FINAL

Hawaii Red-Light Safety Camera Program Report & Engineering Study

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Prepared for

DEPARTMENT OF TRANSPORTATION • STATE OF HAWAII •

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EXECUTIVE SUMMARY

Vehicle red-light running is a prevalent issue and safety concern throughout the State of Hawaii that has led to numerous crashes, some of which have included serious injuries and fatalities. In an effort to supplement traditional police enforcement, the Hawaii Department of Transportation (HDOT) issued administrative rules (HAR 19-151) for the implementation of a red-light safety camera system (RLSCS). The Hawaii State Legislature subsequently passed Act 30 in September 2020, which identified certain requirements to be implemented prior to installation of RLSCS throughout the State.

HDOT, in collaboration with the City and County of Honolulu Department of Transportation Services (DTS), initiated a contract for the study and implementation of a red-light safety camera system project in urban Honolulu with the goal of reducing severe crashes, personal injuries, and fatalities. Funding has been provided for the implementation of red-light camera systems on 17 approaches at 10 intersections. In accordance with the requirements of Act 30, this engineering study was prepared to evaluate 14 intersections for potential RLSCS application. The study assesses intersection approach factors such as signal head visibility, signal timing, and intersection signage and identifies areas where mitigation is necessary or should be considered. Historical crash data and traffic volumes are considered along with RLSCS constructability in recommending viable and preferred intersection approaches.

After ranking the approaches of all 14 intersections and removing those with major constructability concerns or low volumes, the top 17 approaches for the installation of red-light safety camera systems are identified, spanning a total of 10 intersections. These approaches are highlighted in green in the table below. Prior to installation, baseline existing vehicular red-light running (RLR) will be collected at these approaches over the period of one week, which will aid in determining the effectiveness of these systems post-installation.

Beretania Street at Piikoi Street	**Kapiolani Boulevard at Kamakee Street**	**Vineyard Boulevard at Palama Street**	**Vineyard Boulevard at Pali Highway**
NB Piikoi Street	WB Kapiolani Boulevard	NWB Vineyard Boulevard	NWB Vineyard Boulevard
WB Beretania Street	EB Kapiolani Boulevard	SEB Vineyard Boulevard	SEB Vineyard Boulevard
	NB Kamakee Street	NEB Palama Street	NEB Pali Highway
		SWB Palama Street	SWB Pali Highway
N. King Street at Beretania Street	**S. King Street at Ward Avenue**	**Vineyard Boulevard at Liliha Street**	**Pali Highway at School Street**
NB N. King Street	EB King Street	NWB Vineyard Boulevard	NEB Pali Highway
SB N. King Street	NB Ward Avenue	SEB Vineyard Boulevard	SWB Pali Highway
NWB Beretania Street	SB Ward Avenue	NEB Liliha Street	NWB School Street
		SWB Liliha Street	SEB School Street
Likelike Highway at School Street	**N. King Street at River Street**	**N. King Street at Kohou Street**	**McCully Street at Algaroba Street**
NEB Likelike Highway	SB N. King Street	NWB N. King Street	NEB McCully Street
SWB Likelike Highway	WB River Street	SEB N. King Street	SWB McCully Street
NWB School Street	EB River Street	NEB Kohou Street	NWB Algaroba Street
SEB School Street		SWB Kohou Street	SEB Algaroba Street
	N. King Street at Middle Street	**Vineyard Boulevard at Nuuanu Avenue**	
	SEB N. King Street	NWB Vineyard Boulevard	
	NEB Middle Street	SEB Vineyard Boulevard	
	SWB Middle Street	NEB Nuuanu Avenue	
		SWB Nuuanu Avenue	

I. INTRODUCTION

Red-light running (RLR) has become increasingly prevalent throughout the State of Hawaii. It was noted that county police in Hawaii issued 20,885 RLR violations to motorists between the years 2015 - 2019, averaging 4,177 violations per year. From 2014 - 2018, county police identified RLR as an attributable factor in 1,312 intersection collisions, resulting in numerous fatalities and serious injuries[1]. In 2019 alone, RLR was attributed to the deaths of 846[2] people throughout the United States. Due to the crash types associated with RLR, oftentimes those injured or killed are not the offenders themselves, but innocent bystanders. While traditional police enforcement has resulted in tickets issued for RLR, enforcement can be expensive and limited in the number of intersections that can be overseen at once. Automated enforcement has been shown to be a key step to reducing RLR. Researchers have found that cities with automated enforcement, such as red-light camera safety systems (RLSCS), experienced a 24 percent lower rate[2] of fatal crashes at signalized intersections. When combined with other efforts, RLSCS can provide supplemental enforcement of RLR, with the ability to reduce severe collisions, injuries, and fatalities.

A. Background of Red-Light Automated Enforcement

Automated enforcement using RLSCS has been used in parts of the world since the 1960s. It was first implemented in the United States in the early 1990s in New York City. Over the years, the technology has evolved from film cameras that consistently needed to be replaced, to high-definition cameras capable of capturing vehicles in nearly any condition. Today, RLSCS are present in small and major cities across the country, including Chicago, Portland, Sacramento, San Francisco, Scottsdale, and Seattle[2].

RLSCS are connected to traffic signals and use vehicle detection systems to continuously monitor traffic in real time. During each change and clearance interval for the selected movement, the RLSCS capture any vehicle that violates the law and continues to proceed past the stop bar. RLSCS can be programmed to provide leeway, such as grace periods, as well as differentiate where on the roadway the system begins enforcement, depending on the state law. In cases where a RLSCS captures a potential offense, data will include photographs, videos, and the actual time passed from when the vehicle passes the stop bar and the signal turned red. As is the case with Hawaii, this data is provided to the police department to have the final say when it comes to issuing citations. Trained police will review every case, allowing certain violations with extenuating circumstances such as those involving funeral processions or directions from emergency vehicles, to be thrown out. In Hawaii, where a violation has been confirmed by police, the ticket is mailed to the offending vehicle's owner, with direction provided as to how they may proceed.

RLSCS have previously faced legal issues and debates. Critics have expressed concerns with privacy issues that come with these systems. Additionally, there have been concerns that the violator who committed the offense may not always be the registered owner of the vehicle (who receives the ticket). Despite this pushback, there is considerable public support for RLSCS. Research has shown that in communities where RLSCS were removed, crash rates once again go up[2]. With appropriate policy and implementation, RLSCS can have a greater reach and impact than traditional enforcement alone. When coupled with other mitigation measures, RLSCS have been proven to reduce serious crashes, injuries, and fatalities.

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[1] H.B. NO. 1676 S.D. 2 (Haw. 2020)
[2] Insurance Institute for Highway Safety, Highway Loss Data Institute (May 2021)

B. Hawaii State Legislature - Act 30

Act 30 was enacted by the Hawaii State Legislature in September 2020. It established legal precedent regarding the establishment of RLSCS throughout the State of Hawaii, further defining requirements to be implemented prior to installation, including:

- "Conduct a comprehensive engineering review and study of each intersection and implement all necessary and appropriate engineering, design, and traffic-control-signal timing measures[3]."
- "Conduct a study to acquire a baseline average of the number of motor vehicles violating section 291C-32(c) over a period of not less than one week; provided that the baseline average shall be determined prior to the installation of any signs or other official traffic-control devices that indicate an intersection is being considered for a photo red light imaging detector system[3]."

This engineering study assesses each intersection considered for RLSCS and recommends appropriate engineering countermeasures (to be discussed in Section IV), as further defined by the Hawaii Administrative Rules (HAR) (to be discussed in the following section), prior to installation.

A baseline study of existing vehicular red-light running will be conducted prior to installation. This baseline will provide a reference indicating the effectiveness of any installed RLSCS, aiding prosecutors, and serving as basis for future red-light running programs throughout other counties.

C. Hawaii Administrative Rules Related to RLSCS and RLR

The Hawaii Revised Statutes (HRS) are laws set by the Hawaii legislature that govern persons and property within the jurisdiction of the State. According to HRS §291C-32, "Vehicular traffic facing a steady red signal alone shall stop at a clearly marked stop line, but if none, before entering the crosswalk on the near side of the intersection or, if none, then before entering the intersection and shall remain standing until an indication to proceed is shown…" Further administrative procedures and rules regarding the establishment of a Photo Red-Light Imaging Detector System Program to enforce the traffic control signal laws of the State of Hawaii were adopted in HAR Title 19, Chapter 151. In summary, the HAR states:

- "…the State or county shall conduct a study to acquire: (1) A baseline average of the number of red light traffic-control signal violations committed by motor vehicles in accordance with HRS v-4 -4(c), (2) At a minimum, the most recent three years available of motor vehicle crash data involving fatalities, injuries, and property damage at intersections being considered for the installation and operation of a system[4]." – HAR §19-151-5
- "…prior to the installation…[the State or county] shall conduct a comprehensive engineering study to identify conditions that may be present that contribute to red light violations, such as, but not limited to: (1) The grade of an intersection approach, (2) Poor visibility that reduces a motorist's ability to identify signs, signals or other traffic control devices at intersections, (3) Traffic volume, (4) Traffic-control signal timing[4]." – HAR §19-151-5
- "The State or county shall implement appropriate countermeasures for intersections identified in their comprehensive engineering study that may correct conditions that contribute to red light violations prior to the installation and operation of a system. Such countermeasures considered

[3] Act 30, Hawaii State Legislature (2020)
[4] Chapter 151 of Title 19, Hawaii Administrative Rules (2020)

shall consist of, but not limited to: (1) Improving signal head visibility, (2) Additional signal heads, (3) All-Red interval, (4) Appropriate yellow intervals, (5) Signalized intersection warning signs, (6) Advance yellow flashing lights, (7) Adjusting the approach speed, (8) Traffic signal coordination, (9) Advanced vehicle detection, (10) Removal of on-street parking[4]." - HAR §19-151-5

- "[The department] shall conduct a comprehensive informational and educational campaign to assist motorists and the public in understanding the issues fundamental to red light running…As part of the informational and educational campaign, a warning of a photo red light imaging detector violation of HRS section 291C-32 (c) shall be issued and mailed to the registered owner of the motor vehicle at the address on record during the first thirty days of operation at that particular traffic-control signal[4]." - HAR §19-151-6
- "A manufacturer or vendor shall obtain a clear and unobstructed photograph, digital or other visual image of the violation and shall make such visual image available for viewing by the registered owner of the motor vehicle of the alleged violation…The vendor shall make available for viewing to the registered owner of the motor vehicle alleged to be in violation the evidence of the violation on-line. The vendor shall remove and dispose of all images of the photo red light imaging detector system violations upon notification by the court that the case has been resolved[4]." - HAR §19-151-7

II. LITERATURE REVIEW

A literature review was completed of rules, guidelines, and best practices associated with the selection and operation of signalized intersection approaches appropriate for the use of RLSCS. These documents have been summarized in chronological order.

A. *Making Intersections Safer: A Toolbox of Engineering Countermeasures to Reduce Red-Light Running* (ITE, 2003)

The Institute of Transportation Engineers (ITE) released a 2003 comprehensive guide[5] to address concerns related to RLR and to provide countermeasures intended towards mitigating these concerns. It notes that the most prominent crashes due to RLR are angle and turning crashes. It also notes that rear-end collisions are not specifically attributable to RLR, but rather from a vehicle stopping at an intersection while the following vehicle does not.

Field studies point towards various intersection characteristics that could be used to predict RLR occurrences. These variables, as well as their impacts, include:

- Approach Volume: As the number of vehicles increases, the number of RLR infractions will likely increase.
- Signal Cycles: The more often a yellow and subsequent red phase are displayed, the more opportunity there will be for RLR.
- Phase Termination: While actuated phases extend green times as long as the approach is occupied, these may reach a "max-out," regardless of if the approach has cleared. As the frequency of "max-outs" increase, there is greater potential for RLR.
- Traffic Signal Control: Coordinated signals often create platoons through adjacent signals and drivers may have an expectation to proceed through intersections in their platoon. They may also expect yellow times to be long enough to allow them to pass through. Therefore, actuated traffic signal control may result in increased violations.
- Approach Grade: As the downgrade increases on the approach to an intersection, vehicles are less likely to come to a stop.

ITE noted that some independent variables, such as an increase to the entering street ADT, will increase the likelihood of RLR crashes. However, independent variables such as an increase in the number of lanes on a cross-street only led to increases in RLR crashes when the minor street was the entering street, and did not have a significant impact when the major street was the entering street.

- Signal Optimization and Timing: It is recommended to optimize and interconnect adjacent signals along major corridors to reduce the number of stops a vehicle makes, thereby reducing the opportunity for RLR. Similarly, yellow intervals and all-red intervals should be appropriately set using guidance from publications such as the *Manual on Uniform Traffic Control Devices* (*MUTCD*) (FHWA, 2009) (to be discussed in more detail in a later section). Additionally, the usage of vehicle detectors within the dilemma zone, the area where a driver must decide to stop or continue through an intersection, may help reduce the likelihood of drivers running red lights by reducing the number of split-second decisions (it should be noted that if the signal is coordinated and it is the reference phase, detectors are not beneficial).

[5] McGee, H. W. (2003)

ITE provides a summary of items to check when conducting preliminary site visits (see Figure 1).

