. Congestion typically propagates upstream to about the Koko Head Ave. overpass. Sometimes it propagates to the beginning of the west bound H-1 Freeway in Aina Haina.

In the afternoon period, large delays are generated on the segment of freeway between the School St. and Vineyard Blvd. on-ramps, which are shown as delays accumulating upstream of the School St. on-ramp. The Lunalilo St. on-ramp bottleneck amplifies congestion which typically propagates upstream to about the University Ave. overpass. Not showing in Figure 1.3 is congestion occurring during the early afternoon, end-of-school period roughly between 1:30 and 3:30 P.M. This congestion typically occurs between University Ave. and Ward Ave. The Lunalilo St. on-ramp is the main bottleneck during this period.

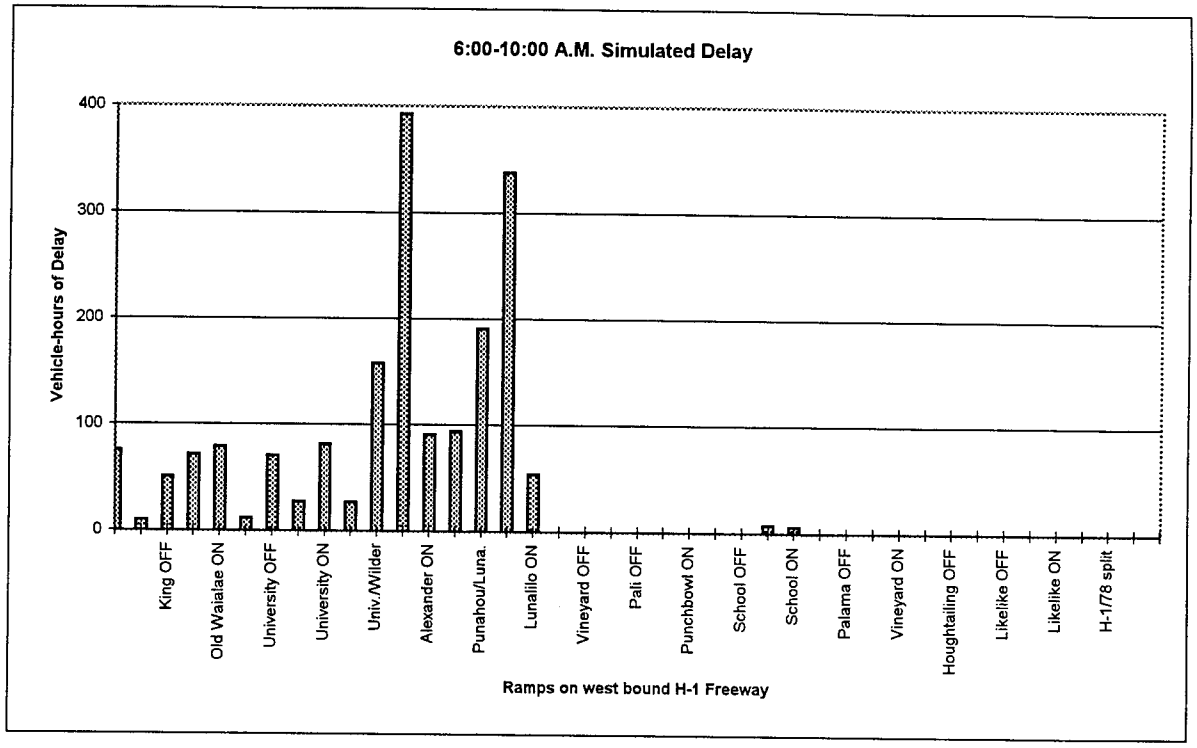


FIGURE 1.2. Morning period delays on west bound H-1 Freeway.

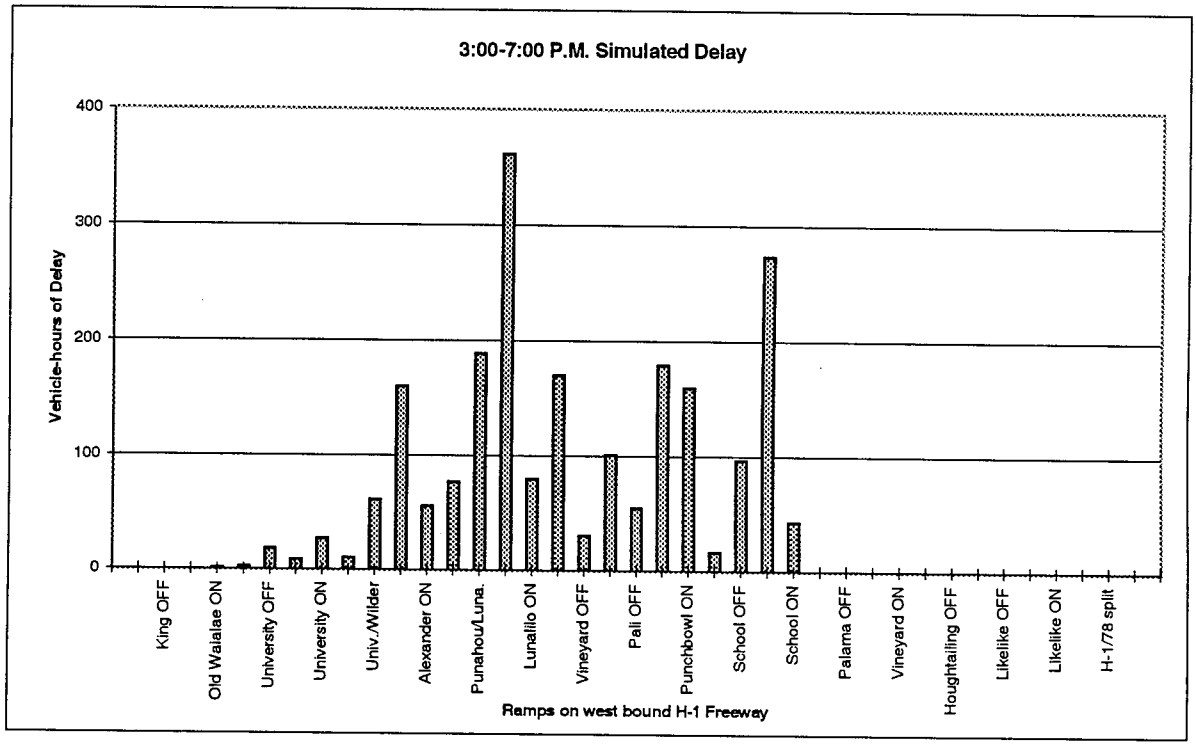


FIGURE 1.2. Afternoon period delays on west bound H-1 Freeway.

CHAPTER TWO: LUNALILO ST. ON-RAMP CLOSURE

2.1 6-10 A.M. ANALYSIS

Figures 1.2 and 1.3 in Chapter 1 present simulation results (delay) for the morning and afternoon base cases for the west bound H-1 Freeway. Figure 2.1 graphically represents the traffic loads on the Lunalilo St. on-ramp and the subsequent Vineyard Blvd. off-ramp. These ramps are connected with an auxiliary lane which widens to two lanes to accommodate the twin-lane Vineyard Blvd. off-ramp. Figure 2.1 shows that for about 1 hour in the morning peak and about 1.5 hours in the afternoon, the total weaving volume is at or higher than 2,500 vph. Nearly all of this activity occurs at the 1-lane section of the auxiliary lane. In the morning period, both the on- and the off-ramp are major contributors, whereas in the afternoon, the on-ramp is the major contributor to the amount of weaving volume. However, as shown in Volume 1, the weaving volume is roughly similar in both periods because in the morning, about 20% of on-ramp traffic is destined to the off-ramp (this traffic does not require a lane change). In the afternoon, this portion less than 5%.

The first half of this Chapter presents morning analyses (6-10 A.M.) and the other half presents afternoon analyses (3-7 P.M.). The analyses are presented in three parts: 1) freeway simulation, 2) Piikoi St. and Lunalilo St. Arterial simulation, and 3) Vineyard Blvd. arterial simulations. Results from a network simulation that includes the west bound freeway and all the aforementioned arterial streets also is presented. A concept drawing of the experimental closure is shown in Figure 2.4.

A major consequence of this ramp closure is the reallocation of existing volumes to the surrounding network. This reallocation is not difficult for the Lunalilo St. on-ramp since the ramp is *re-routed* rather than *closed*, hence, we refer to this case as a "closure." The volume of the Lunalilo St. on-ramp was re-allocated as follows. Firstly, all of the

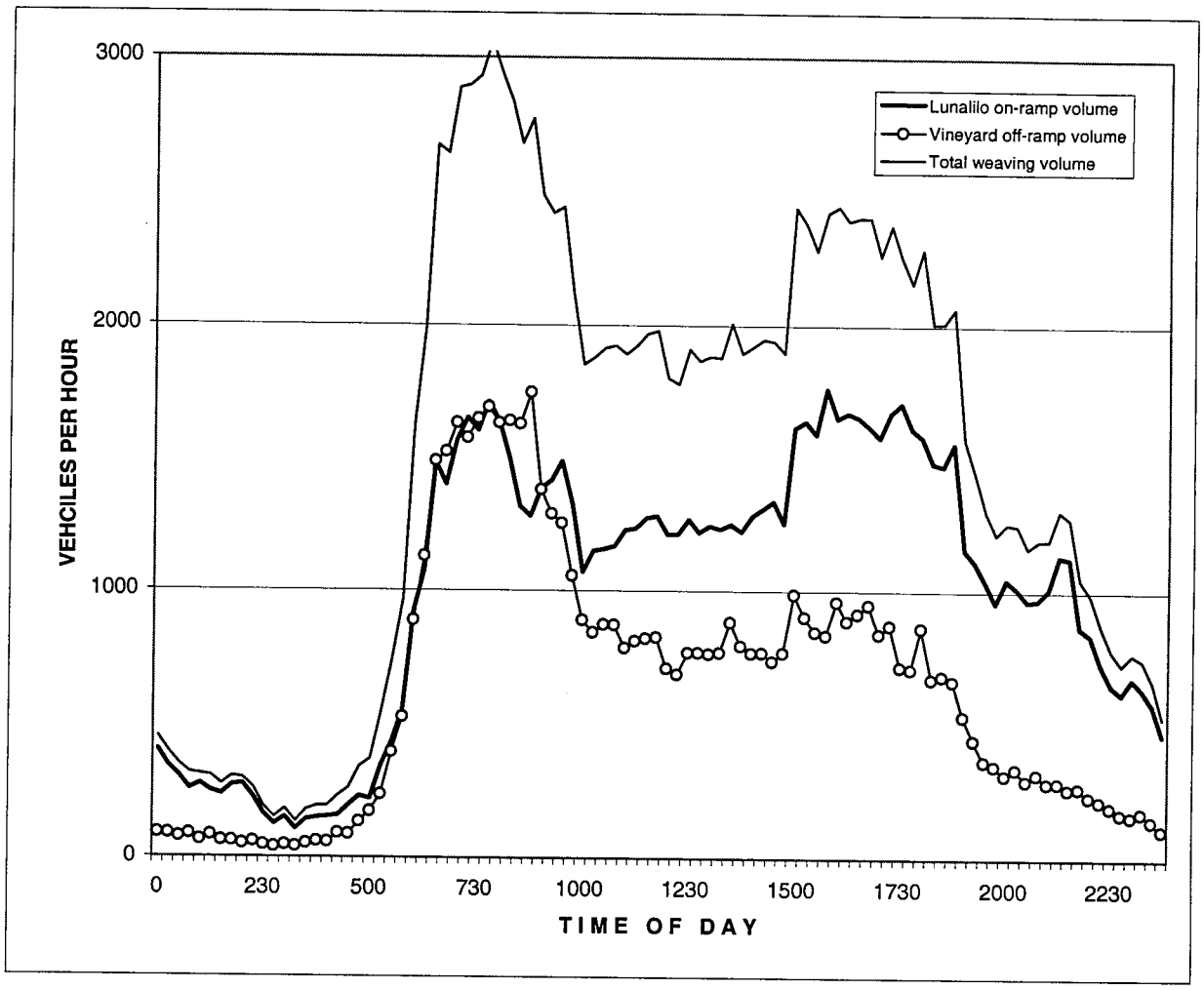


FIGURE 2.1. Hourly equivalents of 15-minute volumes at the location of focus.

Lunalilo St. on-ramp traffic is channeled onto the right lane of the Vineyard Blvd. off-ramp. Then:

- 675 vph were added to the Punchbowl St. on-ramp. These vehicles make a right turn from Vineyard Blvd. onto Punchbowl St. The signal timing at this intersection yields a right turn capacity equal to 700 vph, assuming a reduced saturation flow of 1,500 vphgpl for the (rather tight) right turn movement. Historically, only 15 vehicles execute a right turn between 7:00 and 8:00 A.M. when turning movement data were collected. Beyond the level of 700 vph, queues will grow and motorists are likely to proceed to the other end of Vineyard Blvd. for access to the freeway. This assumption is conservative[1] in the sense that a larger volume traversing the entire length of Vineyard Blvd. was simulated.

- Based on the Lunalilo St. on-ramp survey (Volume 1, section 3.8), the remainder of the volume minus the proportion of the volume which goes to Pali Hwy. and the proportion of the volume that goes onto Vineyard Blvd. was added to the Vineyard Blvd. on-ramp. Hourly volume equivalents do not exceed 1,200 vph, thus, the on-ramp can handle the additional load.

- Based on the on-ramp survey (Volume 1, section 3.8), during the morning period, 20.7% of the west bound Lunalilo St. traffic have Vineyard Blvd. as their exit destination. In other words, 20.7% of the traffic will not be affected by the closure.

- Off ramp volumes downstream of the Lunalilo St. on-ramp were modified based on the percentages from the ramp survey (e.g., in the morning period, 5.5% of the Lunalilo St. on-ramp traffic exits at School St. off-ramp, 2.7% exits at the Palama St. off-ramp and 7.5% exits at Houghtailing St. off-ramp). Since the Lunalilo St. off-ramp is assumed closed, the proportion of its traffic going to the aforementioned downstream off-ramps was subtracted.

[1] Post-experiment analysis showed that this was indeed conservative. Volume shifts showed that about 11% of the Lunalilo St. traffic drove along Vineyard Blvd. to enter the H-1 Freeway using the west bound Vineyard Blvd. on-ramp. Furthermore, analysis of the video tapes showed that the average saturation flow for the right turn movement (from west bound Vineyard Blvd. to Punchbowl St.) is 1,843 vphgpl with a standard deviation of 161 vphgpl. Thus, s=1,800 vphgpl should be used in future applications.

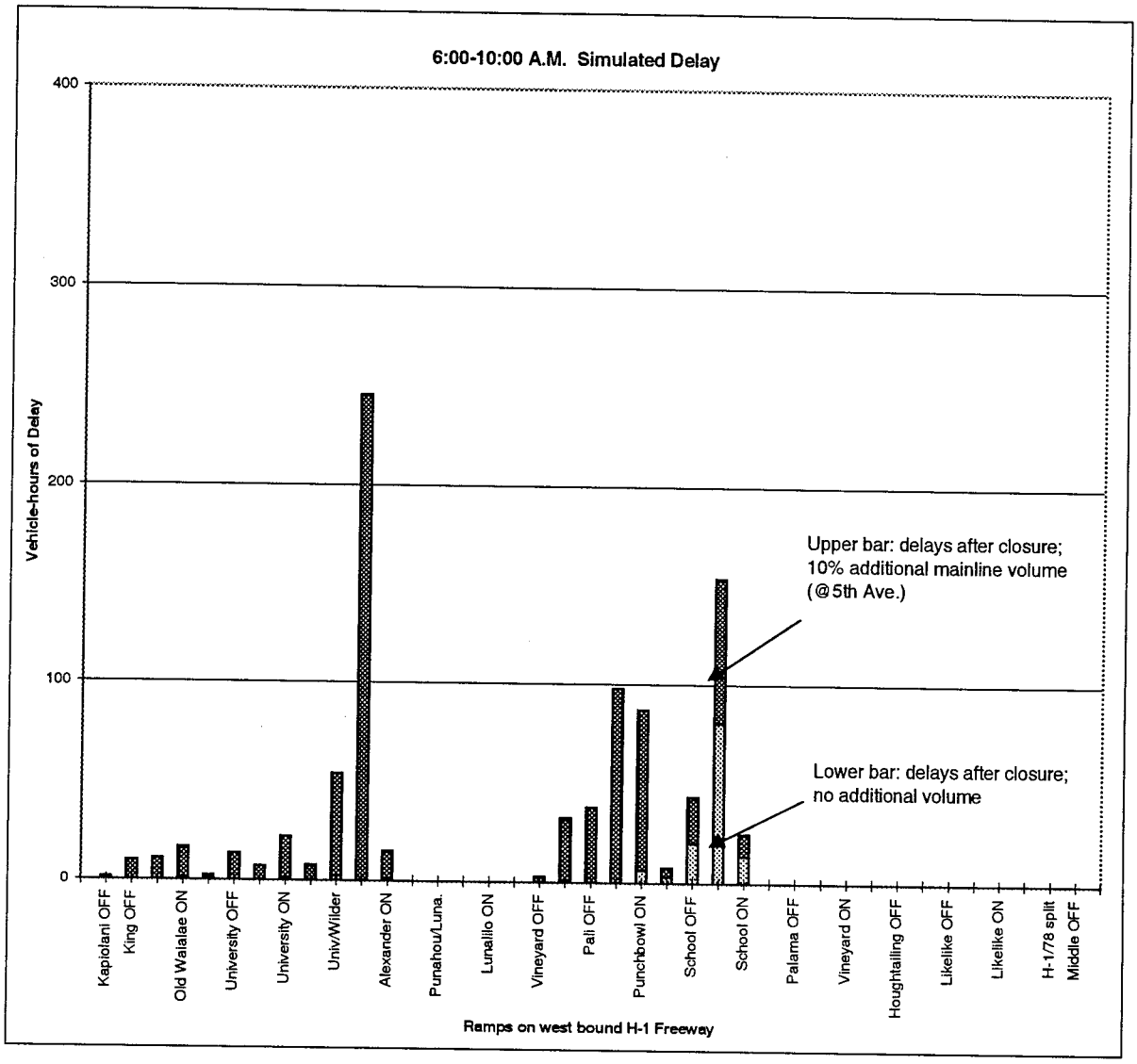


FIGURE 2.2. Morning period delays on west bound H-1 Freeway with the Lunalilo St. on-ramp closed (scale same as in Fig. 1.2).

2.1.1. Freeway Analysis

The morning period results for the freeway are extraordinary: As Figure 2.2 shows, delays all but disappear and near free flow speeds are expected (lower bars on chart). This outcome is possible but it may not occur exactly as simulated because the removal of the bottleneck will allow demand that queues up all the way to Koko Head Ave. to come in earlier, thus causing higher loads. This cannot be simulated by KRONOS because the available input is actual ramp volume. Detailed origin-destination data by time of day (plus latent demand estimates) are required for a more precise assessment of demand-shift effects. The likely outcome of the Lunalilo St. on-ramp closure is that travel time will be reduced considerably, but some slowing will occur, possibly by the Old Waialae Ave., Alexander St. and Punahou St. on-ramps. Less traffic is likely to divert to off-ramps due to the reduced queuing, which will be beneficial to city streets (e.g., Kapiolani Blvd., King St).

To illustrate this more probable outcome, it was assumed that mainline volumes prior to 5th Ave. may increase by as much as 10% after the Lunalilo St. ramp closure. This volume increase is estimated to yield average speeds of 45 mph compared with the 36.1 mph of the existing conditions. Thus, under conservative conditions, the closure of the Lunalilo St. on-ramp is expected to offer a 10% capacity increase and a 19% increase in average speed. The simulation with the additional mainline traffic reveals that both the Alexander St. and School St. on-ramps are significant secondary bottlenecks. Partial traffic diversion from these on-ramps to others may provide a total elimination of bottlenecks along the west bound H-1 Freeway in the morning period.

Additional results are summarized below. The +10% reflects the addition of traffic to the mainline volume before 5th Ave. to account for shifted and latent demand. TT1 is the travel time from Koko Head Ave. to the Kalihi St. overpass. TT2 is the travel time from 5th Ave. to the Pali Hwy. off-ramp.

	Delay (min/veh)	Speed (mph)	TT1 (min)	TT2 (min)
6-10 A.M. Base Case	3.8	36.1	11.0	8.6
6-10 A.M. Lunalilo Closure	0.3	59.2	7.4	3.5
6-10 A.M. Closure + 10%	1.8	45.0	8.9	4.9

2.1.2 Piikoi St. and Lunalilo St. Arterial Analysis

Morning peak period data (7:00 to 8:00 A.M.) were collected on weekdays in late April, 1997 at the intersections of Piikoi St. with Beretania St., Kinau St. and Lunalilo St. and at the intersection of Lunalilo St. with Pensacola St. The measurements taken are consistent with other observations. For example, the October 1996 east bound Piikoi St. on-ramp HDOT volume was 541 vph whereas the project's team count was 498 vph, and the October 1996 west bound Lunalilo St. on-ramp HDOT volume was 1,604 vph whereas the project's team count was 1,634 vph.

TRANSYT-7F was used to estimate average values of delay along the critical path leading to the west bound Lunalilo St. on-ramp. The phasing of all signals consists of a simple 2 phase scheme and is fixed in both morning and afternoon peaks. The timing is as follows (Y+AR is yellow plus all red).

1. Lunalilo = 85	Y+AR = 5	Pensacola = 25	Y+AR = 5; also,	
Lunalilo = 45	Y+AR = 5	Pensacola = 25	Y+AR = 5	offset from master = 6 sec.
2. Piikoi = 37	Y+AR = 5	Lunalilo = 33	Y+AR = 5	offset from master = 5 sec.
3. Piikoi = 39	Y+AR = 5	Kinau = 31	Y+AR = 5	offset from master = 74 sec.
4. Piikoi = 25	Y+AR = 5	Beretania = 45	Y+AR = 5	assumed master controller

The results for the critical movements are tabulated below. The "existing" column reflects saturation flows of 1,700 vph per lane for the critical path, which is equal to the maximum observed throughput of the Lunalilo St. on-ramp. Signals are as observed in the field; they have fixed timings although in some days the intersection of Lunalilo and Pensacola Sts. was operating on a 80 sec. cycle and in others on a 120 sec.

cycle. The 120 sec. cycle gave better results and was the one used in the analyses. Under ramp closure conditions, the saturation flows on the critical path are increased by 10% and the signal timings remain the same. The third option is based on the previous one, but the signals are optimized with the cycle restricted to 80 sec. so that the new timings conform to the signal operations along Beretania St. and King St.

TRANSYT-7F simulation predicted that rerouting Lunalilo St. traffic to Vineyard Blvd. will considerably shorten travel time to reach the Lunalilo St. on-ramp via Piikoi St. and Lunalilo St. These results were corroborated by the INTEGRATION software with the part of the H-1 Fwy. that includes the Lunalilo on-ramp merge and the Vineyard Blvd. off-ramp exit weaving. INTEGRATION predicted that Piikoi St. will be largely free of congestion in the morning peak period and that the average travel time in the simulated network would decrease from 6 minutes to less than 4 minutes[2,3].

Average Delay in Seconds per Vehicle

MOVEMENT	EXISTING	CLOSED	CLOSED/OPT.
Lunalilo/Pensacola;			
Lunalilo WB-TH	56.5	13.7	42.0
Piikoi/Lunalilo			
Piikoi NB-LT	60.2	64.2	5.1
Piikoi/Kinau			
Piikoi NB-TH	75.2	59.8	9.5
Piikoi/Beretania			
Piikoi NB-TH	154.3	82.3	24.0
System average	**131**	**74**	**22**

2.1.3 Vineyard Blvd. Arterial Analysis

Morning peak period data (7:00 to 8:00 A.M.) where collected on weekdays throughout April and May, 1997 at the intersections of Vineyard Blvd. with Punchbowl St., Queen Emma St., Pali Hwy., Nuuanu St., Maunakea St., Aala St., Pua Ln. and Palama St. as

[2] Wang, Y. and Prevedouros, P.D., Evaluation of Integrated Microscopic Simulation Models: CORSIM, INTEGRATION and WATSim, Civil Engineering Technical Report UHM/CE/97-07, Honolulu, 1997.
[3] These results were amply validated with field data, as shown in Chapter 4.

well as the intersections of Pali Hwy. with School St. and the east bound Pali Hwy. off-ramp. The measurements taken are consistent with other observations. For example, the October 1996 east bound Pali Hwy. on-ramp HDOT volume was 882 vph whereas the project's team count was 940 vph, and the October 1996 west bound School St. on-ramp HDOT volume was 1,034 vph whereas the project's team count was 1,092 vph.

The data were analyzed with TRANSYT-7F for assessing average values of delay along the east-west corridor while simultaneously accounting for the signalized intersections along Pali Hwy., including the east bound Pali Hwy. off-ramp. The phasing of all signals along Vineyard Blvd. is actuated with 3 to 8 phases. All signals maintain an approximate 160 second cycle except the signal at Palama St. which was operating at 200[4] seconds. The data (volumes and signal timings) can be found in Volume 1.

Table 2.1 presents a number of results from TRANSYT-7F simulations. All intersections in the network are included in it and a simple depiction of the network is shown at the bottom of it. Table 2.1 shows average delay in seconds per vehicle as defined in the 1985, 1994 and 1997 versions of the Highway Capacity Manual, according to which, average delay in excess of 60 seconds per vehicle corresponds to level of service F (LOS ranges from A, best, to F, worst). Various summary statistics are presented at the bottom of the Table. Summaries for the entire network, which is outlined at the bottom of the Table, are in the top three lines. The bottom 3 summary lines represent only the through movement on east bound and west bound Vineyard Blvd. combined.

Existing conditions are deemed "bearable" since, on the average, the delay is 45 seconds per vehicle. This is quite inferior to the best outcome (resulted from an optimization) of less than 31 seconds per vehicle delay. The actuated mode of operation seems to affect progression negatively. Offsets vary widely and frequently dense platoons of traffic are trapped by red. Interestingly, if all offsets along Vineyard Blvd.

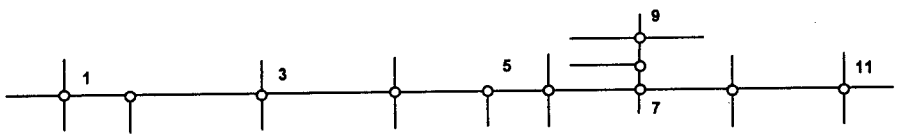
[4] At this location, the west bound left turn signal was malfunctioning as it was giving green time to non-existent traffic, particularly when large vehicles were on the adjacent through lane.

TABLE 2.1 VINEYARD BLVD. NETWORK SIMULATION (TRANSYT-7F) RESULTS

7:30-8:30 A.M. analysis

	INTERSECTION (total, EB and WB delays)	Average Delay (1997 HCM) in seconds per vehicle				
		Existing conditions; field sampled offsets	Optimized conditions; theoretical best (Cycle=126 sec.)	Optimization restricted to existing cycle (160 sec.)	(C) plus all the Lunalilo St. re-directed ramp traffic	(A) plus all the Lunalilo St. re-directed ramp traffic
		A	B	C	D	E
1	Vineyard & Palama	31.5	24.5	25.2	22.9	36.0
	EB	11.0	20.2	13.6	10.8	11.0
	WB	31.2	33.8	35.1	14.3	48.2
2	Vineyard & Pua Ln.	8.0	4.7	18.3	11.0	11.0
	EB	3.2	0.5	22.6	14.3	3.2
	WB	2.1	3.0	1.9	1.0	12.5
3	Vineyard & Liliha	56.2	39.3	42.1	49.1	56.0
	EB	32.6	34.4	16.5	29.5	32.6
	WB	28.8	28.7	35.4	42.6	42.9
4	Vineyard & Aala	40.7	18.3	25.2	26.8	39.4
	EB	24.4	8.8	3.6	15.1	24.4
	WB	18.2	21.8	41.2	23.2	26.0
5	Vineyard & Maunakea	29.8	10.0	19.4	12.3	24.9
	EB	29.4	1.6	20.4	11.6	29.4
	WB	0.2	2.0	2.4	2.6	0.2
6	Vineyard & Nuuanu	34.0	29.2	37.9	31.6	34.3
	EB	13.7	13.8	14.3	11.1	13.7
	WB	19.7	38.4	16.1	19.4	29.0
7	Pali & Vineyard	69.8	57.4	51.6	52.9	65.6
	EB	60.7	54.9	50.0	41.3	60.7
	WB	21.4	17.8	23.4	46.3	25.9
8	Pali & EB Pali off-ramp	31.9	13.7	21.1	21.1	30.8
9	Pali & School	43.2	26.1	29.6	28.6	42.6
	EB	50.3	38.2	54.8	54.8	50.3
	WB	51.3	39.0	56.1	56.1	51.3
10	Vineyard & Q. Emma	42.6	28.2	31.1	27.7	36.5
	EB	13.5	6.1	27.6	15.3	13.5
	WB	5.3	31.0	6.2	4.4	3.2
11	Vineyard & Punchbowl	63.6	45.0	56.0	54.7	64.6
	EB	65.0	44.1	63.9	45.7	65.0
	WB	29.3	32.9	28.8	43.3	51.4
A	NETWORK DELAY	45.0	30.8	35.7	34.6	44.1
V	NETWORK SPEED	5.6	7.6	6.8	7.1	5.9
E	NETWORK % STOPS	69.0	66.0	59.8	60.0	69.0
R						
A	VINEYARD THRU DELAY	25.2	21.9	24.2	23.0	28.4
G	VINEYARD THRU SPEED	11.1	12.2	11.5	11.7	10.1
E	VINEYARD THRU % STOPS	54	57	46	48	58

NETWORK:



are set to zero, the overall delay is expected to improve to less than 44 seconds and the Vineyard Blvd. through speed will increase from the existing 11.1 mph to 12.9 mph.

The analysis supports the contention that the traffic diverted from the west bound Lunalilo St. on-ramp will "fit" on Vineyard Blvd., regardless of whether the signals are optimized or remain unchanged. Certainly average delay along the west bound direction will increase, but it is expected to remain at levels comparable to (and mostly lower than) the east bound direction. No through movement and no intersection is expected to operate at level of service F. Overall Vineyard Blvd. through movement delays are expected to increase from 25.2 to 28.4 seconds per vehicle. Overall network delays are expected to improve from 45 seconds per vehicle (existing) to 44 seconds per vehicle (with the Lunalilo St. on-ramp traffic added) because vehicles are added to utilize the large portions of unutilized west bound green time, thereby improving the overall delay estimate which is a weighted average.

2.1.4 Summary of Morning Analysis

Simulation predicted that the advantages of the morning closure of the Lunalilo St. on-ramp are as follows:

- The most flow-impeding bottleneck on the west bound H-1 Freeway is removed.

- In the morning peak period, nearly free flow conditions from Aina Haina to Middle St. could be observed in the absence of excess demand. If excess demand is present, a 10% simulated increase in the mainline volume will be accommodated at 19% higher speeds.

- Flow on surface streets other than those subjected to arterial analysis (e.g., Kapiolani Blvd., Old Waialae Ave., King St., McCully St. and Punahou St.) is expected to improve due to both a lesser diversion and a reduction in queue length on the on-ramps.

- Considerable improvement is expected on Piikoi St. and Lunalilo St. because the Lunalilo St. on-ramp traffic will be free to move at saturation levels at the onset of green. At the present time, its traffic crawls on the ramp since most of it attempts to merge onto the freeway or is impeded by the traffic exiting at Vineyard Blvd. The capacity gain on this critically

congested single lane on Piikoi and Lunalilo Sts. (which often spills beyond King St.) that leads to the on-ramp is expected to improve by more than 10% (i.e., from the present maximum observed throughput of 1,700 to at least 1,900 vph). Queuing also will be reduced on the right lane on Pensacola St., for the same reason.

- The diversion of traffic to Vineyard Blvd. should be problem-free as long as about half of the diverted traffic remains on the right lane of the Vineyard Blvd. off-ramp on the way to re-enter the H-1 Freeway or proceed to Pali Hwy. using Punchbowl St. Traffic performance along Vineyard Blvd. west of Punchbowl St. is expected to be largely unchanged since diverted traffic will utilize the large amount of green which is presently (unavoidably) wasted due to the heavy east bound traffic.

- A further improvement is likely if the east bound left turn on Vineyard Blvd. at the intersection with Punchbowl St. is banned and its green is given to the west bound direction. In this way, nearly three quarters of the H-1 bound Lunalilo St. on-ramp traffic can make a right turn onto Punchbowl St.

Considerable effort was spent in creating comprehensive travel time scenarios to sum up the worthiness of this closure. The scenarios presented below represent the 7:00 to 8:00 A.M. time period for which full traffic information (streets and freeway) is available.

The estimates on the next page show that, on the average, about 6,000 motorists gain 2.1 minutes and about 1,300 lose 0.9 minutes. Assuming that these savings prevail for 2 hours each regular weekday, of which there are 250 in a year, the annual savings are 95,000 hours. The loss to 1,300 motorists could be lessened by increasing the west bound through-and-right turn green time on Vineyard Blvd. at the intersection with Punchbowl St.

In conclusion, the analysis indicates that the morning peak period, closure of the Lunalilo St. on-ramp presents an opportunity for both HDOT and HDTS to improve the flow on west bound H-1 Freeway with relatively small expenditure and minimal inconvenience to the motoring public.

MOTORIST 1: origin = 5th Ave., destination = Kalihi St. overpass, route = H-1 Fwy.

existing travel time:	**12.3 minutes**
post closure time[5]:	**10.1 minutes**
Number of such motorists:	6,000

MOTORIST 2: origin = Piikoi St., 500 ft. before Beretania St., destination = Kalihi St. overpass.

Existing route: Piikoi St. - Lunalilo St. - Lunalilo on-ramp - H-1 Fwy.

Post closure route 1: Piikoi St. - Lunalilo St. - Lunalilo on-ramp - Vineyard Blvd. - RT onto Punchbowl St. - Punchbowl on-ramp - H-1 Fwy.

Post closure route 2: Piikoi St. - Lunalilo St. - Lunalilo on-ramp - Vineyard Blvd. - Vineyard on-ramp - H-1 Fwy.

existing travel time:	**8.2 minutes**
post closure time (1):	**7.5 minutes**
post closure time (2):	**10.7 minutes**
post closure time (average):	**9.1 minutes**
Number of such motorists:	1,300

[5] The conservative post-closure scenario with an additional 10% demand on the mainline was used.

2.2 3-7 P.M. ANALYSIS

Similar to morning analysis, the volume of the Lunalilo St. on-ramp was re-distributed as follows for the afternoon analysis. Firstly, all of the Lunalilo St. on-ramp traffic is channeled on the right lane of the Vineyard Blvd. off-ramp, then:

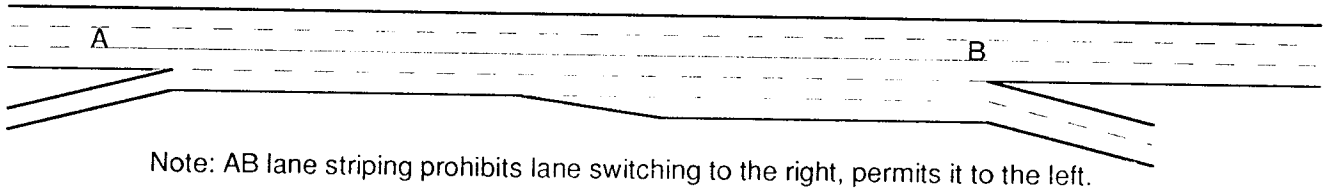
- 400 vph were added to the Punchbowl St. on-ramp. These vehicles make a right turn from Vineyard Blvd. onto Punchbowl St. The signal timing at this intersection yields a right turn capacity equal to 525 vph, assuming a reduced saturation flow of 1,500 vphgpl for the (rather tight) right turn movement. Historically, only 21 vehicles executed a right turn between 4:30 and 5:30 P.M. when turning movement data were collected. Beyond the level of 500 vph, queues will grow and motorists are likely to proceed to the other end of Vineyard Blvd. for access to the freeway. To make the analysis more conservative, 400 instead of 500 vehicles were assigned to the Punchbowl St. on-ramp. In this way, a larger volume is simulated to be traversing the entire length of Vineyard Blvd.

- Based on the Lunalilo St. on-ramp survey (Volume 1, section 3.8), the remainder of the volume minus the proportion of the volume which goes to Pali Hwy. and the proportion of the volume that goes on to Vineyard Blvd. was added to the Vineyard Blvd. on-ramp. A problem occurred at this on-ramp which, during several 15-minute periods, was assigned volumes of 2,400 to 2,800 vehicles. These cannot be handled by the capacity of a single lane on-ramp[6]. Given that it is feasible to make this ramp 2-lanes wide, we proceeded with this modification in effect. This modification is shown in Figure 2.3. The existence or absence of the second on-ramp lane did not have any effect in the morning simulation results because traffic volume is moderate in this area of the freeway.

- Based on the on-ramp survey, 4.5 % in the afternoon period were not assigned to any freeway on-ramp as their destination is Vineyard Blvd., which is were the re-routing takes them. This traffic is not affected by the ramp closure.

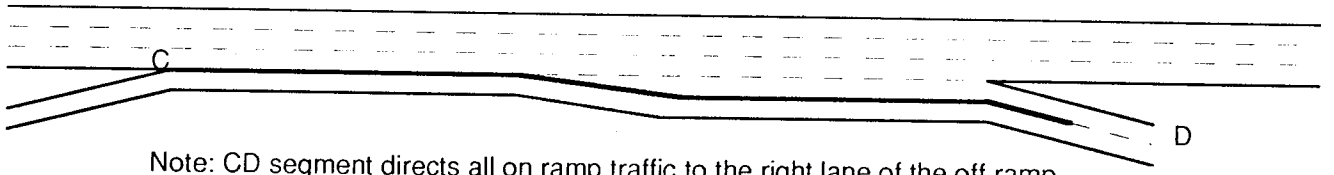
[6] A dozen measurements of the throughput of the Vineyard Blvd. on-ramp were taken in late May 1997. Measurements were taken when there was a continuous (bumper-to-bumper) discharge from the nearest upstream intersection (Palama St.) and there was no blockage at the top of the ramp. The 12 independent measurements represent a total of 315 vehicles. The average headway was estimated at 1.6 seconds which yields a real capacity of 2,250 vph. Individual measurements varied between a low of 1,900 vph and a high of 2,500 vph. Lower capacities were observed when one or two City buses disrupted the smooth bumper-to-bumper convoy.

LUNALILO ST. ON-RAMP & VINEYARD BLVD. OFF-RAMP



EXISTING

Note: AB lane striping prohibits lane switching to the right, permits it to the left.

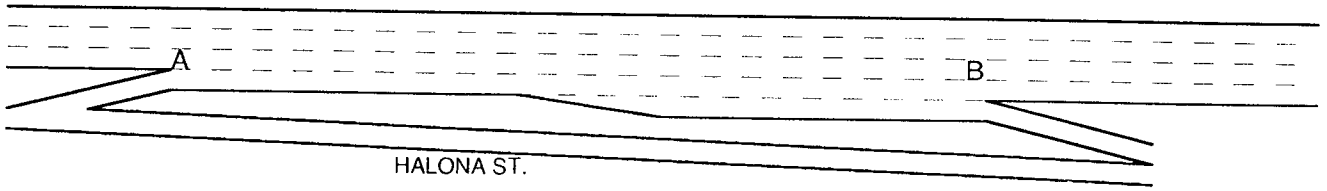


MODELLED

Note: CD segment directs all on ramp traffic to the right lane of the off ramp.

NO SCALE

VINEYARD BLVD. ON-RAMP & HOUGHTAILING ST. OFF-RAMP



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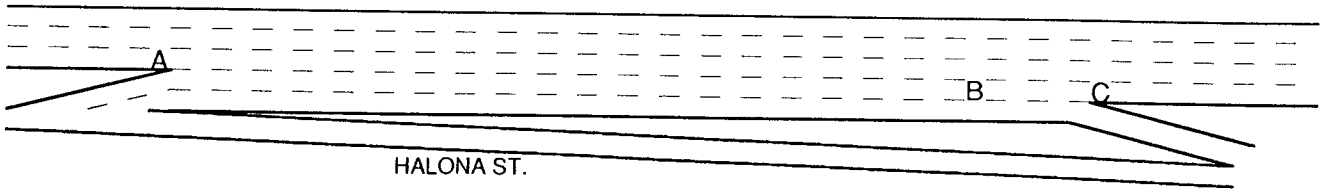


MODELLED

Note: A = Vineyard Blvd. on-ramp upgraded to 2 lanes; AB = additional lane becomes Houghtailing St. off-ramp; BC = Houghtailing St. off-ramp is moved 200 ft. downstream (desirable but not required).

FIGURE 2.3. Modifications for the closure of the Lunalilo St. on-ramp.

- Off-ramp volumes downstream of the Lunalilo St. on-ramp were modified based on the percentages from the ramp survey (e.g., in the afternoon period, 2.5% of the Lunalilo St. on-ramp traffic exits at the School St. off-ramp, 0% exits at the Palama St. off-ramp and 3.5% exits at the Houghtailing St. off-ramp). Since the Lunalilo St. off-ramp is closed, the proportion of its traffic going to the aforementioned downstream off-ramps was subtracted.

2.2.1 Freeway Analysis

The situation is not expected to improve as dramatically as for the morning period because this time the School St. on-ramp also is a major bottleneck. The rerouting of traffic to the Vineyard Blvd. on-ramp cannot relieve congestion in the segment between the Pali Hwy. off-ramp and Likelike Hwy. as shown in Figure 2.4. Nonetheless, simulation predicts that closure will result in largely free flow conditions from Aina Haina to the Pali Hwy. off-ramp.

Furthermore, given that additional demand exists in the form of queues on Alexander St., Punchbowl St. and School St. on-ramps, the Lunalilo St. on-ramp closure offers a 5% capacity increase during the afternoon peak period because the delay for the base case is about equal to a case where the Lunalilo St. on-ramp is closed and a 5% increase is applied to the H-1 Freeway upstream of 5th Ave. for each 15-minute period simulated. Once this capacity is used, the speed is expected to be roughly equal to the base case speed. The benefit will be the quicker removal of traffic from city streets and the earlier termination of congested traffic flow. Under this scenario (e.g., 5% additional mainline traffic), the travel from Aina Haina to the Vineyard Blvd. off-ramp is expected to be essentially delay-free.

Due to the large delays caused by the (anticipated) high volume on the 2-lane Vineyard Blvd. on-ramp, the closure of the Houghtailing St. off-ramp was simulated in the afternoon peak period. The closure of the Houghtailing St. off-ramp and the diversion of all of its flow onto the Palama St. off-ramp produced worse results. This is because a large number of vehicles must weave through a densely occupied right lane of traffic generated by the School St. on-ramp in order to exit at Palama St. Also, the

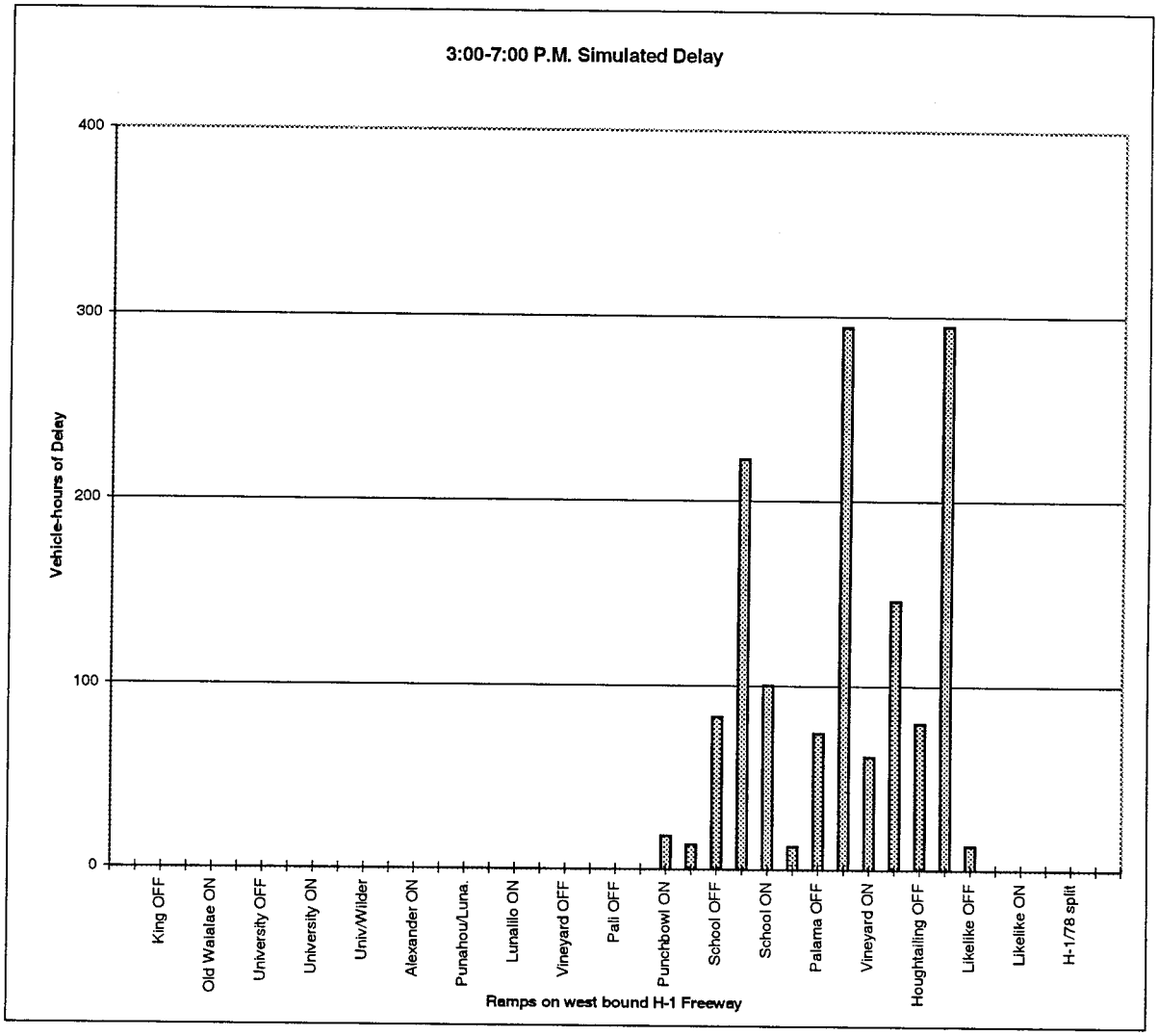


FIGURE 2.4. Afternoon period delays on west bound H-1 Freeway with the Lunalilo St. on-ramp closed (scale same as in Fig. 1.3).

Houghtailing St. closure may not be practical because it triples the volume on the Palama St. off-ramp (from 2,556 vehicles to 7,466 in the 4 hours of the afternoon analysis). This may cause a major back up on the (rather short) Palama St. off-ramp, unless a properly timed signal is installed at its terminus.

The simulation predicts that the section between the Vineyard Blvd. on-ramp and the Likelike Hwy. on-ramp has inadequate capacity. The option of adding a lane from the Vineyard Blvd. on-ramp to the Likelike Hwy. on-ramp and other improvements on this segment were considered in Volume 1.

Selected simulation results from the afternoon "closure" of the Lunalilo St. on-ramp are summarized below. The +5% reflects the addition of traffic to the mainline volume before 5th Ave. to account for shifted and latent demand. TT is the travel time from Koko Head Ave. to the Kalihi St. overpass.

	Delay (min/veh)	Speed (mph)	T T (min)
3-7 P.M. Base Case	4.9	27.9	12.0
3-7 P.M. Lunalilo Closure*	3.5	37.1	10.7
3-7 P.M. Closure* + 5%	4.6	33.5	11.8
3-7 P.M. Closure* + Houghtailing Closure	3.8	36.1	11.0

(*) = includes a twin lane west bound Vineyard Blvd. on ramp as in Figure 2.3.

2.2.2 Piikoi St. and Lunalilo St. Arterial Analysis

Afternoon peak period data (4:30 to 5:30 P.M.) were collected on weekdays in late April 1997 at the intersections of Piikoi St. with Beretania St., Kinau St. and Lunalilo St. and at the intersection of Lunalilo St. with Pensacola St.

The data were analyzed with TRANSYT-7F for assessing average values of delay along the critical path leading to the west bound Lunalilo St. on-ramp. The phasing of all signals is a simple 2 phase scheme and is fixed in both the morning and afternoon peaks. The timing is as follows (Y+AR is yellow plus all red):

1. Lunalilo = 88	Y+AR = 5	Pensacola = 22	Y+AR = 5;	offset from master = n/a;
2. Piikoi = 45	Y+AR = 5	Lunalilo = 25	Y+AR = 5	offset from master = 7 s;
3. Piikoi = 39	Y+AR = 5	Kinau = 31	Y+AR = 5	offset from master = 5 s;
4. Piikoi = 35	Y+AR = 5	Beretania = 35	Y+AR = 5	assumed master control.

The results for the critical movements are summarized below. The "existing" column reflects saturation flows of 1,700 vph per lane for the critical path, which is equal to the maximum observed throughput of the Lunalilo St. on-ramp. The 120 sec. cycle at the intersection of Lunalilo St. with Pensacola St. was retained in the analyses. Under ramp closure conditions, the saturation flows on the critical path were increased by 10% and the signal timings remained the same. The third option was based on the previous one, but the signals were optimized with the cycle restricted to 80 sec. so that the new timings conform with operations on Beretania St. and King St.

Average Delay in Seconds per Vehicle

MOVEMENT	EXISTING	CLOSED	CLOSED/OPT.
Lunalilo/Pensacola;			
Lunalilo WB-TH	29.8	10.9	23.6
Piikoi/Lunalilo			
Piikoi NB-LT	14.1	15.5	4.4
Piikoi/Kinau			
Piikoi NB-TH	***	44.2	8.1
Piikoi/Beretania			
Piikoi NB-TH	***	***	18.2
System average	**178**	**53**	**19**

(*** saturation levels outside the model's limits for reliable delay estimation)

TRANSYT-7F simulation predicted that rerouting Lunalilo St. on-ramp traffic to the Vineyard Blvd. off-ramp would considerably shorten travel time to reach the Lunalilo St. on-ramp via Piikoi St. and Lunalilo St. These results were corroborated by INTEGRATION which predicted that Piikoi St. will be largely free of congestion in the afternoon peak period and that the average travel time in the simulated network will decrease from 6 minutes to less than 4 minutes.

2.2.3 Vineyard Blvd. Arterial Analysis

Afternoon peak period data (4:40 to 5:30 P.M.) were collected on weekdays throughout April and May 1997 at the intersections of Vineyard Blvd. with Punchbowl St., Queen Emma St., Pali Hwy., Nuuanu St., Maunakea St., Aala St., Pua Ln. and Palama St. as well as the intersections of Pali Hwy. with School St. and the east bound Pali Hwy. off-ramp.

The data were analyzed with TRANSYT-7F for assessing average values of delay along the east-west corridor while simultaneously accounting for the signalized intersections along Pali Hwy., including the east bound Pali Hwy. off-ramp. The phasing of all signals along Vineyard Blvd. is actuated with 3 to 8 phases. Signals maintain an approximate 140 second cycle but there is considerable variability. For example, the average at the Vineyard/Pali intersection was about 150 sec. and the average at the adjacent intersections of Vineyard Blvd. with Queen Emma St. and Vineyard Blvd. with Nuuanu Ave. was 120 sec.

Table 2.2 presents a number of results from TRANSYT-7F simulations. All intersections in the network are included in it and a simple depiction of the network is shown at the bottom of it. Table 2.2 shows average delay in seconds per vehicle as defined in the 1985, 1994 and 1997 versions of the Highway Capacity Manual, according to which, average delay in excess of 60 seconds per vehicle corresponds to level of service F (LOS ranges from A, best, to F, worst). Various summary statistics are presented at the bottom of the Table. Summaries for the entire network, which is outlined at the bottom of the Table, are in the top three lines. The bottom 3 summary lines represent only the through movement on east bound and west bound Vineyard Blvd. combined.

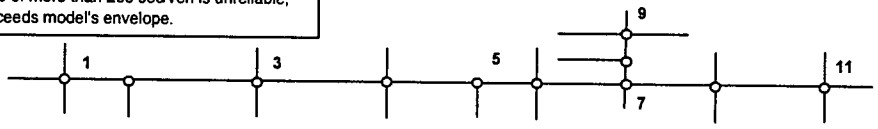
TABLE 2.2. VINEYARD BLVD. NETWORK SIMULATION (TRANSYT-7F) RESULTS

4:30-5:30 P.M. analysis

	INTERSECTION (total, EB and WB delays)	Average Delay (1997 HCM) in seconds per vehicle				
		Existing conditions; field sampled offsets	Optimized conditions; theoretical best (C=116 sec.)	Existing signal timings plus all the Lunalilo St. rerouted ramp traffic	Optimal timings with C=160 plus all the Lunalilo St. rerouted ramp traffic	As (D) with C=140 and no EB left turns at Palama, Liliha, Pali and Q. Emma
		A	B	C	D	E
1	Vineyard & Palama	56.9	15.8	***	25.2	20.9
	EB	38.9	10.9	38.9	11.0	11.4
	WB	110.5	7.2	***	19.6	15.4
2	Vineyard & Pua Ln.	18.1	19.6	13.2	11.4	13.0
	EB	8.9	15.7	8.9	7.9	9.7
	WB	0.6	20.1	0.4	4.7	2.3
3	Vineyard & Liliha	62.3	36.1	***	56.6	30.0
	EB	44.0	20.1	44.0	20.2	24.5
	WB	68.9	40.3	***	43.0	11.6
4	Vineyard & Aala	25.9	17.4	23.7	18.6	22.5
	EB	6.7	2.2	6.7	7.4	22.0
	WB	24.0	18.7	31.1	9.3	8.4
5	Vineyard & Maunakea	13.4	9.0	8.3	11.4	8.2
	EB	4.6	5.3	4.6	17.2	8.8
	WB	0.1	4.2	0.1	1.7	0.5
6	Vineyard & Nuuanu	55.2	26.9	***	38.0	41.2
	EB	21.4	13.4	21.4	26.7	12.8
	WB	45.9	31.4	***	22.2	30.5
7	Pali & Vineyard	68.0	56.1	***	57.4	44.2
	EB	70.2	66.0	70.2	29.6	31.2
	WB	47.3	22.5	***	53.1	41.7
8	Pali & EB Pali off-ramp	60.2	17.5	57.3	24.3	21.9
9	Pali & School	60.0	36.4	70.4	55.2	36.0
	EB	51.2	36.4	51.2	52.1	71.8
	WB	162.6	66.1	162.6	101.0	57.2
10	Vineyard & Q. Emma	39.1	28.3	122.9	26.4	16.5
	EB	6.7	30.1	6.7	5.8	2.8
	WB	22.1	42.1	***	8.4	8.4
11	Vineyard & Punchbowl	57.1	32.5	***	97.8	96.1
	EB	74.1	24.9	74.1	29.3	14.4
	WB	53.7	42.2	***	76.1	85.5
A	NETWORK DELAY	50.2	29.1	***	42.9	35.9
V	NETWORK SPEED	5.1	7.9	0.5	6.1	7.1
E	NETWORK % STOPS	70.0	66.0	63.0	59.0	58.0
R						
A	VINEYARD THRU DELAY	36.8	22.6	***	23.4	20.3
G	VINEYARD THRU SPEED	8.7	12.3	0.4	12.0	13.2
E	VINEYARD THRU % STOPS	58	63	52	44	43

*** = delay estimate of more than 200 sec/veh is unreliable; saturation level exceeds model's envelope.

NETWORK:



Existing conditions are deemed "unbearable" because the average delay at four intersections is longer than one minute (LOS F). This outcome is largely due to poor arterial coordination and sluggish signal operation. Specifically, the signal often remains green for an additional 5 to 10 seconds past the departure of a platoon of traffic instead of changing phase. It seems that the MAX settings are too long or the gap-out parameter is set improperly. Either of these conditions causes the unnecessary extension of phases and elongation of the cycle length. Partial proof that the signal timings are to blame for the congestion along Vineyard Blvd. are the field measurements of saturation flow shown in below.[7] Most measurements are at the level of about 2,000 vehicles per hour of green, well above the HCM "ideal" level of 1,900 vphg. Practically, this means that Honolulu drivers are not sluggish.

Sample saturation flows

Location	Movement & Grade	No. Obs.	No. Vehicles	Average Headway	Satur. Flow
Vineyard @ Pali	EB, TH *	4	47	2.023	1,780 [1]
Pali @ Vineyard	NB, LT **	4	60	1.855	1,940
Punchbowl @ Vineyard	NB, TH *	7	134	1.801	1,999
Vineyard @ Punchbowl	EB, LT **	8	84	1.820	1,978
Vineyard @ Punchbowl	EB, TH **	9	158	1.757	2,049

(*) = slight uphill (**) = level (1) = affected by queuing at the Queen Emma St.

The delay predicted for existing conditions (50 sec. per vehicle) is quite inferior to the best outcome of about 29 seconds per vehicle which is the result of an optimization. The existing actuated mode of operation seems to affect progression negatively. Offsets vary widely and frequently dense platoons of traffic are trapped by red. At a minimum, a progression scheme with all offsets set to zero in the afternoon is recommended. The non-actuated phase should be the west bound through phase and all signals along Vineyard Blvd. should begin at the same time (zero offset), including the signals at Maunakea St. and Pua Ln. (which tend to vary widely due to the small and fluctuating demands on minor movements conflicting with Vineyard Blvd.)

[7] Measurements taken on Thursday, May 29, 1997 (4:00 to 5:45 P.M.). All Vineyard Blvd. measurements pertain to the middle lane.

As shown in Table 2.2, with Vineyard Blvd. traffic signals optimized and Lunalilo St. on-ramp traffic rerouted to Vineyard Blvd., TRANSYT-7F predicts that average west bound delay at signals other than at the Punchbowl St. intersection will be comparable to or lower than existing conditions. For example, the west bound School St. movement at Pali Hwy. was very congested. The Lunalilo St. closure will not make this worse. On the contrary, better signal settings can reduce its delay, but it is expected that it will still be operating at LOS F.

The major negative effects of the Lunalilo St. re-routing seem to concentrate at the intersection of Vineyard Blvd. with Punchbowl St. due to the heavy volume on conflicting movements (west bound Vineyard Blvd., north bound Punchbowl St. and the left turns from east bound Vineyard Blvd.) It would help if the later were eliminated. A grade separation (with Punchbowl St. passing under Vineyard Blvd., or a twin north bound (mauka bound) Punchbowl St. approach without a left turn lane would reduce the delay at this intersection.

The last column in Table 2.2 presents results assuming that left turns from east bound Vineyard Blvd. to Palama St., Liliha St., Pali Hwy. and Queen Emma St. have been banned. These left turns can be replaced by a series of right turns (loop around a block; see Volume 1, Chapter 5 for details). Performance is expected to improve, but not dramatically, and no improvement is predicted at the intersection of Vineyard Blvd. with Punchbowl St. Eliminating all these left turns is not recommended. Instead, it is recommended to set the *max green* and *gap-out* parameters for these left turn phases very carefully and perhaps restrictively.

An afternoon closure is likely to offer a very large benefit during the early afternoon peak between 2:00 to 4:00 P.M. The volume rerouted by the closure would fit on Vineyard Blvd. if: (1) Pali Hwy.-bound motorists use Vineyard Blvd. (not Punchbowl St.) to access the Pali Hwy., and (2) The east bound left turn from Vineyard Blvd. to north bound Punchbowl St. is banned. In this way, the west bound through-and-right turn

green share increases from 30/140 = 21.4% to 41/120 = 34.2%. Based on the ramp survey of destinations, Lunalilo St. on-ramp traffic can be distributed as follows:

85 local traffic on Vineyard Blvd. (most likely turn left at Punchbowl St.)
616 right turn onto Punchbowl St. on-ramp (1,800[8] x 0.342 = 616)
116 right turn onto Pali Hwy. (6.7% per ramp survey)
500 right turn onto School St. on-ramp[9]
360 straight through to Vineyard Blvd. on-ramp[9]
1677 total from summation; actual is 1730

The difference between actual and distributed traffic (53 vehicles) is likely to be absorbed by the surface system (diverted to routes other than the Lunalilo St. on-ramp, i.e., Beretania St. or School St.), or to one of the on-ramps used in the preceding allocation. Based on historical volumes, the proposed re-allocation is feasible for the 2:00 to 3:30 P.M. time period. Such a limited closure is likely to benefit the end-of-school traffic to dissipate prior to the generation of the end-of-business traffic. The 2:00 to 3:30 P.M. period does not strictly require that Pali Hwy. bound motorists do not use the Punchbowl St. route, but requires the ban on the east bound left turns as defined above. Because of the "tight fit" of this change, some congestion for several days should be expected, prior to the motorists' discovering the equilibrium point. For this reason, if implementation is approved, it should start during the summer months.

2.2.4 Summary of Afternoon Analysis

Simulation predicted that the advantages of the afternoon closure of the Lunalilo St. on-ramp are as follows:

- A major bottleneck on the west bound H-1 Freeway is removed.
- In the afternoon peak period, nearly free flow conditions from Aina Haina to the Vineyard Blvd. off-ramp could be observed.
- If excess demand is present, a 5% simulated increase in the mainline volume is expected to be accommodated at base case speeds (Fall

[8] See footnote 1 at the beginning of this chapter (field estimate of saturation flow was 1,843 vphgpl.)
[9] This number was estimated as follows. The 4-6 P.M. traffic was added to form A. The 2-4 P.M. traffic was added to form B. This estimate is (A-B)/2, which ensures that added traffic "fits" the ramp's practical capacity.

1996 conditions). This capacity gain allows for the quicker removal of traffic from surface streets and an overall reduction of the duration of the afternoon peak period.

- Flow on surface streets other than those subjected to arterial analysis (e.g., Kapiolani Blvd., Old Waialae Ave., King St., McCully St. and Punahou St.) should improve due to lesser diversion and queue reduction on the on-ramps.

- Considerable improvement is expected on Piikoi St. and Lunalilo St. because the Lunalilo St. on-ramp traffic will be free to move at saturation levels at the onset of green. At the present time, its traffic crawls on the ramp since most of it attempts to merge onto the freeway or is impeded by the traffic exiting at Vineyard Blvd. The capacity gain on this critically congested single lane on Piikoi and Lunalilo Sts. (which often spills beyond King St.) that leads to the on-ramp is expected to improve by more than 10% (i.e., from the present maximum observed throughput of 1,700 to at least 1,900 vph). Queuing also will be reduced on the right lane on Pensacola St., for the same reason.

- The diversion of traffic to Vineyard Blvd. requires that signals along Vineyard Blvd. are optimized and the Vineyard Blvd. on-ramp is upgraded to a twin lane configuration. This is expected to have no negative effect to crossing streets. The elimination of the east bound left turns from Vineyard Blvd. to Punchbowl St. would be beneficial.

- An alternative to the 3:00 to 7:00 P.M. closure is a limited closure from 2:00 to 3:30 P.M. which only requires a ban of the east bound left turns from Vineyard Blvd. to Punchbowl St. and an advisory to Pali Hwy.-bound motorists to take Vineyard Blvd. to Pali Hwy. instead of taking Punchbowl St. This would aid in the efficient processing of the end-of-school traffic and offer clear conditions for the end-of-business traffic (e.g., separate instead of compound two neighboring demand peaks.)

Considerable effort was spent in creating some comprehensive travel time scenarios which would reveal the worthiness of this ramp "closure." The scenarios presented below represent the 4:30 to 5:30 P.M. time period for which have full traffic information (streets and freeway) are available.

These scenarios show that, on the average, about 6,000 motorists gain 4.2 minutes and about 1,500 may lose up to 1.4 minutes. Specifically, the simulation results show

that the existing travel time is 9.5 minutes and the post-closure travel time is expected to be 8.9 minutes. This assumes that signals can be optimized as TRANSYT-7F predicts. Occasionally, despite capable traffic engineering efforts, large gains through optimization cannot be realized. A conservative assumption was made to use base case (existing as of spring 1997) travel times based on TRANSYT-7F delays in Table 2.2 (column A).

MOTORIST 1: origin = 5th Ave., destination = Kalihi St. overpass, route = H-1 Fwy.

existing travel time:	**13.5 minutes**
post closure time[10]:	**9.3 minutes**
Number of such motorists:	6,000

MOTORIST 2: origin = Piikoi St., 500 ft. before Beretania St., destination = Kalihi St. overpass.

Existing route:	Piikoi St. - Lunalilo St. - Lunalilo on-ramp - H-1 Fwy.
Post closure route 1:	Piikoi St. - Lunalilo St. - Lunalilo on-ramp - Vineyard Blvd. - RT onto Punchbowl St. - Punchbowl on-ramp - H-1 Fwy.
Post closure route 2:	Piikoi St. - Lunalilo St. - Lunalilo on-ramp - Vineyard Blvd. - Vineyard on-ramp - H-1 Fwy.

existing travel time:	**9.5 minutes**
post closure time (1):	**8.8 minutes**
post closure time (2):	**9.0~12.0 minutes**
post closure time (average):	**8.9~10.9 minutes**
Number of such motorists:	1,500

Assuming that the savings shown above prevail for 2 hours each regular weekday, of which there are 250 in a year, the annual savings are 192,500 hours. This result indicates that the afternoon peak period savings are double those in the morning peak period, despite the fact that complete congestion resolution cannot be achieved in the afternoon peak. The reasons for this outcome are as follows:

- About 1,500 vehicles in the afternoon period, 200 more than in the morning peak period are diverted from the freeway.

[10] Uses the conservative post-closure scenario 5% demand added on to west bound H-1 Freeway.

- In the morning period, the diversion of 1,300 vph basically resolves a major bottleneck. In the afternoon peak period however, it not only resolves the bottleneck, but also relieves the heavy downstream flow between the Vineyard Blvd. off-ramp and the Palama St. off-ramp. (A small reduction of volume under heavily congested conditions yields a much greater benefit compared with larger reductions of volume under less congested conditions).

- A small amount of system capacity has been added with the second lane on west bound Vineyard Blvd. on-ramp.

The re-direction of the Lunalilo St. on-ramp traffic onto Vineyard Blvd. combined with the reconstruction of the west bound Vineyard Blvd. on-ramp into a 2-lane facility is expected to benefit peak afternoon traffic flow on the west bound H-1 Freeway between University Ave. and the Pali Hwy. Permanent deployment throughout the afternoon period requires a twin Vineyard Blvd. on-ramp and a considerable effort for optimizing the signal timings along Vineyard Blvd. A more readily available option is the deployment of this closure during the 2:00 to 3:30 P.M. afternoon sub-peak to clear end-of-school traffic.

CHAPTER THREE: EXPERIMENT DESIGN

Freeway and network analyses presented on Volume 1 and in Chapter 2 herein provide a strong indication that a 6:00-10:00 A.M. "closure" (rerouting) of the west bound Lunalilo St. on-ramp is an action with a high potential for improving the flow along this direction of the H-1 Freeway. Network analyses in particular predicted that the rerouting of traffic can be accomplished without any alterations to existing roadways and traffic control devices. This Chapter presents the basic elements for effecting this ramp closure as well as the data collection and analysis procedures for the evaluation of the degree of attainment of simulated improvements.

3.1 ELEMENTS OF THE RAMP CLOSURE EXPERIMENT

The required elements for realizing the closure of the west bound Lunalilo St. on-ramp include: 1) delineation of traffic paths, 2) advisories on portable variable message signs, 3) police supervision, 4) signal control modifications, 5) public information campaign, and 6) selection of time periods for the control (base period) and the experiment. These elements are described below.

- Modification to travel paths: Delineation. Traffic cones were selected for delineating the modified paths of traffic. These are illustrated in Appendix C which presents the design specifications for the experiment site done by the Traffic Branch of HDOT. HDOT contracted a reputable company which specializes in lane delineation and traffic signing for construction, special events and so forth. The same contractor also supervised the delineation, corrected fallen cones and restored capacity when these devices impeded traffic flow. Initially coning was designed with a density of 1 cone every 10 ft. This density along with the very low speeds allowed a safe breaching of the coning. Density was doubled and a police officer was relocated in order to maintain the effectiveness of the coning (see below).

- Modification to travel paths: Advisories. Portable variable or changeable message signs (PCMS) were used to advise the motorists of changes in the travel paths. PCMS location and advisory messages are shown in the design specifications in Appendix C.

- Surveillance and enforcement during the experiment: Police presence at the site. Two police officers were present during most of the period that the experiment lasted. The first officer was stationed at the entrance to the Lunalilo St. on-ramp and was charged with the mission to divert traffic to the through lane on Lunalilo St. in case that excessive back-up is observed on the on-ramp. During the experiment, the officer moved downstream (at the split between the freeway and the off-ramp) to discourage motorists from breaching the coning. The other officer was stationed on the north (mauka) side of the Vineyard Blvd. off ramp, about 1,000 ft. before the intersection with Punchbowl St. and was charged with the mission to divert traffic to the through lane should an excessive build-up of traffic on the right lane occurs which would block the flow on the conned lane from Lunalilo St.

- Signal control changes (signal timings). Minor changes were desirable but not essential for the deployment of the experiment. Traffic flow (existing and post experiment) on Vineyard Blvd. would benefit by setting all signal offsets to zero for the non-actuated phase which is taken to be the east bound through phase along Vineyard Blvd. Changes along Piikoi St. and Lunalilo St. were also suggested. No signal changes were made in order to accommodate this experiment.

PROPOSED TIMING (all changes are shown in boldface):

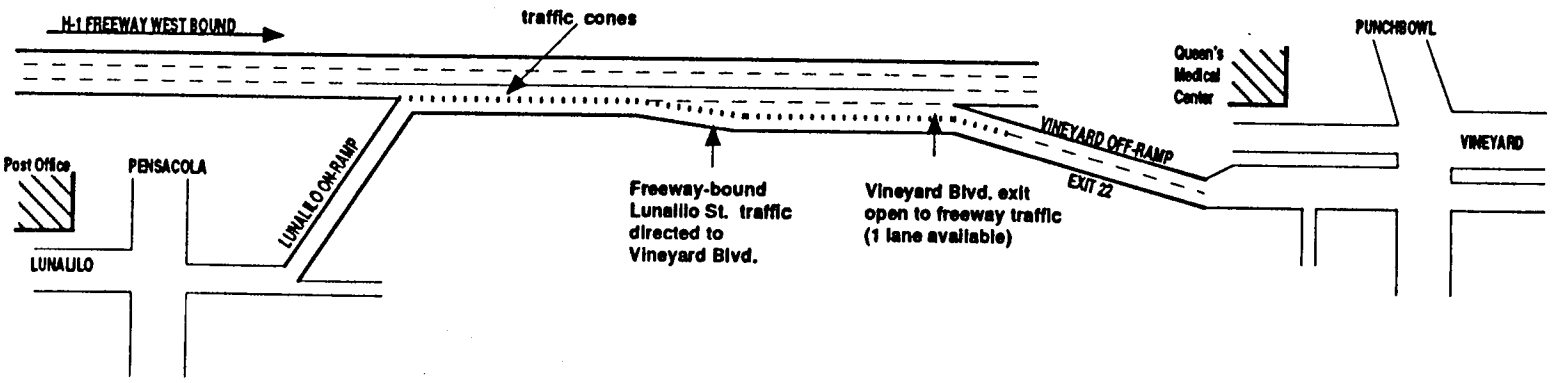
1. Lunalilo = **106**	Y+AR = 5	Pensacola = **44**	Y+AR = 5	offset[1] from master = **58** sec.;
2. Piikoi = 37	Y+AR = 5	Lunalilo = 33	Y+AR = 5	offset from master = **8** sec;
3. Piikoi = 39	Y+AR = 5	Kinau = 31	Y+AR = 5	offset from master = **3** sec;
4. Piikoi = 25	Y+AR = 5	Beretania = 45	Y+AR = 5	assumed master controller

[1] All offsets refer to the beginning of green of the signal phase serving traffic from Ala Moana to the west bound H-1 Fwy.

- Public information campaign. No campaign was conducted because it could cause a temporary change in travel behavior which would produce unrepresentative results. Fair warning to the public was given in the form of a Notice to Motorists (Figure 3.1) printed in the local daily papers for the three weeks in September (the one control week and the two weeks of the experiment). The notice also was circulated to area condomuniums. The notice along with the advisories on the portable changeable message signs provided sufficient information to morning peak period commuters on route choice to their destination. Meetings were conducted with the Senator and Representatives of the affected area and a presentation was given to the respective Neighborhood Board.

- The selection of the time period for the experiment was important. It should include as few holidays and non-instructional days at schools as possible. September and October were the most appropriate months. The base week was September 29 to October 3, 1997 and the experiment was conducted from October 27 to November 7, 1997. The delineation contractor began the coning shortly after 5:30 A.M. to ensure that by 6:00 A.M. the delineation was completed. Soon after 10:00 A.M. the delineation was removed. During the second week of the experiment, coning was removed shortly after 9:30 A.M. because of the free flowing condition of traffic. At 6:00 A.M., the advisory PCMS were turned on and the police officers were at the specified locations.

MONDAY, OCT. 27 THROUGH FRIDAY, NOV. 7
H-1 FREEWAY MORNING CONING OF LUNALILO ON-RAMP



NOTICE TO MOTORISTS

The Department of Transportation (DOT) will be conducting a traffic experiment on the H-1 Freeway in the westbound direction on weekdays beginning October 27 and ending on November 7, 1997 between 5:30 a.m. and 10 a.m. The purpose of the experiment is to see how traffic flows on the H-1 if cars are prohibited from merging into the H-1 traffic at the Lunalilo on-ramp.

During the specified hours, the DOT will place traffic cones at the Lunalilo Street on-ramp to the H-1 to prevent cars from merging onto the through lanes of the H-1. All cars using the Lunalilo Street on-ramp will be required to exit onto Vineyard Boulevard and **will be able to access the H-1 westbound at Punchbowl Street, Aala Street, or Vineyard Boulevard.**

Vehicles wanting to exit the H-1 at Vineyard Boulevard (Exit 22) will be able to exit in the usual manner.

Motorists are advised to use caution and obey all signs and traffic control devices. Motorists specifically are prohibited from crossing the traffic cones.

The experiment will help the DOT determine what will happen to traffic if freeway on and off ramps should be closed in the future. The experiment is being conducted with the cooperation of the City Department of Transportation Services.

For additional information, please call the Department of Transportation, Public Affairs Office, 587-2160.

FIGURE 3.1. Notice to motorists.

3.2 EVALUATION

The evaluation consists of two elements: Data collection and data analysis. The data should demonstrate the degree of success of the ramp closure. The primary type of data that can do this are travel times along specific routes. Traffic volumes were needed to provide an assurance against demand fluctuations. Other surveillance provided spot speed estimates and volume count redundancy (AUTOSCOPE use on surveillance tapes) and assurance against incidents (helicopter surveillance).

3.2.1 Data Collection

Data collection focused on three major elements: Travel times, volumes and motorists' perceptions. These are described below.

`Travel times`

Travel times are the measure than can prove whether savings were realized for freeway users, provided that there were no volume (demand) shifts. Even if demand shifts occur, however, a reliable measure can be estimated. This measure is *vehicle-hours* which accounts both for volume and speed. In addition, actual travel time surveys reveal whether travel time extensions induced to ramp users were reasonable. Travel times were collected along specific routes and at specific intervals.

Important travel time survey elements include routes, departure times, vehicle requirements and crew requirements. These are described below.

Routes: A total of seven routes were devised. They were as follows:

ROUTE 1: 5th Ave. to Pali Hwy. (beginning of on-ramp merge to beginning of off-ramp divergence).

ROUTE 2: 5th Ave. to Kalihi St.[2]

[2] The Kalihi St. overpass is the end of the timed run; then, the return to the trip origins was reached by exiting at Middle St. and looping around via the freeway, King St. or Vineyard Blvd.

ROUTE 3: Piikoi St. (just past King St.) to Kalihi St. via freeway (control period only).

ROUTE 4: Piikoi St. (just past King St.) to Kalihi St. via Punchbowl St. and freeway (experiment).

ROUTE 5: Piikoi St. (just past King St.) to Kalihi St. via Vineyard Blvd. and freeway (experiment).

ROUTE 6: Piikoi St. (just past King St.) to Pali Hwy. via freeway (control period only).

ROUTE 7: Piikoi St. (just past King St.) to Pali Hwy. via Vineyard Blvd. (experiment).

Routes 1 and 2 were run during both the control and the experiment periods. Routes 3, 4 and 5, and routes 6 and 7 were complementary: 3 and 6 were done during the control period and 4, 5 and 7 were done during the experiment period. Figure 3.2 presents a sample data collection sheet that was filled out by the travel time survey crew.

Departure Times: Vehicle departures were set at 6:00, 6:30, 7:00, 7:30, 8:00, 8:30, 9:00 and 9:30 A.M. Routes 1 through 5 could take more than one half hour to complete, including the time required for looping around to reach the origin point. As a result, two vehicles were assigned to these routes. Routes 6 and 7 can be covered within one half hour including the return trip, thus, one vehicle was assigned to these routes.

Vehicle Requirements: Routes 1, 2, 3 and 6 were conducted in the control period. Two vehicles each were assigned to routes 1, 2 and 3, and 1 vehicle to route 6. The total requirement was seven vehicles for the control period. Routes 1, 2, 4, 5 and 7 were conducted in the experiment period. Two vehicles each are needed for routes 2, 4 and 5, and 1 vehicle for routes 1 and 7. The total requirement is eight vehicles for the experiment period.

ROUTE 1: 11th Ave. on-ramp to Pali Hwy. @ Kuakini St.

Date _____ [please include daytime phone number]
Name _____
Phone _____

PASS	START TIME	West (EWA) Bound 11th Ave.	Wilder	Punahou	Pali	Kuakini	RETURN TIME	East (Koko Head) Bound Queen E	Punahou	Old Wai.
1		0:00						0:00		
2		0:00						0:00		
3		0:00						0:00		
4		0:00						0:00		

write down the time exactly as it appears on the dial of the stop-watch, e.g., 00832 74

TIME in this box should be very close to the times listed below for your CAR.

TIME in this box should be whatever the time is when you are on the Pali Hwy. on-ramp to the freeway eastbound.

TIME	Direction	*please comment on unusual conditions such as accidents, lane-blocking debris, ambulances, etc.*

TIME (A.M.)	CAR 1	CAR 2
6:00	begin	
6:30		begin
7:00	begin	
7:30		begin
8:00	begin	
8:30		begin
9:00	begin	
9:30		begin

Start stopwatch at 11th Ave. on-ramp at sign "H-1"-and-"arrow". Record START TIME of day. Headlights on.
Proceed to middle lane of freeway; stay on this lane except for emergencies.
Record elapsed time at pedestrian overpass before Wilder Ave. exit.
Record elapsed time at Punahou St. overpass.
Move from middle to right lane of the freeway after the Vineyard Blvd. exit.
Take the Pali Hwy. exit. Record elapsed time at sign "Exit 21B" on the Pali Hwy. exit.
Proceed on NB (mauka) Pali Hwy. Move to right-most (auxiliary/exit) lane.
Record time at Kuakini St. (where it merges into the Pali Hwy.) Reset the stopwatch.
Exit at Pacific Heights --> LT at Pauoa --> LT at Funchal --> take Pali Hwy. ramp to H-1 EB.
Start stopwatch while on the ramp at the Queen Emma St. overpass. Record RETURN TIME of day.
Proceed to middle lane of freeway; keep lane except for emergencies.
Record elapsed time at the Punahou St. overpass.
Exit at King St. Record elapsed time at Old Waialae Ave. overpass. Reset the stopwatch.
Check time and decide to rest at Market City or proceed straight on Harding St. for the next pass.

FIGURE 3.2. Sample travel time survey form.

The required vehicles could be taxis, State and City & County vehicles allocated to this project for three weeks (weekdays only) or vehicles of a private contractor. Prior to the experiment, HDOT issued a request for proposal and conducted a competitive bid selection. The Hawaii Bicycling League won the contract and arranged for a sufficient number of vehicles and crew.

Crew Requirements: Each vehicle was occupied by a driver and a time-keeper who starts and stops the stopwatch to record the duration of each run. Forms and stopwatches for the drivers were provided by the project's research team. The total requirement was 14 people for the control period and 16 people for the experiment period. Participating crews were given training at the Traffic and Transportation Laboratory at the UH during the weekend prior to the commencement of the survey (separate sessions were done for the control and the experiment periods.)

The drivers were instructed to get to the middle lane of the freeway as soon as it was safe to do so, and move to the right lane for exiting the freeway as late as safety and practicality permitted. They were instructed to follow the pace of the traffic flow and neither overtake nor slow down unless safety or "representativeness" (i.e., go around a slow moving heavy vehicle in the middle lane) made such a maneuver necessary.

Traffic volumes and traffic conditions

Volume data support the validity of the outcomes by accounting for any traffic fluctuations. Volumes also could reveal whether there was a measurable change in throughput. HDOT collected volume son all on- and off-ramps.

Freeway camera and helicopter surveillance helped spot irregular phenomena and unforeseen impacts. Five cameras were monitored: Liliha St., Ward Ave., Punahou St., University Ave. and Koko Head Ave. Prior to the experiment, there was an understanding that each camera's position and zoom would remain unaltered. The position for each camera was set by HDTS technicians in the presence of project manager D. Meller at the HDTS Traffic Center, while the project's investigator was viewing the

camera location from the office via an Internet connection and communicating the desired location over the phone.

The Liliha St. and Ward Ave. cameras produced usable tapes for most of the time. The Punahou St. camera burned out during the third day of the experiment and was not repaired or replaced until after the experiment. The University Ave. camera produced usable tapes for most of the time. The Koko Head Ave. camera was moved to a position that made automated measurement taking impossible. All cameras were relocated at some point during the experiment necessitating adjustment of the AUTOSCOPE detectors and "field of view."

The following measurements were collected and observations were made:

- 15-minute increment on- and off-ramp volumes (collected by HDOT using meters connected to loops or pneumatic tubes).
- Control and experiment period video taping from the 5 surveillance cameras mentioned above. Manual inspection and traffic data extraction with AUTOSCOPE.
- Control and experiment period video taping of west bound Vineyard Blvd. at Punchbowl St. Manual inspection and traffic data extraction with AUTOSCOPE.
- Density, rough speed estimate and identification of problem spots with helicopter surveillance (10 flights during the 2 weeks of the experiment). The HFD McDonell-Douglas (now Boeing) 520N helicopter has a 90 minute flight ability, so freeway surveillance was confined roughly between 7:30 and 8:30 A.M.