Visibility and Conspicuity Features
1. Sight distance to signals
2. Number of signals
3. Positioning of signals—overhead, post-mounted, near-side, far-side
4. Line of sight for visibility restricted signals (programmable)
5. Brightness of signals
6. Conspicuity of signals

Signal Control Parameters
1. Coordination with adjacent signals
2. Timing and cycle length
3. Yellow change interval
4. All-red clearance interval

Geometric Features
1. Grade of approach lanes
2. Pavement condition

Traffic Operations Features
1. Vehicle approach speed
2. Right-turn-on-red
3. Pedestrian usage
4. Truck usage

Figure 1: Traffic Signal Field Review Checklist (ITE)

B. Red Light Camera Systems Operational Guidelines (FHWA, 2005)

The Federal Highway Administration (FHWA) establishes guidelines[6] for the implementation of RLSCS. FHWA noted that the primary contributing factors to RLR crashes include driver behavior, intersection design/operation, vehicle characteristics, and weather. When considering RLSCS, intersection crash data should be collected including location, crash type, crash location and vehicle movement, time of day, weather, type of vehicle, and speed. When crash data is not readily available, analysis can be performed using RLR data; however, this can be problematic if violation data is only representative of a few target-enforcement intersections. Traffic signal timing and other data such as approach grades and volumes should also be collected in the preliminary planning stages.

FHWA breaks down mitigation efforts into the following categories: intersection engineering improvements, education, traditional enforcement (police officers), and RLSCS. Each of these should be considered to determine the most appropriate and effective means to reducing RLR.

- Engineering countermeasures may include: retiming traffic signals and making sure they conform with *MUTCD* guidelines for yellow and all-red times; improving signal head visibility by increasing signal lens sizes as required by *MUTCD* (and considering additional improvements such as backplates); adding signal heads, using advanced yellow flashing lights to signalize upcoming intersections (especially at intersections with limited sight distance); adjusting approach speeds; coordinating adjacent traffic signals; using advanced vehicle detection to prolong green signals if approaching vehicles are still travelling; and removing on-street parking at a minimum of 200 feet from each end of the intersection approach (it should be noted that the Honolulu Traffic Code mandates a minimum distance of 75 feet from the intersection).
- Educational countermeasures include public information campaigns focused on the consequences of RLR, including fatalities, injuries, higher insurance premiums, and medical costs associated with crashes.
- Traditional enforcement using police officers remains an effective way of mitigating RLR and should still play an important role in enforcement even if RLSCS are installed.

[6] U.S. Dept. of Transportation, Federal Highway Administration, National Highway Traffic Safety Administration (2005)

FHWA notes that if RLSCS are the preferred mitigation, certain steps such as establishing stakeholder committees and reviewing legal requirements should be undertaken. When selecting intersections, RLSCS should be based primarily on crash and RLR violation data. Traffic volumes should not be the sole factor when it comes to selecting intersections.

C. *Manual on Uniform Traffic Control Devices for Streets and Highways* (FHWA, 2009)

FHWA publishes federal requirements[7] and guidelines, the latest from 2009, to standardize traffic design and present uniformity across the country. Included in these are requirements and guidelines for the placement and operation of traffic control features, including signs, markings, and signals. The *MUTCD* includes standard ("shall") requirements, as well as recommended/supportive ("should") guidelines for consideration in design.

The following are *MUTCD* requirements pertinent to traffic control signals:

- "…a minimum of two primary signal faces *shall* be provided for the through movement." In cases where there is no signalized through movement, "a minimum of two primary signal faces *shall* be provided for the signalized turning movement that is considered to be the major movement from the approach." (Section 4D.11.01A)
- "…each signal indication *shall*, to the extent practical, be visibility-limited by signal visors, signal louvers, or other means so that an approaching road user's view of the signal indication(s) controlling movements on other approaches is minimized." (Section 4D.12.13)
- "At least one and preferably both of the minimum of two primary signal faces required for the through movement (or the major turning movement if there is no through movement) on the approach *shall* be located between two lines intersecting with the center of the approach at a point 10 feet behind the stop line, one making an angle of approximately 20 degrees to the right of the center of the approach extended, and the other making an angle of approximately 20 degrees to the left of the center of the approach extended." (Section 4D.13.01)
- "A signal face installed to satisfy the requirements for primary left-turn signal faces and primary right-turn signal faces, and at least one and preferably both of the minimum of two primary signal faces required for the through movement (or the major turning movement if there is no through movement) on the approach *shall* be located: (1) No less than 40 feet beyond the stop line, (2) No more than 180 feet beyond the stop line unless a supplemental near-side signal face is provided, and (3) As near as practical to the line of the driver's normal view, if mounted over the roadway." (Section 4D.14.01)
    - "Where the nearest signal face is located between 150 and 180 feet beyond the stop line, engineering judgment of the conditions, including the worst-case visibility conditions, shall be used to determine if the provision of a supplemental near-side signal face would be beneficial." (Section 4D.14.01A)

The following are *MUTCD* guidelines pertinent to traffic control signals:

- "The two primary signal faces required as a minimum for each approach *should* be continuously visible to traffic approaching the traffic control signal, from a point at least the minimum sight distance provided in [Table 1] in advance of and measured to the stop line." (Section 4D.12.04)

[7] U.S. Department of Transportation, Federal Highway Administration (2012)

Table 1: Minimum Sight Distance for Signal Visibility (*MUTCD*)

85th-Percentile Speed	Minimum Sight Distance
20 mph	175 feet
25 mph	215 feet
30 mph	270 feet
35 mph	325 feet
40 mph	390 feet
45 mph	460 feet
50 mph	540 feet
55 mph	625 feet
60 mph	715 feet

  - "If approaching traffic does not have a continuous view of at least two signal faces for at least the minimum sight distance shown in [Table 1], a sign [W3-3] *shall* be installed to warn approaching traffic of the traffic control signal."
- "Locating primary signal faces overhead on the far side of the intersection has been shown to provide safer operation by reducing intersection entries late in the yellow interval and by reducing red signal violations, as compared to post-mounting signal faces at the roadside or locating signal faces overhead within the intersection on a diagonally-oriented mast arm or span wire. On approaches with two or more lanes for the through movement, one signal face per through lane, centered over each through lane, has also been shown to provide safer operation." (Section 4D.11.06)
- "If the posted or statutory speed limit or the 85th-percentile speed on an approach to a signalized location is 45 mph or higher, signal backplates *should* be used on all of the signal faces that face the approach." (Section 4D.12.18)
  - "Signal backplates *should* also be considered for use on signal faces on approaches with posted or statutory speed limits or 85th-percentile speeds of less than 45 mph where sun glare, bright sky, and/or complex or confusing backgrounds indicate a need for enhanced signal face target value." (Section 4D.12.18)

Additionally, the *MUTCD* offers some guidance on both yellow change and red clearance interval timing:

- "A yellow change interval should have a minimum duration of 3 seconds and a maximum duration of 6 seconds." (Section 4D.26.14)
- "…a red clearance interval should have a duration not exceeding 6 seconds" (Section 4D.26.15) and "when used…*shall* be determined using engineering practices." (Section 4D.26.06)
- "Engineering practices for determining the duration of yellow change and red clearance intervals can be found in ITE's "Traffic Control Devices Handbook" and in ITE's "Manual of Traffic Signal Design"." (Section 4D.26.07)

MUTCD acknowledges that it is unrealistic for all existing traffic signals to be brought up to compliance upon publication of new standards, as the signals were installed when different, and potentially conflicting, standards were in place. It states that changes and modifications should be made, to the extent possible, when devices are no longer serviceable or when events such as reconstruction projects occur. While signal timing changes and other minor re-alignments can be implemented for most existing systems, changes that require the addition or modification of equipment may have implications to structural loads. By adding a traffic signal, sign, or backplate to an existing mast arm, additional forces are put on the older poles and foundations that weren't likely designed for these loads. Therefore, it is likely to have non-compliant signals within a traffic signal system that includes over 750 traffic signals, as is the case with Honolulu.

D. *RLR Camera Enforcement Installation Checklist for Non-State Highways* (ODOT, 2019)

The Oregon Department of Transportation (ODOT) released 2019 guidelines[8] that included the following factors to be considered when installing RLSCS:

- Crash history and safety concerns at the intersection.
- Ensuring signal indications comply with current *MUTCD* visibility standards.
- Ensuring the yellow change and red clearance intervals are set appropriately.

If RLSCS are being installed, ODOT also requires that:

- Signs noting that traffic control device compliance is enforced are posted on all major routes into the jurisdiction.
- Signs noting that cameras enforcing RLR may be in use are posted on all approaches where installed.

E. Guidelines for Determining Traffic Signal Change and Clearance Interval (ITE, 2020)

The Institute of Transportation Engineers (ITE) released 2020 updated clearance interval guidelines[9] to help provide a consistently applicable methodology to setting safe and efficient signal timings. This was an update to previous ITE guidance from the 1980's and built upon a recent National Cooperative Highway Research Program (NCHRP) report[10] from 2011. Although ITE released these as voluntary guidelines, they are backed by engineering studies and best practices.

ITE differentiates yellow timing guidelines between through and turning movements, where turning movement times accounted for factors such as reduced intersection entry speed. As Hawaii's program is focused on automated enforcement of straight through-movement violations only, this review only focuses on such guidance. It should be noted that Hawaii operates under a permissive yellow law[9] in which drivers may pass the stop bar legally up until the red signal indication is displayed. Therefore, a properly timed yellow change interval should allow enough time for the driver to see and react to a yellow signal display, and to decelerate to a stop or proceed past the stop bar before the red signal indication is displayed. As such, ITE recommends the following equation for determining yellow timing for through-movements at an intersection:

$$Yellow\ Change\ Interval = t + \frac{1.47 \times V}{2a + 64.4g}$$

For this equation, t is perception-reaction time (standard of 1 second), V is the 85th-percentile approach speed (mph), a is deceleration rate (standard of 10 ft/s^2), and g is the roadway grade (in decimal form, minus for downslope). When speed data is not available for a given approach, ITE stipulates that the 85th-percentile approach speed can be approximated as 7 mph over the posted speed limit.

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[8] Oregon Department of Transportation (2019)
[9] ITE Guidelines for Determining Traffic Signal Change and Clearance Intervals (2020)
[10] McGee, H. W. (2012)

Since Hawaii has a permissive yellow law, vehicles may legally still be traveling through the intersection when the red-light indication is first displayed. Therefore, red clearance intervals may be beneficial and provide an extended amount of time to release traffic before right of way is changed. When used, ITE recommends the following equation for determining all-red clearance intervals at an intersection:

$$Red\ Clearance\ Interval = \left[\frac{W + L}{1.47 \times V}\right] - t_s$$

For this equation, t_s is the conflicting vehicular movement start up delay (standard of 1 second), *V* is the 85th percentile approach speed (mph), and W is the width of the intersection (measured from the stop bar to the far side no-conflict point in feet).

It should be noted that these guidelines from ITE are considered controversial within the profession, with a number of agencies and professional organizations expressing concerns. One of these concerns is related to the use of the 85th-percentile speed, estimated to be 7 mph over the posted speed limit. By calculating signal clearance times using a higher speed limit, it can be inferred through design that traveling at these higher speeds is appropriate. The culmination of designing for these higher speeds is incurred speeding, which in itself has a significant impact on the safety of all roadway users. Therefore, HDOT and DTS use posted speed limit in calculating yellow and all-red times. Separately, HDOT/DTS also use whole numbers when calculating timing, and so all yellow and all-red times are rounded up to the nearest whole number.

As ITE guidelines are recommendations, HDOT/DTS policy can be considered standard. It should be noted that no existing yellow intervals were found to be substandard per the calculation methodology used and any all-red clearances that were found to not meet recommended guidelines have since been updated (during the writing of this report) and are therefore no longer recommended as mitigation. Yellow and all-red traffic signal timings for RLSCS sites are shown in Appendix B.

F. Traffic Signal Requirements: Guidance for HART (DTS, 2020)

DTS released 2020 guidelines[11] for traffic signal requirements within the City and County of Honolulu (C&C). These guidelines are primarily for use on Hawaii Authority for Rapid Transit (HART) related work, following *MUTCD*'s suggestion to bring traffic signals up to standard when undergoing reconstruction. They include:

- One signal face per lane *shall* be centered over each lane on all DTS owned roadways regardless of speed for approaches with two or more lanes.
- 5-inch-wide back plates with a 1-inch retro-reflective tape *shall* be installed for all traffic signal assemblies mounted on the arm of Type-II/III assemblies (mast arms).

Additionally, DTS released the following guidelines to bring outdated signals up to standard when an intersection is being modified or a new intersection is being constructed:

- Programmable visibility (PVI) signal heads *shall* be installed for all protected left turn phases in a way that adjacent through lanes are unable to see the indication.
- All traffic signal indications *shall* be LED.

[11] Frysztacki, Wes, and Jon Nouchi (2020)

G. *Automated Enforcement Program Checklist* (IIHS, 2021)

The Insurance Institute for Highway Safety (IIHS) created a checklist[12] of recommended steps for starting automated enforcement programs. Initially, RLR and crash data should be collected and analyzed. Field observations are recommended to observe other intersection deficiencies, and dialogue with residents and officials is encouraged. If RLSCS are deemed appropriate, intersection conditions such as the traffic signal configuration, timing, and signage must first be addressed to ensure they are compliant with current guidelines and standards.

It is also crucial to ensure the yellow timing is appropriate and follows published guidelines from the *MUTCD* and ITE.