Motorists' perceptions

It is often true that people's perceptions are more important than facts. A case in point is the extensive campaign of the Chicago Transit Authority in the mid 1980s which aimed to promote the rail rapid transit's travel times after surveys revealed that the majority of the traveling public perceived that trips by rail with an actual duration of consistently less

than 25 minutes to be "about an hour" long. Furthermore, in a transportation context, it is not unusual to have perceptions which are in conflict with reality. In other words, a successful application (based on objective measures) may be viewed negatively by the public, and vice-versa.

For these reasons, it was decided to conduct a mail-back questionnaire survey at the end of the experiment. Questionnaires were distributed to motorists at key locations by an HDOT subcontractor (SMS Research, Incorporated won the competitive bid.) Table 4.14 shows the basic characteristics of the survey. Surveys were distributed at points where traffic destined to a given on-ramp form standing queues which facilitated the distribution of questionnaires by 16 pedestrian surveyors to motorists. The surveys were distributed one week after the experiment ended during clear days and during the same time period as the experiment (6 to 10 A.M.).

Notably, no surveys were administered at University Ave. (both on-ramps) because of low volume and no stoppages. On the Old Waialae Ave. on-ramp, although queues usually form in busy periods, its twin lane configuration makes the queue flow continuously, except for about ½ hour every weekday when frequent stoppages occur. The project team was unsuccessful in conducting the single question ("where are you going to exit the freeway?") survey[3] at this location (refer to Volume 1). For this reason, it was decided to not distribute mail-back surveys at this location.

The basic premise of the questionnaire design was that the freeway cross-section past the Lunalilo St. on-ramp has 4 lanes. As such, the freeway motorists can occupy ¾ths of the capacity and the balance goes to the on-ramp motorists; 1500/6000=25% were planned and 1370/5400=25% of the surveys were distributed to Lunalilo St. on-ramp motorists (see analysis in Chapter 4).

[3] During times that the movement was slow but not stopped, drivers on the left lane (the interviewers were adjacent to this lane) would not slow down or would not look at the interviewers because drivers on the expiring right lane were attempting to cut in from of them. It was expected that a similar reaction would occur with the questionnaire surveyors.

3.2.2 Data Analysis

The analysis focuses on comparisons of *control* with *experiment* period measurements. Four basic comparisons were conducted between the control and experiment data:

1. Manual and HDOT counts on the mainline by 5th Ave., and on all on- and off-ramps from Kapiolani Blvd. to Pali Hwy. Analysis is in section 4.2.
2. AUTOSCOPE speeds at University Ave., Punahou St., and Ward Ave. Analysis is in section 4.3.
3. Travel times by route and time of day. Analysis is in section 4.5.

These analyses are followed by a statistical analysis of the 1403 responses received from the questionnaire survey. Analysis is in section 4.5. Once analyses are completed, a summary assessment can be obtained as follows:

ASSESSMENT SOURCE	RESULT
1. In-traffic Travel Times Collected by the Hawaii Bicycling League	.....
2. Traffic Volumes, Manual and from HDOT Meters	.....
3. AUTOSCOPE Speeds (from HDTS Freeway Surveillance Tapes)	
4. Simulation Runs with Data as Developed During the Experiment	.....
5. Motorists' Perception Survey After the End of Experiment	.....

3.3 DUTIES OF THE ORGANIZATIONS INVOLVED

The organizations involved and having a stake in the success of this experiment are the FHWA, HDOT, the City and County of Honolulu (HDTS, HPD and HFD) and the UH project team. Their duties are listed below.

Federal Highway Administration, Hawaii office

- Approval of concept and experiment.

Hawaii DOT

- Set volume counters.
- Procure changeable message signs and arrange for their timely activation and deactivation.
- Procure VCRs and tapes; arrange set-up for recording.
- Procure a lane delineation contractor.
- Participate in helicopter surveillance.
- Organize travel time surveys (in-house, contract, etc.)
- Video taping by HDOT-T of the Vineyard Blvd. and Punchbowl St. intersection.
- Coordinate with the City and County:
  - Department of Transportation Services (cameras, signals, survey, vehicles and drivers).
  - Fire Department (helicopter).
  - Police Department (two police officers).
- Contracting for distribution and collection of post-experiment survey.

City and County of Honolulu

- Provide helicopter for surveillance (HFD).
- Provide two police officers (HPD).

Department of Transportation Services

- Adjusted position of the following cameras:
  - Koko Head Ave.
  - University Ave.
  - Punahou St.
  - Ward Ave.
  - Liliha St.
- Adjusted position of the camera at the intersection of Vineyard Blvd. with Punchbowl St.
- Facilitate HDOT's VCR taping by providing feeds for 5 VCRs for the aforementioned cameras along the H-1 Freeway.
- Set signals as recommended above. (HDOT did not request signal changes and no changes were made).

UH project team under contract 41554

- Provide forms of travel time recording.
- Provide instructions to travel time crews.
- Participate in helicopter surveillance.
- Data reduction: Travel times, counter data, AUTOSCOPE volume and speed measurements.
- Analyze changes in travel times, speeds and volumes between the control and experiment periods.
- Design, code and analyze the questionnaire survey.
- Report (this volume).

CHAPTER FOUR: EXPERIMENT ANALYSIS

4.1 INTRODUCTION

Simulation as well as experience derived from several site visits, timed runs, helicopter surveillance, and discussions with HDOT staff members concluded that the Lunalilo St. on-ramp is a major bottleneck. This is the outcome of heavy ingress and egress weaving. A major advantage of the particular network is that the Lunalilo St. on-ramp extends to become the right lane of the 2-lane Vineyard Blvd. off-ramp. Therefore, the proposed closure is in effect a rerouting to a wide, high-design arterial street, Vineyard Blvd. In addition, Vineyard Blvd. offers three re-entries onto the freeway via downstream on-ramps at about 0.3, 1 and 1.3 miles from the Lunalilo St. on-ramp. These unique elements enabled the execution of an experiment with a small budget and little inconvenience to motorists. The HDOT and FHWA approved a short-term closure using traffic cones, for two consecutive weeks from late October to early November in 1997. A suite of independent measures was planned and conducted to assess the degree of success of the experiment. These measures and analyses are presented in this Chapter.

Four independent measures were used to assess the degree of success of the experiment. They included:

(i) Traffic volumes supplied by the HDOT (from pneumatic tube or loop meters located at all ramps between Koko Head Ave. and Houghtailing St.) as well as manual counts from surveillance tapes. These are analyzed in section 4.2.

(ii) Speeds extracted with the AUTOSCOPE from HDTS freeway surveillance tapes are analyzed in section 4.3.

(iii) In-traffic travel times collected by probe vehicles driven in a systematic way and over specific routes. These are analyzed in section 4.5.

(iv) Motorists' perception responses to a mail-back questionnaire survey administered immediately after the end of closure to about 5,500 motorists. These are analyzed in section 4.6.

Simulation runs with data collected during the experiment were conducted to assess the changes that occurred and investigate the sources of problems with the experiment and the sources of problems with the simulation. These are analyzed in section 4.4.

Known major disruptions to traffic flow are presented in Table 4.1 below. They cover the ten week-days when the experiment was in effect. It was unfortunate that there were three incidents during the 12 hours of experiment conditions in each experiment week. Normally, no more that one incident occurs during the same period. All incidents were independent of the experiment.

TABLE 4.1. KNOWN INCIDENTS DURING THE EXPERIMENTAL RAMP CLOSURE

Day	Date	Incident Situation
Monday	Oct. 27	Three-car collision on the left lane of west bound H-1 Fwy. before the Waialae Ave. off-ramp[4].
Thursday	Oct. 30	Three-car collision on the right lane of west bound H-1 Fwy. before the Waialae Ave. off-ramp.
Friday	Oct. 31	Punchbowl St. and Miller St. C&C DPW paving project caused extensive congestion on both sides of H-1 Fwy.
Tuesday	Nov. 4	Accident on west bound H-1 Fwy. by Houghtailing St. caused extensive congestion.
Thursday	Nov. 6	Radio station KSSK reports a minor accident on Old Waialae Ave. on-ramp which could not be confirmed by a police report nor by the University Ave. CCTV tapes.
Friday	Nov. 7	Stalled Ford Explorer on narrow shoulder about 200 ft. before the beginning of the coning is recorded on the tape filmed by D. Meller on timed drives along the H-1 Fwy.

[4] Because of this incident, congestion built-up for more than a mile on Kalanianaole Hwy., which might have given motorists the wrong impression that the queuing was caused by the closure. The helicopter tape, however, clearly shows that the queue on west bound H-1 Fwy. ended after the Koko Head Ave. overpass. A gap followed and, then, density increased upstream of the accident site.

4.2 VOLUME COUNTS ANALYSIS

The principal objective of volume data collection was to control for unusual shifts in demand which could cause a change in travel times. In other words, the main base for assessing the success of the experiment was travel time reduction. However, travel time reduction may be caused by a significant shift of traffic to routes other than the freeway and its ramps. Thus, the main focus of the volume data collection was the comparison of conditions so that differences are accounted for and results are weighted accordingly.

Volume data shown herein relied heavily on manual counts given the unreliability of counts obtained with pneumatic tubes, which demonstrated major errors at sites where an exact validation could be made. For example, the Old Waialae Ave. on-ramp counts for 6:00-10:00 A.M. compare as follows:

Date	HDOT	Manual
Wednesday, October 29, 1997 (3rd day of closure)	5,940	3,910
Wednesday, November 5, 1997 (8th day of closure)	6,145	3,883

Additional comparisons of volumes are presented in Appendix B. The situation at Old Waialae Ave. on-ramp (with errors exceeding 100%) may be extreme but it is not unique. At times during which the west bound Lunalilo St. on-ramp was congested, errors in specific 15-minute counts exceeded 30%. On the west bound School St. on ramp, pneumatic tube errors exceeded 9% in 8 out of 32 15-minute measurements. Most errors of pneumatic tube meters are in the 4% to 10% range, which is still too high to be useful in general, and in this case in particular, where a possible 5-10% benefit could be masked by the counts. On the other hand, loop meters gave count accuracy well within 1%. The latter counts, along with extensive manual counts from surveillance tapes permitted the conduct of a more reliable assessment based on volumes.

Three tables present traffic flows on west bound H-1 Freeway at the Koko Head Ave., Old Waialae Ave. and Ward Ave. cross-sections and for three time periods:

- Peak hour, defined as 6:45-7:45 A.M.

- Peak period, defined as 6:15-8:15 A.M.
- Experiment period, defined as 6:00-10:00 A.M.

Table 4.2 (Koko Head Ave.) illustrates a small decrease in freeway volume, which, however, is well within the standard deviation resulting from day-to-day variation (and possible measurement errors). This can also be seen with the manual counts in Appendix A. Thus, the supposition that more than 3% of the freeway volume on the segment from Kahala to the University diverted to other routes (e.g., Waialae Ave.) cannot be supported. The Old Waialae Ave. cross-section shows a small decrease in freeway volume, particularly during the peak hour (Table 4.3). However, manual counts shown in Appendix A indicate that the overall drop of volume on both this on-ramp and the adjacent freeway cross-section was not significant. The freeway volume by Ward Ave. was higher by about 2% (Table 4.4). Manual counts also indicate a 5% to 10% increase of the volume on the west bound School St. on-ramp.

More detailed differences between normal and experiment volumes are given in Tables 4.5 and 4.6. Again, changes within ±3% should be considered insignificant. For example, Table 4.6 which contains the total volumes during the 4 hours of the experiment suggests that a 2.4% gain in capacity was realized. Table 4.5 which contains the peak hour volumes suggests that a 6% loss in capacity was realized. Both results are likely, but uncertain because of:

- day-to-day variation;
- measurement errors;
- the "immaturity" of the experiment. The experiment did not last long enough to achieve equilibrium[5]; and,
- the short duration of the experiment did not permit the collection of enough data for reliable statistical testing of hypotheses.

[5] Simulation results typically represent equilibrium (settled) conditions (e.g., no slowing due to curiosity, unfamiliarity, etc.)

TABLE 4.2. FREEWAY MAINLINE BY KOKO HEAD AVE.: MANUAL COUNTS

Year	1996	1997		
Date	Oct., 16	Oct., 1		St. Dev.
Day	WED*	WED	AVG	(% of AVG)
Conditions	normal			
6:45~7:45	4,940	5,301	5,121	5.0%
6:15~8:15	9,265	9,662	9,464	3.0%
6:00~10:00	15,902	16,054	15,978	0.7%

Year	1997				
Date	Oct., 29	Nov. 5		St. Dev.	Diff.
Day	WED	WED	AVG	(% of AVG)	based on
Conditions	experiment				AVG
6:45~7:45	5,058	4,811	4,935	3.5%	-3.6%
6:15~8:15	9,365	9,097	9,231	2.1%	-2.5%
6:00~10:00	15,729	15,719	15,724	0.0%	-1.6%

(*) Synthesized by combining manual counts from the DTS Old Waialae Ave. camera and HDOT counts on upstream ramps.

TABLE 4.3. FREEWAY MAINLINE BY OLD WAIALAE AVE.: MANUAL COUNTS

Year	1996						1997			
Date	Oct., 15	Oct., 16	Oct., 17	Oct., 29	Oct., 30	Oct., 31	Oct., 1	Nov. 19		St. Dev.
Day	TUE	WED	THU	TUE	WED	THU	WED	WED	AVG	(% of AVG)
Conditions	normal									
6:45~7:45	4,695	4,639	4,466	4,535	4,365	4,452	4,507	na	4,523	2.5%
6:15~8:15	8,515	8,373	8,534	8,364	8,258	8,570	8,395	na	8,430	1.3%
6:00~10:00	15,473	15,389	15,462	15,280	15,117	15,503	15,274	na	15,357	0.9%

Year	1997				
Date	Oct., 29	Nov. 5		St. Dev.	Diff.
Day	WED	WED	AVG	(% of AVG)	based on
Conditions	experiment				AVG
6:45~7:45	4,391	4,098	4,245	4.9%	-6.2%
6:15~8:15	8,301	7,959	8,130	3.0%	-3.6%
6:00~10:00	15,076	14,973	15,025	0.5%	-2.2%

TABLE 4.4. FREEWAY MAINLINE BY WARD AVE.: MANUAL COUNTS

Year	1996						1997			
Date	Oct., 15	Oct., 16	Oct., 17	Oct., 29	Oct., 30	Oct., 31	Oct., 1	Nov. 19		St. Dev.
Day	TUE	WED	THU	TUE	WED	THU	WED	WED	AVG	(% of AVG)
Conditions	normal									
6:45~7:45	5,819	6,117	5,980	5,969	5,852	6,030	6,161	5,927	5,982	2.0%
6:15~8:15	11,171	11,681	11,643	11,645	11,486	11,706	11,663	11,632	11,578	1.5%
6:00~10:00	20,852	21,674	21,342	20,968	21,305	21,285	21,600	21,482	21,314	1.3%

Year	1997				
Date	Oct., 29	Nov. 5		St. Dev.	Diff.
Day	WED	WED	AVG	(% of AVG)	based on
Conditions	experiment				AVG
6:45~7:45	5,989	6,045	6,017	0.7%	0.6%
6:15~8:15	11,734	11,734	11,734	0.0%	1.3%
6:00~10:00	21,730	21,862	21,796	0.4%	2.3%

TABLE 4.5. 6:45-7:45 A.M. HDOT METER COUNTS

	Likelike Hwy. OFF	Hough-tailing OFF	Vineyard ON	Palama OFF	School ON	School OFF	Punch-bowl ON	Pali Hwy. OFF	Vineyard OFF (total)	Vineyard OFF (coned)	Lunalilo ON	cross section upstream of experiment	Lunalilo OFF	Punahou ON	Alex-ander ON	Wilder OFF	Univers-ity ON	Univers-ity ON (Yield)	Univers-ity OFF	Old Waialae ON	King St. OFF	H-1 main-line by Kapio-lani	Kapio-lani OFF
Count method	p. tube	p. tube	p. tube	p. tube	p. tube	p. tube	p. tube	p. tube	loop	loop	p. tube	derived	p. tube	p. tube	p. tube	p. tube	p. tube	p. tube	p. tube	marvideo	p. tube	loop	loop
WEDNESDAY, OCT. 29, 1997 (day 3)	445	867	1,117	161	1,152	341	970	573	2,524	1,215	1,253	**6,168**	397	1,135	872	977	457	294	256	907	603	4,736	1,664
WEDNESDAY, NOV. 5, 1997 (day 8)	425	860	988	158	1,169	337	960	561	2,478	1,196	n.a.	**6,292**	360	1,004	1,139	909	468	304	217	899	561	4,525	1,586
WEDNESDAY, OCT. 16, 1996	415	893	870	181	1,066	411	467	647	1,595		**1,556**	**6,652**	**463**	**1,161**	**1,327**	**1,048**	**432**	**286**	**332**	**1,007**	**666**	**4,948**	**1,649**

Percentile Differences (Experiment Day vs. 1996 Base)	Likelike Hwy. OFF	Hough-tailing OFF	Vineyard ON	Palama OFF	School ON	School OFF	Punch-bowl ON	Pali Hwy. OFF	Vineyard OFF (total)	Vineyard OFF (coned)	Lunalilo ON	cross section upstream of experiment	Lunalilo OFF	Punahou ON	Alex-ander ON	Wilder OFF	Univers-ity ON	Univers-ity ON (Yield)	Univers-ity OFF	Old Waialae ON	King St. OFF	H-1 main-line by Kapio-lani	Kapio-lani OFF
WEDNESDAY, OCT. 29, 1997 (day 3)	7.2%	-2.9%	28.4%	-11.0%	8.1%	-17.0%	107.7%	-11.4%	58.2%		-19.5%	**-7.3%**	-14.3%	-2.2%	-34.3%	-6.8%	5.8%	2.8%	-22.9%	-9.9%	-9.5%	-4.3%	0.9%
WEDNESDAY, NOV. 5, 1997 (day 8)	2.4%	-3.7%	13.6%	-12.7%	9.7%	-18.0%	105.6%	-13.3%	55.4%		n.a.	**-5.4%**	-22.2%	-13.5%	-14.2%	-13.3%	8.3%	6.3%	-34.6%	-10.7%	-15.8%	-8.5%	-3.8%

TABLE 4.6. 6:00-10:00 A.M. HDOT METER COUNTS

	Likelike Hwy. OFF	Hough-tailing OFF	Vineyard ON	Palama OFF	School ON	School OFF	Punch-bowl ON	Pali Hwy. OFF	Vineyard OFF (total)	Vineyard OFF (coned)	Lunalilo ON	cross section upstream of experiment	Lunalilo OFF	Punahou ON	Alex-ander ON	Wilder OFF	Univers-ity ON	Univers-ity ON (Yield)	Univers-ity OFF	Old Waialae ON	King St. OFF	H-1 main-line by Kapio- lani	Kapio-lani OFF
Count method	p. tube	p. tube	p. tube	p. tube	p. tube	p. tube	p. tube	p. tube	loop	loop	p. tube	derived	p. tube	p. tube	p. tube	p. tube	p. tube	p. tube	p. tube	man/video	p. tube	loop	loop
WEDNESDAY, OCT. 29, 1997 (day 3)	1,740	2,964	3,921	576	4,279	1,438	3,481	1,937	8,949	4,009	4,208	**21,926**	2,456	3,123	3,361	2,137	1,409	888	1,262	3,949	2,021	17,072	4,397
WEDNESDAY, NOV. 5, 1997 (day 8)	1,667	2,934	3,650	564	4,268	1,406	3,542	1,899	8,010	3,980	n.a.	**22,360**	2,319	2,926	3,902	2,174	1,457	852	1,180	3,883	1,913	16,926	4,488
WEDNESDAY, OCT. 16, 1996	1,701	3,176	3,089	702	4,090	1,762	1,943	2,307	5,800		**5,691**	**21,839**	**2,596**	**2,808**	**3,802**	**2,307**	**1,323**	**873**	**1,353**	**3,989**	**2,018**	**17,318**	**4,327**

Percentile Differences (Experiment Day vs. 1996 Base)	Likelike Hwy. OFF	Hough-tailing OFF	Vineyard ON	Palama OFF	School ON	School OFF	Punch-bowl ON	Pali Hwy. OFF	Vineyard OFF (total)	Vineyard OFF (coned)	Lunalilo ON	cross section upstream of experiment	Lunalilo OFF	Punahou ON	Alex-ander ON	Wilder OFF	Univers-ity ON	Univers-ity ON (Yield)	Univers-ity OFF	Old Waialae ON	King St. OFF	H-1 main-line by Kapio- lani	Kapio-lani OFF
WEDNESDAY, OCT. 29, 1997 (day 3)	2.3%	-6.7%	26.9%	-17.9%	4.6%	-18.4%	79.2%	-16.0%	54.3%		-26.1%	**0.4%**	-5.4%	11.2%	-11.6%	-7.4%	6.5%	1.7%	-6.7%	-1.0%	0.1%	-1.4%	1.6%
WEDNESDAY, NOV. 5, 1997 (day 8)	-2.0%	-7.6%	18.2%	-19.7%	4.4%	-20.2%	82.3%	-17.7%	38.1%		n.a.	**2.4%**	-10.7%	4.2%	2.6%	-5.8%	10.1%	-2.4%	-12.8%	-2.7%	-5.2%	-2.3%	3.7%

There is evidence, however, that supports the conclusion that large shifts in demand upstream of the experiment did not occur and, therefore, the validity of other investigations (e.g., travel times and speeds) is not threatened by demand shifts or reductions.

Many (expected) changes occurred on the west bound approach of the intersection of Vineyard Blvd. with Punchbowl St. Specifically:

- Right turn traffic increased 35 times.
- Through traffic increased by 50%.
- Left turn traffic remained unchanged (this means that practically no west bound Lunalilo St. on-ramp motorists who turn left at this intersection diverted to another route).
- Although there was an advisory variable message sign prior to this intersection informing large vehicles to avoid a right turn onto north bound Punchbowl St. due to its tight radius, most heavy vehicles ignored the advise and successfully negotiated the turn. As mentioned in the previous Chapter, due to the tight platoons, the effective saturation flow for this right turn was in excess of 1,800 vph (i.e., it worked nearly as well as a through lane.)
- The actual maximum utilization of this right turn was 670 vehicles per hour (7:00-7:15 A.M.) which is identical to the simulation capacity of 683 vph.

At times, the queuing on west bound Vineyard Blvd. by Punchbowl St. was extensive. This seems to have occurred for several reasons:

(1) The right turn would queue extensively due to sparsely distributed pedestrians in the crossing. This queue, in-turn, blocked the use of the adjacent through lane.

(2) Some motorists from the neighborhood immediately north of Vineyard Blvd. would block the right lane while waiting for an opportunity to illegally merge into the through lanes of Vineyard Blvd. (cross the solid line). This added to the delay of the right turn lane.

(3) There were only two south bound lanes on Punchbowl St. One of these was usually blocked by traffic turning left into the Queen's Medical Center. As a result, most

motorists drove on the outer (further from the median) of the two left turn lanes on Vineyard Blvd. This caused extensive queuing which, at times, blocked the adjacent through lane.

(4) On occasion, due to the causes in (1), (2) and (3), there were complete stoppages on the coned lane.

Solutions to these issues include:

(1) An exclusive left turn lane into the Queen's Medical Center (under construction in late 1999).

(2) Elimination of the east bound left turns on Vineyard Blvd. when the Lunalilo St. on-ramp closure is in effect (recommended in Volume 1).

(3) Improvement of the geometry of the right turn from Vineyard Blvd. to north bound Punchbowl St. (under consideration, with the option of adding two lanes to north bound Punchbowl St.).

According to Table 4.5, there was a reduction of traffic on the Lunalilo St. on-ramp of about 20%. About 1,250 instead of 1,550 vehicles were recorded in the peak hour. These appear to have been distributed as shown below. The remainder are likely to have rerouted onto Beretania or Prospect and School Sts.

Vehicles	Path	Percent
320	Left turn at Punchbowl St.	25.5
670	Right turn at Punchbowl St.	53.0
95	School St. on-ramp	7.5
183	Vineyard Blvd. on-ramp	14.5
1,268		~100%

4.3 AUTOSCOPE SPEEDS ANALYSIS

Videotapes were made both before and during the experiment using fiber optic leads to HDTS CCTV cameras overlooking the freeway at Koko Head Ave., Old Waialae Ave., Ward Ave., and Punahou St. Traffic speed on the videotapes was measured by two UH Department of Civil Engineering AUTOSCOPE devices. The placement of the Ward Ave. CCTV camera allowed AUTOSCOPE analysis of traffic speed in all west bound freeway lanes approximately 400 ft. downstream from the beginning of coning on the Lunalilo St. on-ramp. Sideways (occluded) views from the other three CCTV cameras limited AUTOSCOPE use to a single freeway lane. At optimum camera orientation, left lane west bound freeway speeds could be simultaneously measured about 1,000 ft. downstream from Koko Head Ave., about 500 ft. downstream Old Waialae Ave., and about 300 ft. downstream Punahou St.

During the experimental closure of the Lunalilo St. on-ramp, two freeway cameras were "lost." HDTS reoriented the Koko Head Ave. camera which precluded use of AUTOSCOPE to evaluate how the experiment affected west bound freeway traffic speed at Koko Head Ave. The camera overlooking the freeway at Punahou St. burned out at dawn on the third day of the experimental ramp closure. It was not replaced during the remainder of the experiment. HDOT Project Manager was told by the HDTS that several other cameras installed about the same time had simultaneously failed, as a result, replacements were not available.

AUTOSCOPE speed measurements from the Old Waialae Ave. camera are presented in Table 4.7. West bound freeway traffic speeds near the University before the experiment do not appear much different from speeds during the experiment. Available AUTOSCOPE speed measurements from the Punahou St. camera are presented in Table 4.8. During the first two days of the experiment, west bound freeway traffic speeds appear to be as good, or better, than normal.

TABLE 4.7. SPEED FROM HDTS CAMERA AT OLD WAIALAE AVE.

	west bound H-1 Freeway, left lane (speed in mph)									
	normal			experiment week 1			experiment week 2			
Time	9/30/97 Tues	10/1/97 Wednes	10/2/97 Thurs	10/28/97 Tues	10/29/97 Wednes	10/30/97 Thurs	11/3/97 Mon	11/4/97 Tues[1]	11/5/97 Wednes	11/6/97 Thurs
6:15:00	55.8	56.6	57.2	51.6	55.2	56.8	55.3	57.5	56.4	54.6
6:30:00	54.0	56.5	54.8	51.1	53.9	54.2	53.2	54.4	51.8	53.7
6:45:00	37.9	30.8	45.0	30.8	33.9	37.8	42.7	47.6	34.1	45.7
7:00:00	20.3	22.1	22.9	20.4	20.9	22.5	21.6	26.0	18.1	19.3
7:15:00	19.1	24.6	22.6	20.7		28.1	19.2	21.0	20.2	17.4
7:30:00	17.8	21.5	20.0	18.1		30.8	18.1	16.6	17.4	16.4
7:45:00	16.1	18.9	18.9	18.8	19.0	17.2	17.3	18.0	18.8	16.4
8:00:00	17.8	17.5	19.9	17.0	16.3	19.0	17.3	17.0	19.2	18.6
8:15:00	13.7	14.2	15.3	14.7	17.0	15.9	14.2	18.6	14.0	15.3
8:30:00	22.0	21.1	38.4	15.9	18.9	30.6	17.6	33.1	22.4	25.5
8:45:00	34.1	56.9	58.1	49.6	33.7	55.9	33.6	57.4	34.7	56.0
9:00:00	53.0	58.5	57.1	53.0	56.4	56.4	57.4	56.8	58.0	56.3
Avg.[2]:	25.2	28.6	31.8	25.9		31.4	25.9	31.2	25.7	28.7

Notes: (1) Houghtailing incident @ 7:15 A.M. (2) All averages are 6:30-9:00. Shaded: camera kept changing position.

TABLE 4.8. SPEED FROM HDTS CAMERA AT PUNAHOU ST.

	west bound H-1 Freeway, left lane (speed in mph)					
	normal			experiment week 1		
Time	9/29/97 Mon	9/30/97 Tues	10/1/97 Wednes	10/27/97 Mon	10/28/97 Tues	10/29/97 Wednes
6:15:00	53.5	54.3	53.9	56.1	55.6	
6:30:00	48.1	50.3	49.8	53.8	53.7	
6:45:00	40.3	38.7	30.3	33.1	35.0	
7:00:00	29.0	22.5	23.2	23.8	25.0	
7:15:00	24.3	18.9	21.7	18.0	22.6	
7:30:00	19.2	20.0	19.6	20.4	25.2	
7:45:00	21.2	19.6	20.6	24.1	25.3	
8:00:00	23.3	21.2	26.7	21.8	22.5	
8:15:00	21.6	22.6	22.3	22.4	22.8	
8:30:00	26.1	24.9	25.0	32.1	32.4	
8:45:00	50.0	31.6	35.4	57.2	40.9	
9:00:00	51.9	38.1	51.6	57.0	55.9	
9:15:00	53.5	53.6	53.1	57.7	55.2	
Avg.:	30.7	25.8	27.6	31.0	30.8	n.a.

Notes: All averages are 6:30-9:00. Shaded: camera malfunction was fixed after experiment ended.

AUTOSCOPE speed measurements from the Ward Ave. CCTV camera are presented in Table 4.9, parts (a) and (b). Freeway traffic speeds in Table 4,9a show the effect of "rubbernecking." Once the cones were placed, the speed on the left lane (which was unaffected by the cones) dropped from 54 mph to 47 mph, only to climb again to 52 mph towards the end of the experiment. A similar effect was observed for the middle lane as well, which has a normal speed of about 48 mph. Furthermore, drivers were clearly cautious about the coning. The right lane of the freeway typically travels at 41 mph, but during the first few days the speed dropped to 35 mph or less, and it began returning to the normal level towards the end of the experiment.

The auxiliary (coned-off) lane experienced a considerable change in speed from about 43 mph to about 35 mph, but it should be expected to stabilize to about 40 mph once a more permanent form of separation is in effect and the causes of queuing on west bound Vineyard Blvd. have been addressed.

4.4 KRONOS SIMULATION OF EXPERIMENT CONDITIONS

The aforementioned volume and speed data and comparisons vis-à-vis the anticipated results beg the question: Where did the simulation go wrong? Perhaps capacity was lost due to coning. In an attempt to discover the source of loss or impedance, simulated and actual travel times were compared. Actual travel times were collected by probe vehicles (these measurements are presented in the next section).

Average speeds for specific times (of departure) during Wednesdays were derived. These are shown as "actual data" in Table 4.10. Control, was the first week in October 1997; the experiment began in the last week of October 1997. During the control period, much like in 1996, a sharp decrease in average speed at 7:00, 7:30 and 8:00 A.M. is observed. During the first Wednesday of the experiment, a similar pattern was observed, but the average speeds were lower and there was a slower relief from

TABLE 4.9a. SPEED FROM DTS CAMERA AT WARD AVE.

	west bound H-1 Freeway, left lane (speed in mph)									
	normal			experiment week 1			experiment week 2			
Time	9/30/97 Tues	10/1/97 Wednes	10/2/97 Thurs	10/28/97 Tues	10/29/97 Wednes	10/30/97 Thurs	11/3/97 Mon	11/4/97 Tues[1]	11/5/97 Wednes	11/6/97 Thurs
6:15:00	63.5	63.5	63.2	54.1	48.8	55.6	51.5	63.3	57.4	60.4
6:30:00	61.9	60.8	61.8	52.7	50.2	53.2	51.5	58.3	53.3	55.6
6:45:00	55.4	55.2	58.5	50.3	48.7	47.6	50.4	52.8	51.0	53.1
7:00:00	56.0	54.3	46.9	48.7	48.6	47.7	48.6	51.7	50.6	53.1
7:15:00	55.4	54.6	54.4	48.3	46.9	47.8	49.1	28.2	51.4	52.0
7:30:00	55.6	52.5	54.5	47.6	47.1	42.3	47.8	51.9	51.7	51.0
7:45:00	50.0	51.4	50.4	46.5	47.9	48.3	47.3	51.5	50.0	52.0
8:00:00	50.9	51.4	52.9	44.0	46.4	47.6	44.6	40.4	48.5	51.5
8:15:00	52.6	52.4	54.0	41.4	44.9	48.8	49.7	47.2	49.5	51.8
8:30:00	53.8	51.5	55.5	46.1	47.0	48.0	49.5	41.7	49.8	49.0
8:45:00	53.8	52.0	60.9	45.5	47.6	48.4	50.3	50.8	51.1	50.5
9:00:00	53.8	55.2	61.8	53.0	51.7	55.6	54.1	65.1	52.7	59.5
Avg.:	53.7	53.0	55.0	47.1	47.7	48.2	49.1	48.1	50.6	52.4

	west bound H-1 Freeway, middle lane (speed in mph)									
	normal			experiment week 1			experiment week 2			
Time	9/30/97 Tues	10/1/97 Wednes	10/2/97 Thurs	10/28/97 Tues	10/29/97 Wednes	10/30/97 Thurs	11/3/97 Mon	11/4/97 Tues[1]	11/5/97 Wednes	11/6/97 Thurs
6:15:00	51.7	58.2	59.2	46.7	50.6	53.6	51.5	57.8	54.2	57.8
6:30:00	55.1	58.4	57.9	47.6	48.3	50.9	49.0	53.9	50.8	52.1
6:45:00	50.9	52.1	55.1	45.8	45.8	46.0	48.1	50.1	48.0	49.9
7:00:00	50.0	50.7	45.2	44.9	45.3	46.5	47.5	48.9	48.1	49.3
7:15:00	49.4	49.9	50.5	42.5	39.3	45.8	46.7	28.9	48.4	49.4
7:30:00	47.7	48.1	49.5	43.5	45.2	40.1	46.0	49.1	48.6	48.5
7:45:00	44.3	46.4	46.0	41.3	44.9	45.3	45.0	49.6	46.3	47.7
8:00:00	43.6	45.2	47.5	37.8	43.4	44.6	39.8	44.1	43.5	45.8
8:15:00	44.2	46.4	47.2	35.2	41.4	44.9	45.9	49.1	45.5	46.0
8:30:00	45.8	45.7	51.0	41.5	42.3	42.8	45.6	49.4	45.6	45.5
8:45:00	46.4	47.6	54.7	39.5	42.7	42.0	45.9	55.5	45.9	45.6
9:00:00	45.3	48.2	55.2	45.8	45.0	49.0	46.9	58.0	47.8	51.5
Avg.[2]:	46.8	48.0	50.2	41.8	43.5	44.7	45.7	48.3	46.8	47.9

Notes: (1) Houghtailing incident @ 7:15 A.M. (2) All averages are 6:30-9:00.

TABLE 4.9b. SPEED FROM DTS CAMERA AT WARD AVE.

	west bound H-1 Freeway, right lane (speed in mph)									
	normal			experiment week 1			experiment week 2			
	9/30/97	10/1/97	10/2/97	10/28/97	10/29/97	10/30/97	11/3/97	11/4/97	11/5/97	11/6/97
Time	Tues	Wednes	Thurs	Tues	Wednes	Thurs	Mon	Tues[1]	Wednes	Thurs
6:15:00	49.4	53.7	52.2	44.4	46.7	48.0	48.1	49.4	49.8	50.3
6:30:00	48.3	51.2	51.8	43.3	44.6	45.3	44.9	45.6	44.7	45.1
6:45:00	44.9	48.2	48.5	41.6	41.0	41.5	42.0	43.2	42.7	44.3
7:00:00	45.3	46.5	43.6	38.2	40.3	41.3	41.5	41.7	42.6	42.7
7:15:00	42.8	42.8	44.7	39.1	34.0	39.2	40.0	33.5	43.0	42.9
7:30:00	37.9	39.9	43.1	37.8	39.6	32.3	39.4	42.6	42.5	41.7
7:45:00	36.9	39.9	38.6	32.4	38.6	36.8	36.4	44.4	40.2	40.8
8:00:00	34.8	38.2	39.0	26.8	35.8	32.8	28.2	38.5	28.9	39.8
8:15:00	36.4	38.0	39.7	19.8	32.1	36.4	38.3	42.0	38.2	37.8
8:30:00	37.3	37.8	44.3	32.5	33.9	31.9	37.6	43.5	37.4	38.2
8:45:00	39.1	39.1	45.3	28.9	32.9	34.4	36.9	47.8	38.3	36.5
9:00:00	38.9	40.4	45.6	33.0	35.3	38.4	35.9	49.6	38.7	41.1
Avg.:	39.4	41.1	43.2	33.0	36.3	36.5	37.6	42.7	39.2	40.6

	west bound H-1 Freeway, auxiliary lane (speed in mph)									
	normal			experiment week 1			experiment week 2			
	9/30/97	10/1/97	10/2/97	10/28/97	10/29/97	10/30/97	11/3/97	11/4/97	11/5/97	11/6/97
Time	Tues	Wednes	Thurs	Tues	Wednes	Thurs	Mon	Tues[1]	Wednes	Thurs
6:15:00	49.5	51.9	49.6	38.7	37.1	40.6	36.7	40.4	40.8	40.1
6:30:00	49.8	51.8	52.4	39.4	37.5	39.9	39.8	40.3	38.9	39.3
6:45:00	48.1	49.9	51.1	37.5	37.0	38.6	39.3	39.3	37.6	40.0
7:00:00	47.0	47.2	46.1	38.3	37.0	38.9	38.8	39.0	39.1	39.8
7:15:00	46.2	45.3	46.0	37.2	30.8	37.7	37.4	35.7	39.4	39.6
7:30:00	42.0	41.4	44.5	35.4	36.0	29.5	36.9	36.9	37.5	38.0
7:45:00	39.4	41.4	41.5	30.5	35.9	34.6	35.3	30.9	36.6	36.2
8:00:00	38.9	40.0	40.3	18.6	34.2	27.9	22.5	29.9	26.6	36.2
8:15:00	39.1	38.9	41.0	21.1	30.6	34.9	35.6	25.0	35.7	35.8
8:30:00	39.7	38.3	45.2	33.5	32.3	33.6	34.1	30.4	35.8	35.6
8:45:00	40.9	42.1	46.2	29.2	32.4	34.8	35.5	33.3	36.4	33.0
9:00:00	40.3	41.4	46.9	34.0	34.4	35.3	33.6	33.9	37.3	34.0
Avg.[2]:	42.2	42.6	44.9	31.5	34.1	34.6	34.9	33.4	36.2	36.8

Notes: (1) Houghtailing incident @ 7:15 A.M. (2) All averages are 6:30-9:00.

TABLE 4.10. ACTUAL AND SIMULATED SPEEDS ON WEST BOUND H-1 FREEWAY WITH AND WITHOUT THE LUNALILO ST. ON-RAMP CLOSURE
(5th Ave. to Pali Hwy., Wednesday, 6 to 10 A.M. Data)

	SPEED (mph)					
Time of Day	6:00	6:30	7:00	7:30	8:00	8:30
ACTUAL DATA						
Control (10/1/97)	**65.5**	**62.4**	**32.2**	**29.3**	**29.6**	**59.4**
Experiment (10/29/97)	**62.7**	**51.7**	**33.9**	**25.3**	**26.4**	**43.7**
SIMULATED DATA						
K8 (10/16/96) base	**62.7**	**48.4**	**35.6**	**28.3**	**28.9**	**28.8**
K8 experiment sim.	**62.9**	**52.5**	**34.7**	**34.1**	**41.5**	**58.2**
K8 exper.+incident sim.	**62.9**	**55.2**	**20.5**	**27.9**	**25.7**	**32.0**

K8 = Kronos freeway simulation software, version 8.

congestion at 8:30 A.M. It must be noted that this Wednesday (day 3 of the experiment) was the worst day in terms of travel times collected by probe vehicles, and it was free of (known) incidents.

The first row of the "simulated data" shows the initial base case with October 1996 data. The match with the actual control data is reasonably good. However, the match of the Lunalilo St. on-ramp closure (labeled *K8-experiment*) simulation results with the actual experiment speeds is similar in shape and in close agreement for several time intervals, but about 40% to 60% too optimistic for the critical 7:30 A.M. and 8:00 A.M. times.

Many attempts were made to replicate these actual speeds. They were based on a progressive reduction of the capacity of the Lunalilo St. on-ramp segment (which is no longer an on-ramp merging into the mainline, but a straight pipeline segment with a base capacity of 2,100 vph per lane) in 2% intervals. We stopped at about a 15% reduction when it became obvious that the resultant speed profiles were too dissimilar.

As it turned out, coning created a type of impedance akin to an incident, instead of a uniform capacity reduction on a given segment. After several attempts it was discovered that a mock-up incident lasting 15 minutes that occurred at 7:00 A.M. which entailed: (1) a complete loss of the right lane; and,

(2) a 10% capacity reduction for the other two lanes,

produced results close to those observed during the worst day of the experiment. The outcome largely supported the supposition that the combined impedance of cones, police, variable message signs, scattered cones, coning truck, etc. created incident conditions which also caused the rapid propagation of congestion past Koko Head Ave.

4.5 TRAVEL TIMES ANALYSIS

This section summarizes the data collected by a travel time survey sub-contractor (the Hawaii Bicycling League) as explained in Chapter 3. Data were collected by crews of two people in vehicles driven on the middle lane of the freeway before and during the experiment. They collected travel times from specific origins to specific destinations along specific routes.

The most consistent outcome of the travel time was the reduction in the variance of travel times. Since a major bottleneck was removed and since this bottleneck was generating about one shock wave per minute (based on the phasing of the signal at the intersection upstream of the on-ramp), travel time variance was reduced. This is shown in Table 4.11 and Figure 4.1 (bottom graph). Figure 4.1 presents results collected by the subcontractor. Table 4.11 presents results from the subcontractor (left side) and independent departures by two members of the research team (right side). Both data sources, on two different segments on the freeway point to a considerable reduction of the coefficient of variation as well as a very small reduction of the average travel time.

Table 4.12 compares the travel times for three Wednesdays. Travel time savings, including slight ones, were observed in 14 of the 32 periods shown in blocks numbered 1 and 2. Observe that at 7:30 A.M., the first Wednesday displays the worst travel times both in block 1 (15.7 min.) and block (17.9 min.).

Table 4.13 summarizes the travel time differences (negative denotes savings) between the base times and the travel times during the first and second week of the experiment. The improvements are small, and typically smaller in the second week of the experiment. This is partly due to the higher frequency of coning violations and the traffic accident by Houghtailing St. The results from Routes 1 and 2 indicate that some improvement was observed in 19 of the 32 periods shown in blocks 1 and 2, Table 4.13.

TABLE 4.11. RAMP CLOSURE REDUCED TRAVEL TIME VARIABILITY

(Data from independent observers)

11th Ave. to Wilder Ave.

TIME	6:00	6:30	7:00	7:30	8:00	8:30	9:00	9:30	
COND.	INDEPENDENT T.T. MEASUREMENTS (min)								
B	2.48	2.30	8.58	9.13	8.48	3.75	2.27	2.22	
A	2.30	2.27	5.93	8.58	8.70	3.97	2.22	2.22	
S	2.30	2.52	5.82	6.85	6.03	2.45	2.30	2.37	
E	2.33	2.45	7.20	9.87	8.40	3.73	2.20	2.08	
	2.30	2.55	6.12	7.63	9.72	4.17	2.82	2.21	
	2.65	2.18	6.00	5.04	7.53	2.42	2.27	2.30	
mean	2.4	2.4	6.6	7.9	8.1	3.4	2.3	2.2	4.4
st.dev.	0.1	0.1	1.1	1.7	1.3	0.8	0.2	0.1	0.7
coefficient of variation									**0.16**

COND.	INDEPENDENT T.T. MEASUREMENTS (min)								
W	2.27	2.25	5.70	7.68	8.07	2.75	2.20	2.02	
E	2.28	2.25	6.02	9.08	8.57	4.62	2.27	1.82	
E	2.28	2.00	5.28	8.62	7.78	2.35	2.33	2.23	
K	2.27	2.38	5.22	8.20	8.26	2.90	2.20	2.20	
	2.20	2.40	4.88	8.97	8.52	4.75	2.12	2.08	
1	2.20	2.52	4.53	8.32	6.70	2.43	2.25	2.27	
mean	2.3	2.3	5.3	8.5	8.0	3.3	2.2	2.1	4.2
st.dev.	0.0	0.2	0.5	0.5	0.7	1.1	0.1	0.2	0.4
coefficient of variation									**0.10**

COND.	INDEPENDENT T.T. MEASUREMENTS (min)								
W	2.28	2.31	4.78	8.30	7.73	2.28	2.30	2.35	
E	2.30	2.67	7.35	7.77	8.62	4.53	2.15	2.13	
E	2.35	2.64	8.10	9.07	8.90	2.20	2.20	2.02	
K	2.20	2.33	4.74	8.13	7.90	2.33	2.13	2.20	
	2.08	2.75	6.98	8.92	8.59	4.53	2.27	2.13	
2	2.18	2.72	6.88	9.35	9.44	2.35	2.15	2.18	
mean	2.2	2.6	6.5	8.6	8.5	3.0	2.2	2.2	4.5
st.dev.	0.1	0.2	1.4	0.6	0.6	1.2	0.1	0.1	0.5
coefficient of variation									**0.12**

Wilder Ave. to Pali Hwy.

TIME	6:45	7:00	7:15	
	5.11	6.41	5.45	
		4.43	4.94	
		6.07	5.21	
B		5.72	5.81	
A		5.89	5.87	
S		5.43	6.34	
E		5.32		
		6.65		
		4.52		
		5.66		
		6.01		
mean	5.1	5.6	5.6	5.6
st.dev.		0.7	0.5	0.6
coefficient of variation				**0.11**

W	4.81	5.78	5.14	
E		5.25	5.73	
E		5.28	5.79	
K		6.33	5.64	
		5.43		
1,2		5.61		
mean	4.8	5.6	5.6	5.5
st.dev.		0.4	0.3	0.4
coefficient of variation				**0.07**

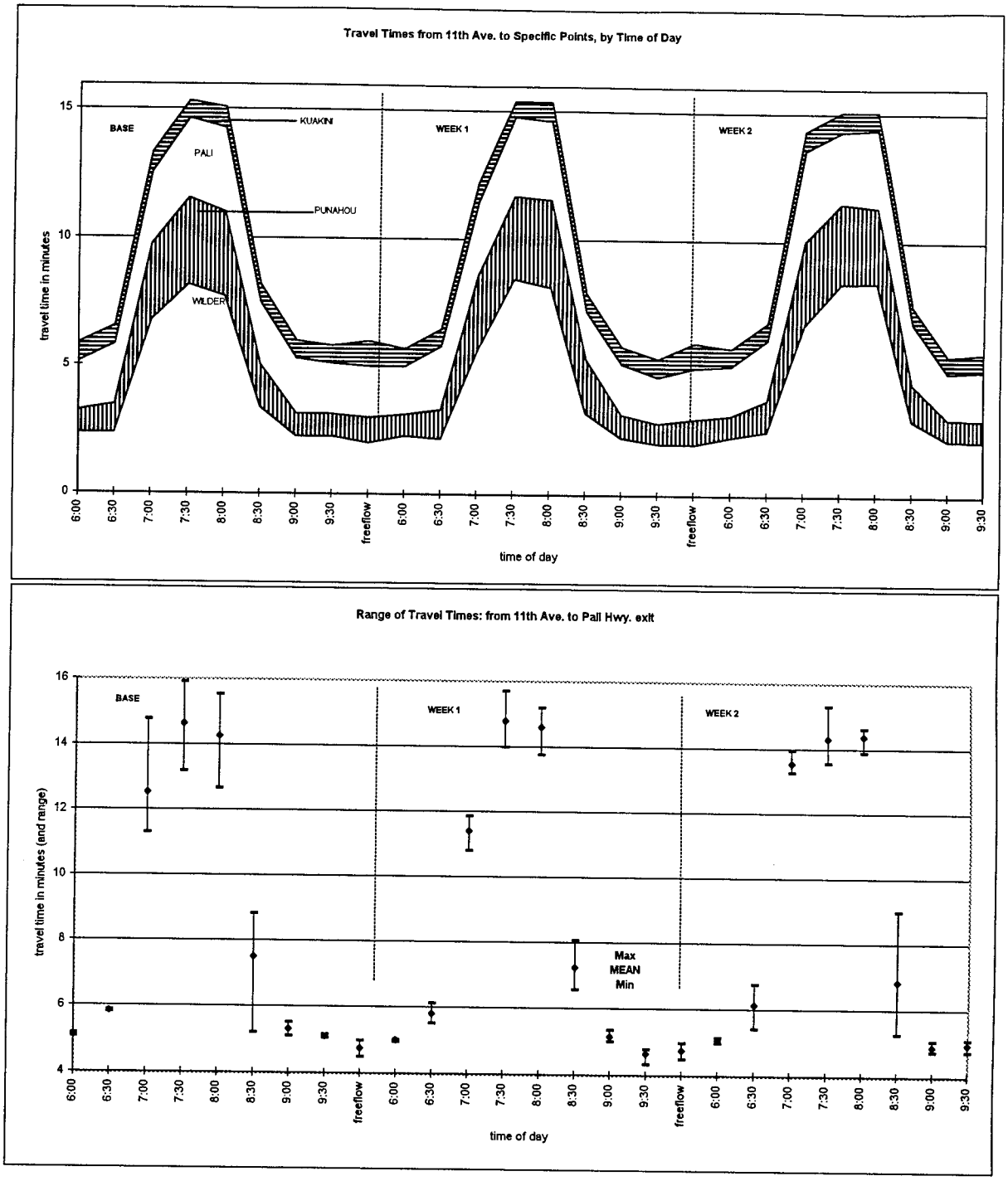


FIGURE 4.1. Statistics of Route 1, 11th Ave. to Pali Hwy.

TABLE 4.12. SUMMARY OF ALL ROUTES
(Wednesday Travel Times in Minutes)

	TIME OF DEPARTURE	6:00	6:30	7:00	7:30	8:00	8:30	9:00	9:30
1	11th Ave. to Pali Hwy. exit								
	BASE	5.1	5.8	11.5	14.8	15.6	8.8	5.1	5.1
	EXPERIMENT-WEEK 1	5.0	5.8	11.9	15.7	14.8	8.1	5.1	4.4
	EXPERIMENT-WEEK 2	5.1	6.8	13.4	13.6	14.6	9.0	4.8	4.8
2	11th Ave. to Likelike Hwy. o/p								
	BASE	7.2	8.4	14.1	16.5	19.0	11.4	8.2	7.5
	EXPERIMENT-WEEK 1	7.2	8.8	13.4	17.9	17.2	10.4	7.0	7.5
	EXPERIMENT-WEEK 2	7.2	10.2	14.9	16.6	17.2	11.6	7.5	7.0
3	Piikoi/King to Lunalilo/Pensacola								
	BASE	1.0	2.0	2.3	3.4	8.1	2.0	2.7	1.4
	EXPERIMENT-WEEK 1	1.2	1.2	1.3	1.2	1.5	2.0	1.0	1.7
	EXPERIMENT-WEEK 2	1.1	1.0	1.3	2.2	2.3	1.3	1.1	1.8
4	Piikoi/King to Pali@Kuakini (EXP=via Pali Hwy.)								
	BASE	3.0	3.2	4.2	5.3	8.8	3.3	3.7	3.9
	EXPERIMENT-WEEK 1	5.2	5.4	6.7	6.3	5.2	7.9	5.8	6.3
	EXPERIMENT-WEEK 2	5.2	4.1	4.1	5.4	8.1	6.6	7.6	7.5
5	Piikoi/King to Likelike Hwy. o/p (EXP=via Punchbowl on-ramp)								
	BASE	4.4	5.0	6.3	7.0	11.9	5.6	6.1	4.9
	EXPERIMENT-WEEK 1	6.2	6.7	6.6	7.8	7.9	7.8	5.4	7.7
	EXPERIMENT-WEEK 2	5.4	6.4	5.7	8.5	9.1	6.5	6.2	6.9
6	Piikoi/King to Likelike Hwy. o/p (EXP=via Vineyard on-ramp)								
	BASE	4.4	5.0	6.3	7.0	11.9	5.6	6.1	4.9
	EXPERIMENT-WEEK 1	8.5	8.3	8.9	11.2	10.8	9.6	9.3	10.6
	EXPERIMENT-WEEK 2	7.6	8.9	7.9	11.4	11.4	10.9	11.5	12.4

TABLE 4.13. SUMMARY OF ALL ROUTES IN TERMS OF % CHANGE FROM BASE (Average of Tue., Wed. & Thu. Data for 3 Weeks, Minutes)

	TIME OF DEPARTURE	6:00	6:30	7:00	7:30	8:00	8:30	9:00	9:30
1	11th Ave. to Pali Hwy. exit								
	EXPERIMENT-WEEK 1	-2%	-1%	-9%	1%	2%	-4%	-3%	-9%
	EXPERIMENT-WEEK 2	-1%	5%	8%	-2%	1%	-9%	-8%	-3%
2	11th Ave. to Kalihi St. o/p								
	EXPERIMENT-WEEK 1	0%	8%	-11%	1%	-1%	-1%	-9%	3%
	EXPERIMENT-WEEK 2	0%	13%	-2%	5%	-3%	-4%	-8%	1%
3	Piikoi/King to Lunalilo/Pensacola								
	EXPERIMENT-WEEK 1	-3%	-13%	-22%	-42%	-74%	-20%	-24%	1%
	EXPERIMENT-WEEK 2	10%	-12%	-24%	-37%	-75%	-15%	-14%	-2%
4	Piikoi/King to Pali@Kuakini (EXP=via Pali Hwy.)								
	EXPERIMENT-WEEK 1	39%	59%	48%	24%	-21%	72%	81%	60%
	EXPERIMENT-WEEK 2	75%	26%	14%	11%	-7%	34%	63%	61%
5	Piikoi/King to Kalihi St. o/p (EXP=via Punchbowl on-ramp)								
	EXPERIMENT-WEEK 1	23%	26%	19%	16%	-29%	22%	18%	54%
	EXPERIMENT-WEEK 2	24%	17%	26%	26%	-23%	23%	12%	43%
6	Piikoi/King to Kalihi St. o/p (EXP=via Vineyard on-ramp)								
	EXPERIMENT-WEEK 1	74%	69%	58%	72%	0%	72%	80%	114%
	EXPERIMENT-WEEK 2	64%	63%	58%	54%	10%	61%	104%	137%

The reader may be tempted to conclude that travel times on west bound H-1 Freeway are rather short, e.g., under normal morning rush conditions, it takes less than 16 minutes from Aina Haina to the Pali Hwy. and less than 20 minutes from Aina Haina to the Likelike Hwy. Nevertheless, these times are 250% to 300% longer than those possible at reasonable freeway speeds (e.g., 60 mph) under free flow conditions.

Figure 4.1 displays Route 1 travel times (11^{th} Ave. on-ramp to the Pali Hwy. off-ramp). The recorded times show a narrowing of the peak (top graph), particularly during the first week of the experiment. Similar observations apply to Route 2 (11^{th} Ave. on-ramp to the Kalihi St. overpass) shown in Figure 4.2. Again, consistency of travel times improved. Note that base statistics are from 3 days, whereas experiment statistics are from 6 days, including 3 incidents in each of the two weeks. Yet, travel times are much more consistent.

One prediction that came true during the experiment was the de-congestion of Piikoi St. This can be seen in the top graph in Figure 4.3 as well as in block 3 of Table 4.13. The re-routing of Piikoi St. traffic to Vineyard Blvd. resulted in a travel time increase of 2 to 4 minutes. Travel times from Piikoi at King to Kalihi St. overpass (middle graph) and Pali Hwy. (bottom graph) increased due to the diversion onto Vineyard Blvd. The increase is small (about 2 minutes) for those who used Punchbowl St. (mauka) to Pali Hwy. or H-1 Freeway, and larger for those who used Vineyard Blvd. to its entire length.

There is evidence[6] that, at times, travel time savings were considerable, as shown in Figure 4.4. The author of this report was driving, systematically on the left lane, and the HDOT Project Manager was taping continuously during the last day of the experiment (Friday), and the Friday after that. Despite the small incidents described in the note accompanying this Figure, considerable travel time savings were realized, both for the 7:00 and 7:40 A.M. runs from 11th Ave. to Pali Hwy. Specifically, about a 15%

[6] The tape offers valuable visual testimony which could convince skeptics for a long term morning ramp closure.

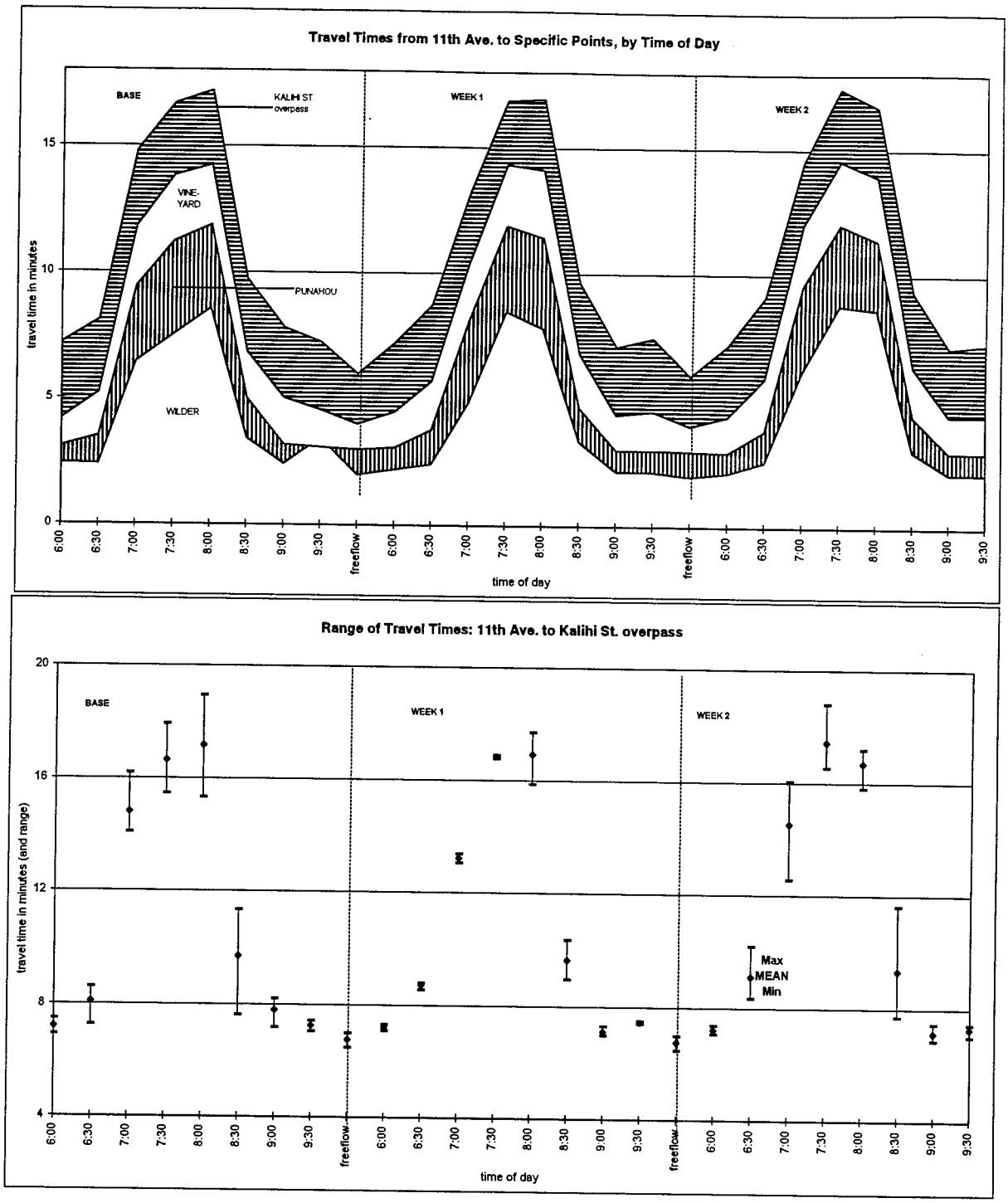


FIGURE 4.2. Statistics of Route 2, 11th Ave. to Kalihi St.

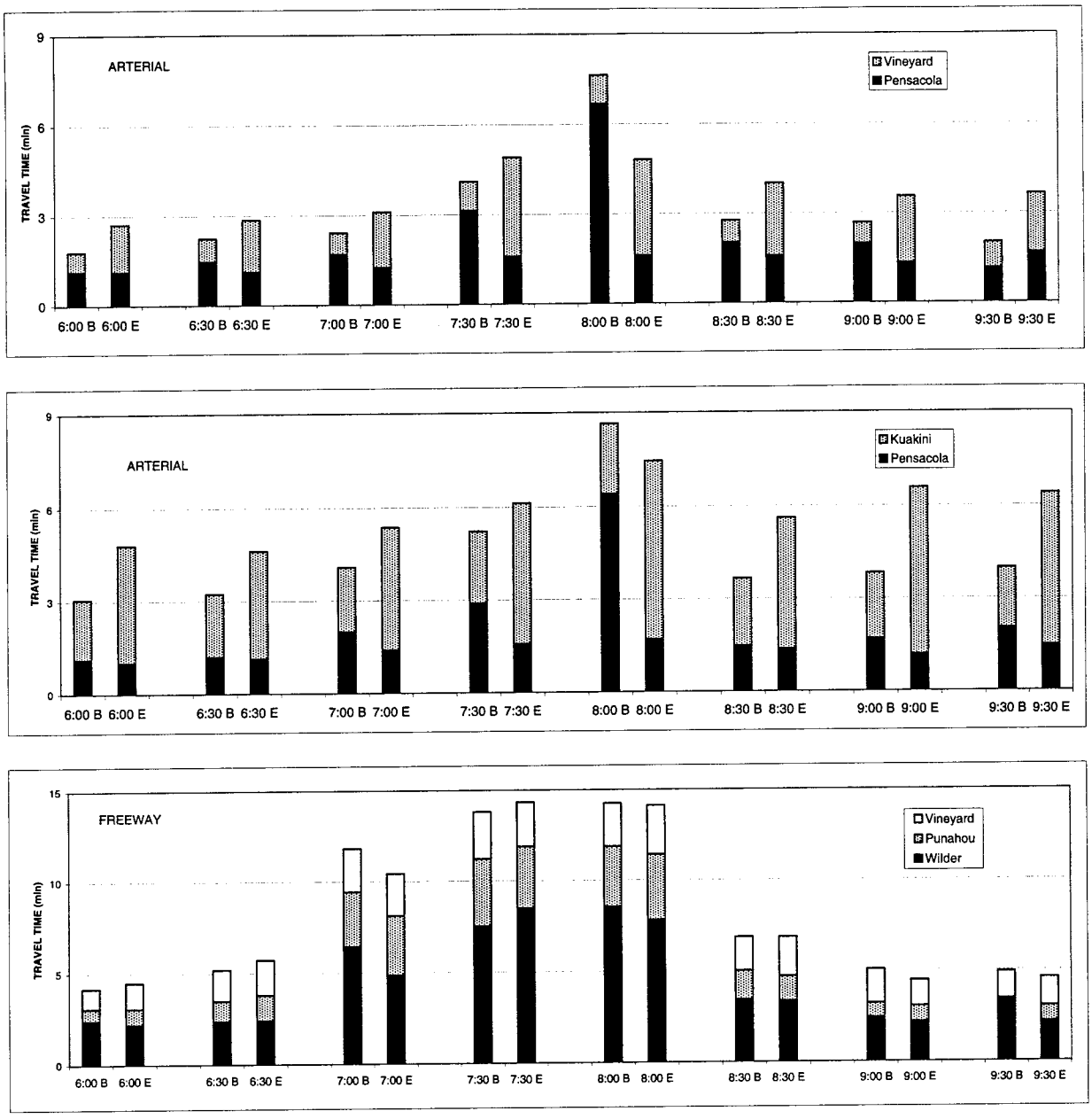


FIGURE 4.3. Freeway and arterial travel time under (B)ase and (E)xperiment conditions.

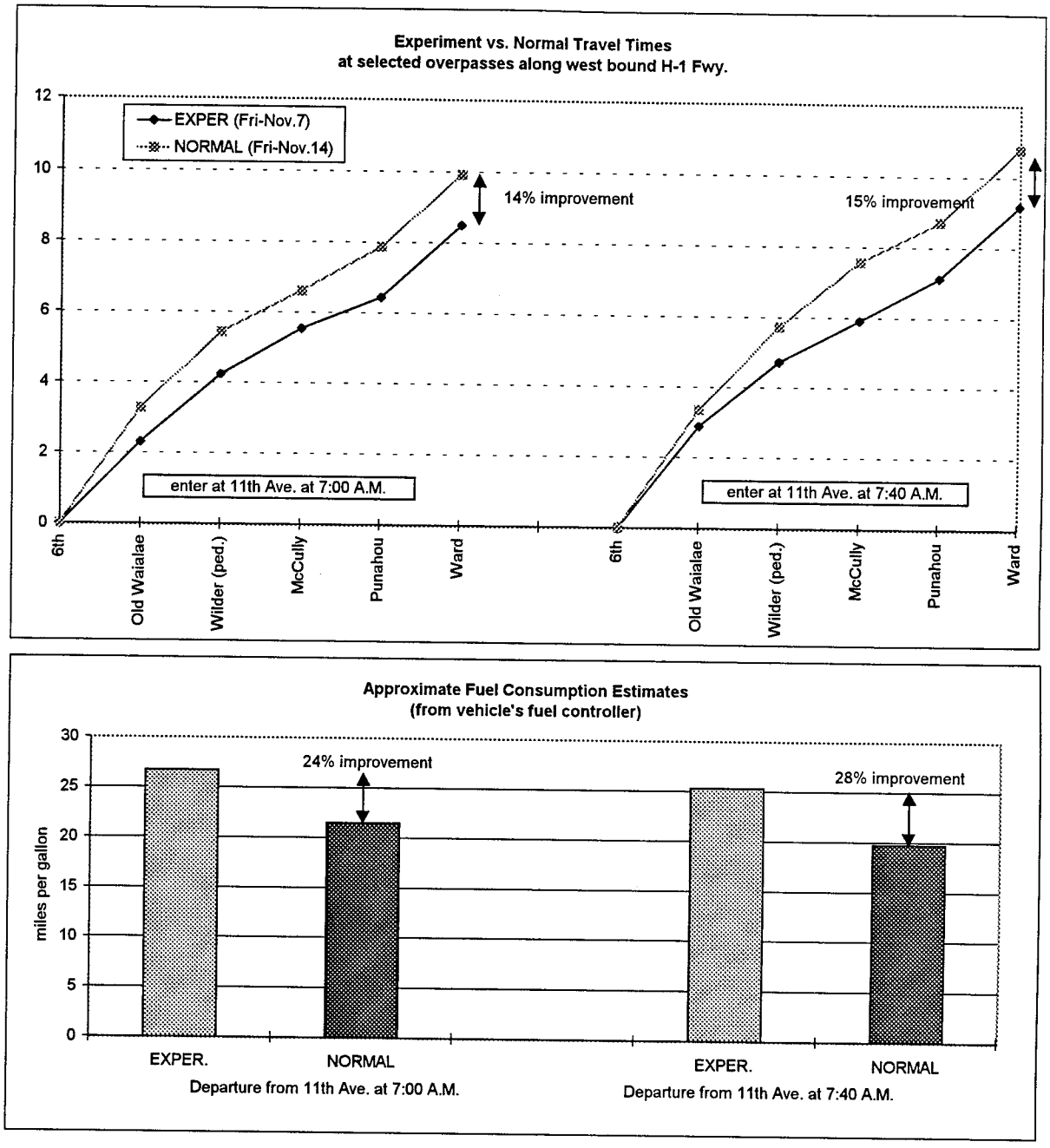


FIGURE 4.4. Travel time and fuel consumption comparisons between the last day (Friday, Nov. 7, 1997) of the Lunalilo St. on-ramp closure experiment, and the following Friday, Nov. 14 with normal flow.

Note: Friday, Nov. 7 at 7:12 A.M., stalled vehicle on right shoulder about 300 ft. from beginning of coning; also at the same time, displaced cone between the left and middle lanes of the freeway at about 200 ft. past the beginning of the coning.

improvement in travel time was recorded at both 7:00 and 7:40 A.M. in the field during the last day of the experiment. The pre-experiment simulation (with 1996 data) had predicted an 8% and 16% improvement in travel times for 7:00 and 7:30 A.M., respectively.

A considerable concomitant improvement to the fuel efficiency as reported by the vehicle's trip computer (which was zeroed before each run[7]) also was observed. Fuel efficiency in miles per gallon (mpg) for the two runs shown improved as follows:

7:00 A.M.:	from	21.5 mpg	to	26.7 mpg
7:40 A.M.:	from	19.8 mpg	to	25.3 mpg

This closure, therefore, has the potential to reduce travel time by 15% and improve travel time consistency. A 15% reduction in travel time corresponds to a 2 minute reduction from a 15 minute freeway trip. The travel time data indicate that motorists on the closed Lunalilo St. on-ramp did not suffer delays longer than 2 minutes. NCHRP 431[8] states that the cost of shifting 1 minute from uncongested to congested travel, for a 15 minute trip, is $0.52. Thus, the closure of this ramp has the potential of travel time savings valued at about $10,500.[9] The same report includes valuations of travel time reliability. For example, for work trips, the value of reliability is as follows:

Higher Income Motorists	$0.26 per minute of standard deviation
Lower Income Motorists	$0.22 per minute of standard deviation

Table 4.11 indicates that the experiment (despite the occurrence of several incidents) reduced the standard deviation by average travel time by 0.2 minutes. This adds another $600 to the value of the experiment, bringing the total value of daily savings

[7] Over 4,000 miles, the error between the vehicle's trip computer and the actual gallons of fuel put at the pump was less than 1.2%.
[8] Small, K.A. et al., VALUATION OF TRAVEL TIME SAVINGS AND PREDICTABILITY IN CONGESTED CONDITIONS FOR HIGHWAY USER-COST ESTIMATION, NCHRP Report 421, Transportation Research Board, Washington, D.C., 1999.
[9] About $12,500 saved on freeway travel (in two hours, when congestion is at its worst) minus the losses from the roughly 1,200 Lunalilo St. on-ramp motorists who may experience up to 2 minutes of delay.

to about $11,000. This estimate excludes gains in fuel consumption and emissions, which, based on the sampled fuel efficiency data showed above could be substantial.

4.6 MOTORISTS PERCEPTIONS: RAMP SURVEY ANALYSIS

People's perception (that is, their quantitative or qualitative estimation) of a property or characteristic is often more important than its true magnitude. For example, surveys for the Chicago Transit Authority revealed that the majority of the traveling public perceived that trips with the *L* (Chicago's metro rail) from northern suburbs to downtown were "about an hour" long, whereas their true peak period duration was consistently shorter than 35 minutes. Such a disparity was observed for this project, but it was the opposite to CTA's experience. Although the actual results were mixed, the motorists responses were clearly positive, as described in this section.

The perceptions of motorists where measured with a questionnaire survey distributed at most on-ramps in the corridor a week after the experiment ended. The characteristics of the questionnaire survey are detailed in Table 4.14. The survey instruments (one for the closed-on ramp and one for all other on-ramps) are shown in Figures 4.5 and 4.6 along with summarized responses.

The overall response rate of 26% (Table 4.14) is considered good given the absence of reminders and incentives, and the distribution to drivers in queues (as opposed to receiving the questionnaire at the convenience of their home). The Lunalilo St. on-ramp motorists comprise 20% of the 1,403 responses. Table 4.15 shows that two separate surveys on the destination of motorists using the Lunalilo St. on-ramp produced comparable results. The data collected in February 1997 were used in the analyses supporting the experimental closure of this on-ramp.

The percentile responses to the question *what do you think about weekday morning coning of the Lunalilo St. on-ramp?* shown at the bottom of Figures 4.5 and 4.6 can be summarized as follows:

TABLE 4.14. POST CLOSURE SURVEY CHARACTERISTICS

Location	Person	Intersection	Design Target	Actual Distributed	Responses Received	Response Rate
1	1	Lunalilo/Pensacola	600	1370	285	20.8%
	2	Lunalilo/Pensacola	400			
	3	Lunalilo/Piikoi	500			
2	4	Punahou/Dole	300	500	179	35.8%
	5	Punahou/Dole	500			
3	6	Alexander/Dole	600	720	189	26.3%
	7	Alexander/Dole	200			
4	8	5TH Ave/Harding	350	710	137	19.3%
	9	5TH Ave/Harding	250			
	10	5TH Ave/Harding	150			
5	11	11TH Ave/Harding	450	700	134	19.1%
	12	11TH Ave/Harding	150			
	13	11TH Ave/Harding	150			
6	14	Kalanianaole/Aina Koa	450	1400	479	34.2%
	15	Kalanianaole/Aina Koa	150			
	16	Kalanianaole/Aina Koa	800			
			6000	5400	1403	26.0%

TABLE 4.15. DESTINATIONS OF WB LUNALILO ST. ON-RAMP MOTORISTS

(Results from Independent Surveys)

	question-naire survey	motorist interviews
	(November '97)	(February '97)
VINEYARD	20%	21%
PALI	7%	12%
SCHOOL	4%	5%
PALAMA	1%	3%
HOUGHT'G	12%	8%
LIKELIKE	4%	5%
OTHER	53%	46%
observations	285	295

Motorists	VERY GOOD	GOOD	NEUTRAL	BAD	VERY BAD
Lunalilo St.	13.0	11.6	23.2	24.9	27.3
H-1 Fwy.	28.9	22.0	39.1	7.0	3.0

A majority of 51% of the freeway motorists found the experiment good or very good; only 10% of freeway motorists found the experiment bad or very bad. On the other hand, 52% of the Lunalilo St. on-ramp motorists found the experiment bad or very bad, but it is surprising that more than 25% of these motorists found the closure good or very good. Overall, these results are considered outstanding.

Figures 4.5 and 4.6 summarize the actual response counts. The results from extensive statistical analyses are included in Appendices D1 and D2 which contain the statistical output from each of the two questionnaires. A number of detailed analyses of the post-closure surveys are presented in Appendix D3 and are summarized below. Also, 72 questionnaires contained unsolicited written comments. These were copied verbatim and were included in Appendix D4. Of the 72 questionnaires, 44 (or 61%) contained positive comments.

- Punahou St. on-ramp motorists were most pleased (3.9/5.0 rating) with the results and thought that travel times had shortened.
- Most other on-ramp motorists were pleased (3.6/5.0) with the results.
- About 15% of the motorists may have rated the experiment well (*good* or *very good*) because they thought it was safer due to the elimination of aggressive merging by the Lunalilo St. on-ramp. The premise, hypothesized by Meller, was that there may be motorists who rated the experiment well although they perceived that travel times had worsened. A count revealed 66 out of 437 motorists who exited at or past the closure gave a good rating for the closure but perceived that speeds were slower.

Place Distributed	107 Piikoi	103 Luna.	75 Pensa.	No Information (NI) = 2		
Time Distributed:	25 6:30+	62 7:00+	71 7:30+	29 8:00+	55 8:30+	26 9:00+

NI = 17

Please respond only once to this

1 Shortly after you were handed this survey, **did you drive onto the west bound** (Ewa-bound) **H-1 Freeway?**

NO → Please discard this survey.

YES → Please continue.

2 After you were handed this survey and drove onto the westbound H-1 Freeway, **which Freeway exit did you take?** (please check one exit)

- [57] Vineyard Blvd. exit
- [20] Pali Highway exit
- [11] School St. exit
- [2] Palama St. exit
- [33] Houghtailing St. exit
- [12] Likelike Hwy. exit
- [150] other exit

3 Last week, **did you change the time you began driving on weekday mornings because of traffic cones on the Lunalilo St. on-ramp to the Freeway?** (please check one answer)

- [186] no, not much change
- [6] don't know
- [73] yes, usually started trip earlier
- [16] yes, usually started trip later

NI = 4

4 Last week, **did you notice any change in your travel time** on weekday mornings? (please check one answer)

- [33] a little faster
- [17] a lot faster
- [47] same as usual
- [110] a little slower
- [63] a lot slower
- [13] don't know

NI = 2

5 Last week, **did you drive onto the westbound Lunalilo Street on-ramp to the H-1 Freeway while traffic cones routed traffic to Vineyard Boulevard?** (please check one answer)

- [1] no, not even once
- [16] on 1 morning
- [88] on 2 or 3 mornings
- [180] or 4 or more mornings

6 If you normally use the westbound Lunalilo St. on-ramp to the H-1 Freeway, and last week you decided not to use this ramp because of the traffic cones, **which route did you take?** (please check all applicable answers)

multiple responses allowed

- [31] got on Freeway at Punahou
- [25] drove west on Beretania St.
- [28] drove on Auwaiolimu, Prospect or Thurston
- [8] got on Freeway at Alexander
- [7] drove west on Kapiolani Blvd.
- [4] other: Ala Moana/Nimitz (please specify)

7 **What do you think about weekday morning coning of the Lunalilo St. on-ramp?** (please check one answer)

- [37] VERY GOOD
- [33] GOOD
- [66] NEUTRAL
- [71] BAD
- [78] VERY BAD

FIGURE 4.5. Summary of surveys distributed to Lunalilo St. on-ramp motorists.

Place Distributed NI = 2	Puna. 179	Alex. 189	5th 137	11th 134	A.Koa 169	Kal. 210
Time Distributed NI = 15	6:30- 171	7:00- 304	7:30- 237	8:00- 191	8:30- 111	9:00+ 91

Please respond only once to this

1 Shortly after you were handed this survey, **did you drive onto the west bound** (Ewa-bound) **H-1 Freeway?**

NO → Please discard this survey.

YES → Please continue.

2 After you were handed this survey and drove onto the westbound H-1 Freeway, **which Freeway exit did you take?** (please check one exit)

138	Kapiolani Blvd. exit	69	Lunalilo St. exit	13	Palama St. exit
48	King St. exit	268	Vineyard Blvd. exit	74	Houghtailing St. exit
30	University Ave. exit	67	Pali Highway exit	20	Likelike Highway exit
77	Wilder Ave. exit	41	School St. exit	273	other exit

NI = 2

3 Last week, **did you change the time you began driving on weekday mornings because of traffic cones on the Lunalilo St. on-ramp to the Freeway?** (please check one answer)

958	no, not much change	50	yes, usually started trip earlier
63	don't know	44	yes, usually started trip later

NI = 5

4 Last week, **did you notice any change in your travel time** on weekday mornings? (please check one answer)

369	a little faster	134	a little slower
116	a lot faster	61	a lot slower
360	same as usual	76	don't know

NI = 4

4	Nehoa/Prospect/School
2	Ala Moana/Nimitz
7	Pahoa/Harding/Kilauea

5 Last week, **did you drive a different route on weekday mornings because you thought that the Freeway was more congested than usual?** (please check one answer)

1003	no change in usual route (please go to question 7)	59	2 or 3 mornings
38	different route 1 morning	11	4 or more mornings

NI = 9

6 If you took a different route, **which streets did you use?** (please check all applicable answers)

multiple responses allowed

29	Waialae Ave.	40	King or Beretania St.	13	other (please specify):
26	Kapiolani Blvd.	20	Wilder or Dole St.		

7 **What do you think about weekday morning coning of the Lunalilo St. on-ramp?** (please check one answer)

317	VERY GOOD	242	GOOD	429	NEUTRAL	76	BAD	33	VERY BAD

NI = 23

FIGURE 4.6. Summary of surveys distributed to west bound H-1 Freeway motorists.

- Analysis of variance between a number of independent variables and the respondents' rating for the experiment revealed the *perceived travel speed change* is highly significant and it alone explains more than 49% of the variance. Second most important factor was *whether the respondent exited at or drove past the site* which alone explained 7% of the variance. Both findings are analyzed below.

Figure 4.7a shows that motorists who exited at the site, past the site, or at the immediate neighborhood of the site thought that travel speeds were faster. Motorists who exited well before the site, thought that travel speeds were slower. Figure 4.7b is similar but the distance is expressed from the point (upstream of the site) where the respondent received the questionnaire. Indeed, the further away from the site, the lesser the perceived benefit. This is consistent with reality since there are several secondary bottlenecks upstream of the closed ramp. The largest gains in speed are reported by those entering the freeway at the Punahou St. on-ramp. These results are statistically significant given that pairwise t-tests of the responses indicate that:

- Motorists who exited at or past the site rated the experiment significantly higher than those who exited before the site (t=8.57, 99.9%).
- Motorists who exited at or past the site perceived significantly higher travel speeds than those who exited before the site (t=9.57, 99.9%).
- Motorists who exited at or past the site rerouted significantly less because of perceived congestion than those who exited before the site (t=4.10, 99.9%).

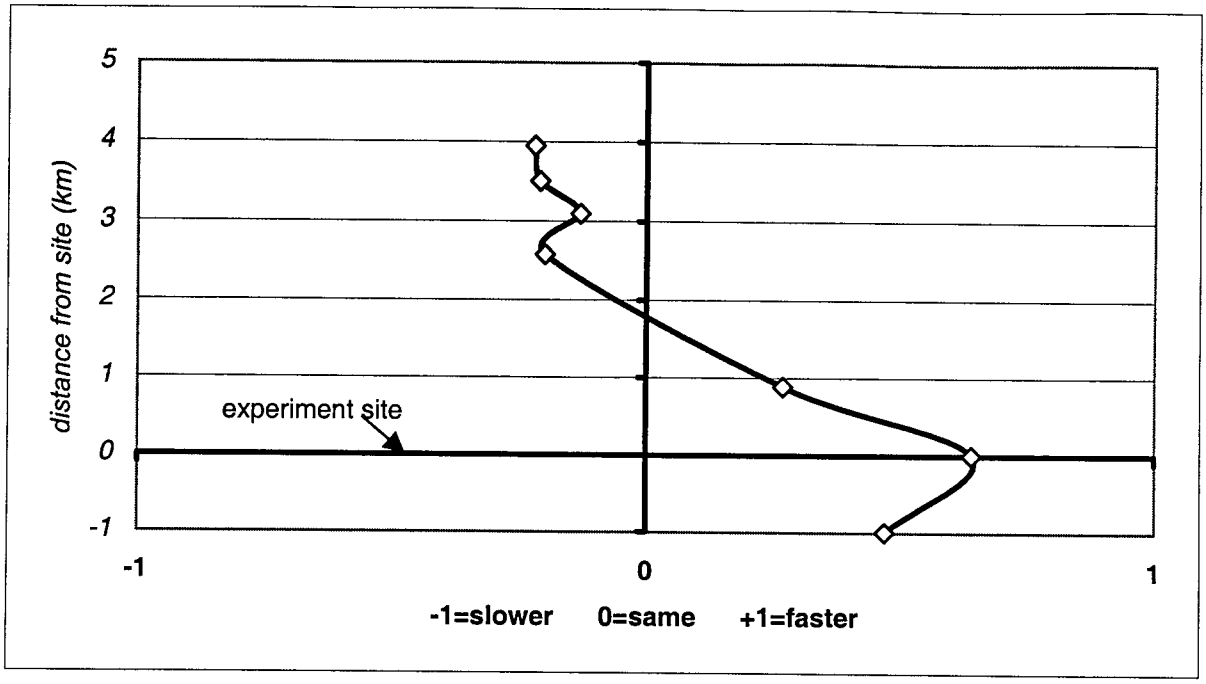


FIGURE 4.7a. Perception of speed gains vis-à-vis distance of exit point from site.