It should be noted that no existing yellow intervals were found to be substandard per the calculation methodology used. Any all-red clearances that were found to not meet recommended guidelines have since been updated (during the writing of this report) and are therefore no longer recommended as mitigation.

Advisory committees should be established to oversee the successful implementation of the program and coordinate public outreach and education programs.

When ultimately determining which intersections to install RLSCS at, violations with the most severe safety impacts should be prioritized. Considerations such as the grace period, fine structure, citation review process, and appeals processes should all be established prior to implementation and conform to local law. Once locations have been decided, warning signs should be installed and a probationary period in which no fines are given should begin.

Violations should consistently be monitored, and before-and-after comparisons of crash and violation data should be analyzed. Updated guidance should continuously be reviewed, coupled with other roadway design improvements.

H. Additional Research

Additional peer-reviewed publications on RLSCS and RLR were reviewed. Many of these articles provided support and background for RLSCS similar to the aforementioned national standards and guidelines. However, research into which intersections and approaches benefited from RLSCS was often inconclusive, and at times even contradictory.

One article[13] stated that RLSCS were not as effective in reducing crashes at intersections with ADTs over 40,000 or with high levels (20+ per year) of existing rear-end crashes. It was noted that while RLSCS frequently reduce (by up to 24%) right angle collisions, their installation may lead to an increase (by up to 32%) in rear-end crashes. While rear-end crashes are typically less severe in nature than right angle crashes, intersections that already have issues with rear-end crashes may experience exacerbated results. Since rear-end crashes are often less severe, they don’t always show up in the tabulation of major traffic crashes, instead being classified as a minor crash. None of the study intersections had high numbers of

[12] Insurance Institute for Highway Safety, Highway Loss Data Institute (May 2021)
[13] Goldenbeld, C., Daniels, S., & Schermers, G. (2019)

rear-end crashes. Additionally, this article confirmed that RLSCS have a greater impact and provide greater safety benefits at intersections with high levels of existing RLR. It was noted that intersections with speed limits of 50-60 km/h (equivalent to 31-37 mph), saw greater benefits from RLSCS than intersections with higher speed limits. No approaches for this study had posted speed limits over 35 mph. Additionally, intersections with separated right turn lanes were shown to experience a larger reduction in right angle crashes with RLSCS than intersections without these exclusive lanes. Lastly, this article suggested that RLSCS were most impactful at intersections with a high number of right-angle crashes when compared to their ADT. Intersections with high volume approaches and longer cycle lengths were noted to be prime locations for these systems as they showed some of the greatest improvement.

Another report[14] analyzed various roadway characteristics at intersections with high levels of RLR and established a regression model to predict these occurrences elsewhere. It was determined that the following variables were most effective at determining the likelihood of RLR: number of approach lanes, number of crossing lanes, and the approach ADT. While the number of approach lanes and ADT were shown to be directly correlated to the likelihood of RLR (as these variables go up, the likelihood of RLR increases as well), the number of crossing lanes was shown to be inversely related (as this variable goes up, the likelihood of RLR decreases). This is contradictory to findings in other publications such as ITE. Additionally, this research showed that approach direction may also be directly correlated to the likelihood of RLR, where E/W approaches traveling into heavy glare may be more likely to run red lights, although this was ultimately determined to be inconclusive due to limited data.

There is limited research into how pedestrian crossings may be related to RLR. Pedestrians crossing the far leg of an intersection with high levels of RLR are likely at the greatest risk, as their walk interval often begins shortly after the oncoming yellow ends, leaving them vulnerable to vehicles running the red. However, at intersections with leading protected left phasing, this will be less significant, as often the pedestrian walk interval does not begin until after the protected phase has ended. Either way, studies have shown that approximately 5% of RLR casualties are pedestrians or bicyclists[15], and intersections with high levels of multimodal activity may benefit from greater levels of automated enforcement. Pedestrian and bicycle crossing volumes were not provided or collected with this study, however the propensity for high-volume crossing locations were noted.

I. Summary of Recommendations

Review of the aforementioned documents recommends the following variables be considered when identifying approaches and success thereof a RLSCS:

- *Approach Volume*: Higher volumes (ADT) tend to increase RLR infractions.
- *Signal Visibility*: Factors such as the number of signals within the 20˚ cone of vision, sight distance, whether a signal is post mounted or on a mast arm, and the use of back plates increase driver visibility and compliance.
- *Yellow Change and Red Clearance Intervals*: Appropriately timed clearance intervals that account for factors such as grade and speed tend to decrease the likelihood of RLR crashes.
- *Pedestrian Volume*: Indicate approaches where RLR crashes may have more severe consequences.

[14] Hill, S. E., & Lindly, J. K. (2003)
[15] Allyn, B. (2019, August 29)

- *Advanced Vehicle Detection*: Approaches that are coordinated with adjacent signalized intersections tend to have lower incidences of RLR.

Additional factors recommended for consideration, however omitted from analysis due to inconclusive or varying data include:

- *Pavement Condition*: This is constantly changing and therefore a less permanent variable for consideration.
- *Turn Lane Configurations*: As this program is focused on through movement violations only, turn lane configurations are less of a factor.
- *Brightness of Signals*: All new or reconstructed traffic signals require LED signal heads and therefore it can be assumed that the agency will update to the latest standards when possible.
- *Truck Usage*: Limited data exists on the existence of trucks along these routes.

III. INTERSECTION APPROACH SELECTION CRITERIA

A. Preselection Methodology

HDOT, in collaboration with DTS, identified 14 intersections to consider when determining viable approaches for implementing RLSCS. The ultimate goal for this pilot project is a successfully implemented system. Funding was provided for the installation of RLSCS on 17 approaches that span a total of ten intersections. The selected intersections are located within the districts between Makapuu Point and the Daniel K. Inouye International Airport (HNL).

The initial intersection assessment completed by HDOT and DTS identified where geometric conflicts, signal timing, or other regulatory standards were unable to be brought up to current requirements within the time frame of the pilot project. These intersections were omitted from further consideration by HDOT and DTS. In addition, certain corridors were omitted due to extenuating circumstances. For example, Ala Moana Highway/Nimitz Highway has an adaptive signal pilot project being undertaken; Kalanianaole Highway utilizes median-separated contraflow; and Dillingham Boulevard and other corridors are under construction as a part of the HART project. At the time of selection, construction along the Pali Highway, from Vineyard Boulevard to Waokanaka Street, had been delayed. It is currently under construction and thus stands to benefit from upgraded traffic signal equipment, however repaving and other significant efforts are still underway.

HDOT's process for the selection of intersections included the consideration of major crashes from 2014 – 2018, with priority given to intersections with a high number of crashes related to RLR, pedestrian-involvement, and speed. A major crash is a crash involving a motor vehicle that occurs on a public highway or street resulting in a fatality, personal injury, or property damage of $3,000 or more. DTS's process was similar, with a higher priority given to intersections with high pedestrian activity or pedestrian-involved crashes.

B. Preselected Intersections

The following 14 intersections (see Figure 2), in no particular order, were preselected by HDOT and DTS to be analyzed as part of this engineering study for the implementation of RLSCS:

1. Beretania Street at Piikoi Street
2. Kapiolani Boulevard at Kamakee Street
3. Vineyard Boulevard at Palama Street
4. Vineyard Boulevard at Pali Highway
5. N. King Street at Beretania Street
6. S. King Street at Ward Avenue
7. Vineyard Boulevard at Liliha Street
8. Pali Highway at School Street
9. Likelike Highway at School Street
10. N. King Street at River Street
11. N. King Street at Kohou Street
12. McCully Street at Algaroba Street
13. N. King Street at Middle Street
14. Vineyard Boulevard at Nuuanu Avenue

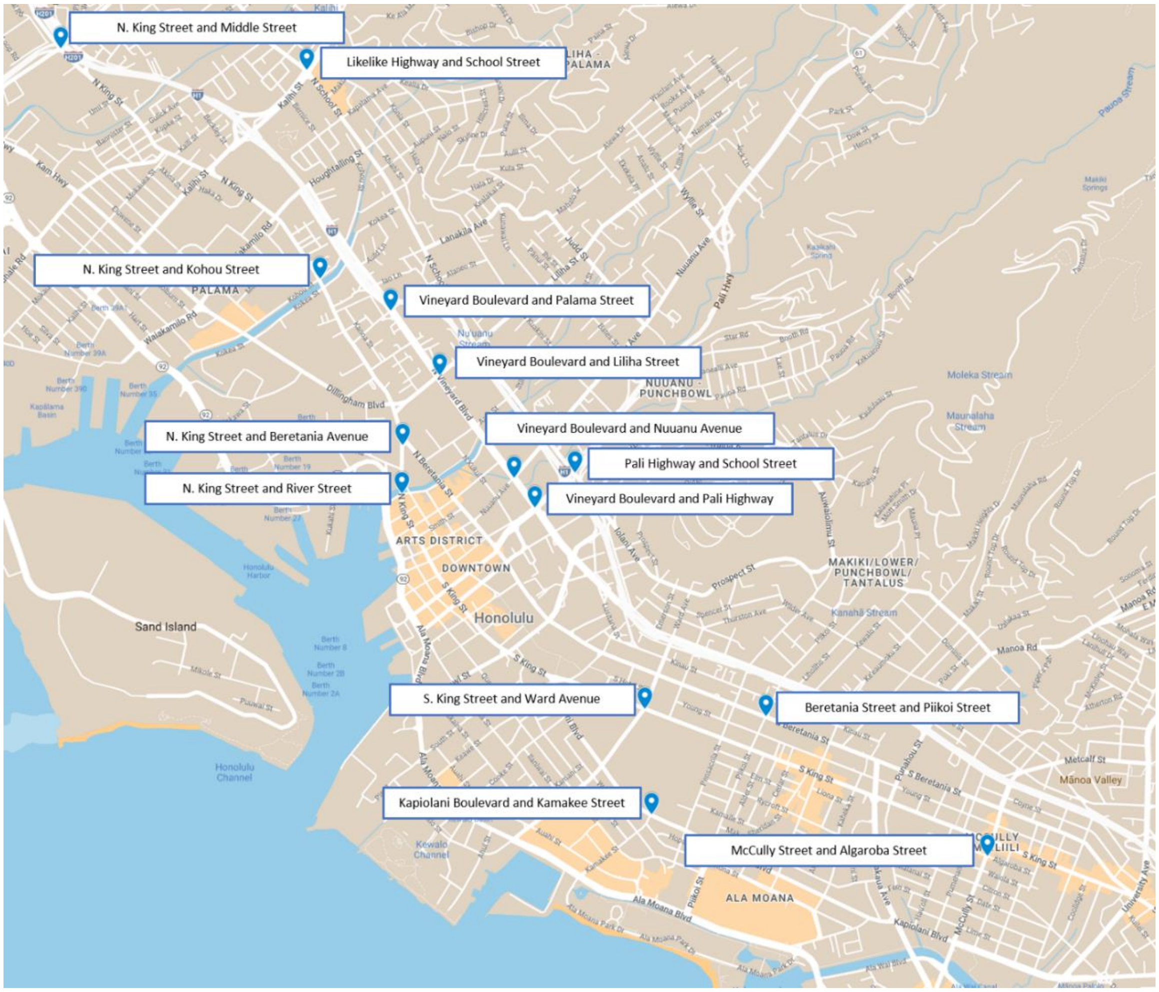

Figure 2: Preselected Intersections for Red-Light Safety Camera Program

C. Engineering Study

This study analyzes each of the 14 intersections against the RLR and RLSCS factors identified in the literature review. Intersection approach details and major crash history data were gathered and are summarized within Section IV of this report. This data was used to assess constructability and identify engineering mitigation measures, culminating in a determination of the viability of installing RLSCS for each approach.

Updated and detailed 2016 – 2020 major crash history summaries from the 14 HDOT/DTS identified intersections were provided for use in this study. Data included tabulations of crashes with fatalities, serious injury, non-serious injury, property damage-only, pedestrian involvement, disregard of traffic control devices (i.e., RLR), and speed involvement. This crash data represented the latest available at the time of this report as required within HAR §19-151-5. This data is different from that which was used in the initial assessment from HDOT/DTS (2014 – 2018) which is why crash records may not align.

Through coordination with HDOT/DTS during the writing of this report, all existing yellow and all-red traffic signal timings were updated to reflect the recommended changes discussed in the following sections, as further detailed in Appendix B.

IV. INTERSECTION APPROACH STUDY

The following section provides an analysis of the 14 intersections against the RLR and RLSCS factors identified, including a summary of intersection approach details and 2016 - 2020 major crash history. It also includes an assessment of intersection approach engineering mitigation measures, constructability concerns, and recommendations.

A. Beretania Street at Piikoi Street

Figure 3: Beretania Street at Piikoi Street

1. Intersection Summary

Beretania Street at Piikoi Street is a four-leg signalized intersection in the Lower Punchbowl area.