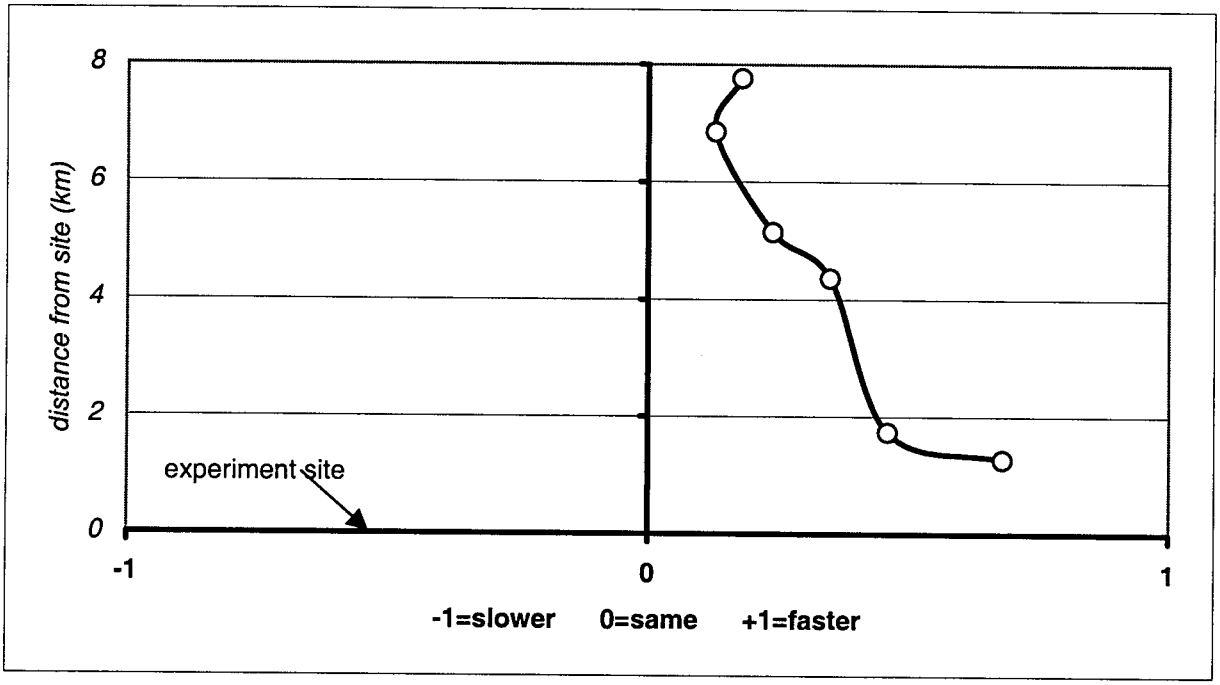


FIGURE 4.7b. Perception of speed gains vis-à-vis distance of survey pick up point from site.

CHAPTER FIVE: SUMMARY AND POST-EXPERIMENT RECOMMENDATIONS

5.1 SUMMARY

Computer simulation analyses of west bound H-1 Freeway flow conditions based on 1996 data indicated that the Lunalilo St. on-ramp is a primary bottleneck along the freeway during the morning peak period. This is so because the heavy in-flow of the Lunalilo St. on-ramp conflicts with the heavy out-flow of the Vineyard Blvd. off-ramp. The combination generates an acutely problematic weaving situation during peak periods.

Simulation showed that morning closure of the Lunalilo St. on ramp would result in substantial travel time savings for the west bound freeway section between Koko Head Ave. and Ward Ave. The local geometry enables the rerouting of Lunalilo St. on ramp traffic onto Vineyard Blvd. without entering the freeway. About 20% of Lunalilo St. on-ramp motorists typically exit at the Vineyard Blvd. off-ramp. Once on Vineyard Blvd., Lunalilo St. motorists can re-enter the freeway via the west bound Punchbowl St., School St. and Vineyard Blvd. on-ramps. Street-level analysis showed that the rerouted traffic can be handled by Vineyard Blvd.

Based on these findings, the HDOT and FHWA approved a short-term closure, with traffic cones, for two consecutive weeks from late October to early November in 1997. A suite of independent measures were conducted to evaluate the experiment. They can be summarized as follows.

MEASURE	RESULT
In-traffic Travel Times	Slightly Positive
Traffic Volumes, Manual and from Meters	Some Negative, Most Insignificant
AUTOSCOPE Speeds	Negative, Promising
Simulation Runs with Experiment Data	Promising
Motorists' Perception Survey	Positive

Overall, results showed strong promise for long-term benefit. Speed dropped in the vicinity of the traffic cones, then gradually increased through the end of the experiment. By the last (10^{th}) day of the experiment, peak morning travel time on west bound H-1 Freeway between 6^{th} Ave. and Ward Ave. was 15% faster than normal. Based on NCHRP 431 and actual statistics collected during this experimental closure, travel time savings and a reduction in travel time variation valued at $11,000 can be achieved on typical week days. This amount is a conservative estimate: It accounts for the losses of rerouted traffic but excludes savings in fuel consumption and pollution.

A week after the experiment was completed, surveys were distributed to motorists at upstream on-ramps. The majority of the 1,120 respondents wanted the morning coning to continue and relatively few disliked the experiment. Equal attention was given to the impacts on motorists using the Lunalilo St. on-ramp. Although it was assumed that most users of the Lunalilo St. on-ramp would dislike the experiment, about ¼ liked the morning coning and ¼ were neutral. As anticipated, the normal freeway-bound queue on Piikoi and Lunalilo Sts. was replaced with queuing on the Vineyard Blvd. off-ramp. Travel time increased for drivers rerouted to the Vineyard Blvd. on-ramp. However, the closure reduced travel time for reaching the Lunalilo St. on-ramp and did not significantly increase travel time for those rerouted to the Punchbowl St. on-ramp.

During the brief (10 days) period of the experiment, better results could not be achieved given the presence of:

- cones, hesitant motorists and "rubbernecking"
- breaches of coning and the fact that cones spilled across the freeway daily
- variable message signs, police and cone truck, and
- brief but systematic overflow of the west bound Vineyard Blvd. off-ramp.

The experimental Lunalilo St. on-ramp closure could not offer the simulated benefits because it did not become a "normal" traffic phenomenon, which is what the simulations represented. Six incidents during the experiment also had a negative effect on the outcomes.

5.2 LESSONS LEARNED

- Experimenting with on-ramp closure on a major interstate-class freeway is:
    - doable
    - safe
    - affordable
    - a likely "winner" for the HDOT[1]

- Short-term real-world experimentation cannot achieve simulated results because equilibrium and normal driving conditions cannot be achieved within a few weeks.

- Careful simulation can reveal likely traffic outcomes from modifications.

- Large organizations such as HDOT and HDTS can cooperate successfully.

- Several immediate and low-cost operational changes must occur on the central part of the H-1 Freeway which offers very poor level of service for about four hours every weekday.

The coning subcontractor's impressions about the experimental closure of the Lunalilo St. on-ramp is presented in Figure 5.1. Clearly, the closure cannot succeed if (1) traffic cones are used, and (2) enforcement is not conspicuous. Most alternatives are also problematic:

- The weaving problem at this location theoretically might be solved by reconstructing the on-and off-ramp so that the on-ramp merges with the freeway at a point past the Vineyard Blvd. off-ramp. Another alternative would be to relocate the beginning of the Vineyard Blvd. off-ramp after the Lunalilo St. off-ramp (e.g., with a parallel

[1] The motorist survey revealed that even when the results are mixed or mediocre, the effort by the HDOT to improve the level of service is appreciated by the majority of the motorists.

SUN Industries Inc. Lic. ABC-10998

August 31, 1998

Mr. Doug Meller
State of Hawaii
Department of Transportation--Planning
600 Kapiolani Boulevard--Room 304
Honolulu, Hawaii 96813

Re: H-1 Lunalilo Experimental Coning

Dear Mr. Meller;

Sun Industries was involved in the Experimental Coning of H-1 Lunalilo On Ramp in November-December 1997. At your request we are submitting our comments on the project.

1. Traffic continously "broke thru" the 28" cones at various locations all along the string of 240 cones. We believe this was primaraly due to former habits of being able to access H-1 via Lunalilo for so many prior years.

2. The stationing of Police Officers was critical in reducing the break throughs, especially at the H-1/Lunalilo gore and the Vineyard off ramp gore.

3. Speed of traffic on H-1 seemed to improve with no back-ups in the immediate area.

4. Traffic backed-up on the Vineyard off ramp due to traffic lights at Punchbowl/Vineyard not being in sequence to handle the heavy left turn at Punchbowl.

5. Use of 42" delineators in lieu of cones would take too long to deploy and pick-up under existing conditions.

6. Our deployment of 28" traffic cones at rate of 8 MPH (standard speed) created traffic build-up behind our vehicle due to motorist being in such a rush.

Should you have any questions regarding this letter, please contact me at your convenience.

Sincerely;

Tom L. Hamm
Traffic Services

660 Mapunapuna Street • Honolulu, Hawaii 96819 • Tel: (808) 833-2502 • Fax: (808) 834-5630
Metal Framing & Building Systems: (808) 836-1751 • Rental & Traffic Control Services: (808) 841-2022

FIGURE 5.2. Feedback from coning subcontractor.

viaduct over Lunalilo St.), which is raised to meet the existing Vineyard Blvd. off-ramp alignment at its highest point. Both options are problematic in terms of constructability, right of way, adherence to freeway design standards, and aesthetics.

- Permanent closure of access to the freeway with a concrete barrier is likely to generate strong opposition from the densely populated Makiki and Ala Moana neighborhoods and negate efforts to manage this problematic on-ramp. Additional difficulties associated with this action are listed below.

- Closure of the on-ramp between 4:00 and 6:00 P.M. is difficult due to capacity problems on west bound Vineyard Blvd. and on the west bound on-ramps available to diverted traffic. Several additional actions such as construction of a two-lane on-ramp at the west end of Vineyard Blvd. and west bound signal progression are prerequisites to a peak afternoon or around-the-clock closure.

- Temporary closure with 28" traffic cones or 42" delineators placed in in-pavement bases is expensive and creates undesirable impedance to motorists.[2] Experience from the experiment suggests that closure with the placement of some type of physical divider (cone, delineator or barrier) will be counter-productive if it is placed close to freeway traffic.

- Moveable barrier closure with a light-duty "Zipmobile" is possible but: (1) capital and operating cost is high; and, (2) present Zipmobile technology "zips" a barrier from A to B and "unzips" it from B to A. Zipping the moveable barrier from a staging area on Lunalilo St. to Vineyard Blvd. would be acceptable; the few on-ramp motorists at 5 A.M. will have to follow the Zipmobile at 5 mph for about 10 minutes. However, unzipping the barrier from Vineyard Blvd. to Lunalilo St. would require the closure of the Lunalilo St. on-ramp for about 15 minutes at 9:30 A.M. This arrangement would be unacceptable. Long queues are likely to develop and they

[2] Delineators offer the advantage of secure placement. They bend and return to their original shape. However, they require more time than cones for placement and removal. Specifically, Safe-Hit posts require about 5.5 seconds for placement into twist lock bases

could have a heavy impact on freeway flow once they are released. Additional traffic control devices would also be required for the safe closure of the ramp.

5.3 RECOMMENDATIONS FOR LONG-TERM DEPLOYMENT

An inexpensive process for managing freeway access from the west bound Lunalilo St. on-ramp could be based on traffic signs, pavement markings and automated enforcement with mailed traffic citations. Specifically, an overhead freeway sign is proposed for the Lunalilo St. on-ramp, as shown in Figure 5.2. The sign would be placed about 250 ft. prior to the gore of the on-ramp and the freeway. The sign could either be an LED-technology variable message sign (VMS), or a simpler VMS with the typical three (3) motorized segments which rotate at 120° intervals. The segment flipping mechanism or electronic VMS activation can be either pretimed or remotely controlled.

The sign would operate in two states; one that prohibits merging onto the freeway and another that is identical to present time conditions. State (1) in Figure 5.2 prohibits merging onto the freeway between the times of, for example, 6:00 and 9:30 in the morning and between the times of 2:30 and 4:00 in the afternoon. State (2) in Figure 5.2 is the *status quo* and, under the proposed plan, it remains in effect for nineteen hours every weekday and throughout the weekend. In this way, the "closure" of this ramp is temporary and limited. Appropriate warning signs should be placed on all streets leading to the on-ramp. The purpose of the signs would be to inform motorists about the prohibition of merging onto the freeway and the presence of automated enforcement.

This system could be modified to become an autonomous intelligent ramp management (AIRM) system which detects the speed on the right lane of the west bound H-1 Freeway about 500 ft. upstream the Lunalilo St. on-ramp and automatically activates the merging prohibition once a specified threshold and persistence are exceeded (e.g., speed below 35 mph for more than 30 seconds with a sampling rate of 10 sec. or less).

(assuming that the bases remain free of obstructions and excluding the time for going from one base to the next), which makes their use on a 1,000 ft. stretch time consuming and potentially hazardous.

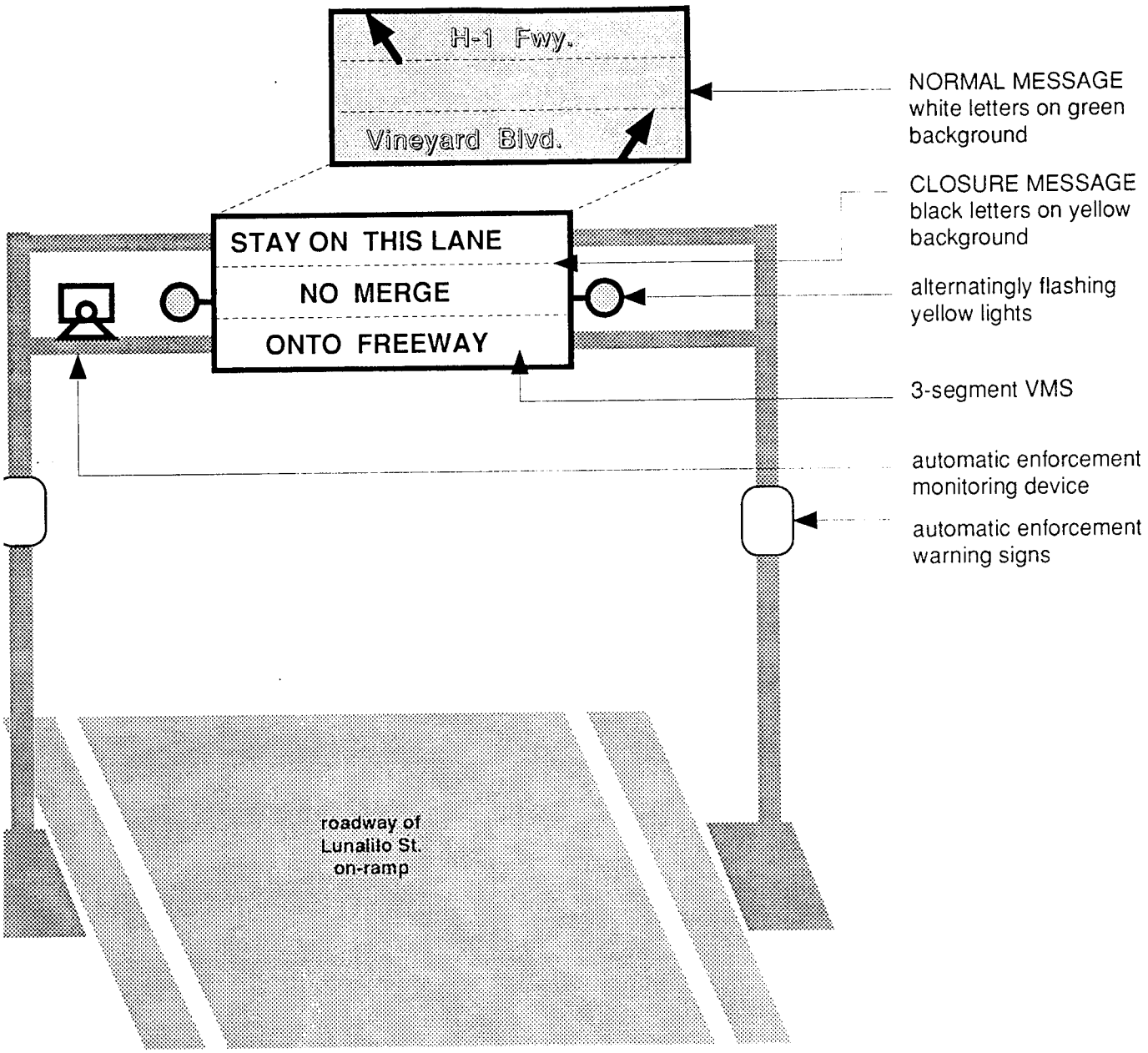


FIGURE 5.2. Ramp closure with signs and automated enforcement.

More analysis is needed because AIRM may cause prolonged or unpredictable prohibitions on freeway access that may anger ramp users and/or lead to a high rate of violations.

Non-intrusive closure and automated enforcement are the two major elements necessary for the successful deployment of a long-term closure. Automated enforcement requires (1) a law that permits automated enforcement of lane changing, and (2) a suitable automated enforcement apparatus.

Non-intrusive closure basically consists of the request to the motorists to *not merge onto the freeway*. This is communicated by sign(s) similar to the one in Figure 5.2. In addition, the line that on-ramp motorists must not cross could be highlighted in a custom color and/or pattern (e.g., a blue dotted line). A more desirable alternative would be the use of lighted lane markings that would be turned on when the "closure" is in effect and would be turned off when access to the freeway is open. For example, lights installed every 10 to 30 ft. (possibly flashing in random order) would guide Lunalilo St. motorists to the right lane of the Vineyard Blvd. off-ramp. The same lights would guide freeway motorists to the left lane of the Vineyard Blvd. off-ramp for exiting the freeway.

A potentially suitable device for delineating the proper path for on-ramp motorists when the "closure" is in effect is the LEDLine™ System which is used to delineate lanes at highways and airports. The demonstration of a foot-long segment under Hawaii's sun was disappointing. The intensity of the LEDs was too weak for day-time use under clear conditions. Another potentially suitable device is the LightGuard™ System in-pavement signal head which also is based on LED technology (`www.crosswalks.com`). It has been devised for alerting drivers about pedestrian crossings. A local demonstration of a sample device under Hawaii's sun was encouraging. The flashing light remained visible for several hundred feet even when the sun light shone directly on the device's "window." The LightGuard devices are not expected to be a hindrance to weaving traffic because their housing is only ½" above the pavement surface. Although the devices are manufactured to withstand traffic and slow plows, their long term reliability in a freeway

environment has not been tested. The application of lighted guides requires installation and electrification.

Enforcement of traffic law is performed by police handing over citations to violators. A Hawaii Law introduced in 1998 allowed automated enforcement only for the purpose of red-light violation and speeding. This law also enables issuance of citations by mail. Automated enforcement for this the Lunalilo St. on-ramp "closure" requires a new law that permits automated enforcement of lane changing. Both Project Manager Meller and Investigator Prevedouros testified several times during the 1999 Legislature in favor of a bill to authorize automated enforcement of longitudinal lane markings violations. HDOT and HPD also submitted supporting testimony. The bill became law in the form of Act 263, Session Laws of Hawaii, 1999 and is included in Appendix F.

Critical components of the enabling legislation include the following:

1. Enable technology-based automated enforcement.
2. Enable citation issuance by mail and define who is responsible for enforcement.
3. Provide that those responsible for enforcement have access to names and addresses corresponding to vehicle registration (license) numbers.
4. Provide that the captured images are *prima facie* evidence of a violation.
5. Provide that the registered owner is responsible for the citation unless another person accepts the responsibility.

Automated enforcement also requires a suitable computer-based apparatus. Traditional automated enforcement devices for speeding and red-light violations are not suitable for this purpose because:

- The technology for camera-based enforcement of speed or red light violations does not seem to be (affordably) modifiable to lane changing enforcement over a 1,000 ft. stretch of freeway.
- Computer-based image recognition systems may have difficulty in enforcing lane changing from right to left, but allowing lane changing from left to right. A highly sophisticated version of the machine vision code already available in Autoscope-type devices would be required (sideways vehicle tracking). This is not expected to work due to pervasive occlusion and real-world limitations (visibility, curvature along the alignment, drivers veer left or right with no intent for violation, etc.).
- This one-site application (with little apparent demand for other sites in Hawaii or the mainland) along with its limited application (e.g., up to 4 hours per work day) is not likely to attract any contractors willing to finance it and gain from a portion of the proceeds from violations.

On the other hand, two key ingredients of all these systems, *video imaging* and *automatic license recognition* are all that is needed for the development of an inexpensive custom apparatus for the application of automated enforcement at this location. The apparatus basically compares the license plates of vehicles at the beginning and at the end of the "closed" lane. These should match perfectly. If a vehicle that was recorded at the Lunalilo St. on-ramp is not found at the Vineyard Blvd. off-ramp, then, this vehicle violated the lane change prohibition and would be mailed a citation.

The proposed apparatus consists of the following elements:

(1) One or two surveillance cameras are aimed at the front (and/or rear) views of vehicles on the Lunalilo St. on-ramp, as shown in Figure 5.2. The cameras focus on the vehicle's license plate. For most vehicles, this also permits a full view of the front and/or rear of the vehicle.

(2) One or two surveillance cameras are aimed at the front (and/or) rear views of vehicles on the right lane at the beginning of the Vineyard Blvd. off-ramp where the lane-change prohibition is still in effect.

(3) A cable link that connects these cameras to a computer housed in an protected enclosure at the site or at a remote location.[3]

(4) Off-the-shelf software that performs license plate recognition of the vehicles on the on-ramp and those on the off-ramp.

(5) A custom software subroutine that compares on-ramp and off-ramp license plates and identifies those vehicles which did not appear at the off-ramp. These are violators. The software also stores the applicable video segments to be used as proof should the citation be contested.

(6) An off-the-shelf automated ticket-by-mail issuance of citation based on DMV records. This could be the same as those used for automatically captured red-light running and speeding violations. Act 263 gives authorized operators access to vehicle records of registration for the purpose of automated enforcement.

(7) Errors by the system are likely to be rare since it will function during three daylight hours. Contested citations can be checked manually by comparing the on-ramp and off-ramp video tapes (simultaneous, time-lagged comparison). **Warnings should be issued by mail in lieu of citations while the system is being fine-tuned.**

Will the "closure" work if there are many violators? Detroit engineers during the John C. Lodge Freeway ramp closures in the mid-1960s (see Volume 1 for details) observed the "sheep effect": when a car violated the prohibition, several more followed it onto the closed on-ramp. Despite warnings and automated enforcement, many violations may occur at the Lunalilo St. site, particularly in the first few months of implementation. KRONOS simulation showed that a violation rate of 25% during the 6 to 10 A.M. closure would be as effective as a complete ramp closure.[4] In other words, the west bound Lunalilo St. on-ramp ceases being a major bottleneck in the morning once its volume drops below 75% of the level recorded in 1996 and used in the simulations.

5.4 ADDITIONAL RECOMMENDATIONS

A long term experimental closure of the Lunalilo St. on-ramp is recommended for weekdays and between 6:00 and 9:30 A.M. It is also recommended that an early

[3] Existing HDTS fiber optic lines may be usable for this purpose.

[4] Given that 20% do not merge into the freeway, the effective violation rate is 31%.

afternoon "closure" between 2:00 and 3:30 P.M. is attempted on an experimental basis. The "closure" should be done without any intrusive devices on the pavement (such as cones, delineators or barriers) and without the physical presence of police. Instead, the closure should be effected with ample traffic warnings, automated enforcement and possibly guidance with in-pavement lights. The infrastructure proposed for this implementation can be characterized as "light" in both form and expenditure. This permits an application on a long-term experimental basis with the option of removal with minor disruption.

During the long term application, an effort should be made to record the effects of this "closure." At a minimum, HDTS cameras on Punahou St., Ward Ave. and at the intersection of Vineyard Blvd. with Punchbowl St. should be used for periodic video tapping. Analysis of volumes and speeds should be performed with the taped data. In addition, periodic drive-by inspections and travel time collection by a 2-person crew on one vehicle would be beneficial and instrumental in discovering any unintended consequences. Full records of violations captured by the enforcement systems should be analyzed after removing personal data. Problems with automated enforcement components (hardware and software) as well as with the lane guidance lights should be recorded so that application can be considered at other sites.

Three additional actions would nearly eliminate the delays caused to Lunalilo St. on-ramp motorists. They are:[5]

(1) Installation of exclusive left turn lane on south bound Punchbowl St. going into the Queen's Medical Center. This will reduce queues on Vineyard Blvd. and permit a more balanced use of the twin left turns. Presently, motorists tend to avoid the left of the two left turning lanes.

(2) Elimination of the east bound left turns from Vineyard Blvd. to Punchbowl St. when the Lunalilo St. on-ramp closure is in effect. This action would reroute fewer than 150 vehicles during the morning peak hour and would increase west bound Vineyard

[5] See Volume 1 for details.

Blvd. capacity by about 60% for left turns and more than 30% for through and right turns. Early afternoon closure of this lane also is desirable.

(3) Improvement of the geometry of the right turn from Vineyard Blvd. to north bound Punchbowl St. This was under consideration by the City in fall 1999 along with the option of adding two lanes to north bound Punchbowl St.[6]

[6] Volume 1 of this study proposes an underpass (Punchbowl St. going under Vineyard Blvd.) as a permanent solution to the traffic congestion problems at this critical intersection.

LIST OF APPENDICES

Appendix A: Manual Freeway and Ramp Counts from CCTV

EXHIBIT A.1. CAMERA OBSERVATIONS
West Bound H-1 Fwy. at Koko Head Ave.

	Wed. 10-1-97	Wed. 10-29-97	Wed. 11-5-97
TIME	NORMAL	EXPERIMENT	NORMAL
6:15:00	709	669	696
6:30:00	997	935	924
6:45:00	1377	1310	1248
7:00:00	1418	1401	1314
7:15:00	1287	1249	1177
7:30:00	1219	1098	1072
7:45:00	1129	1104	1101
8:00:00	1112	1125	1121
8:15:00	1123	1143	1140
8:30:00	941	959	1176
8:45:00	1007	903	883
9:00:00	878	908	972
9:15:00	700	740	774
9:30:00	748	764	718
9:45:00	723	703	701
10:00:00	686	718	702
TOTAL	16054	15729	15719
% based on max NORMAL flow	100	98	98

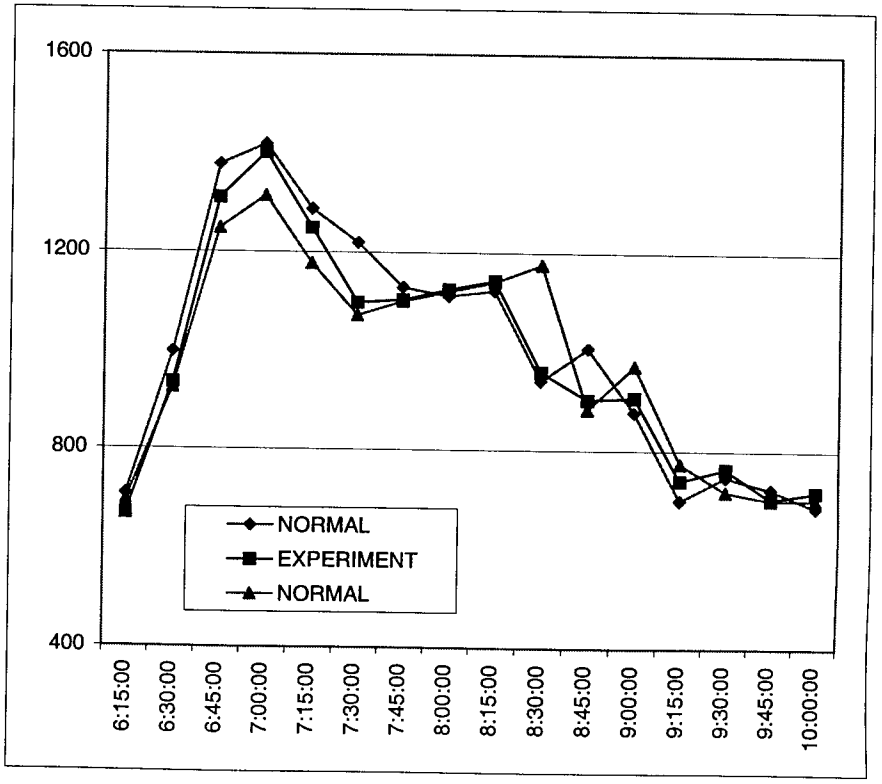


EXHIBIT A.2. CAMERA OBSERVATIONS
West Bound H-1 Fwy. at Old Waialae Ave.

	NORMAL			EXPERIMENT					
TIME	Monday 9/29/97	Wednes. 10/1/97	Thursday 10/2/97	Monday 10/27/97	Wednes. 10/29/97	Thursday 10/30/97	Monday 11/3/97	Wednes. 11/5/97	Thursday 11/6/97
6:15:00	760	777	783		741	752		800	
6:30:00	1145	1186	1105		1118	1058		1057	
6:45:00	1268	1224	1226		1237	1203		1128	
7:00:00	1169	1089	1183		1132	1172		967	
7:15:00	1104	1154	1121		1087	1019		1033	
7:30:00	1036	1040	1038		935	1107		970	
7:45:00	914	907	953		949	898		978	
8:00:00	936	939	963		914	983		958	
8:15:00	968	856	868		929	852		868	
8:30:00	934	989	898		980	1019		992	
8:45:00	895	926	961		845	971		1022	
9:00:00	931	995	1015		950	962		956	
9:15:00	818	842	826		856	750		881	
9:30:00	786	811	751		840	795		812	
9:45:00	766	748	759		801	723		786	
10:00:00	679	791	737		762	745		765	
TOTAL	15109	15274	15187	N.A.	15076	15009	N.A.	14973	N.A.
% based on max NORMAL flow	99	100	99	-	99	98	-	98	-

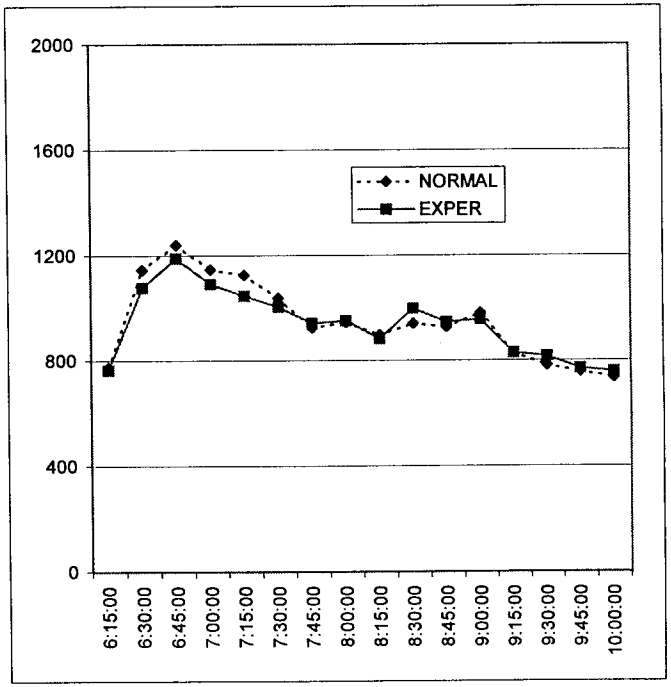


EXHIBIT A.3. CAMERA OBSERVATIONS: West Bound Old Waialae Ave. On-ramp

	NORMAL			
TIME	Monday 9/29/97	Tuesday 9/30/97	Wednes. 10/1/97	Thursday 10/2/97
6:15:00	195	218	203	212
6:30:00	260	259	277	217
6:45:00	303	276	298	295
7:00:00	221	220	224	229
7:15:00	211	202	225	208
7:30:00	216	178	216	219
7:45:00	206	190	190	200
8:00:00	204	190	216	210
8:15:00	220	194	199	195
8:30:00	216	230	233	264
8:45:00	259	255	270	282
9:00:00	282	284	279	297
9:15:00	318	293	279	262
9:30:00	301	286	317	258
9:45:00	299	262	327	302
10:00:00	294	313	251	274
TOTAL	4005	3850	4004	3924
% based on max NORMAL flow	100	96	100	98

EXPERIMENT							
Monday 10/27/97	Tuesday 10/28/97	Wednes. 10/29/97	Thursday 10/30/97	Monday 11/3/97	Tuesday 11/4/97	Wednes. 11/5/97	Thursday 11/6/97
202	217	211	197	209	204	227	224
240	238	263	273	236	252	227	238
287	292	273	303	283	278	283	275
217	225	215	217	232	233	207	210
204	216	225	245	203	208	210	206
195	210	194	228	201	172	199	200
197	204	195	188	202	202	203	192
196	204	197	213	210	216	204	217
214	209	210	203	176	210	201	201
208	224	225	216	213	226	220	239
267	259	265	296	256	241	269	258
272	318	286	280	264	303	302	258
308	286	292	266	274	290	291	318
301	275	339	301	252	281	289	290
292	268	280	298	269	288	277	276
253	267	240	316	269	276	274	267
3853	3912	3910	4040	3749	3880	3883	3869
96	98	98	101	94	97	97	97

EXHIBIT A.4. CAMERA OBSERVATIONS: West Bound H-1 Fwy. at Ward Ave.

	NORMAL				EXPERIMENT								NORMAL	
TIME	Monday 9/29/97	Tuesday 9/30/97	Wednes. 10/1/97	Thursday 10/2/97	Monday 10/27/97	Tuesday 10/28/97	Wednes. 10/29/97	Thursday 10/30/97	Monday 11/3/97	Tuesday 11/4/97	Wednes. 11/5/97	Thursday 11/6/97	Wednes. 11/19/97	Thursday 11/19/97
6:15:00	1156	978	1149	1132	1048	1154	1144	1098			1156	1051	1113	
6:30:00	1484	1453	1429	1498	1376	1556	1479	1409			1427	1496	1397	
6:45:00	1640	1503	1597	1545	1500	1579	1554	1654			1489	1575	1430	
7:00:00	1662	1331	1466	1457	1487	1538	1533	1537			1499	1508	1492	
7:15:00	1537	1496	1510	1398	1462	1499	1515	1530			1514	1444	1506	
7:30:00	1402	1474	1588	1322	1447	1536	1387	1439			1543	1454	1499	
7:45:00	1331	1436	1334	1388	1462	1454	1431	1427			1472	1447	1461	
8:00:00	1454	1352	1394	1339	1389	1401	1445	1428			1378	1464	1465	
8:15:00	1290	1294	1345	1150	1374	1292	1390	1437			1412	1378	1382	
8:30:00	1372	1394	1402	1073	1409	1424	1429	1398			1365	1456	1386	
8:45:00	1182	1284	1314	1058	1267	1368	1370	1434			1418	1405	1344	
9:00:00	1264	1123	1272	1046	1222	1244	1356	1267			1399	1163	1268	
9:15:00	963	1165	1149	1107	1126	1156	1186	1127			1224	1152	1150	
9:30:00	1096	1114	1190	1067	1080	1115	1196	1135			1152	1100	1204	
9:45:00	1276	1181	1259	1018	1152	1135	1192	1137			1237	1151	1195	
10:00:00	1066	1213	1202	950	1137	1137	1123	1150			1177	1077	1190	
TOTAL	**21175**	**20791**	**21600**	**19548**	**20938**	**21588**	**21730**	**21607**	**N.A.**	**N.A.**	**21862**	**21321**	**21482**	**N.A.**
% based on max NORMAL flow	**98**	**96**	**100**	**91**	**97**	**100**	**101**	**100**			**101**	**99**	**99**	

EXHIBIT A.5. CAMERA OBSERVATIONS: West Bound School St. On-ramp

	NORMAL				EXPERIMENT								NORMAL	
TIME	Monday 9/29/97	Tuesday 9/30/97	Wednes. 10/1/97	Thursday 10/2/97	Monday 10/27/97	Tuesday 10/28/97	Wednes. 10/29/97	Thursday 10/30/97	Monday 11/3/97	Tuesday 11/4/97	Wednes. 11/5/97	Thursday 11/6/97	Wednes. 11/19/97	Thursday 11/19/97
6:15:00	313	302	306	320	317	322			321		339		284	304
6:30:00	309	297	339	312	360	335			331		322		322	315
6:45:00	330	325	334	302	353	359			328		357		314	325
7:00:00	295	290	291	256	198	301			309		296		301	299
7:15:00	275	285	294	266	62	306			301		331		296	279
7:30:00	289	277	271	280	303	307			307		316		288	311
7:45:00	275	269	253	286	317	293			301		311		318	282
8:00:00	285	270	282	265	285	282			275		302		305	278
8:15:00	263	266	285	253	247	308			272		308		267	273
8:30:00	239	222	239	236	244	264			272		282		260	225
8:45:00	227	213	238	226	244	231			226		268		227	231
9:00:00	189	232	231	234	208	265			234		235		203	210
9:15:00	218	216	202	233	214	219			241		223		214	195
9:30:00	187	190	173	209	206	215			204		238		194	194
9:45:00	221	208	228	194	210	238			214		220		194	221
10:00:00	191	214	196	235	226	217			235		233		194	197
TOTAL	4106	4076	4162	4107	3994	4462	N.A.	N.A.	4371	N.A.	4581	N.A.	4181	4139
% based on max NORMAL flow	98	97	100	98	96	107	N.A.	N.A.	105	N.A.	110	N.A.	100	99

EXHIBIT A.6. CAMERA OBSERVATIONS: West Bound Vineyard at Punchbowl - All Lanes

	EXPERIMENT								NORMAL	
TIME	Monday 10/27/97	Tuesday 10/28/97	Wednes. 10/29/97	Thursday 10/30/97	Monday 11/3/97	Tuesday 11/4/97	Wednes. 11/5/97	Thursday 11/6/97	Wednes. 11/19/97	Thursday 11/19/97
6:15:00	334	359	337	326	332	347	320	338	205	229
6:30:00	417	423	420	429	475	455	519	439	284	282
6:45:00	607	560	526	546	565	548	539	585	349	378
7:00:00	559	551	607	551	545	542	561	546	366	341
7:15:00	648	**682**	662	653	632	619	602	608	416	423
7:30:00	**694**	651	635	594	596	617	662	610	396	426
7:45:00	668	**697**	663	670	**691**	645	610	623	420	405
8:00:00	**697**	641	**686**	**751**	**701**	636	675	**682**	435	423
8:15:00	658	641	587	608	614	656	**683**	635	435	**464**
8:30:00	658	655	661	665	677	677	659	612	**445**	**450**
8:45:00	**705**	**684**	670	666	658	673	653	614	**454**	**478**
9:00:00	632	641	643	596	613	605	586	590	**442**	413
9:15:00	620	639	665	660	678	632	645	596	432	400
9:30:00	564	538	521	551	556	531	535	519	311	315
9:45:00	611	596	600	609	586	606	615	595	345	351
TOTAL	**9072**	**8958**	**8883**	**8875**	**8919**	**8789**	**8864**	**8592**	**5735**	**5778**
% based on max NORMAL flow	**158**	**156**	**155**	**155**	**156**	**153**	**155**	**150**	**100**	**101**
7:45-8:45 peak (normal)	2718	2621	2604	2690	2650	2642	2670	2543	1769	1815
% based on max NORMAL flow	**150**	**144**	**143**	**148**	**146**	**146**	**147**	**140**	**97**	**100**

Appendix B: Volume Counts Comparisons

Comparisons of volumes collected by the following means, as applicable:

- manual counts from CCTV surveillance
- inductive loop meters
- pneumatic tube meters

TABLE B.1. COUNT COMPARISONS
WEST BOUND H-1 FREEWAY MAINLINE

TIME	TAPE (manual)	HDOT (composite)	% ERR	TAPE (manual)	HDOT (composite)	% ERR
	Wednesday 10/29/97			Wednesday 11/5/97		
6:15:00	669	628	-6.1%	696	663	-4.7%
6:30:00	935	938	0.3%	924	903	-2.3%
6:45:00	1310	1200	-8.4%	1248	1111	-11.0%
7:00:00	1401	1234	-11.9%	1314	1110	-15.5%
7:15:00	1249	1172	-6.2%	1177	1052	-10.6%
7:30:00	1098	1007	-8.3%	1072	1017	-5.1%
7:45:00	1104	1124	1.8%	1101	1005	-8.7%
8:00:00	1125	1163	3.4%	1121	1183	5.5%
8:15:00	1143	1243	8.7%	1140	1151	1.0%
8:30:00	959	1222	27.4%	1176	1251	6.4%
8:45:00	903	892	-1.2%	883	1130	28.0%
9:00:00	908	890	-2.0%	972	934	-3.9%
9:15:00	740	760	2.7%	774	805	4.0%
9:30:00	764	734	-3.9%	718	723	0.7%
9:45:00	703	716	1.8%	701	718	2.4%
10:00:00	718	691	-3.8%	702	688	-2.0%
6:00-10:00	**15729**	**15614**	**-0.7%**	**15719**	**15444**	**-1.7%**
6:45-7:45	**5058**	**4613**	**-8.8%**	**4811**	**4290**	**-10.8%**

Note: Freeway mainline counts were conducted by the Kapiolani Blvd. off-ramp, with loops. The composite flows were derived as shown below.

H-1 by KOKO HEAD	=	H-1 by KAPIOLANI (loops)
	+	KAPIOLANI off-ramp (loops)
	-	5TH AVE on-ramp (p. tube)
	-	11TH AVE on-ramp (p.tube)

TABLE B.2. COUNT COMPARISONS
WEST BOUND OLD WAIALAE AVE. ON-RAMP

	Pn. Tube						CCTV						ERROR					
TIME	Tuesday 10/28/97	Wednes. 10/29/97	Thursday 10/30/97	Tuesday 11/4/97	Wednes. 11/5/97	Thursday 11/6/97	Tuesday 10/28/97	Wednes. 10/29/97	Thursday 10/30/97	Tuesday 11/4/97	Wednes. 11/5/97	Thursday 11/6/97	Tuesday 10/28/97	Wednes. 10/29/97	Thursday 10/30/97	Tuesday 11/4/97	Wednes. 11/5/97	Thursday 11/6/97
6:15:00	220	223	204	217	228	235	217	211	197	204	227	224	1.4%	5.7%	3.6%	6.4%	0.4%	4.9%
6:30:00	251	267	277	248	243	238	238	263	273	252	227	238	5.5%	1.5%	1.5%	-1.6%	7.0%	0.0%
6:45:00	438	458	490	303	418	300	292	273	303	278	283	275	50.0%	67.8%	61.7%	9.0%	47.7%	9.1%
7:00:00	424	388	365	463	462	360	225	215	217	233	207	210	88.4%	80.5%	68.2%	98.7%	123.2%	71.4%
7:15:00	408	431	456	410	478	442	216	225	245	208	210	206	88.9%	91.6%	86.1%	97.1%	127.6%	114.6%
7:30:00	472	428	321	370	445	441	210	194	228	172	199	200	124.8%	120.6%	40.8%	115.1%	123.6%	120.5%
7:45:00	461	427	414	441	453	415	204	195	188	202	203	192	126.0%	119.0%	120.2%	118.3%	123.2%	116.1%
8:00:00	452	446	469	476	465	481	204	197	213	216	204	217	121.6%	126.4%	120.2%	120.4%	127.9%	121.7%
8:15:00	450	470	439	459	439	448	209	210	203	210	201	201	115.3%	123.8%	116.3%	118.6%	118.4%	122.9%
8:30:00	485	500	341	385	517	485	224	225	216	226	220	239	116.5%	122.2%	57.9%	70.4%	135.0%	102.9%
8:45:00	333	434	301	236	560	269	259	265	296	241	269	258	28.6%	63.8%	1.7%	-2.1%	108.2%	4.3%
9:00:00	345	306	281	314	302	262	318	286	280	303	302	258	8.5%	7.0%	0.4%	3.6%	0.0%	1.6%
9:15:00	282	297	268	289	296	335	286	292	266	290	291	318	-1.4%	1.7%	0.8%	-0.3%	1.7%	5.3%
9:30:00	291	343	312	292	294	295	275	339	301	281	289	290	5.8%	1.2%	3.7%	3.9%	1.7%	1.7%
9:45:00	276	282	306	293	283	278	268	280	298	288	277	276	3.0%	0.7%	2.7%	1.7%	2.2%	0.7%
10:00:00	265	240	309	287	262	277	267	240	316	276	274	267	-0.7%	0.0%	-2.2%	4.0%	-4.4%	3.7%
TOTAL	5853	5940	5553	5483	6145	5561	3912	3910	4040	3880	3883	3869	49.6%	51.9%	37.5%	41.3%	58.3%	43.7%

TABLE B.3. COUNT COMPARISONS
WEST BOUND PUNAHOU ST. ON-RAMP

	TAPE (manual)	HDOT (Pn.Tube)	% ERR
TIME	Tuesday 10/28/97		
6:15:00	122	122	0.0%
6:30:00	179	186	3.9%
6:45:00	181	188	3.9%
7:00:00	215	226	5.1%
7:15:00	240	270	12.5%
7:30:00	280	391	39.6%
7:45:00	265	296	11.7%
8:00:00	269	335	24.5%
8:15:00	208	285	37.0%
8:30:00	162	173	6.8%
8:45:00	124	139	12.1%
9:00:00	119	124	4.2%
9:15:00	122	149	22.1%
9:30:00	119	137	15.1%
9:45:00	98	106	8.2%
10:00:00	102	110	7.8%
6:00-10:00	**2805**	**3237**	**15.4%**
6:45-7:45	**916**	**1075**	**17.4%**

TABLE B.4. COUNT COMPARISONS
WEST BOUND CONED LANE (AUXILIARY)

	Loop on Vineyard off-ramp						Pneumatic tube on Lunalilo on-ramp					
TIME	Tuesday 10/28/97	Wednes. 10/29/97	Thursday 10/30/97	Tuesday 11/4/97	Wednes. 11/5/97	Thursday 11/6/97	Tuesday 10/28/97	Wednes. 10/29/97	Thursday 10/30/97	Tuesday 11/4/97	Wednes. 11/5/97	Thursday 11/6/97
6:15:00	177	152	142	150	146	155	178	152	146	154		169
6:30:00	173	182	198	201	197	183	179	190	199	204		202
6:45:00	233	231	233	244	241	232	236	235	234	249		235
7:00:00	266	265	244	249	246	268	268	277	247	253		261
7:15:00	306	291	295	276	263	283	314	294	312	282		306
7:30:00	358	344	278	339	336	313	369	356	324	354		312
7:45:00	336	315	335	312	351	310	367	326	345	366		354
8:00:00	305	307	319	277	304	325	401	333	368	353		313
8:15:00	289	281	301	304	306	250	337	318	319	340		242
8:30:00	239	287	246	233	284	242	259	303	255	222		249
8:45:00	261	269	248	259	237	245	273	279	253	269		253
9:00:00	253	254	270	241	239	267	258	272	274	250		268
9:15:00	261	273	274	254	256	262	270	281	288	263		270
9:30:00	280	269	253	247	275	242	288	284	252	266		266
9:45:00	280	289	255	289	299	299	290	308	273	294		311
TOTAL	4017	4009	3891	3875	3980	3876	4287	4208	4089	4119	N.A.	4011

	C C T V (manual counts)					
TIME	Tuesday 10/28/97	Wednes. 10/29/97	Thursday 10/30/97	Tuesday 11/4/97	Wednes. 11/5/97	Thursday 11/6/97
6:15:00	175	161	144	153	146	154
6:30:00	176	189	198	201	195	183
6:45:00	233	230	227	247	237	236
7:00:00	278	267	247	250	245	267
7:15:00	307	286	301	279	263	283
7:30:00	357	348	279	341	336	310
7:45:00	347	320	330	333	362	315
8:00:00	294	314	317	266	289	324
8:15:00	287	272	302	305	307	254
8:30:00	241	289	248	221	284	243
8:45:00	260	270	250	261	237	247
9:00:00	252	271	269	247	241	268
9:15:00	264	263	277	254	255	261
9:30:00	280	271	249	254	276	247
9:45:00	281	288	261	290	299	296
TOTAL	4032	4039	3899	3902	3972	3888

	Loop error						Pneumatic tube error					
TIME	Tuesday 10/28/97	Wednes. 10/29/97	Thursday 10/30/97	Tuesday 11/4/97	Wednes. 11/5/97	Thursday 11/6/97	Tuesday 10/28/97	Wednes. 10/29/97	Thursday 10/30/97	Tuesday 11/4/97	Wednes. 11/5/97	Thursday 11/6/97
6:15:00	1.1%	-5.6%	-1.4%	-2.0%	0.0%	0.6%	1.7%	-5.6%	1.4%	0.7%		9.7%
6:30:00	-1.7%	-3.7%	0.0%	0.0%	1.0%	0.0%	1.7%	0.5%	0.5%	1.5%		10.4%
6:45:00	0.0%	0.4%	2.6%	-1.2%	1.7%	-1.7%	1.3%	2.2%	3.1%	0.8%		-0.4%
7:00:00	-4.3%	-0.7%	-1.2%	-0.4%	0.4%	0.4%	-3.6%	3.7%	0.0%	1.2%		-2.2%
7:15:00	-0.3%	1.7%	-2.0%	-1.1%	0.0%	0.0%	2.3%	2.8%	3.7%	1.1%		8.1%
7:30:00	0.3%	-1.1%	-0.4%	-0.6%	0.0%	1.0%	3.4%	2.3%	16.1%	3.8%		0.6%
7:45:00	-3.2%	-1.6%	1.5%	-6.3%	-3.0%	-1.6%	5.8%	1.9%	4.5%	9.9%		12.4%
8:00:00	3.7%	-2.2%	0.6%	4.1%	5.2%	0.3%	36.4%	6.1%	16.1%	32.7%		-3.4%
8:15:00	0.7%	3.3%	-0.3%	-0.3%	-0.3%	-1.6%	17.4%	16.9%	5.6%	11.5%		-4.7%
8:30:00	-0.8%	-0.7%	-0.8%	5.4%	0.0%	-0.4%	7.5%	4.8%	2.8%	0.5%		2.5%
8:45:00	0.4%	-0.4%	-0.8%	-0.8%	0.0%	-0.8%	5.0%	3.3%	1.2%	3.1%		2.4%
9:00:00	0.4%	-6.3%	0.4%	-2.4%	-0.8%	-0.4%	2.4%	0.4%	1.9%	1.2%		0.0%
9:15:00	-1.1%	3.8%	-1.1%	0.0%	0.4%	0.4%	2.3%	6.8%	4.0%	3.5%		3.4%
9:30:00	0.0%	-0.7%	1.6%	-2.8%	-0.4%	-2.0%	2.9%	4.8%	1.2%	4.7%		7.7%
9:45:00	-0.4%	0.3%	-2.3%	-0.3%	0.0%	1.0%	3.2%	6.9%	4.6%	1.4%		5.1%
TOTAL	-0.4%	-0.7%	-0.2%	-0.7%	0.2%	-0.3%	6.3%	4.2%	4.9%	5.6%	N.A.	3.2%

TABLE B.5. COUNT COMPARISONS
WEST BOUND SCHOOL ST. ON-RAMP

	Pn. Tube		CCTV		ERROR	
TIME	Tuesday 10/28/97	Wednes. 11/5/97	Tuesday 10/28/97	Wednes. 11/5/97	Tuesday 10/28/97	Wednes. 11/5/97
6:15:00	293	315	322	339	-9.0%	-7.1%
6:30:00	319	299	335	322	-4.8%	-7.1%
6:45:00	324	324	359	357	-9.7%	-9.2%
7:00:00	289	278	301	296	-4.0%	-6.1%
7:15:00	282	295	306	331	-7.8%	-10.9%
7:30:00	289	307	307	316	-5.9%	-2.8%
7:45:00	269	289	293	311	-8.2%	-7.1%
8:00:00	256	275	282	302	-9.2%	-8.9%
8:15:00	281	288	308	308	-8.8%	-6.5%
8:30:00	249	261	264	282	-5.7%	-7.4%
8:45:00	209	235	231	268	-9.5%	-12.3%
9:00:00	246	244	265	235	-7.2%	3.8%
9:15:00	208	208	219	223	-5.0%	-6.7%
9:30:00	209	213	215	238	-2.8%	-10.5%
9:45:00	221	218	238	220	-7.1%	-0.9%
10:00:00	213	219	217	233	-1.8%	-6.0%
TOTAL	**4157**	**4268**	**4462**	**4581**	**-6.8%**	**-6.8%**

Appendix C: HDOT Experiment Site Design Specifications

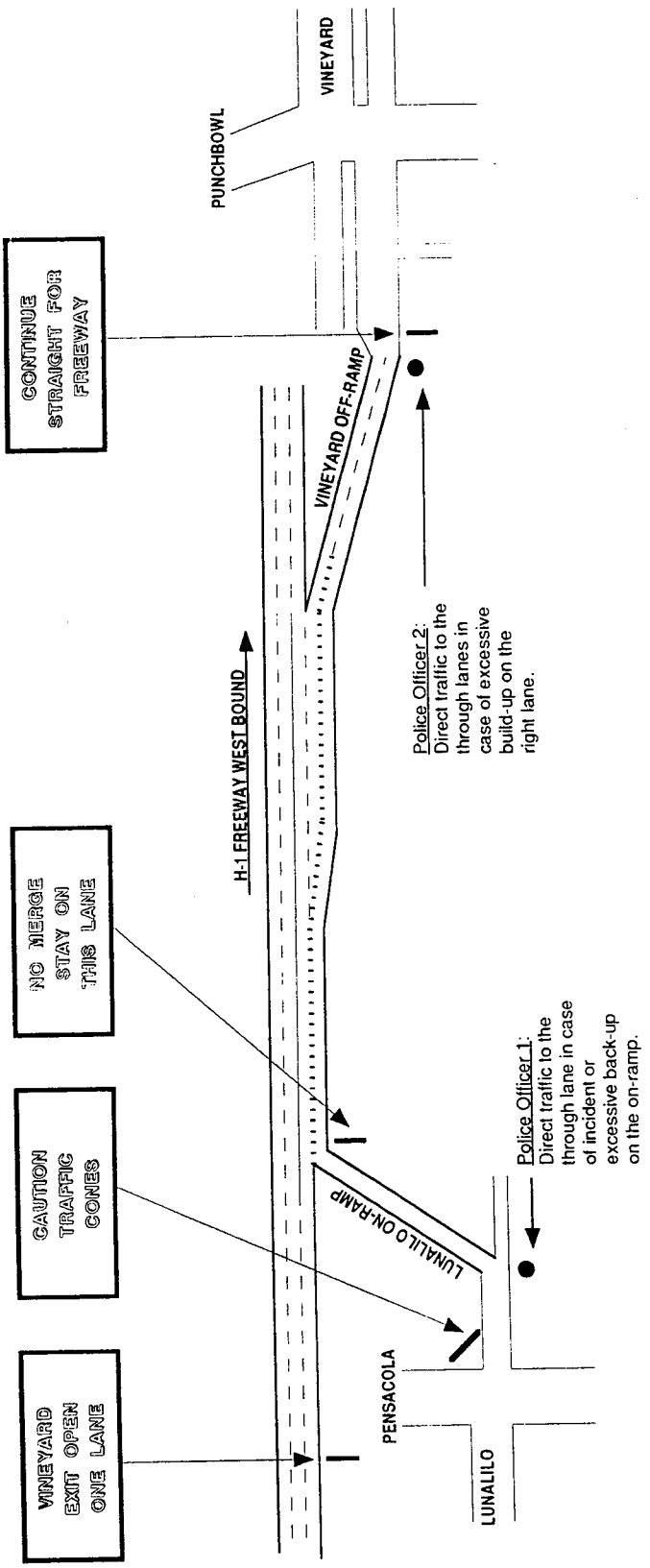


FIGURE C.1. Conceptual design for experiment site.

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

SPECIFICATIONS, PROPOSAL AND PLANS

FOR

INTERSTATE ROUTE H-1

EXPERIMENTAL MORNING TRAFFIC CHANNELIZATION

WESTBOUND LUNALILO STREET ON-RAMP AND VINEYARD BOULEVARD OFF-RAMP

PROJECT NO. SPR-0010(19), PART II

WORK ORDER NO. 899

DISTRICT OF HONOLULU

ISLAND OF OAHU

1997

SCOPE OF SERVICES

2.1 GENERAL - The Contractor shall provide traffic control services and safety measures necessary for the implementation of the project entitled, "Interstate Route H-1, Experimental Morning Traffic Channelization, Westbound Lunalilo On-Ramp and Vineyard Boulevard Off-Ramp, Project No. SPR-0010(19), Part II, Work Order No. 899" herein after referred to as the "Project".

2.2 COORDINATION BY THE STATE - The Contractor shall coordinate all work with the State Traffic Operations Section, phone number 587-2177.

2.3 WORK BY CONTRACTOR - Unless indicated otherwise, the Contractor shall perform all services necessary to complete the work required for this Project including, but not limited to the following:

a. Furnish, install, remove and maintain traffic cones, signs and portable changeable message signs.

b. Cover and uncover existing signs.

c. Program and maintain pre-advisory and advisory messages on portable changeable message signs.

d. Hire two (2) special duty police officers to provide traffic control during incidents (lane blockage by displaced cones, accidents, stalled vehicles, etc.).

2.4 Special Duty Police Officers - The first officer shall be stationed near the entrance to the Lunalilo on-ramp to provide traffic control, such as diverting traffic to the through lane on Lunalilo Street, should excessive back-up occur on the on-ramp due to an incident.

The second officer shall be stationed on the Vineyard Boulevard off-ramp, about one thousand (1000) feet before the intersection with Punchbowl Street to provide traffic control, such as diverting traffic to the through lanes, should excessive back-up occur in the right lane which would block flow from Lunalilo Street or resulting from an incident.

TIME OF PERFORMANCE

3.1 CONTRACT TIME - The Contractor shall perform the necessary work as described in Section 2 - Scope of Services for ten (10) weekday mornings from Monday October 27, 1997 through Friday November 7, 1997 between 5:30 am and 10:00 am. The Contractor shall have all cones, signs and portable variable message signs completely in place at 5:30 am and shall have the Lunalilo Street on-ramp completely opened at 10:00 am.

The Contractor shall provide pre-advisory messages from Wednesday October 22, 1997 to Sunday October 26, 1997. 5:30 am to 12-Noon on Wednesday to Friday and 8:00 am to 7:00 pm on Saturday and Sunday.

3.2 STATE EVALUATION - The State shall be entitled to revise the hours Contractor's services are needed.

3.3 LIQUIDATED DAMAGES - The State will assess the Contractor liquidated damages of three hundred dollars ($300.00) for every one-to fifteen-minute increment that the Lunalilo Street on-ramp is not closed or opened to the public as specified in the contract time (Section 3.1). The maximum amount assessed per day shall be three thousand dollars ($3,000.00). The State will decide the time and liquidated damages assessed.

The State may consider delays caused by a problem beyond the Contractor's control in closing and opening the Lunalilo Street on-ramp on time for not charging liquidated damages. Equipment breakdown is not a cause to waive liquidated damages.

INDEX TO DRAWINGS	
SHEET NO.	DESCRIPTION
1	TITLE SHEET
2	TRAFFIC CONING PLAN
3	TRAFFIC SIGNING PLAN

FED. ROAD DIST. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAW.	SPR-0010(19)	1997	1	3

STATE OF HAWAII

DEPARTMENT OF TRANSPORTATION

HIGHWAYS DIVISION

HONOLULU, HAWAII

PLANS FOR

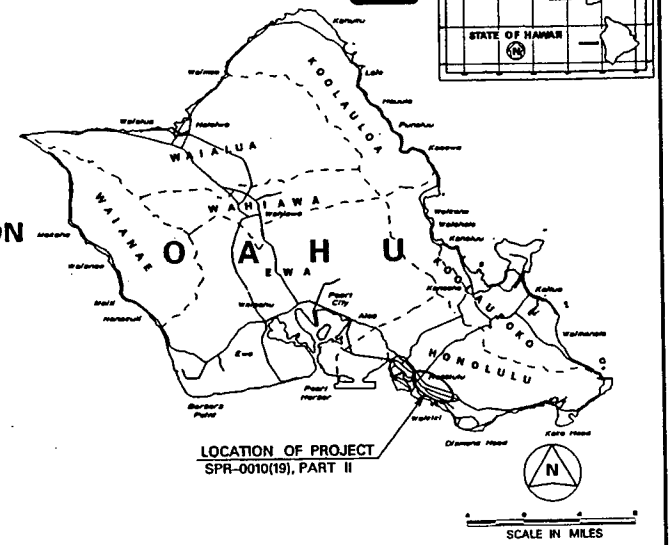
INTERSTATE ROUTE H-1

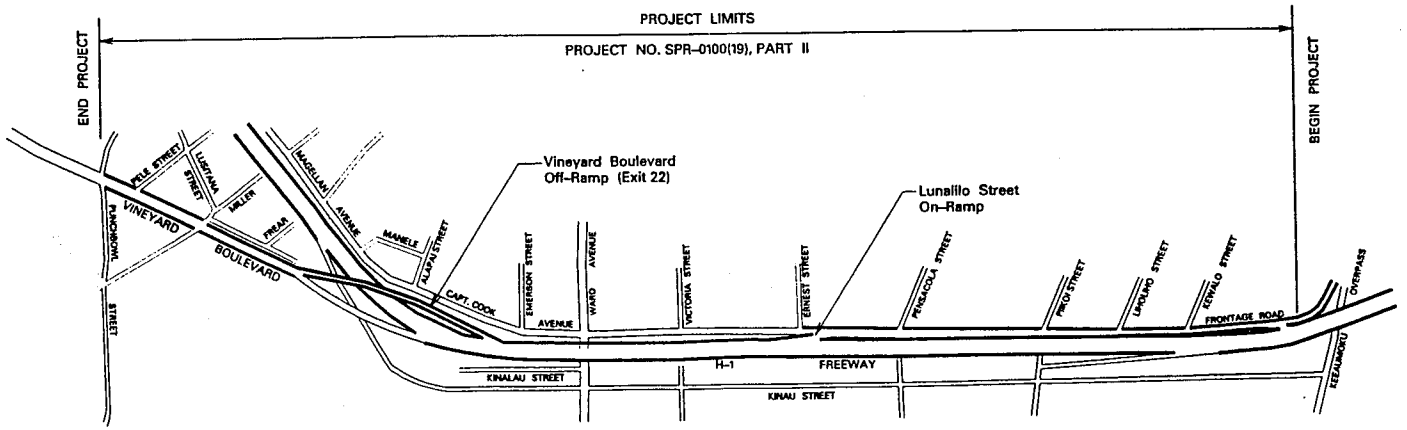
EXPERIMENTAL MORNING TRAFFIC CHANNELIZATION WESTBOUND LUNALILO STREET ON-RAMP AND VINEYARD BOULEVARD OFF-RAMP

PROJECT NO. SPR-0010(19), PART II

DISTRICT OF HONOLULU

ISLAND OF OAHU

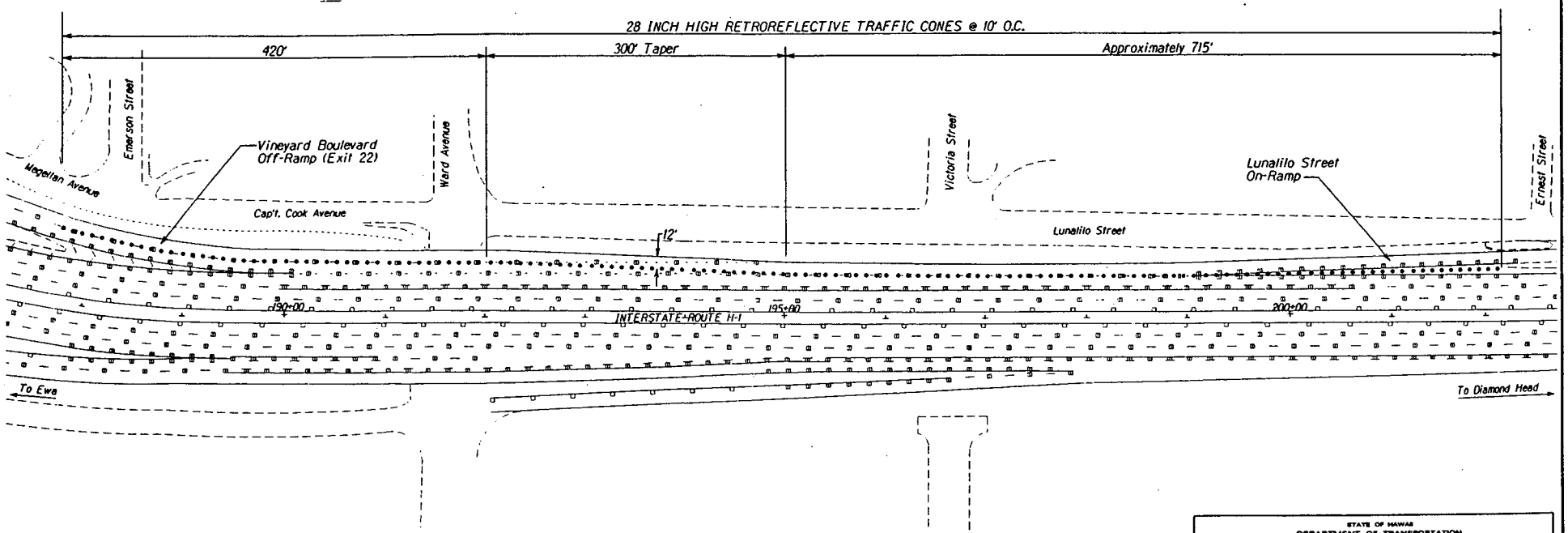




HWY-TO — DESIGNED BY: BRYAN KIMURA, P.S. & E. BY — PHONE: 587-2177 — DATE: OCT., 1997

FED. ROAD DIST. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAW.	SPR-0010(19)	1997	2	3

SCALE 1" = 100'



STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

TRAFFIC CONING PLAN

Interstate Route H-1
EXPERIMENTAL MORNING TRAFFIC CHANNELIZATION
Westbound Lunalilo Street On-Ramp and
Vineyard Boulevard Off-Ramp
WORK ORDER NO. 899
PROJECT NO. SPR-0010(19), PART II

Scale: 1"=100' Date: Oct., 1997

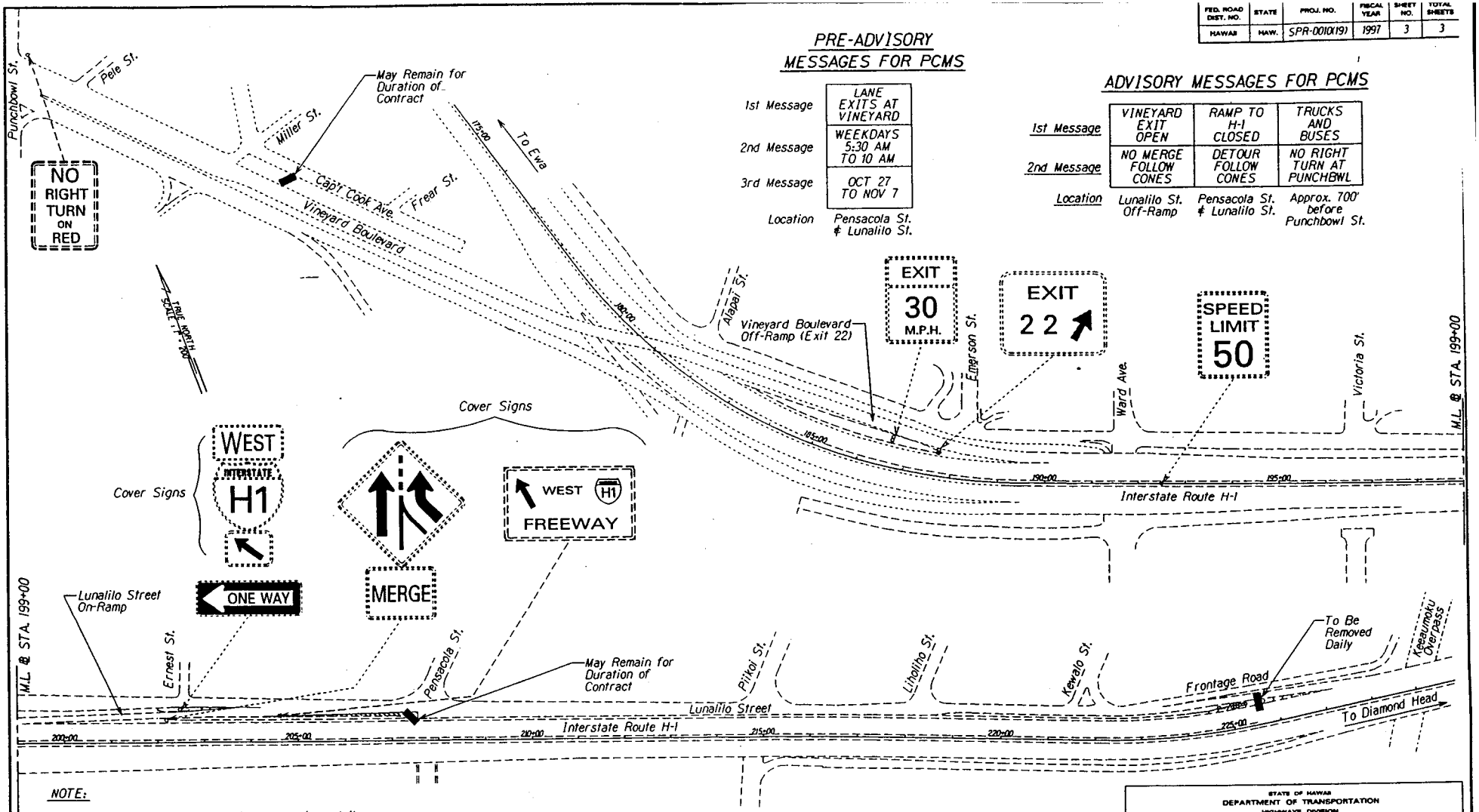
FED. ROAD DIST. NO.	STATE	PROJ. NO.	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
HAWAII	HAW.	SPR-0010(19)	1997	3	3

PRE-ADVISORY MESSAGES FOR PCMS

1st Message	LANE EXITS AT VINEYARD
2nd Message	WEEKDAYS 5:30 AM TO 10 AM
3rd Message	OCT 27 TO NOV 7
Location	Pensacola St. & Lunalilo St.

ADVISORY MESSAGES FOR PCMS

1st Message	VINEYARD EXIT OPEN	RAMP TO H-1 CLOSED	TRUCKS AND BUSES
2nd Message	NO MERGE FOLLOW CONES	DETOUR FOLLOW CONES	NO RIGHT TURN AT PUNCHBWL
Location	Lunalilo St. Off-Ramp	Pensacola St. & Lunalilo St.	Approx. 700' before Punchbowl St.



NOTE:

1. The Contractor shall cover and uncover signs daily. Signs shall be covered from 5:30 a.m. to 10:00 a.m. or as directed by the State.
2. The Contractor shall display required advisory messages only when coning is in place.

LEGEND:

■ Portable Changeable Message Sign (PCMS)

STATE OF HAWAII
DEPARTMENT OF TRANSPORTATION
HIGHWAYS DIVISION

TRAFFIC SIGNING PLAN

Interstate Route H-1
EXPERIMENTAL MORNING TRAFFIC CHANNELIZATION
Westbound Lunalilo Street On-Ramp and Vineyard Boulevard Off-Ramp
WORK ORDER NO. 899
PROJECT NO. SPR-0010(19), PART II

Scale: 1"=200' Date: Oct. 1997

SHEET No. 3 OF 3 SHEETS

Appendix D: Post-Experiment Survey

D1: Statistical summary of Lunalilo St. on-ramp surveys

D2: Statistical summary of WB H-1 Fwy. on-ramp surveys

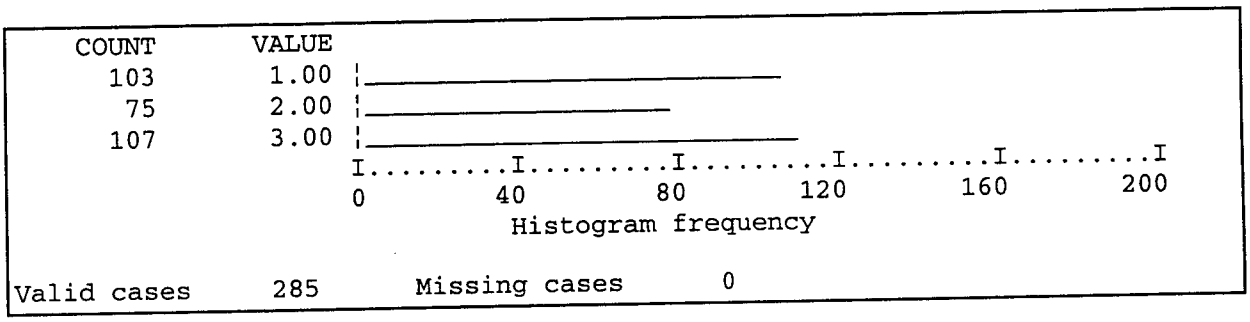
D3: Statistical analysis of WB H-1 Fwy. on-ramp surveys

D4: Unsolicited comments on surveys

D1: Statistical summary of Lunalilo St. on-ramp surveys

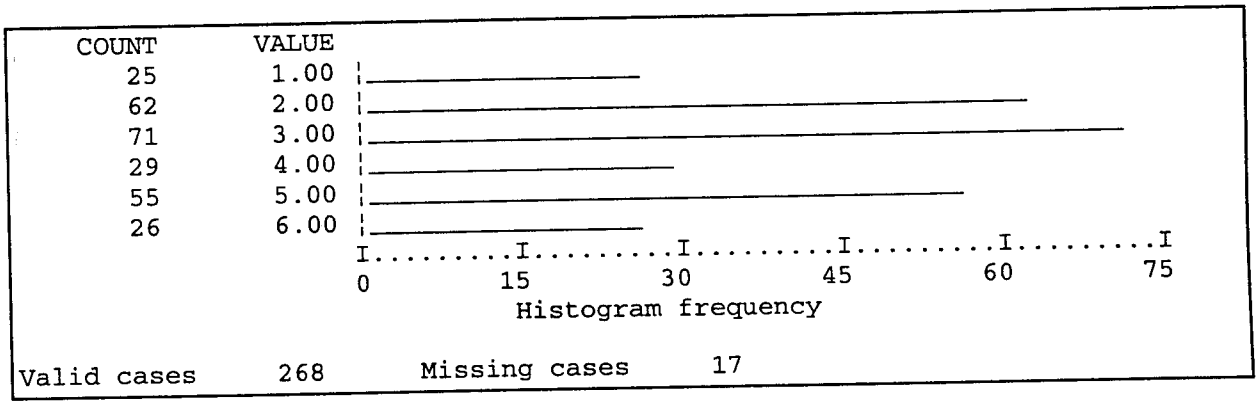
LOCAT **LOCATION OF DISTRIBUTION**

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
LUNALILO	1.0	103	36.1	36.1	36.1
PENSACOLA	2.0	75	26.3	26.3	62.5
PIIKOI	3.0	107	37.5	37.5	100.0
	Total	285	100.0	100.0	



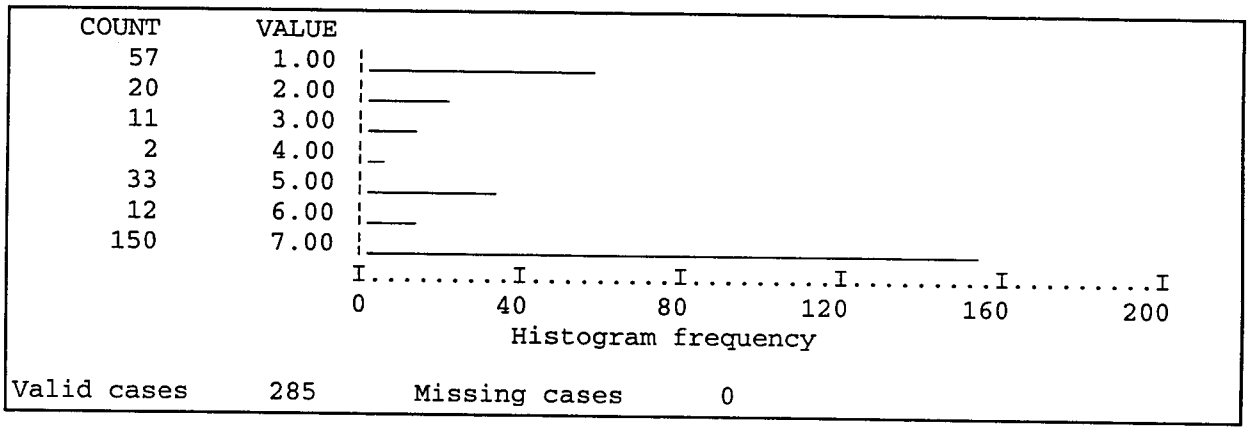
TIME **TIME OF DISTRIBUTION**

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
6:30+	1.0	25	8.8	9.3	9.3
7:00+	2.0	62	21.8	23.1	32.5
7:30+	3.0	71	24.9	26.5	59.0
8:00+	4.0	29	10.2	10.8	69.8
8:30+	5.0	55	19.3	20.5	90.3
9:00+	6.0	26	9.1	9.7	100.0
	9.0	17	6.0	Missing	
	Total	285	100.0	100.0	



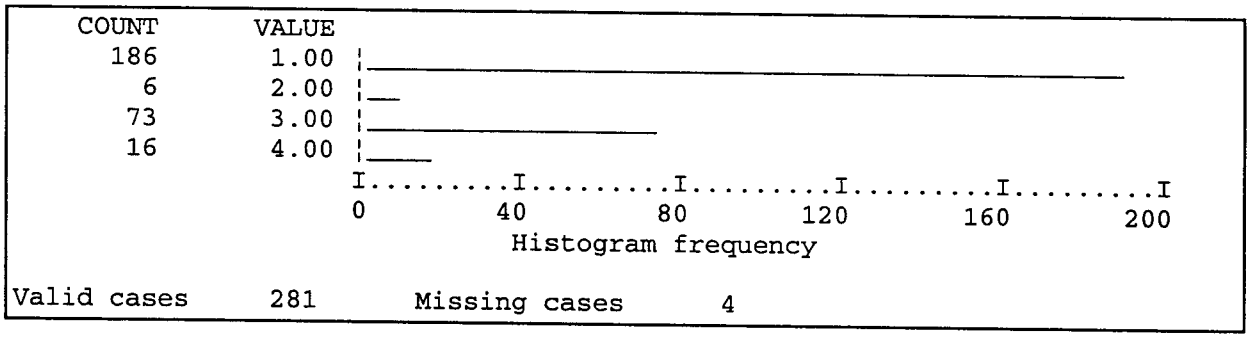
EXIT **FREEWAY EXIT USED**

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
VINEYARD BLVD	1.0	57	20.0	20.0	20.0
PALI HWY	2.0	20	7.0	7.0	27.0
SCHOOL ST	3.0	11	3.9	3.9	30.9
PALAMA ST	4.0	2	.7	.7	31.6
HOUGHTAILING	5.0	33	11.6	11.6	43.2
LIKELIKE HWY	6.0	12	4.2	4.2	47.4
OTHER	7.0	150	52.6	52.6	100.0
	Total	285	100.0	100.0	



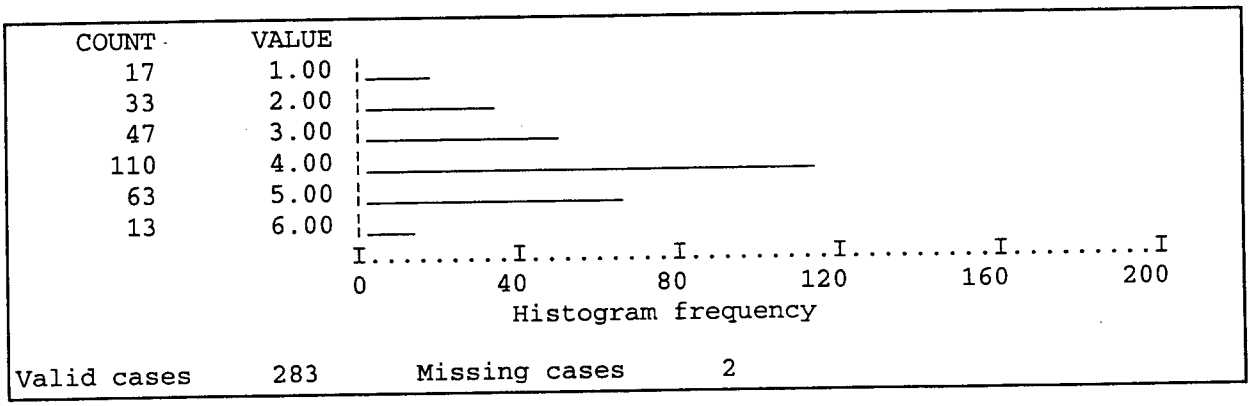
DEPTIME **DID EXPER AFFECT DEPARTURE TIME?**

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
NO CHANGE	1.0	186	65.3	66.2	66.2
DONT KNOW	2.0	6	2.1	2.1	68.3
STARTED EARLIER	3.0	73	25.6	26.0	94.3
STARTED LATER	4.0	16	5.6	5.7	100.0
NO RESPONSE	9.0	4	1.4	Missing	
		-------	-------	-------	
	Total	285	100.0	100.0	