- Both streets are classified as arterials and operate as one-way corridors, with Beretania Street travelling in the WB direction, and Piikoi Street travelling in the NB direction.
- There are numerous businesses fronting each leg of the intersection in addition to an elementary school in the NW corner and nearby residential homes.
- On the Beretania Street approach, there is a driveway on the north (mauka, meaning 'towards the mountains') side approximately 125 feet from the stop bar, and one approximately 10 feet back on the south (makai, meaning 'towards the ocean') side.
- On the Piikoi Street approach, there is a driveway on the west (Ewa direction) side approximately 60 feet from the stop bar, and one approximately 10 feet from the east (Diamond Head direction) side.
- There is a curbside bike lane along the north side of Beretania Street, but no marked bike facilities on Piikoi Street. There are marked pedestrian crosswalks as well as paved sidewalks on both sides of the street at all four legs of the intersection.
- Pedestrian counts obtained from a DTS database maintained by *UrbanLogiq* show crossing volumes are generally highest within the eastern crosswalk, followed by the northern crosswalk.
- On-street parking is restricted along both approaches.
- There is a bus stop located on the near-east side of the NB Piikoi Street approach.

A summary of the intersection approach conditions for Beretania Street at Piikoi Street is provided in Table 2. Where an approach characteristic should be considered for mitigation prior to RLSCS installation, it has been highlighted in yellow in the table. Note the only required mitigation is ensuring standard yellow interval. Additional figures including intersection approach views, cone of vision diagrams, and the traffic signal ring and barrier diagram are included in Appendix A.

Table 2: Summary of Intersection Approach Conditions at Beretania Street at Piikoi Street

	Piikoi Street NB Approach	Beretania Street WB Approach
Approach ADT (HPMS 2017) (veh/day)	29,391	20,301
Posted Speed Limit (mph)	25	30
Lane Configuration	↰ ↑ ↑ ↑ ↑	↑ ↑ ↑ ↑ ↱
# of Signal Heads and Location	4 on mast arm, 1 on far-left pole	3 on mast arm, 1 on far-left pole, 1 on near-right pole, 1 on far-right pole
Signal Head Centered over Lanes?	Yes	No
Approach Grade	Flat	Flat
Far Side Signal Distance from Stop Bar (feet)	110	72
Signal Lens Size (inches)	12	12
Backplates on Mast Arm Signal Heads?	No	No
Advance Vehicle Detection?	No	No
Cycle Length (AM, MID, PM) (seconds)	90, 90, 90	
Available Green Time (AM, MID, PM) (seconds)	30, 35, 35	50, 45, 45
Existing Yellow Interval (seconds)	4	4
Existing Red Clearance (seconds)	1	1
2 Signals in Cone of Vision?	Yes	Yes

A summary of the crash history for Beretania Street at Piikoi Street from 2016 - 2020 is provided in Table 3. Crashes involving vehicles from different approaches are listed under the approach in which the offending vehicle was traveling from.

Table 3: Crash History and Baseline RLR Violations at Beretania Street at Piikoi Street

	Rear End Crashes	Right Angle Crashes	Sideswipe Crashes	Pedestrian or Bicyclist Involved Crashes	Speed Involved Crashes	Red Light Running Related Crashes	Dusk or Night Time Crashes	Crashes During Times of Sunrise or Sunset	Injury Involved Crashes	Fatality Involved Crashes	Total Crashes
NB Piikoi Street	-	2	-	-	-	3	1	-	3	-	3
WB Beretania Street	1	2	1	-	1	2	2	-	3	-	4

Notes:
1) Total Crashes was the summation of all reported crashes at each approach, including some not listed above due to them having another crash-type. Other reported contributing factors were listed, of which some crashes had multiple, while others had none.
2) This crash data was collected under the Highway Safety Improvement Program of Title 23, United States Code (U.S.C.), Section 148. This data is protected under Title 23, U.S.C., Section 407, and is intended for highway safety and educational purposes only. This information may not be used in any Federal or State court proceeding in any action for damages arising from any occurrence at a location mentioned or addressed in the information provided.

2. Engineering Mitigation

This intersection meets the minimum *MUTCD* guidelines for the number of signal heads for the primary movement for each approach. There are no observed obstructions on the approach or sight line visibility issues within the 20˚ cone of vision. However, prior to the installation of RLSCS, necessary mitigation at this intersection includes:

- Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

Other mitigation measures to consider prior to the installation of RLSCS include:

- Installing backplates on all traffic signals mounted on mast arms.
  - The WB Beretania Street approach is of greater need due to its location on an E/W corridor that results in potential glare issues associated with the rising/setting of the sun.
  - It is noted that neither approach included a RLR crash during sunrise or sunset.
- Relocating the overhead utility wires from crossing in front of the NB Piikoi Street approach signals, potentially providing a visual obstruction.

3. Constructability Concerns

There are no constructability concerns associated with either approach at this intersection, although it was noted that multiple safety cameras may be required and placed on opposites sides of the roadway to capture violations due to its programmable visibility (PVI) signal heads.

4. Recommendations

Both approaches to the intersection of Beretania Street at Piikoi Street provide viable options for the installation of RLSCS. A school is located adjacent to the intersection indicating the potential for a higher number of children crossing and additional safety needs. There is sufficient approach visibility for vehicles and both approaches have a history of RLR related crashes with a low number of rear end crashes which further add to their viability. The engineering mitigation measures should be considered prior to the installation of RLSCS for either approach.

B. Kapiolani Boulevard at Kamakee Street

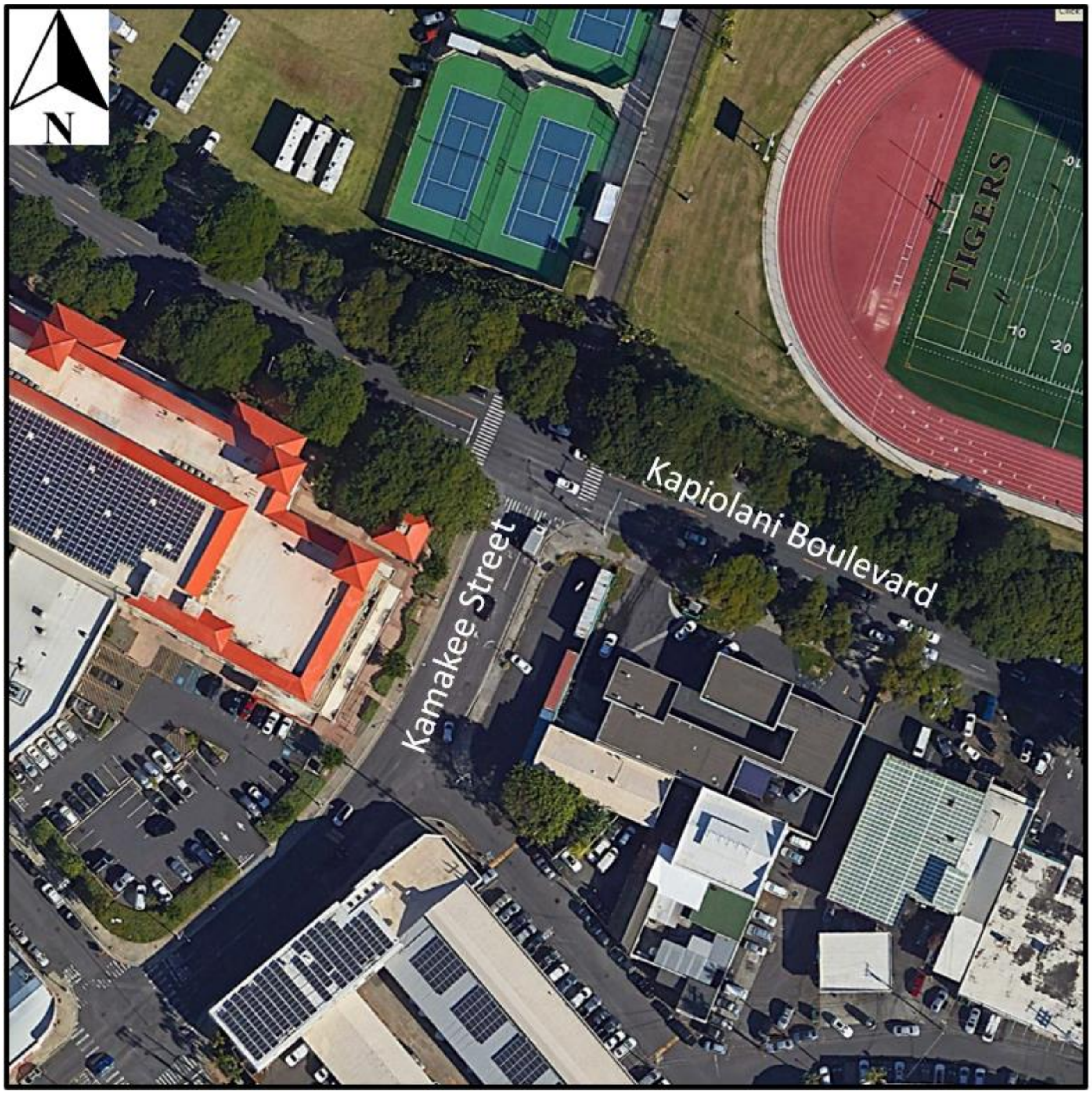

Figure 4: Kapiolani Boulevard at Kamakee Street

1. Intersection Summary

Kapiolani Boulevard at Kamakee Street is a three-leg signalized intersection in the Kakaako area.

- Kapiolani Boulevard is classified as an arterial and operates with contraflow during the peak hours, with an additional WB travel lane in the AM and an additional EB travel lane in the PM.
- Kamakee Street is classified as a collector.
- There are numerous retail stores, commercial facilities, and residential condominiums located nearby. Additionally, there is a high school on the north side of the intersection.

- There is a driveway on the eastern side of the Kamakee Street approach approximately 85 feet from the stop bar, but no driveways along the Kapiolani Boulevard approaches.
- There are no marked bike facilities at this intersection.
- There are marked pedestrian crosswalks across all legs of the intersection.
- Paved sidewalks exist on both sides of the street for all legs of the intersection.
- Pedestrian counts obtained as part of a nearby project show crossing volumes are highest across the western crosswalk, followed by the southern crosswalk.
- On-street parking is restricted along all approaches.
- There is a bus stop located on the near side of the EB Kapiolani Boulevard approach, and the far side of the WB Kapiolani Boulevard approach.

A summary of the intersection approach conditions for Kapiolani Boulevard at Kamakee Street is provided in Table 4. Where an approach characteristic should be considered for mitigation prior to RLSCS installation, it has been highlighted in yellow in the table. Note the only required mitigation is ensuring standard yellow interval. Additional figures including intersection approach views, cone of vision diagrams, and the traffic signal ring and barrier diagram are included in Appendix A.

Table 4: Summary of Intersection Approach Conditions at Kapiolani Boulevard at Kamakee Street

	Kamakee Street NB Approach	Kapiolani Boulevard WB Approach	Kapiolani Boulevard EB Approach
Approach ADT (HPMS 2017) (veh/day)	3,283	13,231	13,231
Posted Speed Limit (mph)	25	35	35
Lane Configuration	↰ ↱	↰↑ ↑ ↑	↑ ↑ ↑↱
# of Signal Heads and Location	1 on far-left pole, 1 on far-right pole	2 on mast arm, 1 on far-left pole	2 on mast arm, 1 on far-right pole
Signal Head Centered over Lanes?	No	No	No
Approach Grade	Flat	Flat	Flat
Far Side Signal Distance from Stop Bar (feet)	85	75	103
Signal Lens Size (inches)	12	12	12
Backplates on Mast Arm Signal Heads?	No	No	No
Advance Vehicle Detection?	No	No	No
Cycle Length (AM, MID, PM) (seconds)	120, 100, 120		
Available Green Time (AM, MID, PM) (seconds)	30, 30, 30	80, 60, 80	80, 60, 80
Existing Yellow Interval (seconds)	4	4	4
Existing Red Clearance (seconds)	1	1	1
2 Signals in Cone of Vision?	No	Yes	Yes

A summary of the crash history for Kapiolani Boulevard at Kamakee Street from 2016 - 2020 is provided in Table 5. Crashes involving vehicles from different approaches are listed under the approach in which the offending vehicle was traveling from.

Table 5: Crash History and Baseline RLR Violations at Kapiolani Boulevard at Kamakee Street

	Rear End Crashes	Right Angle Crashes	Sideswipe Crashes	Pedestrian or Bicyclist Involved Crashes	Speed Involved Crashes	Red Light Running Related Crashes	Dusk or Night Time Crashes	Crashes During Times of Sunrise or Sunset	Injury Involved Crashes	Fatality Involved Crashes	Total Crashes
WB Kapiolani Boulevard	2	1	-	1	1	-	1	-	3	-	4
EB Kapiolani Boulevard	-	-	-	-	-	-	-	-	1	-	1
NB Kamakee Street	-	-	-	1	-	-	-	-	1	-	1

Notes:
1) Total Crashes was the summation of all reported crashes at each approach, including some not listed above due to them having another crash-type. Other reported contributing factors were listed, of which some crashes had multiple, while others had none.
2) This crash data was collected under the Highway Safety Improvement Program of Title 23, United States Code (U.S.C.), Section 148. This data is protected under Title 23, U.S.C., Section 407, and is intended for highway safety and educational purposes only. This information may not be used in any Federal or State court proceeding in any action for damages arising from any occurrence at a location mentioned or addressed in the information provided.

2. Engineering Mitigation

This intersection meets the minimum *MUTCD* guidelines for the number of signal heads for the primary movement for each approach. Overhead tree branches along Kapiolani Boulevard partially obstruct sight lines; however, there are at least 2 signals within the 20˚ cone of vision for each approach. There is only one signal located within the 20˚ cone of vision for the NB Kamakee Street approach. Prior to the installation of RLSCS, necessary mitigation at this intersection includes:

- Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

Other mitigation measures to consider prior to the installation of RLSCS include:

- Installing backplates on all traffic signals mounted on mast arms.
  - While the EB/WB Kapiolani Boulevard approaches would be of greatest need due to their location on an E/W alignment, overhead trees provide a backdrop to the signals and generally prevent glare issues associated with the rising/setting of the sun.
- Adding a third signal head on the mast arms to the WB and EB Kapiolani Boulevard approaches to better align overhead with the three through-lanes in each direction and trimming the overhanging trees to ensure these signals are visible.
- Adding an additional signal head centered on the far side of the NB Kamakee Street approach to provide the preferred 2 signals within the 20˚ cone of vision.

3. Constructability Concerns

There are no major constructability concerns associated with any approach at this intersection. It was noted that an upcoming water main construction project along the north side of Kapiolani Boulevard could potentially delay implementation. Additionally, the existing tree line on both sides of Kapiolani Boulevard may require the location of RLSCS to be adjusted from its preferred location to provide optimal visibility.

4. Recommendations

The EB/WB approaches of Kapiolani Boulevard provide viable options with sufficient visibility for vehicles. The NB approach of Kamakee Street does not provide a viable option for the installation of RLSCS due to it not having any through-lane movements, and concerns with signal visibility within the 20˚ cone of vision. There is no specific history of RLR related crashes at this intersection; however, it is adjacent to a school indicating the potential for a higher number of children crossing and additional safety needs. The engineering mitigation measures should be considered prior to the installation of RLSCS for any approach.

C. Vineyard Boulevard at Palama Street

Figure 5: Vineyard Boulevard at Palama Street

1. Intersection Summary

Vineyard Boulevard at Palama Street is a four-leg signalized intersection in the Kalihi-Palama area.

- Vineyard Boulevard is classified as an arterial and is separated by a landscaped median of varying width.
- Palama Street is classified as a collector.
- The surrounding area is primarily residential with both single and multi-family homes, although there are also some offices and small commercial businesses along Vineyard Boulevard.

- On Vineyard Boulevard, there are driveways approximately 130 feet from the stop bar on the NWB approach, and approximately 85 feet from the SEB approach.
- On Palama Street, there is a driveway approximately 100 feet from the stop bar on the NEB approach.
- There are no marked bike facilities at this intersection.
- There are marked crosswalks across all legs except for the NW Vineyard Boulevard leg.
- Paved sidewalks exist on both sides of the roadway on all four legs. However, the sidewalk adjacent to the SW Palama Street leg of the intersection terminates approximately 85 feet past the stop bar.
- On-street parking is restricted along all approaches.
- There are no bus stops within 100 feet of any approach to the intersection.
- HPMS 2017 ADT volumes were not available for SWB Palama Street.
    - Instead, tube count volumes from 2012 were taken from the *UrbanLogiq* database.

A summary of the intersection approach conditions for Vineyard Boulevard at Palama Street is provided in Table 6. Where an approach characteristic should be considered for mitigation prior to RLSCS installation, it has been highlighted in yellow in the table. Note the only required mitigation is ensuring standard yellow interval. Additional figures including intersection approach views, cone of vision diagrams, and the traffic signal ring and barrier diagram are included in Appendix A.

Table 6: Summary of Intersection Approach Conditions at Vineyard Boulevard at Palama Street

	Palama Street NEB Approach	Palama Street SWB Approach	Vineyard Boulevard NWB Approach	Vineyard Boulevard SEB Approach
Approach ADT (HPMS 2017) (veh/day)	3,700	8,447*	12,337	12,337
Posted Speed Limit (mph)	25	25	30	30
Lane Configuration	↰ ↑↱	↰↑ ↱	↰ ↑ ↑ ↑↱	↰ ↑ ↑ ↑↱
# of Signal Heads and Location	1 on far-left pole, 1 on far-right pole	1 on far-left pole, 1 on far-right pole	1 on mast arm, 1 on far-left pole, 2 on far-center pole, 1 on far-right pole	1 on mast arm, 1 on far-left pole, 2 on far-center pole, 1 on far-right pole
Signal Head Centered over Lanes?	No	No	No	No
Approach Grade	Slight Downhill	Flat	Flat	Flat
Far Side Signal Distance from Stop Bar (feet)	161	171	125	125
Signal Lens Size (inches)	12	12	12	12
Backplates on Mast Arm Signal Heads?	No	No	No	No
Advance Vehicle Detection?	No	No	Yes	Yes
Cycle Length (AM, MID, PM) (seconds)	160, 160, 160			
Available Green Time (AM, MID, PM) (seconds)	39, 54, 54	39, 54, 54	104, 89, 89	104, 89, 89
Existing Yellow Interval (seconds)	4	4	4	4
Existing Red Clearance (seconds)	2	2	1	1
2 Signals in Cone of Vision?	Yes	Yes	Yes	Yes

A summary of the crash history for Vineyard Boulevard at Palama Street from 2016 - 2020 is provided in Table 7. Crashes involving vehicles from different approaches are listed under the approach in which the offending vehicle was traveling from.

Table 7: Crash History and Baseline RLR Violations at Vineyard Boulevard at Palama Street

	Rear End Crashes	Right Angle Crashes	Sideswipe Crashes	Pedestrian or Bicyclist Involved Crashes	Speed Involved Crashes	Red Light Running Related Crashes	Dusk or Night Time Crashes	Crashes During Times of Sunrise or Sunset	Injury Involved Crashes	Fatality Involved Crashes	Total Crashes
NWB Vineyard Boulevard	-	-	1	-	1	1	1	-	1	1	1
SEB Vineyard Boulevard	1	-	-	-	-	-	-	1	1	-	1
NEB Palama Street	3	-	-	3	1	-	5	-	5	-	8
SWB Palama Street	-	-	-	2	-	-	-	-	2	-	2

Notes:
1) Total Crashes was the summation of all reported crashes at each approach, including some not listed above due to them having another crash-type. Other reported contributing factors were listed, of which some crashes had multiple, while others had none.
2) This crash data was collected under the Highway Safety Improvement Program of Title 23, United States Code (U.S.C.), Section 148. This data is protected under Title 23, U.S.C., Section 407, and is intended for highway safety and educational purposes only. This information may not be used in any Federal or State court proceeding in any action for damages arising from any occurrence at a location mentioned or addressed in the information provided.

2. Engineering Mitigation

This intersection meets the minimum *MUTCD* guidelines for the number of signal heads for the primary movement for each approach and there are no observed obstructions or issues with sight line visibility within the 20˚ cone of vision. However, prior to the installation of RLSCS, necessary mitigation measures at this intersection include:

- Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

Other mitigation measures to consider prior to the installation of RLSCS include:

- Adding an additional near-right traffic signal for the NEB Palama Street approach.
  - Although not required, this signal would supplement the far side signals.
    - A supplemental signal head is recommended if the nearest far side signal is between 150 feet and 180 feet past the stop bar.
- Adding an additional traffic signal head to the mast arms for both the NWB and SEB Vineyard Boulevard approaches to better align overhead with the three through-lanes in each direction.
- Adding *Intersection Warning (W3-3)* signage to the SEB Vineyard approach to warn drivers of the oncoming intersection.
- Installing backplates on all traffic signals mounted on mast arms.
  - The NWB/SEB Vineyard Boulevard approaches would be of greatest need due to their location on a predominantly E/W alignment that results in potential glare issues associated with the rising/setting of the sun.

3. Constructability Concerns

There are no major constructability concerns associated with any approach at this intersection.

4. Recommendations

Installation of RLSC at this intersection location adjacent to freeway on/off-ramps may help provide traffic calming for vehicles traveling through the neighborhood. The northeast bound approach to the intersection from Palama Street has a higher propensity for crashes; however, data did not show evidence that these crashes were directly correlated with red-light running. The engineering mitigation measures should be considered prior to the installation of RLSCS for any approach.

D. Vineyard Boulevard at Pali Highway

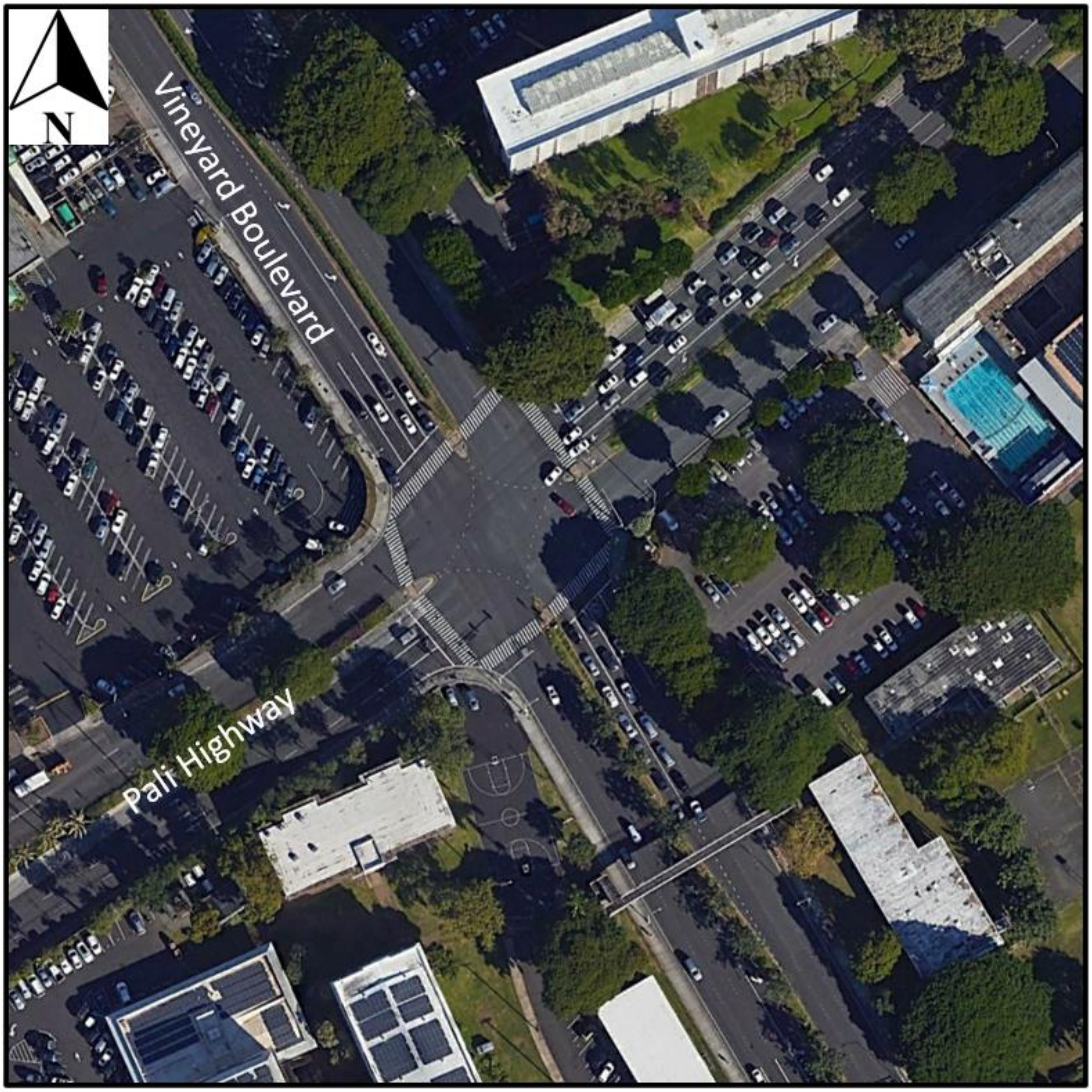

Figure 6: Vineyard Boulevard at Pali Highway

1. Intersection Summary

Vineyard Boulevard at Pali Highway is a four-leg signalized intersection in Downtown Honolulu.

- Vineyard Boulevard is classified as an arterial.
- The NEB approach of Pali Highway is classified as an arterial while the SWB approach is classified as a highway.
- Both corridors are separated by landscaped medians of varying widths.
- The surrounding area is highly urbanized, with a mix of commercial centers, multi-family homes, and a school.

- There is a driveway on the near side of the NWB Vineyard Boulevard approach, approximately 120 feet from the stop bar.
- There are no marked bike facilities at this intersection.
- There are marked pedestrian crosswalks across all legs of the intersection.
- Paved sidewalks exist on both sides of the street for all four legs of the intersection.
- On-street parking is restricted along all approaches.
- There is a bus stop located on the near side of the SWB Pali Highway approach.

A summary of the intersection approach conditions for Vineyard Boulevard at Pali Highway is provided in Table 8. Where an approach characteristic may be considered for mitigation, it has been highlighted in yellow in the table. Note the only required mitigation is ensuring standard yellow interval**.** Additional figures including intersection approach views, cone of vision diagrams, and the traffic signal ring and barrier diagram are included in Appendix A. It should be noted that since this intersection is currently under construction, the provided data is based on the proposed conditions and configuration.