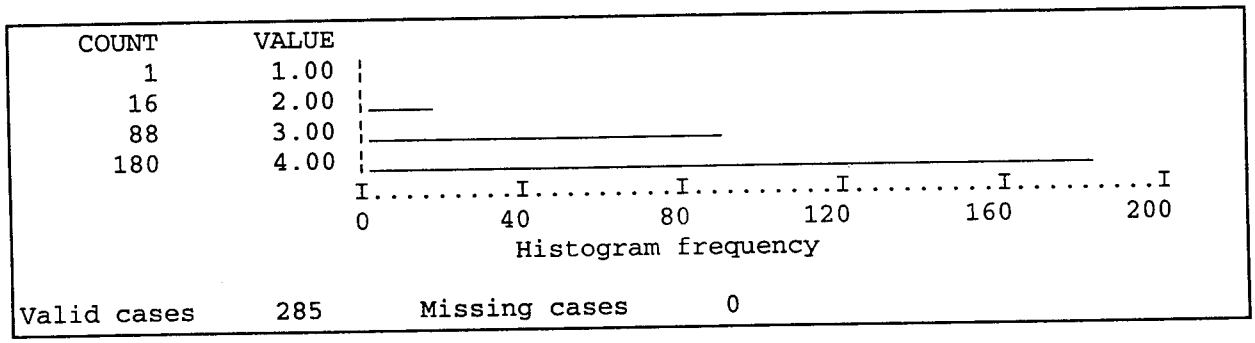
TRAVTIME **DID EXPER AFFECT TRAVEL TIME?**

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
A LOT FASTER	1.0	17	6.0	6.0	6.0
A LITTLE FASTER	2.0	33	11.6	11.7	17.7
SAME	3.0	47	16.5	16.6	34.3
A LITTLE SLOWER	4.0	110	38.6	38.9	73.1
A LOT SLOWER	5.0	63	22.1	22.3	95.4
DONT KNOW	6.0	13	4.6	4.6	100.0
NO RESPONSE	9.0	2	.7	Missing	
	Total	285	100.0	100.0	



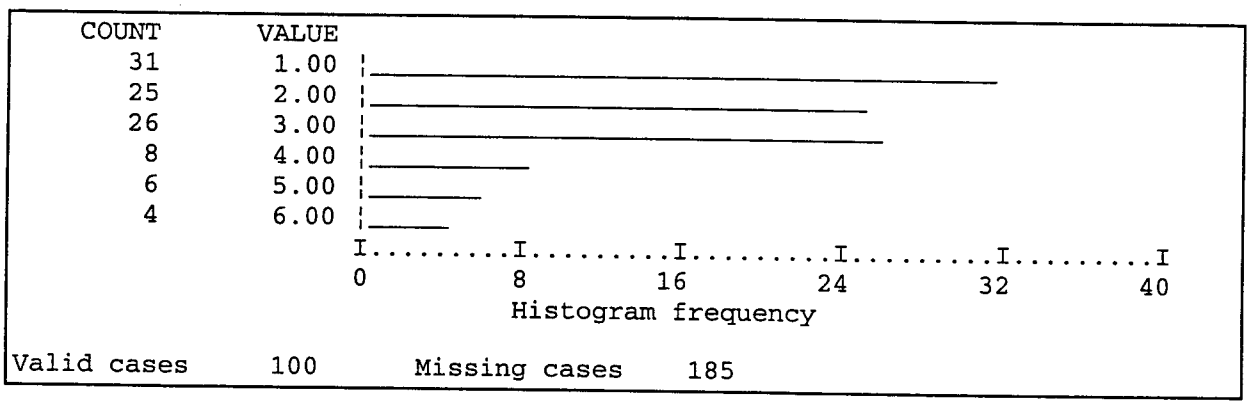
TOOKLUNA **DID RESPONDENT USE CONED ON-RAMP?**

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
NEVER	1.0	1	.4	.4	.4
1 TIME	2.0	16	5.6	5.6	6.0
2 OR 3 TIMES	3.0	88	30.9	30.9	36.8
4+ TIMES	4.0	180	63.2	63.2	100.0
	Total	285	100.0	100.0	



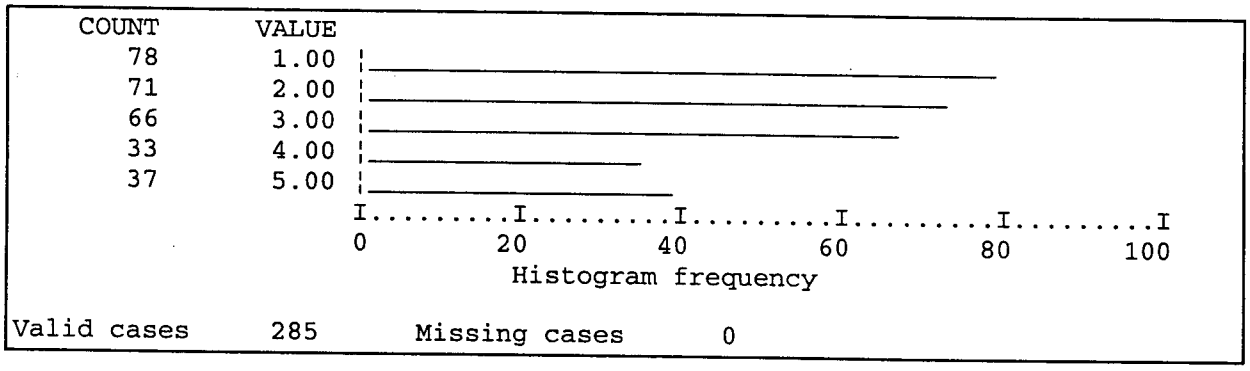
ROUTE1 **FIRST ALTERNATE ROUTE USED**

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
PUNAHOU ON-RAMP	1.0	31	10.9	31.0	31.0
BERETANIA	2.0	25	8.8	25.0	56.0
AUWAI,PROSPECT,THURS	3.0	26	9.1	26.0	82.0
ALEXANDER ON-RAMP	4.0	8	2.8	8.0	90.0
KAPIOLANI	5.0	6	2.1	6.0	96.0
ALA MOANA/NIMITZ	6.0	4	1.4	4.0	100.0
NO RESPONSE	9.0	185	64.9	Missing	
	Total	285	100.0	100.0	



GRADE **WHAT DO YOU THINK OF THE EXPERIMENT?**

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
VERY BAD	1.0	78	27.4	27.4	27.4
BAD	2.0	71	24.9	24.9	52.3
NEUTRAL	3.0	66	23.2	23.2	75.4
GOOD	4.0	33	11.6	11.6	87.0
VERY GOOD	5.0	37	13.0	13.0	100.0
	Total	285	100.0	100.0	



ZIPCODE

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
AIEA/HALAWA	701.0	2	.7	1.7	1.7

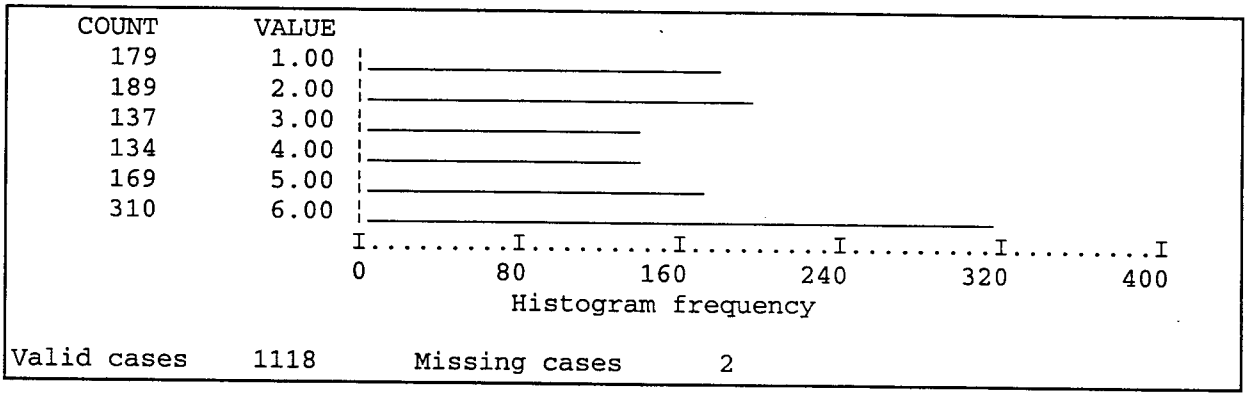
EWA	706.0	1	.4	.8	2.5
KAILUA	734.0	1	.4	.8	3.4
KANEOHE	744.0	1	.4	.8	4.2
PEARL CITY	782.0	3	1.1	2.5	6.7
MILILANI	789.0	1	.4	.8	7.6
WAIPAHU	797.0	3	1.1	2.5	10.1
HONOLULU	813.0	4	1.4	3.4	13.4
KAKAAKO	814.0	22	7.7	18.5	31.9
WAIKIKI	815.0	3	1.1	2.5	34.5
KAIMUKI	816.0	2	.7	1.7	36.1
KALIHI	817.0	6	2.1	5.0	41.2
SALT LAKE	818.0	1	.4	.8	42.0
MOANALUA,AIRPORT	819.0	2	.7	1.7	43.7
WAIALAE NIU-KULIOUOU	821.0	3	1.1	2.5	46.2
MAKIKI/UNIV	822.0	55	19.3	46.2	92.4
HAWAII KAI	825.0	2	.7	1.7	95.0
MCCULLY/MOILIILI	826.0	6	2.1	5.0	100.0
	999.0	166	58.2	Missing	
	Total	285	100.0	100.0	

Valid cases 119 Missing cases 166

D2: Statistical summary of west bound H-1 Fwy. on-ramp surveys

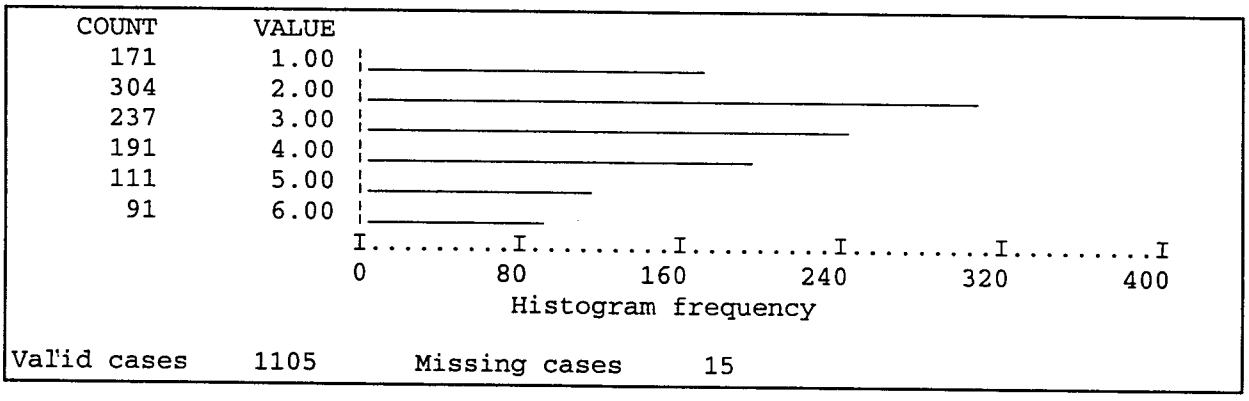
LOCAT **LOCATION OF DISTRIBUTION**

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
PUNAHOU	1.0	179	16.0	16.0	16.0
ALEXANDER	2.0	189	16.9	16.9	32.9
5TH	3.0	137	12.2	12.3	45.2
11TH	4.0	134	12.0	12.0	57.2
AINA KOA	5.0	169	15.1	15.1	72.3
KALANIANAOLE	6.0	310	27.7	27.7	100.0
	99.0	2	.2	Missing	
	Total	1120	100.0	100.0	



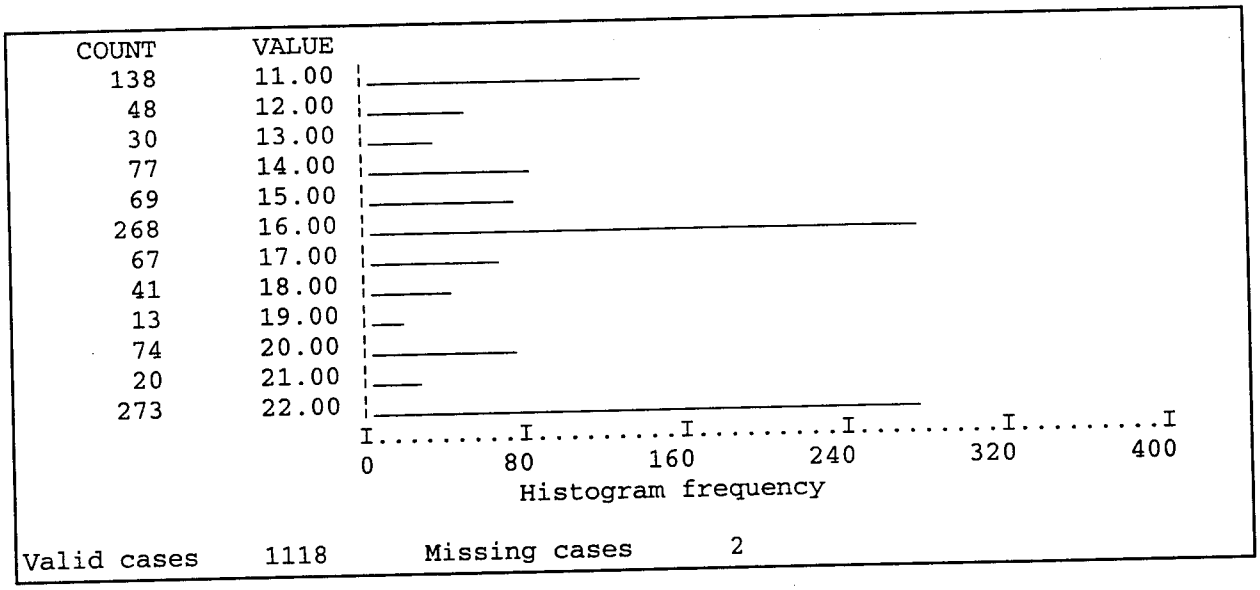
TIME **TIME OF DISTRIBUTION**

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
6:30+	1.0	171	15.3	15.5	15.5
7:00+	2.0	304	27.1	27.5	43.0
7:30+	3.0	237	21.2	21.4	64.4
8:00+	4.0	191	17.1	17.3	81.7
8:30+	5.0	111	9.9	10.0	91.8
9:00+	6.0	91	8.1	8.2	100.0
	9.0	15	1.3	Missing	
	Total	1120	100.0	100.0	



EXIT **FREEWAY EXIT USED**

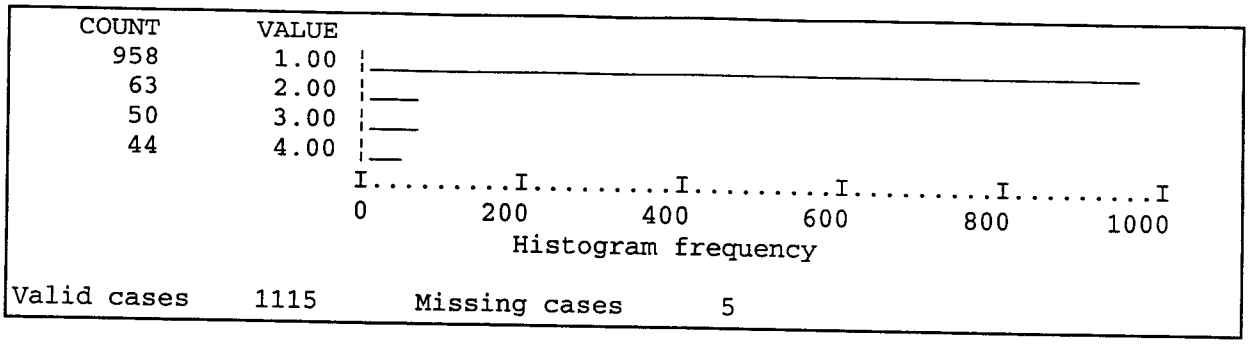
Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
KAPIOLANI	11.0	138	12.3	12.3	12.3
KING	12.0	48	4.3	4.3	16.6
UNIVERSITY	13.0	30	2.7	2.7	19.3
WILDER	14.0	77	6.9	6.9	26.2
LUNALILO	15.0	69	6.2	6.2	32.4
VINEYARD BLVD	16.0	268	23.9	24.0	56.4
PALI	17.0	67	6.0	6.0	62.3
SCHOOL	18.0	41	3.7	3.7	66.0
PALAMA	19.0	13	1.2	1.2	67.2
HOUGHTAILING	20.0	74	6.6	6.6	73.8
LIKELIKE	21.0	20	1.8	1.8	75.6
OTHER	22.0	273	24.4	24.4	100.0
NO RESPONSE	99.0	2	.2	Missing	
	Total	1120	100.0	100.0	



Valid cases 1118 Missing cases 2

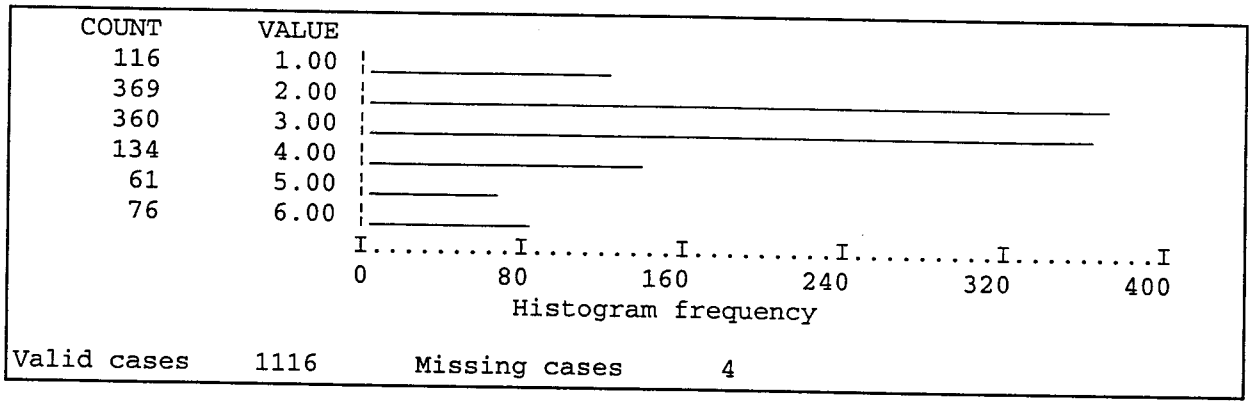
DEPTIME **DID EXPER AFFECT DEPARTURE TIME?**

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
NO CHANGE	1.0	958	85.5	85.9	85.9
DONT KNOW	2.0	63	5.6	5.7	91.6
STARTED EARLIER	3.0	50	4.5	4.5	96.1
STARTED LATER	4.0	44	3.9	3.9	100.0
NO RESPONSE	9.0	5	.4	Missing	
	Total	1120	100.0	100.0	



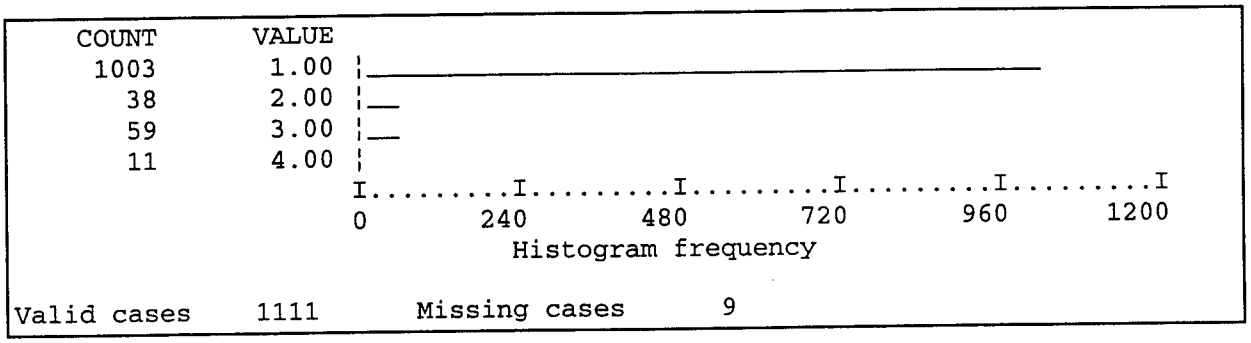
TRAVTIME **DID EXPER AFFECT TRAVEL TIME?**

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
A LOT FASTER	1.0	116	10.4	10.4	10.4
A LITTLE FASTER	2.0	369	32.9	33.1	43.5
SAME	3.0	360	32.1	32.3	75.7
A LITTLE SLOWER	4.0	134	12.0	12.0	87.7
A LOT SLOWER	5.0	61	5.4	5.5	93.2
DONT KNOW	6.0	76	6.8	6.8	100.0
NO RESPONSE	9.0	4	.4	Missing	
	Total	1120	100.0	100.0	



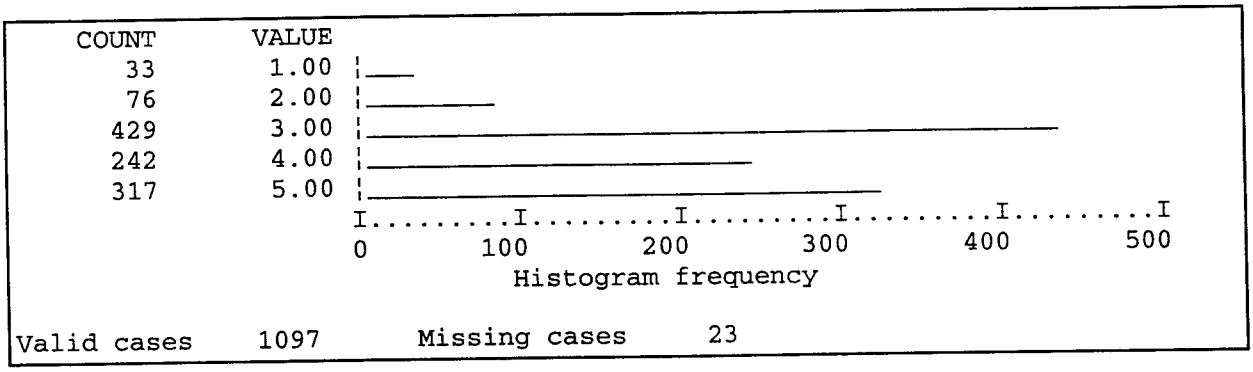
DIFFRT **DIVERTED DUE TO CONGESTION?**

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
NO CHANGE	1.0	1003	89.6	90.3	90.3
1 MORNING	2.0	38	3.4	3.4	93.7
2 OR 3 MORNINGS	3.0	59	5.3	5.3	99.0
4+ MORNINGS	4.0	11	1.0	1.0	100.0
NO RESPONSE	9.0	9	.8	Missing	
	Total	1120	100.0	100.0	



GRADE **WHAT DO YOU THINK OF THE EXPERIMENT?**

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
VERY BAD	1.0	33	2.9	3.0	3.0
BAD	2.0	76	6.8	6.9	9.9
NEUTRAL	3.0	429	38.3	39.1	49.0
GOOD	4.0	242	21.6	22.1	71.1
VERY GOOD	5.0	317	28.3	28.9	100.0
	9.0	23	2.1	Missing	
	Total	1120	100.0	100.0	



ZIPCODE

Value Label	Value	Frequency	Percent	Valid Percent	Cum Percent
AIEA/HALAWA	701.0	11	1.0	2.4	2.4
EWA	706.0	2	.2	.4	2.9
MAKAKILO	707.0	2	.2	.4	3.3
KAILUA	734.0	2	.2	.4	3.7
KANEOHE	744.0	5	.4	1.1	4.8
PEARL CITY	782.0	3	.3	.7	5.5
MILILANI	789.0	2	.2	.4	5.9
NANAKULI-MAKAHA	792.0	1	.1	.2	6.2
WAIMANALO	795.0	1	.1	.2	6.4
WAIPAHU	797.0	2	.2	.4	6.8
HONOLULU	813.0	12	1.1	2.6	9.5
KAKAAKO	814.0	7	.6	1.5	11.0
WAIKIKI	815.0	18	1.6	4.0	15.0
KAIMUKI	816.0	85	7.6	18.7	33.7
KALIHI	817.0	20	1.8	4.4	38.1
SALT LAKE	818.0	5	.4	1.1	39.2
MOANALUA,AIRPORT	819.0	12	1.1	2.6	41.9
WAIALAE NIU-KULIOUOU	821.0	106	9.5	23.3	65.2
MAKIKI/UNIV	822.0	56	5.0	12.3	77.5
HAWAII KAI	825.0	87	7.8	19.2	96.7
MCCULLY/MOILIILI	826.0	15	1.3	3.3	100.0
	999.0	666	59.5	Missing	
	Total	1120	100.0	100.0	

Valid cases 454 Missing cases 666

D3: Statistical analysis of west bound H-1 Fwy. on-ramp surveys

EFFECT OF TIME AND ENTRY POINT (ON-RAMP)

LOCATION OF DISTRIBUTION	TIME OF DISTRIBUTION	WHAT DO YOU THINK OF THE EXPERIMENT?	TRAVEL TIME WAS MUCH FASTER=2,1,0,-1,-2=MUCH SLOWER	0=DID NOT REROUTE, 1=REROUTED AT LEAST ONCE
PUNAHOU	6:30+	4.2	.77	0.00
	7:00+	4.0	.72	.02
	7:30+	4.0	.67	.10
	8:00+	3.9	.71	.04
	8:30+	4.2	.64	0.00
	9:00+	2.6	-.20	.40
	Mean	**3.9**	**.68**	**.04**
ALEXANDER	6:30+	3.6	.67	.07
	7:00+	3.7	.42	.13
	7:30+	3.6	.45	.15
	8:00+	3.4	.39	.07
	8:30+	3.3	1.00	0.00
	9:00+	3.6	.44	.10
	Mean	**3.6**	**.46**	**.11**
5TH	6:30+	3.5	.34	.14
	7:00+	3.8	.48	.17
	7:30+	3.8	.43	.10
	8:00+	3.5	-.15	.37
	8:30+	3.7	.62	.20
	9:00+	3.1	.09	.07
	Mean	**3.6**	**.35**	**.16**
11TH	6:30+	3.8	.80	.10
	7:00+	3.7	.41	.09
	7:30+	3.3	.00	.07
	8:00+	3.4	.20	.14
	8:30+	3.2	.20	.10
	9:00+	3.8	.15	0.00
	Mean	**3.6**	**.24**	**.10**
AINA KOA	6:30+	3.5	.21	.10
	7:00+	3.5	-.27	.17
	7:30+	3.6	.21	0.00
	8:00+	3.6	.06	.10
	8:30+	3.8	.47	.05
	9:00+	3.5	-.17	0.00
	Mean	**3.6**	**.13**	**.08**
KALANIANAOLE	6:30+	3.9	.43	.02
	7:00+	3.7	.17	.10
	7:30+	3.5	.00	.15
	8:00+	4.0	.74	.08
	8:30+	3.4	.15	.14
	9:00+	3.4	-.03	.03
	Mean	**3.6**	**.18**	**.10**

EFFECT OF TIME AND EXIT POINT (OFF-RAMP)

FREEWAY EXIT USED	TIME OF DISTRIBUTION	WHAT DO YOU THINK OF THE EXPERIMENT?	TRAVEL TIME WAS MUCH FASTER=2,1,0,-1,-2=MUCH SLOWER	0=DID NOT REROUTE, 1=REROUTED AT LEAST ONCE
KAPIOLANI	6:30+	3.1	.13	.18
	7:00+	3.3	-.27	.20
	7:30+	3.2	-.17	.12
	8:00+	3.0	-.62	.17
	8:30+	3.3	.14	0.00
	9:00+	3.7	0.00	0.00
	Mean	**3.3**	**-.22**	**.14**
KING	6:30+	3.0	0.00	0.00
	7:00+	3.4	.00	.08
	7:30+	3.2	-.21	0.00
	8:00+	3.0	-.50	.43
	8:30+	3.3	-.14	.14
	9:00+	3.0	-.50	0.00
	Mean	**3.3**	**-.21**	**.13**
UNIVERSITY	6:30+	3.7	.25	0.00
	7:00+	3.0	-.67	.67
	7:30+	3.0	-.50	.33
	8:00+	3.3	-.50	.50
	8:30+	3.3	.50	.17
	9:00+	3.1	-.14	0.00
	Mean	**3.2**	**-.13**	**.23**
WILDER	6:30+	3.2	-.18	.15
	7:00+	3.5	-.23	.13
	7:30+	3.3	-.29	.28
	8:00+	3.8	.25	0.00
	8:30+	3.2	-.11	.10
	9:00+	3.4	0.00	.14
	Mean	**3.3**	**-.20**	**.16**
LUNALILO	6:30+	4.3	1.00	.33
	7:00+	3.2	-.21	.21
	7:30+	4.2	.64	.09
	8:00+	3.8	.37	.17
	8:30+	3.8	.67	.17
	9:00+	2.8	-.22	0.00
	Mean	**3.6**	**.27**	**.14**
VINEYARD BLVD	6:30+	4.0	.69	0.00
	7:00+	4.1	.67	.04
	7:30+	3.9	.70	.10
	8:00+	4.1	.69	.06
	8:30+	4.0	.59	.06
	9:00+	3.8	.25	.05
	Mean	**4.0**	**.64**	**.06**

PALI	6:30+	4.0	.58	0.00
	7:00+	4.2	.88	.12
	7:30+	3.6	.08	.08
	8:00+	2.7	.14	0.00
	8:30+	3.8	.40	0.00
	9:00+	3.8	1.00	.20
	Mean	**3.8**	**.56**	**.07**
SCHOOL	6:30+	4.2	.86	0.00
	7:00+	4.3	1.25	0.00
	7:30+	4.0	.75	0.00
	8:00+	3.8	.44	.11
	8:30+	3.7	1.00	0.00
	9:00+	3.0	0.00	0.00
	Mean	**3.9**	**.77**	**.02**
PALAMA	7:00+	3.5	0.00	.25
	7:30+	3.7	.33	.33
	8:00+	4.5	1.00	0.00
	8:30+	3.0	0.00	0.00
	9:00+	2.5	-1.00	0.00
	Mean	**3.5**	**.08**	**.15**
HOUGHTAILING	6:30+	3.9	.71	0.00
	7:00+	3.9	.70	0.00
	7:30+	3.8	.37	.06
	8:00+	3.6	.67	.10
	8:30+	4.0	.67	0.00
	9:00+	3.7	.50	0.00
	Mean	**3.8**	**.61**	**.03**
LIKELIKE	6:30+	4.5	1.00	0.00
	7:00+	3.9	.38	0.00
	7:30+	4.7	1.00	0.00
	8:00+	5.0	2.00	0.00
	8:30+	5.0	2.00	0.00
	9:00+	2.5	-1.00	.50
	Mean	**4.1**	**.68**	**.05**
OTHER	6:30+	3.7	.42	.09
	7:00+	3.6	.38	.10
	7:30+	3.5	.13	.15
	8:00+	3.7	.65	.04
	8:30+	3.4	.21	.19
	9:00+	3.4	.13	.06
	Mean	**3.6**	**.37**	**.10**

SAFER?

Approximate assessment of motorists who thought the experiment was GOOD or VERY GOOD because it was safer: Count those who gave a Good/Very Good rating despite the fact that they reported no travel time savings.

During experiment travel time was	exited at Vineyard	exited past Vineyard	both
Much Slower	0 (0.0%)	2 (0.8%)	2 (0.5%)
Slower	8 (4.4%)	3 (1.2%)	11 (2.5%)
Same	25 (13.9%)	28 (10.9%)	53 (12.1%)
Total respondent pool	180 (18.3%)	257 (12.8%)	437 (15.1%)

EFFECT OF EXITING BEFORE, AT OR PAST THE EXPERIMENT ZONE

DID MOTORISTS SEE THE EXPERIMENT ZONE?	TIME OF DISTRIBUTION	WHAT DO YOU THINK OF THE EXPERIMENT?	TRAVEL TIME WAS MUCH FASTER=2,1,0,-1,-2=MUCH SLOWER	0=DID NOT REROUTE, 1=REROUTED AT LEAST ONCE
NO, EXITED BEFORE EXPERIMENT	6:30+	3.3	.12	.15
	7:00+	3.4	-.23	.18
	7:30+	3.3	-.12	.14
	8:00+	3.3	-.25	.21
	8:30+	3.4	.21	.11
	9:00+	3.3	-.12	.03
	Mean	**3.3**	**-.11**	**.15**
YES, EXITED AT EXPERIMENT ZONE	6:30+	4.0	.69	0.00
	7:00+	4.1	.67	.04
	7:30+	3.9	.70	.10
	8:00+	4.1	.71	.06
	8:30+	4.0	.59	.06
	9:00+	3.9	.24	.04
	Mean	**4.0**	**.64**	**.06**
YES, EXITED PAST EXPERIMENT ZONE	6:30+	3.9	.55	.05
	7:00+	3.8	.54	.08
	7:30+	3.6	.26	.11
	8:00+	3.6	.61	.05
	8:30+	3.6	.48	.08
	9:00+	3.3	.15	.10
	Mean	**3.7**	**.47**	**.08**

SUMMARY BY ON-RAMP

LOCATION OF DISTRIBUTION	WHAT DO YOU THINK OF THE EXPERIMENT?	TRAVEL TIME WAS MUCH FASTER=2,1,0,-1,-2=MUCH SLOWER	0=DID NOT REROUTE, 1=REROUTED AT LEAST ONCE
PUNAHOU	3.9	.68	.04
ALEXANDER	3.6	.46	.11
5TH	3.6	.35	.16
11TH	3.6	.24	.10
AINA KOA	3.6	.13	.08
KALANIANAOLE	3.6	.18	.10

t-tests for independent samples of SEEN IT DID MOTORISTS SEE THE EXPERIMENT

Variable	Number of Cases	Mean	SD	SE of Mean
GRADE WHAT DO YOU THINK OF THE EXPERIMENT?				
NO, EXITED BEFORE	343	3.3353	.918	.050
YES, EXITED AT EX	267	4.0262	1.038	.064

Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff
Unequal	**-8.57**	534.43	**.000**	.081	(-.849, -.533)

Motorists who exited at Vineyard rate the experiment significantly higher than those who exited earlier.

Variable	Number of Cases	Mean	SD	SE of Mean
FASTER TRAVEL TIME WAS MUCH FASTER=2,1,0,-1,-2				
NO, EXITED BEFORE	329	-.1125	.915	.050
YES, EXITED AT EX	255	.6431	.969	.061

Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff
Unequal	**-9.57**	530.37	**.000**	.079	(-.911, -.601)

Motorists who exited at Vineyard thought that the travel time was significantly lower than those who exited earlier. Those who exited before Vineyard perceived an increase in travel times, on the average.

Variable	Number of Cases	Mean	SD	SE of Mean
REROUTE 0=DID NOT REROUTE, 1=REROUTED AT LEAST ONCE				
NO, EXITED BEFORE	362	.1519	.359	.019
YES, EXITED AT EX	270	.0556	.229	.014

Variances	t-value	df	2-Tail Sig	SE of Diff	CI for Diff
Unequal	**4.10**	616.35	**.000**	.023	(.050, .143)

Motorists who exited past Vineyard re-routed significantly less because of perceived congestion compared with those who exited earlier.

ANALYSIS OF VARIANCE

FASTER TRAVEL TIME WAS MUCH FASTER=2,1,0,-1,-2=
BY TIME TIME OF DISTRIBUTION
LOCAT LOCATION OF DISTRIBUTION

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	50.457	10	5.046	4.975	.000
TIME	12.577	5	2.515	2.480	.030
LOCAT	38.150	5	7.630	7.524	.000
2-way Interactions	26.954	25	1.078	1.063	.380
TIME LOCAT	26.954	25	1.078	1.063	.380
Explained	77.411	35	2.212	2.181	.000
Residual	1005.033	991	1.014		
Total	1082.444	1026	1.055		

TIME and LOCAT have a significant correlation with FASTER but, combined, they explain only 7.2% of the observed variance (77.411/1082.444).

FASTER TRAVEL TIME WAS MUCH FASTER=2,1,0,-1,-2=
BY DIFFRT DIVERTED DUE TO CONGESTION?
SEEN IT DID MOTORISTS SEE THE EXPERIMENT ZONE?

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	158.041	5	31.608	35.233	.000
DIFFRT	60.477	3	20.159	22.471	.000
SEEN IT	76.219	2	38.110	42.480	.000
2-way Interactions	9.490	5	1.898	2.116	.061
DIFFRT SEEN IT	9.490	5	1.898	2.116	.061
Explained	167.531	10	16.753	18.674	.000
Residual	922.236	1028	.897		
Total	1089.767	1038	1.050		

DIFFRT and SEEN IT have a significant correlation with FASTER but, combined, they explain only 15.4% of the observed variance.

GRADE WHAT DO YOU THINK OF THE EXPERIMENT?
BY FASTER TRAVEL TIME WAS MUCH FASTER=2,1,0,-1,-2
TIME TIME OF DISTRIBUTION

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	568.348	9	63.150	109.998	.000
FASTER	559.548	4	139.887	243.663	.000
TIME	.927	5	.185	.323	.899
2-way Interactions	7.217	20	.361	.629	.894
FASTER TIME	7.217	20	.361	.629	.894
Explained	575.565	29	19.847	34.571	.000
Residual	562.044	979	.574		
Total	1137.610	1008	1.129		

FASTER and TIME have a significant correlation with GRADE. Combined, they explain a considerable portion, 50.6%, of the observed variance.

GRADE WHAT DO YOU THINK OF THE EXPERIMENT?
BY LOCAT LOCATION OF DISTRIBUTION
DIFFRT DIVERTED DUE TO CONGESTION?

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	91.672	8	11.459	10.964	.000
LOCAT	12.673	5	2.535	2.425	.034
DIFFRT	74.270	3	24.757	23.687	.000
2-way Interactions	17.987	14	1.285	1.229	.247
LOCAT DIFFRT	17.987	14	1.285	1.229	.247
Explained	109.659	22	4.984	4.769	.000
Residual	1111.004	1063	1.045		
Total	1220.663	1085	1.125		

LOCAT and DIFFRT have a significant correlation with GRADE but, combined, they explain only 9% of the observed variance.

GRADE WHAT DO YOU THINK OF THE EXPERIMENT?
BY FASTER TRAVEL TIME WAS MUCH FASTER=2,1,0,-1,-2=
DIFFRT DIVERTED DUE TO CONGESTION?

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	581.095	7	83.014	148.201	.000
FASTER	508.385	4	127.096	226.900	.000
DIFFRT	8.060	3	2.687	4.796	.003
2-way Interactions	9.108	10	.911	1.626	.094
FASTER DIFFRT	9.108	10	.911	1.626	.094
Explained	590.203	17	34.718	61.980	.000
Residual	560.702	1001	.560		
Total	1150.905	1018	1.131		

FASTER and DIFFRT have a significant correlation with GRADE. Combined, they explain a considerable portion, 51.3%, of the observed variance.

GRADE WHAT DO YOU THINK OF THE EXPERIMENT?
BY FASTER TRAVEL TIME WAS MUCH FASTER=2,1,0,-1,-2=
LOCAT LOCATION OF DISTRIBUTION

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	585.340	9	65.038	116.460	.000
FASTER	572.832	4	143.208	256.435	.000
LOCAT	7.930	5	1.586	2.840	.015
2-way Interactions	15.847	20	.792	1.419	.104
FASTER LOCAT	15.847	20	.792	1.419	.104
Explained	601.187	29	20.731	37.121	.000
Residual	553.991	992	.558		
Total	1155.178	1021	1.131		

FASTER and LOCAT have a significant correlation with GRADE. Combined, they explain a considerable portion, 52%, of the observed variance.

GRADE WHAT DO YOU THINK OF THE EXPERIMENT?
BY FASTER TRAVEL TIME WAS MUCH FASTER=2,1,0,-1,-2
SEEN IT DID MOTORISTS SEE THE EXPERIMENT ZONE?

Source of Variation	Sum of Squares	DF	Mean Square	F	Signif of F
Main Effects	581.128	6	96.855	173.280	.000
FASTER	510.119	4	127.530	228.160	.000
SEEN IT	4.243	2	2.122	3.796	.023
2-way Interactions	10.253	8	1.282	2.293	.020
FASTER SEEN IT	10.253	8	1.282	2.293	.020
Explained	591.381	14	42.241	75.573	.000
Residual	563.979	1009	.559		
Total	1155.359	1023	1.129		

FASTER and SEEN IT have a significant correlation with GRADE. Combined, they explain a considerable portion, 51.2%, of the observed variance.