Table 8: Summary of Intersection Approach Conditions at Vineyard Boulevard at Pali Highway

	Pali Highway NEB Approach	Pali Highway SWB Approach	Vineyard Boulevard NWB Approach	Vineyard Boulevard SEB Approach
Approach ADT (HPMS 2017) (veh/day)	16,261	12,019	11,527	11,527
Posted Speed Limit (mph)	25	25	30	30
Lane Configuration	↰ ↑ ↑ ↱	↰ ↑ ↑ ↱	↰ ↑ ↑ ↱	↰ ↑ ↑ ↱
# of Signal Heads and Location	4 on mast-arm, 1 on far-left pole, 1 on far-right pole, 1 on near pole	4 on mast-arm, 1 on far left-pole, 1 on far-right pole, 1 on near pole	4 on mast-arm, 1 on far-left pole, 1 on far-right pole, 1 on near pole	4 on mast-arm, 1 on far-left pole, 1 on far-right pole, 1 on near pole
Signal Head Centered over Lanes?	Yes	Yes	Yes	Yes
Approach Grade	Flat	Slight Downhill	Slight Uphill with Crown	Slight Uphill
Far Side Signal Distance from Stop Bar (feet)	163	160	170	170
Signal Lens Size (inches)	12	12	12	12
Backplates on Mast Arm Signal Heads?	Yes	Yes	Yes	Yes
Advance Vehicle Detection?	No	No	No	No
Cycle Length (AM, MID, PM) (seconds)	160, 160, 160			
Available Green Time (AM, MID, PM) (seconds)	75, 73, 73	75, 73, 73	75, 77, 77	75, 77, 77
Existing Yellow Interval (seconds)	4	4	4	4
Existing Red Clearance (seconds)	2	2	2	2
2 Signals in Cone of Vision?	Yes	Yes	Yes	Yes

A summary of the crash history for Vineyard Boulevard at Pali Highway from 2016 - 2020 is provided in Table 9. Crashes involving vehicles from different approaches are listed under the approach in which the offending vehicle was traveling from.

Table 9: Crash History and Baseline RLR Violations at Vineyard Boulevard at Pali Highway

	Rear End Crashes	Right Angle Crashes	Sideswipe Crashes	Pedestrian or Bicyclist Involved Crashes	Speed Involved Crashes	Red Light Running Related Crashes	Dusk or Night Time Crashes	Crashes During Times of Sunrise or Sunset	Injury Involved Crashes	Fatality Involved Crashes	Total Crashes
NWB Vineyard Boulevard	2	-	-	2	-	-	2	-	2	-	5
SEB Vineyard Boulevard	2	1	-	1	-	1	1	1	3	-	4
NEB Pali Highway	1	-	-	-	-	-	-	-	1	-	1
SWB Pali Highway	2	-	-	-	-	-	1	-	-	-	2

Notes:
1) Total Crashes was the summation of all reported crashes at each approach, including some not listed above due to them having another crash-type. Other reported contributing factors were listed, of which some crashes had multiple, while others had none.
2) This crash data was collected under the Highway Safety Improvement Program of Title 23, United States Code (U.S.C.), Section 148. This data is protected under Title 23, U.S.C., Section 407, and is intended for highway safety and educational purposes only. This information may not be used in any Federal or State court proceeding in any action for damages arising from any occurrence at a location mentioned or addressed in the information provided.

2. Engineering Mitigation

This intersection meets the minimum *MUTCD* guidelines for the number of signal heads for the primary movement for each approach and there are no observed obstructions or issues with sight line visibility within the 20˚ cone of vision. Due to the ongoing replacement of all above ground traffic signal equipment, pavement, and markings at this intersection, no other engineering mitigations are recommended.

3. Constructability Concerns

There are no major constructability concerns associated with any approach at this intersection. It was noted that this intersection is currently being reconstructed and traffic signals are being modernized as part of the Pali Highway Resurfacing project.

4. Recommendations

All approaches at the intersection of Vineyard Boulevard at Pali Highway provide viable options for the installation of RLSCS. A school is located adjacent to the intersection indicating the potential for a higher number of children crossing and additional safety needs. If possible, the installation of any RLSCS should coincide with the reconstruction of the intersection to minimize construction impacts. In addition, it would be of benefit if the completion of the Pali Highway repaving were to happen prior to, or soon after, the installation of RLSCS.

E. N. King Street at Beretania Street

Figure 7: N. King Street at Beretania Street

1. Intersection Summary

N. King Street at Beretania Street is a three-leg signalized intersection in the Kalihi-Palama area.

- Both streets are classified as arterials.
- N. King Street travels SB before splitting in two, continuing as N. King Street in the SB direction and skewing into Beretania Street in the SEB direction.
- Traffic traveling NB along N. King Street primarily consists of busses and vehicles turning off Iwilei Road, as N. King Street operates as one-way in the NB direction just south of this intersection.

- Vehicles travelling in the NWB direction along Beretania Street must continue NB onto N. King Street and are not allowed to make any turning movements at the intersection.
- Vehicles travelling NB on N. King Street are able to make a right turn to head SEB on Beretania Street using a channelized right-turn lane not controlled by the signal.
- There is a dedicated bus-only lane in the SB direction along N. King Street.
- The surrounding area has a mix of commercial businesses, restaurants, multi-family housing facilities, and a park.
- There is a driveway on the west side of N. King Street just after the SB approach.
- There are no marked bike facilities at this intersection.
- There is a marked crosswalk separating the N. King Street approaches that spans across the intersection fronting the Beretania Street approach.
- There is paved sidewalk on both sides of the road along all legs of the intersection.
- There is on-street parking on the NWB Beretania Street approach, however, it is restricted starting approximately 90 feet from stop bar.
- There are bus stops on the near side of all three approaches.

A summary of the intersection approach conditions for N. King Street at Beretania Street is provided in Table 10. Where an approach characteristic should be considered for mitigation prior to RLSCS installation, it has been highlighted in yellow in the table. Note the only required mitigation is ensuring standard yellow interval. Additional figures including intersection approach views, cone of vision diagrams, and the traffic signal ring and barrier diagram are included in Appendix A.

Table 10: Summary of Intersection Approach Conditions at N. King Street at Beretania Street

	King Street NB Approach	King Street SB Approach	Beretania Street NWB Approach
Approach ADT (HPMS 2017) (veh/day)	6,323	20,150	14,191
Posted Speed Limit (mph)	25	25	25
Lane Configuration	↑ ↑	↰ ↑ ↑ ↑	↑ ↑ ↑ ↑
# of Signal Heads and Location	1 on light pole, 1 on far-left pole, 1 on far-right pole	2 on mast arm, 1 on near-left pole, 1 on far-left pole, 1 on near pole	2 on mast arm, 1 on far-left pole, 1 on near pole
Signal Head Centered over Lanes?	No	No	No
Approach Grade	Slight Uphill	Slight Downhill	Flat
Far Side Signal Distance from Stop Bar (feet)	120	53	60
Signal Lens Size (inches)	12	12	12
Backplates on Mast Arm Signal Heads?	No	No	No
Advance Vehicle Detection?	No	No	No
Cycle Length (AM, MID, PM) (seconds)	90, 90, 90		
Available Green Time (AM, MID, PM) (seconds)	54	27	51
Existing Yellow Interval (seconds)	4	3	4
Existing Red Clearance (seconds)	2	0	2
2 Signals in Cone of Vision?	Yes	Yes	Yes

A summary of the crash history for N. King Street at Beretania Street from 2016 - 2020 was analyzed. The only provided crash data involved a transit-rider falling while on the bus. No other crash data was provided at this intersection.

2. Engineering Mitigation

This intersection meets the minimum *MUTCD* guidelines for the number of signal heads for the primary movement for each approach and there are no observed obstructions or issues with sight line visibility within the 20˚ cone of vision. Prior to the installation of RLSCS, necessary mitigation measures at this intersection include:

- Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

Other mitigation measures to consider prior to the installation of RLSCS include:

- Installing backplates on all traffic signals mounted on mast arms.
    - The NWB Beretania Street approach would be of greatest need due to its location on an E/W alignment that results in potential glare issues associated with the rising/setting of the sun.

3. Constructability Concerns

There are no major constructability concerns associated with any approach at this intersection. However, there are bus stops adjacent to each approach leg, as well as a dedicated bus-only lane in the SB N. King Street direction, all of which need to be considered to provide optimal visibility for any proposed RLSCS.

4. Recommendations

The SB N. King Street and NWB Beretania Street approaches both provide viable options for the installation of RLSCS; however, the bus stops and bus only lane approaching this intersection may present visibility conflicts for RLSC installation. The engineering mitigation measures should be considered prior to the installation of RLSCS for any approach.

F. S. King Street at Ward Avenue

Figure 8: S. King Street at Ward Avenue

1. Intersection Summary

S. King Street at Ward Avenue is a four-leg signalized intersection between Downtown Honolulu and the Kakaako area.

- Both streets are classified as arterials.
- Ward Avenue operates with contraflow in the SB direction during the AM Peak.
- S. King Street operates as a one-way corridor in the EB direction.

- There are numerous offices, medical facilities, parks, and commercial businesses in the surrounding vicinity. Ambulances accessing Straub Medical Center commonly travel through this intersection, enroute to the ambulance bay off of Hotel Street, north of the intersection.
- There are no driveways within 150 feet of any approach to the intersection.
- There is a two-way protected bike lane on the north side of S. King Street and one-way protected bike lanes on either side of Ward Avenue, south of the intersection.
- There are marked pedestrian crosswalks as well as paved sidewalks on both side of the street at all four legs of the intersection.
- Pedestrian counts obtained from the *UrbanLogiq* database show a heavy mix of pedestrians, with upwards of 225 crossings throughout the peak hour, spread throughout each crosswalk.
- On-street parking is marked and permitted along the south side of the S. King Street approach; however, it is restricted starting approximately 170 feet from the stop bar.
- Similarly, parking is marked on the NB Ward Avenue approach, however, it is restricted starting approximately 100 feet from the stop bar.
- There is a bus stop on the far side of the SB Ward Avenue approach.

A summary of the intersection approach conditions for S. King Street at Ward Avenue is provided in Table 11. Where an approach characteristic should be considered for mitigation prior to RLSCS installation, it has been highlighted in yellow in the table. Note the only required mitigation is ensuring standard yellow interval. Additional figures including intersection approach views, cone of vision diagrams, and the traffic signal ring and barrier diagram are included in Appendix A.

Table 11: Summary of Intersection Approach Conditions at S. King Street at Ward Avenue

	Ward Avenue NB Approach	Ward Avenue SB Approach	King Street Eastbound Approach
Approach ADT (HPMS 2017) (veh/day)	6,717	6,717	24,006
Posted Speed Limit (mph)	25	25	30
Lane Configuration	↑ ↑ ↱	↑ ↑	↰ ↑ ↑ ↑ ↱
# of Signal Heads and Location	1 on far-left pole, 2 on far-right pole	2 on mast arm, 1 on far-left pole	1 on light pole, 1 on far-left pole, 1 on far-right pole
Signal Head Centered over Lanes?	No	Yes	No
Approach Grade	Flat	Flat	Flat
Far Side Signal Distance from Stop Bar (feet)	93	93	103
Signal Lens Size (inches)	12	12	12
Backplates on Mast Arm Signal Heads?	No	No	No
Advance Vehicle Detection?	No	No	No
Cycle Length (AM, MID, PM) (seconds)	90, 90, 90		
Available Green Time (AM, MID, PM) (seconds)	46, 40, 35	46, 40, 35	34, 40, 45
Existing Yellow Interval (seconds)	4	4	4
Existing Red Clearance (seconds)	1	1	1
2 Signals in Cone of Vision?	Yes	Yes	Yes

A summary of the crash history for S. King Street at Ward Avenue from 2016 – 2020 is provided in Table 12. Crashes involving vehicles from different approaches are listed under the approach in which the offending vehicle was traveling from.

Table 12: Crash History and Baseline RLR Violations at S. King Street at Ward Avenue

	Rear End Crashes	Right Angle Crashes	Sideswipe Crashes	Pedestrian or Bicyclist Involved Crashes	Speed Involved Crashes	Red Light Running Related Crashes	Dusk or Night Time Crashes	Crashes During Times of Sunrise or Sunset	Injury Involved Crashes	Fatality Involved Crashes	Total Crashes
SEB King Street	-	3	-	7	-	2	3	1	8	-	10
NEB Ward Avenue	-	1	-	-	-	1	1	-	1	-	1
SWB Ward Avenue	-	2	-	1	-	1	2	-	2	-	3

Notes:
1) Total Crashes was the summation of all reported crashes at each approach, including some not listed above due to them having another crash-type. Other reported contributing factors were listed, of which some crashes had multiple, while others had none.
2) This crash data was collected under the Highway Safety Improvement Program of Title 23, United States Code (U.S.C.), Section 148. This data is protected under Title 23, U.S.C., Section 407, and is intended for highway safety and educational purposes only. This information may not be used in any Federal or State court proceeding in any action for damages arising from any occurrence at a location mentioned or addressed in the information provided.

2. Engineering Mitigation

This intersection meets the minimum *MUTCD* guidelines for the number of signal heads for the primary movement for each approach and there are no observed obstructions or issues with sight line visibility within the 20˚ cone of vision. However, prior to the installation of RLSCS, necessary mitigation measures at this intersection include:

- Trimming the overhanging landscaping that obstructs visibility at the SB Ward approach.
- Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

Other mitigation measures to consider prior to the installation of RLSCS include:

- Installing an additional signal head on the near-right side of the EB S. King Street approach to improve visibility.
- Installing backplates on the traffic signals mounted on the mast arm for SB Ward Avenue.
  - o The EB S. King Street approach would be of greatest need due to its location on an E/W alignment that results in potential glare issues associated with the rising/setting of the sun; however, no signals on this approach are mounted on mast arms.
- Replacing the existing faded *No Left Turn (R3-2)* sign on the near-right side of the SB Ward Avenue approach.

3. Constructability Concerns

There are no major constructability concerns associated with any approach at this intersection, although it was noted that multiple safety cameras may be required and placed on opposites sides of the roadway on S. King Street due to its width and potential obstructions. Additionally, contraflow lanes along Ward Avenue would need to be programmed specific to the time of day if proposing RLSCS there.

4. Recommendations

The EB approach of S. King Street provides a viable option for the installation of RLSCS due to its propensity for crashes. While the existing signal configuration without a mast arm is not preferred, especially considering the number of approach lanes, it meets all minimum MUTCD requirements. NEB and SWB Ward Avenue provide viable options for the installation of RLSCS. The SWB Ward Avenue approach has a preferred existing signal configuration and a higher propensity for crashes. Both approaches along Ward Street provide existing sufficient visibility for vehicles. The engineering mitigation measures should be considered prior to the installation of RLSCS for any approach.

G. Vineyard Boulevard at Liliha Street

Figure 9: Vineyard Boulevard at Liliha Street

1. Intersection Summary

Vineyard Boulevard at Liliha Street is a four-leg signalized intersection in the Kalihi-Palama area.

- Vineyard Boulevard is classified as an arterial and is separated by a landscaped median of varying width.
- Liliha Street is classified as a collector.
- The surrounding area has a mix of commercial businesses, single and multi-family homes.
- There is a driveway on the SEB Vineyard Boulevard approach, approximately 65 feet from the stop bar.

- There is a driveway on the SWB Liliha Street approach, approximately 115 feet from the stop bar.
- There are no marked bike facilities at the intersection.
- There are marked pedestrian crosswalks across all legs of the intersection.
- Paved sidewalks exist on both side of the street at all four legs of the intersection.
- Pedestrian counts obtained as part of a nearby project show crossing volumes are highest across the NE Liliha Street leg, followed by the SE Vineyard Boulevard leg.
- On-street parking is permitted on the NWB Vineyard Boulevard approach. A sign delineating the parking limits used to exist approximately 75 feet from the stop bar, however, the sign is no longer present.
- No other approaches permit on-street parking.
- There are bus stops on the near sides of all approaches, with the exception on the NWB Vineyard Boulevard approach, where the stop is located on the far side.

A summary of the intersection approach conditions for Vineyard Boulevard at Liliha Street is provided in Table 13. Where an approach characteristic should be considered for mitigation prior to RLSCS installation, it has been highlighted in yellow in the table. Note the only required mitigation is ensuring standard yellow interval. Additional figures including intersection approach views, cone of vision diagrams, and the traffic signal ring and barrier diagram are included in Appendix A.

Table 13: Summary of Intersection Approach Conditions at Vineyard Boulevard at Liliha Street

	Liliha Street NEB Approach	Liliha Street SWB Approach	Vineyard Boulevard NWB Approach	Vineyard Boulevard SEB Approach
Approach ADT (HPMS 2017) (veh/day)	9,428	9,428	9,850	12,337
Posted Speed Limit (mph)	25	25	30	30
Lane Configuration	↰ ↑ ↱	↰ ↑ ↱	↰ ↑ ↑ ↱	↰ ↑ ↑ ↱
# of Signal Heads and Location	3 on mast arm, 1 on far-left pole, 1 on far-right pole, 1 on near pole	3 on mast arm, 1 on far-left pole, 1 on far-right pole, 1 on near pole	2 on mast arm, 1 on far-left pole, 1 on far-center pole, 1 on far-right pole	2 on mast arm, 1 on far-left pole, 1 on far-center pole, 1 on far-right pole
Signal Head Centered over Lanes?	Yes	No	No	No
Approach Grade	Flat	Slight Downhil	Flat	Slight Downhill
Far Side Signal Distance from Stop Bar (feet)	162	170	133	128
Signal Lens Size (inches)	12	12	12	12
Backplates on Mast Arm Signal Heads?	No	No	Yes	Yes
Advance Vehicle Detection?	No	No	Yes	Yes
Cycle Length (AM, MID, PM) (seconds)	160, 160, 160			
Available Green Time (AM, MID, PM) (seconds)	61, 66, 66	61, 66, 66	89, 84, 84	89, 84, 84
Existing Yellow Interval (seconds)	4	4	5	4
Existing Red Clearance (seconds)	1	1	1	1
2 Signals in Cone of Vision?	Yes	Yes	Yes	Yes

A summary of the crash history for Vineyard Boulevard at Liliha Street from 2016 - 2020 is provided in Table 14. Crashes involving vehicles from different approaches are listed under the approach in which the offending vehicle was traveling from.

Table 14: Crash History and Baseline RLR Violations at Vineyard Boulevard at Liliha Street

	Rear End Crashes	Right Angle Crashes	Sideswipe Crashes	Pedestrian or Bicyclist Involved Crashes	Speed Involved Crashes	Red Light Running Related Crashes	Dusk or Night Time Crashes	Crashes During Times of Sunrise or Sunset	Injury Involved Crashes	Fatality Involved Crashes	Total Crashes
NWB Vineyard Boulevard	2	2	-	2	-	2	1	2	5	-	6
SEB Vineyard Boulevard	1	1	-	1	1	1	3	-	4	-	5
NEB Liliha Street	-	2	2	2	1	2	3	-	4	1	6
SWB Liliha Street	1	1	1	-	-	-	-	-	-	-	3

Notes:
1) Total Crashes was the summation of all reported crashes at each approach, including some not listed above due to them having another crash-type. Other reported contributing factors were listed, of which some crashes had multiple, while others had none.
2) This crash data was collected under the Highway Safety Improvement Program of Title 23, United States Code (U.S.C.), Section 148. This data is protected under Title 23, U.S.C., Section 407, and is intended for highway safety and educational purposes only. This information may not be used in any Federal or State court proceeding in any action for damages arising from any occurrence at a location mentioned or addressed in the information provided.

2. Engineering Mitigation

This intersection meets the minimum *MUTCD* guidelines for the number of signal heads for the primary movement for each approach and there are no observed obstructions or issues with sight line visibility within the 20˚ cone of vision. However, prior to the installation of RLSCS, necessary mitigation measures at this intersection include:

- Increasing the size of the *Left on Green Arrow Only (R10-5)* signs on the NEB and SWB Liliha Street approaches to be 30 inches x 36 inches in accordance with *MUTCD* standards.
- Restricting parking starting at a minimum of 75 feet from the stop bar on the NWB Vineyard Boulevard approach.
- Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

Other mitigation measures to consider prior to the installation of RLSCS include:

- Installing backplates on all traffic signals mounted on mast arms for signal heads located on both Liliha Street approaches.
- Adding a third signal head to the NWB and SEB Vineyard Boulevard approaches to better align overhead with the three through-lane movements.
- Shifting the middle signal head for the NEB and SWB Liliha Street approaches to be centered over the inner-most through-lane.
- Relocating the overhead utility wires that currently obstruct the visibility of the signal mast arm on the NEB Liliha Street approach to be higher.

3. Constructability Concerns

An existing utility pole located approximately 70 feet back of the stop bar on the NEB Liliha Street approach will obstruct the camera view of at least one signal head located on the mast arm. The nearside bus stop, along with the high volumes of busses along the corridor, may potentially obscure the RLSCS view of vehicles, posing additional constructability concerns with this approach. There are no major constructability concerns associated with the other three approaches of this intersection.

4. Recommendations

There is crash history at all three of these approaches to the Vineyard Boulevard at Liliha Street intersection, including red-light running related crashes at the northwest bound and southeast bound Vineyard Boulevard approaches. The northeast bound Liliha Street approach also has red-light running related crash history. The engineering mitigation measures should be considered prior to the installation of RLSCS for any approach.

H. Pali Highway at School Street

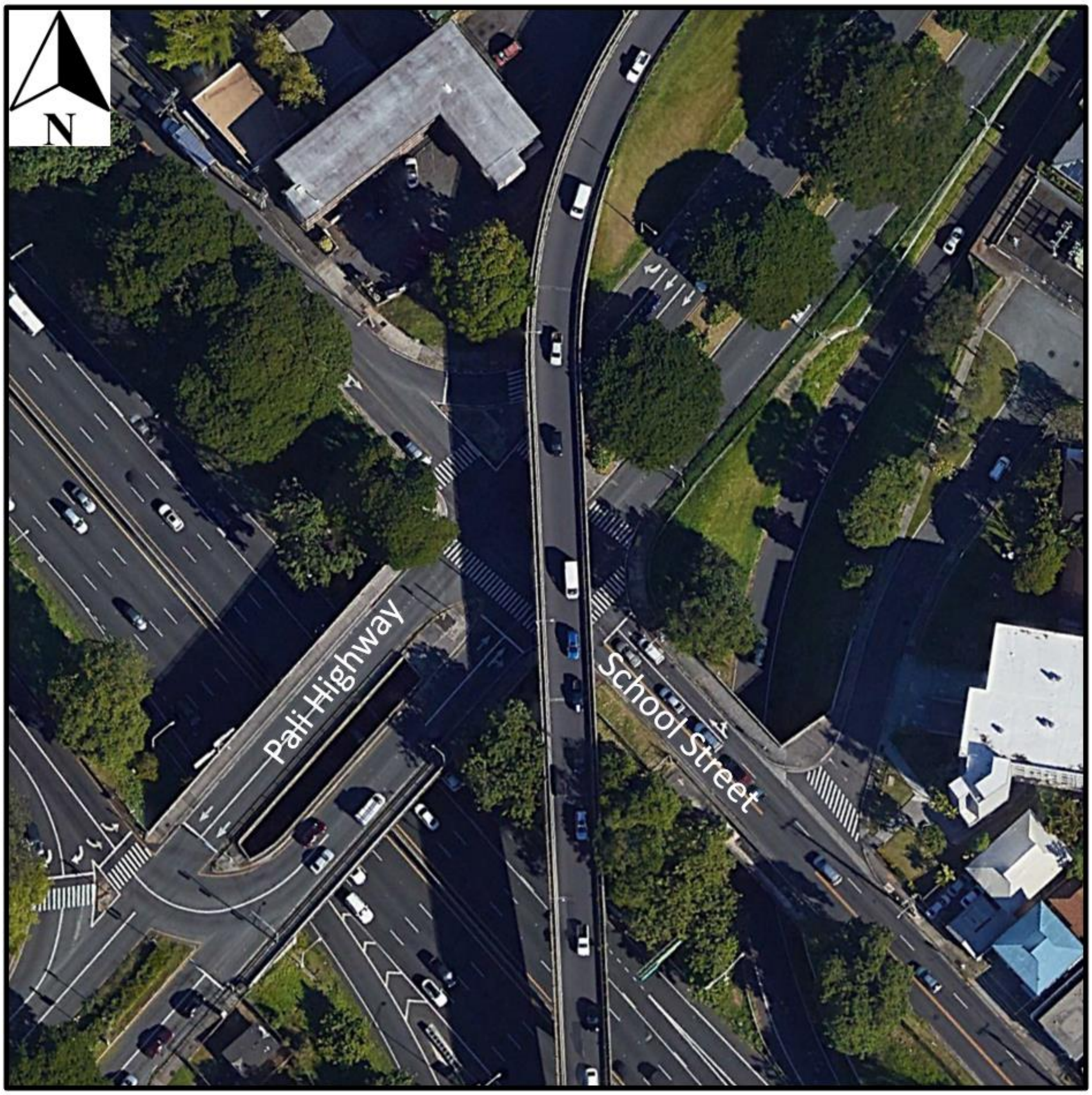

Figure 10: Pali Highway at School Street

1. Intersection Summary

Pali Highway at School Street is a four-leg signalized intersection in the Nuuanu – Punchbowl area.

- Pali Highway is classified as a highway and is separated by a landscaped median on the NE leg and a concrete bridge deck on the SW leg.
- School Street is classified as an arterial.
- The intersection is under a freeway interchange, with some single-family homes off School Street.
- There are no driveways within 150 feet of any approach to the intersection.
- There are no marked bike facilities at the intersection.
- There are marked pedestrian crosswalks across all four legs of the intersection.
- There is continuous sidewalk on the south side of School Street and both sides of the SW leg of Pali Highway.
- On-street parking is restricted at all approaches to the intersection.
- There are no bus stops located within 100 feet of any approach to the intersection.

A summary of the intersection approach conditions for Pali Highway at School Street is provided in Table 15. Where an approach characteristic may be considered for mitigation, it has been highlighted in yellow in the table. Note the only required mitigation is ensuring standard yellow interval. Additional figures including intersection approach views, cone of vision diagrams, and the traffic signal ring and barrier diagram are included in Appendix A. It should be noted that since this intersection is currently under construction, the provided data is based off the proposed conditions and configuration.