MULTIPLE REGRESSION

Dependent Variable.. GRADE WHAT DO YOU THINK OF THE EXPERIMENT

Multiple R .68623
R Square .47092
Adjusted R Square **.46988**
Standard Error .77417
F = 452.15319 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
DIFFRT	-.104104	.046349	-.053295	-2.246	**.0249**
FASTER	.694405	.024603	.669714	28.225	**.0000**
(Constant)	3.583124	.061766		58.011	**.0000**

GRADE = 3.58 -0.10 × DIFFRT + 0.69 × FASTER

Dependent Variable.. GRADE WHAT DO YOU THINK OF THE EXPERIMENT

Multiple R .68710
R Square .47210
Adjusted R Square **.47107**
Standard Error .77290
F = 456.54066 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
REROUTE	-.189388	.085991	-.051727	-2.202	**.0279**
FASTER	.696112	.024317	.672321	28.626	**.0000**
(Constant)	3.480219	.027355		127.223	**.0000**

GRADE = 3.48 -0.19 × REROUTE + 0.70 × FASTER

Dependent Variable.. GRADE WHAT DO YOU THINK OF THE EXPERIMENT

Multiple R .68578
R Square .47029
Adjusted R Square **.46925**
Standard Error .77422
F = 453.23482 Signif F = .0000

Variable	B	SE B	Beta	T	Sig T
FASTER	.701361	.024611	.677390	28.498	**.0000**
NOSEEN	-.063533	.054806	-.027555	-1.159	.2466
(Constant)	3.480285	.031876		109.182	**.0000**

GRADE = 3.48 -0.06 × NOSEEN + 0.70 × FASTER

Appendix E: Newspaper Articles on Experiment

Items 1 to 6: Honolulu press, editorials, etc. on the Lunalilo St. on-ramp closure experiment in 1997

Item 7: Experimental multiple ramp closures in Chicago, Illinois in 1997

Rower arrives from California. A-4

Honolulu Star-Bulletin
Hawaii

Waipio Valley group wants ditch water diverted from streams returned. A-5

Lunalilo on-ramp closed mornings

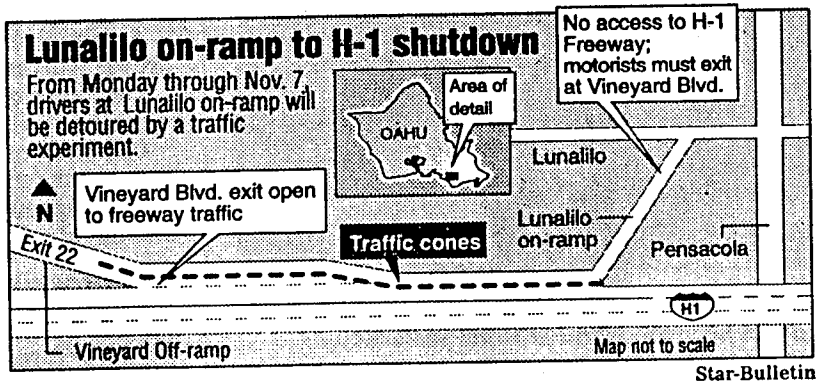
Westbound commuters will have to enter H-1 elsewhere through Nov. 7

BY MARY ADAMSKI
Star-Bulletin

Here's a message for morning commuters who take the Lunalilo Street on-ramp to head west on the H-1 freeway: detour ahead.

There will be no access to the freeway at that busy midtown ramp during morning rush hour starting Monday. The ban will continue between 5:30 and 10 a.m. on weekdays through Nov. 7.

Motorists who drive onto the ramp will be required to continue in the lane that leads to Vineyard Boulevard. From there, westbound access to the freeway is possible at Punchbowl Street, Aala Street or at the Palama end of Vineyard.



Star-Bulletin

Motorists will still be able to leave the freeway using that Vineyard off-ramp.

The change is expected to reduce congestion and increase the speed of traffic on the freeway through town. It's all part of a Department of Transportation experiment to determine the effects on traffic flow with just that one factor removed.

"We are seriously looking at a number of conflicting on- and off-ramps and what can be done, things people have been complaining about for years," said department spokeswoman Marilyn Kali. The study will look at the oldest stretch of freeway through Honolulu, which has several spots where on- and off-ramps are very close and "there is a constant conflict of movement," she said. "There is a lot of conflict that slows traffic in that area."

The study, funded by the state Legislature, will continue for the next three years, with other ramp-closing experiments likely.

Key to the study is a computer model put together by the University of Hawaii department of civil engineering. The program used data collected from vehicle counts and video surveys in that area to project what will happen to the traffic pattern from 11th Avenue to Pali Highway, Kali said.

"We are testing the computer simulation to see if we can trust the assumptions," Kali said. "The computer model shows that when we do this, it will have a tremendous effect. It will increase the average vehicle speed and reduce the congestion by just making this one change. We need to test if the computer model is reliable."

"We're only doing it in the morning. What kind of effect it will have on people who use it is what we want to find out.

"We are not talking about closing it permanently."

VICH

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The Honolulu Advertiser
HAWAII
B
Tuesday, October 28, 1997
City Desk: 525-8090

Closing on-ramp speeds traffic

READERLINE

"How did the closing of the Lunalilo on-ramp affect your morning commute?"

Please call the Advertiser at 525-5464.

State testing plan that stops merge from Lunalilo to H-1

By Lynda Arakawa
Advertiser Staff Writer

Closing the H-1 Freeway Lunalilo Street on-ramp yesterday morning speeded westbound traffic, and would probably save motorists time if it were done regularly, the state Department of Transportation said yesterday.

On the first day of a two-week experiment, the agency began judging the effect of eliminating the merging of cars from the Lunalilo on-ramp, which shares space with the Vineyard Boulevard off-ramp.

"You have a significant problem with people trying to get on and people trying to get off, all within a close distance," said Marilyn Kali, department spokeswoman. "When it was first built back in the '50s it was fine, but we had less than half the cars we do now."

During the testing period, westbound motorists on Lunalilo Street still stream past the Makiki post office and up the H-1 ramp. But instead of being allowed to merge onto the freeway, they are led by traffic cones onto the Vineyard Boulevard off-ramp.

From there they can get on the H-1 via on-ramps at Punchbowl or Aala streets.

The on-ramp will be coned weekdays from 5:30 to 10 a.m. until Nov. 7.

Kali said things seemed to move smoothly yesterday.

"Left and center lanes did seem from the air to move faster than normal. The right lane where you get off obviously was a little slower. We think as the experiment progresses over the next two weeks we should expect to find time savings.

"A lot of people were trying to figure out what was happening," Kali noted, "slowing down to read the signs, trying to find out how the cones got them onto the Vineyard off-ramp.

"But all in all for a first day it went pretty well. We think people will get used to it in the next day or so."

About half a dozen people called the department yesterday, she said, some praising the change and a few saying it was inconvenient. One Makiki resident said the traffic lights on Vineyard Boulevard need to be synchronized better.

Police reported no problems.

Kali said her department would evaluate the change using camera and aerial observations and traffic counts. The study will test a computer model developed at the University of Hawaii that showed significant improvements in traffic flow from closing the on-ramp.

If the model proves to be accurate, it can be used to evaluate other on- and off- ramps and major commute arteries such as King, Beretania, Ward and Piikoi streets.

Partaking in the Pali experience

Estate shares plan with faculty

CHILD ABUSE

Let common sense dictate what to do

Every thinking person in Hawaii should second Caroline Halovsky's call for common-sense wisdom in dealing with child abuse ("If they use drugs, they can't be trusted," Letters, Oct. 26).

Let's take it a step beyond moral support, though. I suggest the establishment of a Department of Common Sense. Every law, every judicial decision, every bureaucratic regulation, every interpretation of any law, rule, or regulation by anyone in the state and county governments would need the DOCS stamp of approval before becoming effective.

Who would run DOCS? Volunteers from among Hawaii's common-sense community. This would automatically eliminate all experts, professionals, lawyers, politicians, judges, bureaucrats, and their associates.

Bob Biggs

Foster care isn't a magic answer

Once again we are faced with the tragic abuse of a child, followed by the usual round of finger-pointing and calls for investigations and studies. Attorney Herbert Hamada was right: There is no magic answer ("Abuse team shocked guaranteeing safety from harm.

It stands to reason that drug addiction and proper parenting are not compatible. However, as long as they are making an honest effort to get back their children, should these parents be denied that right?

It takes a simple court order to remove children from their parents. It is many times more difficult to re-unite them.

Garret H. Yanagi, Ph.D.
Clinical psychologist

TRAFFIC

Downtowners don't need Lunalilo ramp

Having an off-ramp just after an on-ramp at Lunalilo slows up the overall flow of our freeway, particularly when combined with the less-than-courteous behavior of many motorists who won't allow merging traffic in front of them. It is no surprise that opinions are mixed on the experimental closure of the Lunalilo on-ramp to H-1.

Traffic that is generally backed up for miles could be greatly improved by fully closing the Lunalilo on-ramp.

Traffic trying to get to downtown from Lunalilo Street simply should not be entering this high-traffic exit during morning rush hour, but should be directed to Beretania Street via Pensacola or Ward.

Alexander C. Kinzler

Honolulu Star-Bulletin
Hawaii
NOVEMBER 8, 1997 · SATURDAY AFTERNOON · PAGE A-

Office of Hawaiian Affairs prepares for next legislative session. A-4

Company will continue to operate City Store for at least 30 days. A-4

Lunalilo closure experiment yields disappointment

Time saved by closing the on-ramp fell short of anticipated results

BY ALAN MATSUOKA
Star-Bulletin

Results are unofficial, but the experimental closure of the Lunalilo Street on-ramp apparently was not as successful as predicted, the state Transportation Department said.

The idea behind the two-week experiment was that closing the ramp during the morning rush hour — and routing vehicles to on-ramps farther on — would help speed traffic and reduce congestion on the H-1 freeway passing through town.

The department had anticipated about a 25 percent increase in speed and, as a result, a 15 percent increase in capacity, a spokeswoman said yesterday, the last day of the experiment.

That would translate into time savings for the typical commuter.

Instead, it initially appears that speed and capacity improved only about 5 percent to 10 percent, said spokeswoman Marilyn Kali.

"I think just from a first quick analysis, we didn't seem to get the time savings that we had hoped for," Kali said. "We had hoped for about five minutes, and I don't think we got that."

The Lunalilo on-ramp will return to normal Monday, allowing traffic to merge onto the freeway. The department said a final analysis will take about two months to complete and include data from several sources, including test drivers and videotape shot from a helicopter.

Drivers along various on- and offramps also will be handed survey forms by the department on Thursday and Friday, asking how the experiment affected them. Until the analysis is finished, no decision will be made on whether to make the ramp closure permanent or not.

Kali said the results were affected by crashes or stalled cars on three separate days, and the city's decision to close down a lane on Punchbowl Street for resurfacing.

Perhaps a dozen people called the department, with more expressing positive comments, she said. But Makiki residents closest to the on-ramp "thought it was a terrible idea."

The experiment essentially was a test to see if predictions from a University of Hawaii computer model were valid, Kali said.

If the final analysis shows they were not, then the model will have to be "tweaked," she said.

The Honolulu Advertiser
Final Edition
On Oahu 50¢

Ramp closure saved 2 minutes

Results of experiment analyzed

By Mike Gordon
Advertiser Staff Writer

Two minutes.

That's about all the time saved in the morning by westbound commuters subjected to a state Department of Transportation experiment that closed the Lunalilo Street on-ramp to the H-1 Freeway. The 10-day test concluded yesterday.

Traffic planners were hoping for a five-minute saving, said Marilyn Kali, department spokeswoman, but it's too early to pronounce the experiment a failure.

Transportation officials and members of the University of Hawaii's civil engineering department will analyze data over the next few months.

They ran the experiment to judge a computer model that the civil engineers designed to predict time savings and freeway speeds. They want to know if the computer model is dependable, Kali said.

But they didn't count on three accidents, a city repaving job along Punchbowl Street, rubbernecking drivers slowing down to read warning signs, and a whole bunch of motorists running over the traffic cones marking the route.

"They just knocked them down," Kali said. "Almost every half hour they had to go back and reset the cones. We don't know why people did that."

The experiment used traffic counting devices, video cameras and test drivers traveling

See Ramp, Page A2

Ramp: Closure saved commuters only 2 minutes

FROM PAGE ONE

on specific routes at specific times.

During the test, westbound motorists on Lunalilo Street were allowed to drive past the Makiki post office and up the H-1 ramp. But instead of being allowed to merge onto the freeway, they were led, by the placement of traffic cones, onto the Vineyard Boulevard off-ramp and onto other freeway on-ramps.

Kali said traffic times decreased about 5 percent for commutes between 11th Avenue and the Pali Highway, and about 10 percent from 11th Avenue and the Likelike. Also, some drivers noticed faster times along Vineyard Boulevard.

"From the calls we got, we had more people in favor of this," Kali said. "We had a few people who expressed concerns because they thought we were discriminating against Makiki residents."

The busy section of H-1 was built in 1950s when Oahu had fewer than half the cars it has now.

Kali said a follow-up survey will be handed out at 16 locations on Thursday and Friday mornings. Nine thousand questionnaires will be distributed.

KOKUA LINE

By June Watanabe

▲▲▲

Traffic lights considered at on-ramps

QUESTION: Why doesn't the city put stoplights at certain freeway on-ramps, like they do in California? One example is when cars enter the freeway on the Lunalilo on-ramp, where there's also an off-ramp. Another example is the Punahou off- and on-ramp. I think traffic would flow easier.

ANSWER: It's the state that would decide such matters, and it turns out that the Department of Transportation is considering installing "ramp metering traffic control signals" at certain freeway entrances.

But, first, it plans to conduct a study on the feasibility of installing ramp meters on the H-1, H-2 and Moanalua freeways, said transportation spokeswoman Marilyn Kali.

The study would be part of the Akamai Highway Information program, which seeks "to increase the operational efficiency of our freeways," she said.

Kali also noted there are federal guidelines regarding freeway ramp controls, such as doing an engineering analysis of the physical and traffic conditions of the highway; determining freeway capacity and demand/capacity for each freeway section; and giving consideration to public acceptance and enforcement requirements of ramp controls, as well as alternate means of increasing the capacity, reducing the demand or improving the characteristics of the freeway.

KENNEDY PLAN HAS OPPOSITION IN GREEKTOWN

By Jon Hilkevitch, Tribune Transportation Writer
Web-posted Wednesday, December 3, 1997; 6:04 a.m. CST

Hoping to finally undo the work of ramp-happy highway design engineers of the 1950s, Chicago and state transportation officials held hearings Tuesday to gauge public reaction to a plan that would eliminate one-fourth of the 23 ramps on a milelong downtown section of the Kennedy Expressway.

The $29 million project would permanently close six tightly spaced entrance and exit ramps on the Kennedy (Interstate Highway 90/94) from Hubbard Street to the Eisenhower Expressway (I-290). It also would rehabilitate seven deteriorating cross-street bridges, modeling them after the newly rebuilt Madison Street span.

The participants at Tuesday's hearings gave the plan high marks for improving safety by streamlining traffic flow; mixed reviews in terms of too much extra traffic being funneled to nearby thoroughfares; and harsh criticism for the anticipated economic impact on nearby businesses.

Under the plan, the following six ramps would be closed:
- NB and SB Kennedy entrances from Monroe Street.
- NB Kennedy exit to Monroe.
- NB and SB Kennedy entrances from Washington Street.
- SB Kennedy exit to Adams Street.

Many remaining ramps would be redesigned to improve the turning radius for trucks, and the ramps would be lengthened to ease merging into traffic on and off the Kennedy, which handles about 250,00 vehicles each weekday.

Pointing to an aerial map depicting an improved Monroe Street ramp to the Eisenhower, Peter Godowski, a consultant project manager with the Illinois Department of Transportation, said, "You're getting an added block of safety where people have the extra seconds to weave in more carefully, instead of jumping into moving traffic abruptly."

Opposition to the plan was strongest among business owners in Greektown, who complained that closing the Adams Street exit ramp would run counter to private and city-funded investment in recent years in the Halsted Street neighborhood. These entrepreneurs were not appeased by fancy graphics and officials who redicted that visitors to the area's restaurants and shops would know to use exits at Monroe, Madison or Randolph Streets if the Adams ramp were closed.

"With the dot game you play there on the map with the traffic (flow), you forgot to put a way for our customers to get to us," said Maria Melidis, whose family owns the Pegasus

Restaurant & Taverna, 130 S. Halsted St. "I need a fair answer, and not playing the games."

Although officials opposed requests to hold another public hearing before making a final decision on the plan, "a follow-up meeting of some kind will be held in the next two weeks and (the public's) concerns will be addressed," said Barbara Maloof, a spokeswoman for the Chicago Department of Transportation. A decision on the plan is expected by early next year.

The proposal presented by the state and city transportation departments followed a pilot study during which the six ramps were temporarily closed for a week in early July. Although some motorists were forced to adjust their commuting routes, police reported improved traffic flow, fewer accidents and a drop in lane-weaving maneuvers near the ramps.

D. James, a West Side resident who did not want his first name used, said he attended Tuesday's hearing primarily to "make sure that all these millions of dollars are being spent wisely. But I support the changes, despite the inconveniences," James said. "Merging into expressway traffic from the left-hand ramp on Monroe is not my idea of a good time."

All ramps will remain open until the last year of the bridge portion of the project, said Michael Matkovic, an IDOT engineer. Work on the Adams Street bridge would begin early next year, followed by the bridges over Lake and Van Buren Streets in 1999, the bridges over Randolph and Jackson Streets in 2000 and the spans over Washington and Monroe Streets in 2001.

Appendix F: Act 263, Session Laws of Hawaii 1999

ACT 263

CONFERENCE COMMITTEE REPORT NO. 22

Honolulu, Hawaii
April 29, 1999

RE: S.B. No. 709
S.D. 1
H.D. 2
C.D. 1

Honorable Norman Mizuguchi
President of the Senate
Twentieth State Legislature
Regular Session of 1999
State of Hawaii

Honorable Calvin K.Y. Say
Speaker, House of Representatives
Twentieth State Legislature
Regular Session of 1999
State of Hawaii

Sir:

Your Committee on Conference on the disagreeing vote of the Senate to the amendments proposed by the House of Representatives in S.B. No. 709, S.D. 1, H.D. 2, entitled:

"A BILL FOR AN ACT RELATING TO TRAFFIC ENFORCEMENT,"

having met, and after full and free discussion, has agreed to recommend and does recommend to the respective Houses the final passage of this bill in an amended form.

The purpose of this measure is to allow use of a photo technology system to enforce the violation of unlawful crossing of longitudinal lane markings in conjunction with the photo red light and speed imaging detector demonstration project.

Upon further consideration, your Committee on Conference has amended this measure by using the Senate Draft of the bill. This draft was further amended by:

(1) Changing the procedures relating to rebutting prima facie evidence of a traffic violation obtained pursuant to the photo technology system establishing that the

registered owner was the operator of the vehicle during a violation of the applicable traffic laws. As amended, the prima facie evidence may be rebutted by submission of a declaration under penalty of perjury signed by both the registered owner and the vehicle operator. The declaration shall state the name, current address, and driver's license number of the vehicle operator and a description of the violation. Within forty-eight hours of receiving this information, the contractor or appropriate county police department shall cause a summons or citation to be mailed to the operator of the vehicle;

(2) Deleting language that limited use of a photo technology system in any one location from thirty minutes after sunrise to thirty minutes before sunrise; and

(3) Making technical, nonsubstantive changes for purposes of clarity and consistency.

Your Committee on Conference is in accord with the intent and purpose of S.B. No. 709, S.D. 1, H.D. 2, as amended herein, and recommends that it pass Final Reading in the form attached hereto as S.B. No. 709, S.D. 1, H.D. 2, C.D. 1.

Respectfully submitted,

MANAGERS ON THE PART OF THE HOUSE

KENNETH T. HIRAKI, Co-Chair

KENNY GOODENOW, Co-Chair

BOB NAKASONE, Member

MANAGERS ON THE PART OF THE SENATE

CAL KAWAMOTO, Co-Chair

MATTHEW M. MATSUNAGA, Co-Chair

ROBERT BUNDA, Member

K. MARK TAKAI, Member

LES IHARA, JR., Member

GALEN FOX, Member

RANDY IWASE, Member

SAM SLOM, Member

THE SENATE
TWENTIETH LEGISLATURE, 1999
STATE OF HAWAII

S.B. NO. 709 S.D. 1 H.D. 2 C.D. 1

A BILL FOR AN ACT

RELATING TO TRAFFIC ENFORCEMENT.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF HAWAII:

SECTION 1. The legislature finds that there is a need to reduce traffic congestion on Hawaii's roads through the stricter enforcement of traffic control laws.

In 1998, a three-year demonstration project was established that used new photo technologies to catch drivers who run red lights or exceed the posted speed limit on Hawaii's roads. In particular, Act 234, Session Laws of Hawaii 1998, established the photo red light imaging and photo speed imaging detector demonstration project, which allows for the testing of these technologies by private contractors and, among other things, for the mailing of citations to violators rather than requiring the citation to be physically given to the violator.

The purpose of this Act is to amend Act 234 to allow for the use of other photo technologies, such as hand-held or mounted video cameras, conventional cameras, and digital cameras, other than photo speed imaging detectors and photo red light imaging devices, to produce photographic identification of vehicles that illegally cross longitudinal traffic lane markings. In addition, this Act amends the demonstration project to close a loop hole

with respect to registered owners of vehicles who are not the operators of the vehicle at the time of the alleged violation. Finally, this Act amends the traffic code to allow for the mailing of traffic citations to violators on access control roads to provide for greater enforcement of the traffic laws, reduce the potential for accidents, and speed up traffic flow.

PART I

SECTION 2. Section 286-45, Hawaii Revised Statutes, is amended by amending subsection (b) to read as follows:

"(b) Any private contractor that has entered into a contract with a county to implement the [photo red light imaging and photo speed imaging detector] traffic enforcement demonstration project pursuant to [[]section 5 et seq. of[]] Act 234, Session Laws of Hawaii 1998, may obtain from the county finance director the names and addresses of registered motor vehicle owners, which shall be used only as is necessary to carry out the provisions of the contract and the purposes of that Act and may not otherwise be publicly disclosed."

SECTION 3. Section 286-172, Hawaii Revised Statutes, is amended by amending subsection (a) to read as follows:

"(a) Subject to authorization granted by the chief justice with respect to the traffic records of the violations bureaus of the district courts and of the circuit courts, the director of

transportation shall furnish information contained in the statewide traffic records system in response to:

(1) Any request from a state, a political subdivision of a state, or a federal department or agency, or any other authorized person pursuant to rules adopted by the director of transportation under chapter 91;

(2) Any request from a person having a legitimate reason, as determined by the director, as provided under the rules adopted by the director under paragraph (1), to obtain the information for verification of vehicle ownership, traffic safety programs, or for research or statistical reports;

(3) Any request from a person required or authorized by law to give written notice by mail to owners of vehicles; or

(4) Any request from a private contractor that has entered into a contract with a county as may be necessary to implement the [photo red light imaging and photo speed imaging detector] traffic enforcement demonstration project pursuant to [] section 5 et seq. of [] Act 234, Session Laws of Hawaii 1998. The private contractor may obtain from the director of transportation the names and addresses of registered motor vehicle owners,

which shall be used only as is necessary to carry out the provisions of the contract and the purposes of that Act and may not otherwise be publicly disclosed."

SECTION 4. Section 291C-38, Hawaii Revised Statutes, is amended by amending subsection (c) to read as follows:

"(c) Longitudinal traffic lane markings shall have the following applications:

(1) A broken white line is used to indicate the edge of the traffic lane where travel is permitted in the same direction on both sides of the line and may be crossed by vehicular traffic when the crossing can be made with safety.

(2) A broken yellow line is used to indicate the left edge of a traffic lane where traffic on the other side of the line moves in the opposite direction and may be crossed by vehicular traffic only when overtaking or passing a vehicle proceeding in the same direction or when executing a left turn and then only if the movement can be made with safety and does not interfere with traffic moving in the opposite direction.

(3) A solid white line is used to indicate the edge of the traffic lane where travel in the same direction is permitted on both sides of the line but where movement

from lane to lane is considered to be hazardous. A solid white line may be crossed only in unusual circumstances and then only with great care. A double width solid white line is used to emphasize a greater degree of hazard.

(4) A solid white line is also used to indicate the right edge of the pavement.

(5) A double solid white line is used to indicate the edges of traffic lanes where travel in the same direction is permitted on both sides of the double line but where movement from lane to lane is considered to be dangerous. The crossing of a double solid white line by vehicular traffic is prohibited.

(6) A solid yellow line is used to indicate the left edge of a traffic lane where overtaking and passing on the left is prohibited. The crossing of a solid yellow line by vehicular traffic is prohibited except when the crossing is part of a left turn movement.

(7) A solid yellow line is also used to indicate the left edge of each roadway of a divided street or highway.

(8) A double solid yellow line is used to indicate the separation between lanes of traffic moving in opposite directions. The crossing of a double solid yellow line

by vehicular traffic is prohibited except when the crossing is part of a left turn movement.

(9) A double line consisting of a broken yellow line and a solid yellow line is used to indicate a separation between lanes of traffic moving in opposite directions and vehicular traffic adjacent to the broken line is permitted to overtake or pass if the movement can be made with safety and does not interfere with traffic moving in the opposite direction. The crossing of this double line by vehicular traffic adjacent to the solid line is prohibited except when the crossing is part of a left turn movement.

(10) A double broken yellow line is used to indicate the edge of a reversible traffic lane where the direction of the vehicular traffic may be changed from time to time.

(11) A dotted line is used to indicate the extension of a line through an intersection or interchange. It shall be the same color as the line it extends. [The] Unless authorized by a traffic-control device or a traffic or police officer under section 291C-31, the crossing of a dotted line by vehicular traffic is subject to the same prohibitions and exceptions as are applicable to the

line it extends.

(12) A solid white line when supplemented by official signs or pavement markings, is used to indicate the separation of bicycle lanes from lanes of vehicular traffic flowing in the same direction. Except as allowed under section 291C-123, vehicles other than bicycles shall be prohibited from operating in a bicycle lane."

SECTION 5. Section 291C-163, Hawaii Revised Statutes, is amended by amending subsection (a) to read as follows:

"(a) This chapter shall not be deemed to prevent counties with respect to streets and highways under their jurisdiction from:

(1) Regulating or prohibiting stopping, standing, or parking except as provided in section 291C-111;

(2) Regulating traffic by means of police officers or official traffic-control devices;

(3) Regulating or prohibiting processions or assemblages on the highways;

(4) Designating particular highways or roadways for use by traffic moving in one direction;

(5) Establishing speed limits for vehicles in public parks;

(6) Designating any highway as a through highway or

designating any intersection as a stop or yield intersection;

(7) Restricting the use of highways;

(8) Regulating the operation and equipment of and requiring the registration and inspection of bicycles, including the requirement of a registration fee;

(9) Regulating or prohibiting the turning of vehicles or specified types of vehicles;

(10) Altering or establishing speed limits;

(11) Requiring written accident reports;

(12) Designating no-passing zones;

(13) Prohibiting or regulating the use of controlled-access roadways by any class or kind of traffic;

(14) Prohibiting or regulating the use of heavily traveled streets by any class or kind of traffic found to be incompatible with the normal and safe movement of traffic;

(15) Establishing minimum speed limits;

(16) Designating hazardous railroad grade crossing;

(17) Designating and regulating traffic on play streets;

(18) Prohibiting pedestrians from crossing a roadway in a business district or any designated highway except in a crosswalk;

(19) Restricting pedestrian crossing at unmarked crosswalks;

(20) Regulating persons propelling push carts;

(21) Regulating persons upon skates, coasters, sleds, and other toy vehicles;

(22) Adopting and enforcing such temporary or experimental regulations as may be necessary to cover emergencies or special conditions;

(23) Adopting maximum and minimum speed limits on streets and highways within their respective jurisdictions;

(24) Adopting requirements on stopping, standing, and parking on streets and highways within their respective jurisdictions except as provided in section 291C-111;

(25) Entering into an agreement with any private contractor to implement the [photo red light imaging and photo speed imaging detector] traffic enforcement demonstration project pursuant to [[]section 5 et seq. of[]] Act 234, Session Laws of Hawaii 1998; or

(26) Adopting such other traffic regulations as are specifically authorized by this chapter."

SECTION 6. Section 291C-165, Hawaii Revised Statutes, is amended by amending subsection (b) to read as follows:

"(b) In every case when a citation is issued, the original of the citation shall be given to the violator[, or in]; provided

that:

(1) In the case of an unattended vehicle, the original of the citation shall be affixed to the vehicle as provided for in section 291C-167[, or in]; or

(2) In the case of [a]:

(A) A vehicle utilizing the high occupancy vehicle lane illegally[,]; or

(B) A traffic or other violation on a controlled access facility that is recorded through the use of a hand-held or mounted video camera, conventional camera, or digital camera that produces photographic identification of a vehicle,

the original of the citation shall be sent by certified or registered mail, with a return receipt that is postmarked within forty-eight hours of the time of the incident, to the registered owner of the vehicle at the address on record at the vehicle licensing division as provided in section 291C-223. If the end of the forty-eight hour period falls on a Saturday, Sunday, or holiday, then the ending period shall run until the end of the next day which is not a Saturday, Sunday, or holiday; provided that the administrative judge of the district courts may allow a carbon copy of the citation

to be given to the violator or affixed to the vehicle and provide for the disposition of the original and any other copies of the citation."

PART II

SECTION 7. Act 234, Session Laws of Hawaii 1998, is amended as follows:

1. By adding a new section 1A to read:

"SECTION 1A. The legislature finds that there is a need to reduce traffic congestion during rush hour, particularly on controlled access facilities such as the H-1 freeway on Oahu.

In some instances, vehicles that illegally cross certain longitudinal traffic lane markings create hazardous driving situations that slow down traffic, thereby adding to rush hour congestion. Current law, however, requires police officers in these instances to pull over violators and hand them a ticket. Requiring police officers to pull vehicles over is both counterproductive -- it simply increases traffic congestion as motorists rubberneck to see why someone was being pulled over -- as well as extremely dangerous on the freeway. The legislature therefore finds that in situations involving illegal crossing of longitudinal traffic lane markings, conventional enforcement methods are dangerous and delay law-abiding drivers. However, in these situations existing law does not allow for citations to be

mailed to violators.

In other instances, the existing design of the H-1 freeway is inadequate to handle the large volume of traffic during rush hour. These situations can be corrected in some instances by the use of signs, traffic cones, and other traffic control devices to route vehicles in a manner that tends to reduce traffic congestion. For example, the state department of transportation has used traffic control devices to prohibit vehicles from crossing over certain lanes on the H-1 freeway at the Lunalilo Street on-ramp as an experiment to see how traffic flows on H-1 if cars are prohibited from merging into the H-1 traffic at that on-ramp. While the department found that the traffic control devices significantly improved the flow of traffic, which could speed up the morning and afternoon commute into downtown Honolulu, there are two potential problems with this approach.

The first problem is that existing law needs to be changed to allow for the police or traffic control devices to direct motorists not to cross the dotted lines on certain lanes during specified hours. Second, in trial runs, many drivers simply ignored cones or posted signs and crossed over into the prohibited lanes anyway. In order to effectively change these motorists' driving behavior, a further change in the law is necessary to allow for traffic enforcement through video

surveillance that would allow for the mailing of traffic citations rather than requiring officers to pull motorists over in traffic to hand them a ticket.

The legislature finds that hand-held or mounted video cameras, conventional cameras, or digital cameras, can be used to produce photographic identification of vehicles that illegally cross longitudinal traffic lane markings. These photo systems could be operated by police officers or could be contracted out to a private contractor."

2. By amending section 5 by adding a new definition to be appropriately inserted and to read:

""Photo technology system" means hand-held or mounted video cameras, conventional cameras, or digital cameras, other than photo speed imaging detectors or photo red light imaging devices, that are used to improve traffic enforcement and reduce traffic congestion by producing photographic identification of a vehicle which crosses longitudinal traffic lane markings in violation of section 291C-38(c)."

3. By amending section 6 to read:

"SECTION 6. **[Photo red light imaging and photo speed imaging detector] Traffic enforcement demonstration project.** (a) Subject to this Act, each county may establish a three-year demonstration project in selected areas of that county to provide

for the implementation of photo red light imaging, [and] photo speed imaging detector, or photo technology systems to improve traffic enforcement as provided in this Act. The demonstration project shall be limited to state or county highways and shall document the effectiveness of these systems. The contractor shall provide a public information campaign to inform local drivers about the use of [the photo red light imaging and photo speed imaging detector] these systems before any citation or summons is actually issued.

(b) Notwithstanding any other law to the contrary, the demonstration project may include the use of photo technology systems in addition to photo red light imaging or photo speed imaging detector systems, including hand-held or mounted video cameras, conventional cameras, or digital cameras to improve traffic enforcement and reduce traffic congestion, particularly on controlled access facilities on Oahu. These photo technology systems:

(1) May be operated by either private contractors or county police department personnel at the election of the police chief of each county;

(2) Shall be used only to produce photographic identification of vehicles which are operated in violation of section 291C-38(c), Hawaii Revised

Statutes, regarding longitudinal traffic lane markings."

4. By adding a new section 8A to read:

"SECTION 8A. **Photo technology systems.** (a) Subject to this Act, each county may establish photo technology systems imposing monetary liability on the registered owner of a motor vehicle for failure to comply with section 291C-38(c), Hawaii Revised Statutes, regarding longitudinal traffic lane markings, in accordance with this Act. Each county may provide for the installation and operation of photo technology systems on no more than twenty-five state or county highways at any one time in any county; provided that these systems shall primarily be used on controlled access facilities on Oahu.

(b) Proof of a violation of section 291C-38(c), Hawaii Revised Statutes, shall be evidenced by information obtained from the photo technology systems authorized pursuant to this Act. A certificate, sworn to or affirmed by the contractor or the contractor's agent or employee, or a facsimile thereof, based upon inspection of photographs, microphotographs, videotape, or other recorded images produced by the system, shall be prima facie evidence of the facts contained therein. Any photographs, microphotographs, videotape, or other recorded images, including digitally produced images, evidencing a violation shall be

available for inspection in any proceeding to adjudicate the liability for that violation.

(c) A contractor may issue a citation or summons pursuant to section 10 of this Act on the basis of a photo technology system if the following conditions are met:

(1) The photo technology system is operated by a uniformed police officer or a contractor who is authorized to operate that system pursuant to this Act;

(2) Signs indicating that a photo technology system is in use are posted on all major routes entering the area in question, as far as practicable, providing notice to a motorist that such a system may be used; and

(3) The photo technology system is used for no more than four hours per day in any one location.

The conditions specified in this subsection shall not apply when the information gathered is used for highway safety research or to issue warning citations not involving a fine, court appearance, or a person's driving record."

5. By amending subsection (a) of section 9 to read:

"(a) Each county shall designate locations on state or county highways in that county that are appropriate for the installation of:

(1) Photo red light imaging or photo technology systems,

with the assistance of the director; and

(2) Photo speed imaging detector systems, without the assistance of the director."

6. By amending subsection (a) of section 10 to read:

"(a) Notwithstanding any law to the contrary, whenever any motor vehicle is determined by means of:

(1) The photo red light imaging system to have disregarded a steady red signal in violation of section 291C-32(a)(3), Hawaii Revised Statutes; [or]

(2) The photo speed imaging detector system to be in excess of the legal speed limit in violation of section 291C-102, Hawaii Revised Statutes[,]; or

(3) The photo technology system to have crossed longitudinal traffic lane markings in violation of section 291C-38(c), Hawaii Revised Statutes,

the contractor shall cause a summons or citation as described in this section to be sent by certified or registered mail, with a return receipt that is postmarked within forty-eight hours of the time of the incident, to the registered owner of the vehicle at the address on record at the vehicle licensing division. If the end of the forty-eight hour period falls on a Saturday, Sunday, or holiday, then the ending period shall run until the end of the next day which is not a Saturday, Sunday, or holiday."

7. By amending section 11 to read:

"SECTION 11. **Registered owner's responsibility for a summons or citation.** In any proceeding for a violation of this Act, the information contained in the summons or citation mailed in accordance with section 291C-165(b), Hawaii Revised Statutes, or section 10 of this Act shall be deemed evidence that the registered vehicle violated section 291C-32(a)(3), 291C-38(c), or 291C-102, Hawaii Revised Statutes."

8. By amending section 12 to read:

"SECTION 12. **Prima facie evidence.** (a) Whenever [the] a citation for violation of chapter 291C, Hawaii Revised Statutes, is issued pursuant to section 291C-165, Hawaii Revised Statutes, or whenever a photo red light imaging system, photo technology system, or [the] photo speed imaging detector system determines a motor vehicle to be in violation of section 291C-102, 291C-38(c), or 291C-32(a)(3), Hawaii Revised Statutes, as applicable, evidence that the motor vehicle described in the citations or summons issued pursuant to this Act was operated in violation of those sections of the Hawaii Revised Statutes, together with proof that the person to whom the summons or citation was sent was the registered owner of the motor vehicle at the time of the violation, shall constitute prima facie evidence that the registered owner of the motor vehicle was the person who

committed the violation.

(b) The registered owner of the vehicle may rebut the prima facie evidence in subsection (a) by:

(1) Submitting a written statement as provided in section 291D-6(b)(2), Hawaii Revised Statutes; provided that, if the registered owner alleges that another person was operating the vehicle at the time of the alleged violation, then the registered owner shall submit a declaration under penalty of perjury signed by both the registered owner and the vehicle operator. The declaration shall state the name, current address, and driver's license number of the vehicle operator at the time of the alleged violation along with the date, time, place, and nature of the alleged violation. Within forty-eight hours of receiving this information contained in the declaration, the contractor or the appropriate county police department shall cause a summons or citation to be mailed to the operator as provided in section 291C-165, Hawaii Revised Statutes, or section 10 of this Act;

(2) Testifying in open court under oath that the [person] registered owner was not the operator of the vehicle at the time of the alleged violation[; or], in which case

the registered owner shall submit to the court a declaration under penalty of perjury signed by both the registered owner and the vehicle operator. The declaration shall state the name, current address, and driver's license number of the vehicle operator at the time of the alleged violation along with the date, time, place, and nature of the alleged violation. Within forty-eight hours of receiving this information, the contractor or the appropriate county police department shall cause a summons or citation to be mailed to the operator as provided in section 291C-165, Hawaii Revised Statutes, or section 10 of this Act;

(3) Presenting, prior to the return date established on the citation or summons issued pursuant to this Act, a letter of verification of loss from the police department to the court adjudicating the alleged violation[.]; or

(4) Submitting an affidavit, prior to the return date established on the citations or summons issued pursuant to this Act, that the vehicle in question was a rental or U-drive vehicle subject to section 14 of this Act."

9. By amending section 15 to read:

"SECTION 15. **Penalty.** The penalties for all consequences

of a violation for speeding initiated by the use of a photo speed imaging detector system, [or] for disregarding a steady red signal initiated by the use of a photo red light imaging system, or for illegally crossing longitudinal traffic lane markings initiated by the use of a photo technology system shall be as provided in section 291C-161, Hawaii Revised Statutes."

10. By amending subsection (a) of section 16 to read:

"(a) The department shall develop a request for proposals to purchase, lease, rent, use, install, maintain, and operate photo red light imaging [and], photo speed imaging detector, or photo technology systems in any county as provided in this Act. The request for proposals and all aspects of the contract shall be subject to chapter 103D, Hawaii Revised Statutes."

11. By amending subsections (a) and (b) of section 17 to read:

"(a) Each county, with prior approval from the department, may contract with one or more contractors to purchase, lease, rent, use, install, maintain, and operate photo red light imaging [and], photo speed imaging detector, or photo technology systems as provided in this Act.

(b) Notwithstanding any other law to the contrary, the contractor shall provide the following services and activities to implement the photo speed imaging detector [and], photo red light

imaging, or photo technology systems:

(1) Equipment installation;

(2) Data processing, including custom software development and integration;

(3) Staffing and training of law enforcement personnel and other persons as necessary to provide for effective traffic enforcement;

(4) Film delivery, retrieval, and processing;

(5) Image evaluation;

(6) License plate identification and verification;

(7) Review of individual motor vehicle registration records, pursuant to sections 286-45 and 286-172, Hawaii Revised Statutes, to obtain access only to the registered motor vehicle owner's name and address; this data shall only be used as is necessary to carry out the provisions of the contract and the purposes of this Act and may not otherwise be publicly disclosed;

(8) Citation generation, processing, and tracking;

(9) Data transfer to agency and court;

(10) Violation and statistical data collection, analysis, and reporting;

(11) Twenty-four-hour support services, consulting, technical assistance, and Internet access;

(12) Community awareness and public relations services; and

(13) Any other services, activities, or equipment deemed necessary by the department and each county.

12. By amending subsection (f) of section 17 to read:

"(f) The department of budget and finance shall create an account and set aside a portion of the revenues received from the fines obtained from citations initiated as a result of the [photo speed imaging detector and photo red light imaging] traffic enforcement demonstration project to offset the contractor's costs of operating the photo speed imaging detector [and], photo red light imaging, and photo technology systems."

13. By amending section 23 to read:

"SECTION 23. **Report.** Each county shall submit interim and final reports to the legislature as follows:

(1) The interim report shall document the progress made in implementing the demonstration project and any contract entered into with a private contractor. The interim report shall be submitted to the legislature no later than twenty days before the convening of the regular sessions of 1999 and 2000; and

(2) The final report shall evaluate the effectiveness of the demonstration project, and shall include the following:

(A) The total fine revenue generated by using the photo speed imaging detector [and], photo red light imaging, or photo technology systems;

(B) The number of citations and summonses issued by the photo speed imaging detector [and], photo red light imaging, or photo technology systems;

(C) The amount paid to the contractor providing the photo speed imaging detector [and], photo red light imaging, or photo technology systems;

(D) The effect of the demonstration project on traffic safety;

(E) The degree of public acceptance of the project;

(F) The process of administration of the project;

(G) An evaluation of the costs and benefits of the project;

(H) A review of the effectiveness of contracts entered into under this Act and the performance of the contractor;

(I) Recommendations for design or planning changes that might reduce traffic congestion on state or county highways; and

(J) Findings and recommendations as to whether to continue any contract entered into pursuant to

this Act, make the project permanent, or adopt another alternative.

The final report shall include any proposed implementing legislation as may be necessary, and shall be submitted to the legislature no later than twenty days before the convening of the regular session of 2001."

SECTION 8. Statutory material to be repealed is bracketed. New statutory material is underscored.

SECTION 9. This Act shall take effect upon its approval.

REPORT TITLE:
Traffic Enforcement

DESCRIPTION:
Amends the photo red light imaging and photo speed imaging detector demonstration project by including other photo technology systems to improve traffic enforcement and reduce traffic congestion by producing photographic identification of a vehicle which crosses longitudinal traffic lane markings. (CD1)