Table 15: Summary of Intersection Approach Conditions at Pali Highway at School Street

	Pali Highway NEB Approach	Pali Highway SWB Approach	School Street NWB Approach	School Street SEB Approach
Approach ADT (HPMS 2017) (veh/day)	12,019	11,450	6,050	6,050
Posted Speed Limit (mph)	25	25	25	25
Lane Configuration	↑ ↑→	↑ ↑ ↱	↑ ↑→	↑→
# of Signal Heads and Location	1 on far-middle pole, 1 on far-right pole	1 on far-middle pole, 1 on far-right pole, 2 overhead on bridge deck	1 on far-left pole, 1 on middle-right pole	1 on far-left ple, 1 on middle-left pole, 1 on near pole
Signal Head Centered over Lanes?	No	No	No	No
Approach Grade	Flat	Flat	Flat	Flat
Far Side Signal Distance from Stop Bar (feet)	65	73	65	125
Signal Lens Size (inches)	12	12	12	12
Backplates on Mast Arm Signal Heads?	No	No	No	No
Advance Vehicle Detection?	No	No	No	No
Cycle Length (AM, MID, PM) (seconds)	160, 160, 160			
Available Green Time (AM, MID, PM) (seconds)	108, 110, 107	108, 110, 107	46, 44, 47	46, 44, 47
Existing Yellow Interval (seconds)	4	4	4	4
Existing Red Clearance (seconds)	2	2	2	2
2 Signals in Cone of Vision?	Yes	Yes	Yes	Yes

A summary of the crash history for Pali Highway and School Street from 2016 - 2020 is provided in Table 16. Crashes involving vehicles from different approaches are listed under the approach in which the offending vehicle was traveling from.

Table 16: Crash History and Baseline RLR Violations at Pali Highway at School Street

	Rear End Crashes	Right Angle Crashes	Sideswipe Crashes	Pedestrian or Bicyclist Involved Crashes	Speed Involved Crashes	Red Light Running Related Crashes	Dusk or Night Time Crashes	Crashes During Times of Sunrise or Sunset	Injury Involved Crashes	Fatality Involved Crashes	Total Crashes
NEB Pali Highway	-	5	-	-	1	1	3	1	4	-	5
SWB Pali Highway	-	5	-	-	-	4	1	-	2	-	5
NWB School Street	1	2	-	1	-	2	2	-	3	-	4
SEB School Street	-	-	-	-	-	-	-	-	-	-	0

Notes:
1) Total Crashes was the summation of all reported crashes at each approach, including some not listed above due to them having another crash-type. Other reported contributing factors were listed, of which some crashes had multiple, while others had none.
2) This crash data was collected under the Highway Safety Improvement Program of Title 23, United States Code (U.S.C.), Section 148. This data is protected under Title 23, U.S.C., Section 407, and is intended for highway safety and educational purposes only. This information may not be used in any Federal or State court proceeding in any action for damages arising from any occurrence at a location mentioned or addressed in the information provided.

2. Engineering Mitigation

This intersection meets the minimum *MUTCD* guidelines for the number of signal heads for the primary movement for each approach and there are no observed obstructions or issues with sight line visibility within the 20˚ cone of vision. Due to the ongoing replacement of all above ground traffic signal equipment, pavement, and marking at this intersection, there are no recommended engineering mitigation measures.

3. Constructability Concerns

Installation of RLSCSs for the NEB Pali Highway approach and the NWB School Street approach are problematic due to the optimal locations being on bridge decks. The installation of a red-light camera pole and associated conduit on a bridge presents constructability concerns in that a structural assessment, review, and permitting will be needed which will add extensive time to the design and construction effort. The installation of a pole on an existing bridge typically includes installation of the pole within the existing bridge railing or sidewalk, or as a cantilevered structure off the bridge deck or beam. In addition, the associated conduit would be attached along the outside of the bridge deck to a place off the deck where a separate pullbox can be installed for enabling cable connections. In addition, it was noted that this intersection is currently being reconstructed and traffic signals are being modernized as part of the Pali Highway Resurfacing project.

4. Recommendations

The SWB Pali Highway approach provides a viable option for the installation of RLSCS. Installation of RLSCS at this location may help provide traffic calming as vehicles continue into Downtown Honolulu and higher pedestrian areas. Due to the nature of the intersection and proximity of the H-1 Freeway overpass, the traffic signal configuration is not as preferred; however, it meets all minimum MUTCD requirements. RLSCS installation is not preferred for the NEB Pali Highway and NWB School Street approaches due to constructability issues. If possible, the installation of any RLSCS should coincide with the reconstruction of the intersection to minimize construction impacts. In addition, it would be of benefit if the completion of the Pali Highway repaving were to happen prior to, or soon after, the installation of RLSCS.

I. Likelike Highway at School Street

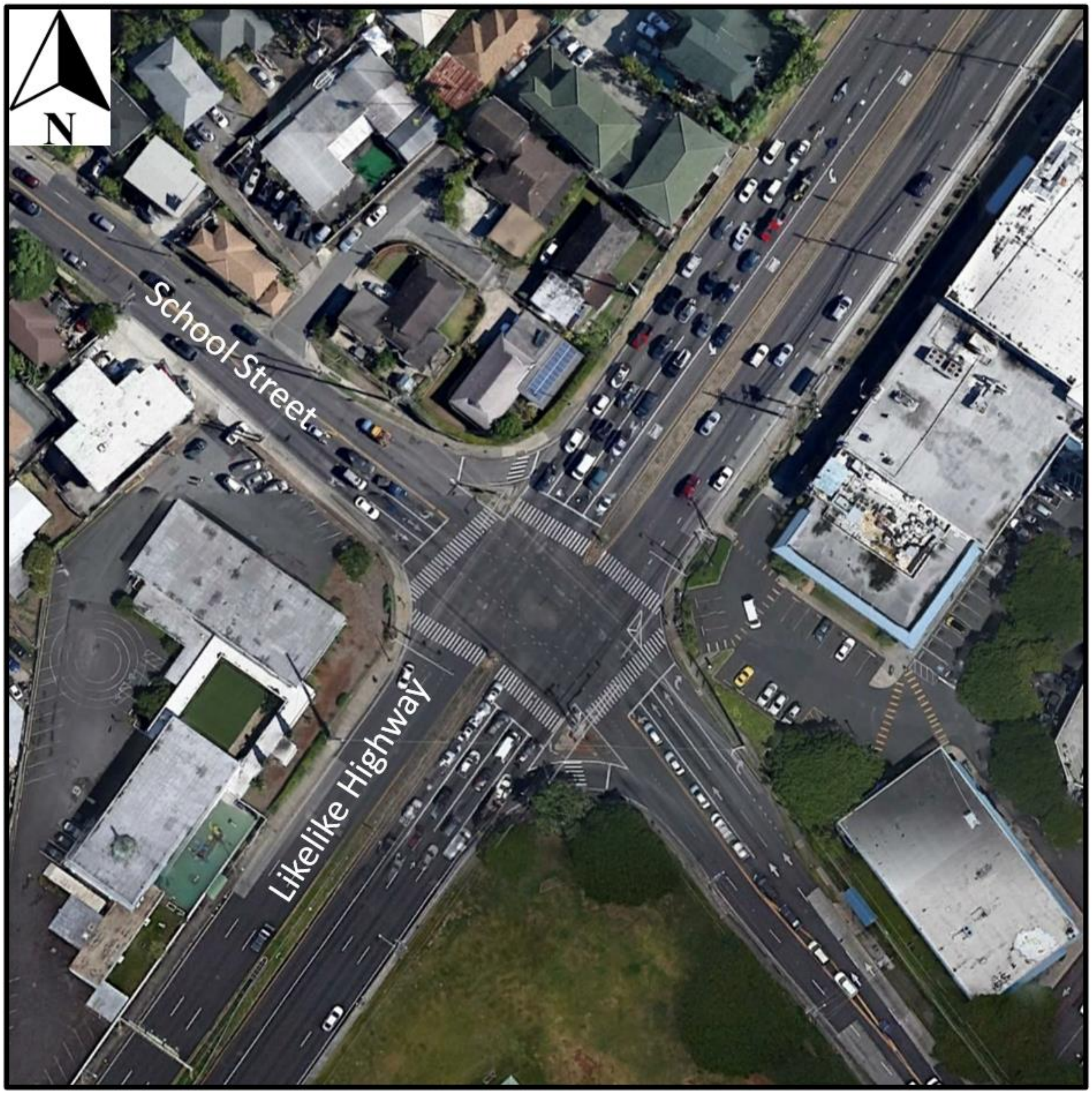

Figure 11: Likelike Highway at School Street

1. Intersection Summary

Likelike Highway at School Street is a four-leg signalized intersection in the Kalihi Valley.

- Likelike Highway is classified as a highway.
- South of the intersection, Likelike Highway becomes Kalihi Street, which is classified as a collector.
- Both legs are separated by a landscaped median of varying width.
- School Street is classified as an arterial.
- There is a driveway located approximately 115 feet from the stop bar on the NW leg of School Street.

- There are no marked bike facilities at the intersection.
- There are marked pedestrian crosswalks across all legs of the intersection.
- Paved sidewalks exist on both sides of the street at all four legs of the intersection.
- On-street parking is restricted at all approaches to the intersection. There are no bus stops located within 100 feet of any approach to the intersection.

A summary of the intersection approach conditions for Likelike Highway at School Street is provided in Table 17. Where an approach characteristic should be considered for mitigation prior to RLSCS installation, it has been highlighted in yellow in the table. Note the only required mitigation is ensuring standard yellow interval. Additional figures including intersection approach views, cone of vision diagrams, and the traffic signal ring and barrier diagram are included in Appendix A.

Table 17: Summary of Intersection Approach Conditions at Likelike Highway at School Street

	Likelike Highway NEB Approach	Likelike Highway SWB Approach	School Street NWB Approach	School Street SEB Approach
Approach ADT (HPMS 2017) (veh/day)	24,534	17,444	9,999	8,356
Posted Speed Limit (mph)	25	25	30	30
Lane Configuration	↰ ↑ ↑ ↑↱	↰ ↑ ↑ ↑↱	↰ ↑ ↑ ↱	↰ ↑ ↑↱
# of Signal Heads and Location	2 on mast arm, 1 on far-left pole, 2 on far-center pole, 1 on far-right pole	2 on mast arm, 1 on far-left pole, 2 on far-center pole, 1 on far-right pole	2 on mast arm, 1 on far-left pole, 1 on far-right pole, 1 on near pole	2 on mast arm, 1 on far left-pole, 1 on far-right pole
Signal Head Centered over Lanes?	No	No	No	No
Approach Grade	Slight Uphill	Slight Donwhill	Slight Uphill	Slight Downhill
Far Side Signal Distance from Stop Bar (feet)	130	121	138	140
Signal Lens Size (inches)	12	12	12	12
Backplates on Mast Arm Signal Heads?	Yes	Yes	No	No
Advance Vehicle Detection?	Yes	Yes	Yes	Yes
Cycle Length (AM, MID, PM) (seconds)	140, 140, 140			
Available Green Time (AM, MID, PM) (seconds)	43, 43, 43	43, 43, 43	72, 72, 72	72, 72, 72
Existing Yellow Interval (seconds)	4	4	5	5
Existing Red Clearance (seconds)	2	2	2	2
2 Signals in Cone of Vision?	Yes	Yes	Yes	Yes

A summary of the crash history for Likelike Highway at School Street from 2016 - 2020 is provided in Table 18. Crashes involving vehicles from different approaches are listed under the approach in which the offending vehicle was traveling from.

Table 18: Crash History and Baseline RLR Violations at Likelike Highway at School Street

	Rear End Crashes	Right Angle Crashes	Sideswipe Crashes	Pedestrian or Bicyclist Involved Crashes	Speed Involved Crashes	Red Light Running Related Crashes	Dusk or Night Time Crashes	Crashes During Times of Sunrise or Sunset	Injury Involved Crashes	Fatality Involved Crashes	Total Crashes
NEB Likelike Highway	2	-	-	-	-	-	1	1	1	-	2
SWB Likelike Highway	2	1	-	-	2	1	2	-	3	-	3
NWB School Street	2	3	-	1	-	1	1	2	5	-	7
SEB School Street	1	2	1	3	1	1	4	1	4	1	7

Notes:
1) Total Crashes was the summation of all reported crashes at each approach, including some not listed above due to them having another crash-type. Other reported contributing factors were listed, of which some crashes had multiple, while others had none.
2) This crash data was collected under the Highway Safety Improvement Program of Title 23, United States Code (U.S.C.), Section 148. This data is protected under Title 23, U.S.C., Section 407, and is intended for highway safety and educational purposes only. This information may not be used in any Federal or State court proceeding in any action for damages arising from any occurrence at a location mentioned or addressed in the information provided.

2. Engineering Mitigation

This intersection meets the minimum *MUTCD* guidelines for the number of signal heads for the primary movement for each approach and there are no observed obstructions or issues with sight line visibility within the 20˚ cone of vision. However, prior to the installation of RLSCS, necessary mitigation measures at this intersection include:

- Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

Other mitigation measures to consider prior to the installation of RLSCS include:

- Adding an additional traffic signal head to the mast arm for the SWB Likelike Highway approach to better align overhead with the three through-lanes.
- Adding an additional traffic signal head to the mast arm for the SEB School Street approach to improve visibility.
- Installing backplates on the traffic signals mounted on the mast arms for both School Street approaches.
  - The School Street approaches are on an E/W alignment that results in potential glare issues associated with the rising/setting of the sun.

3. Constructability Concerns

There are no major constructability concerns associated with any approach at this intersection.

4. Recommendations

All approaches to the intersection of Likelike Highway and School Street provide viable options for the installation of RLSCS due to crash history and visibility. The crash history includes RLR related crashes at the NWB and SEB School Street approaches, as well as the SWB Likelike Highway approach. The engineering mitigation measures should be considered prior to the installation of RLSCS for either approach.

J. N. King Street at River Street

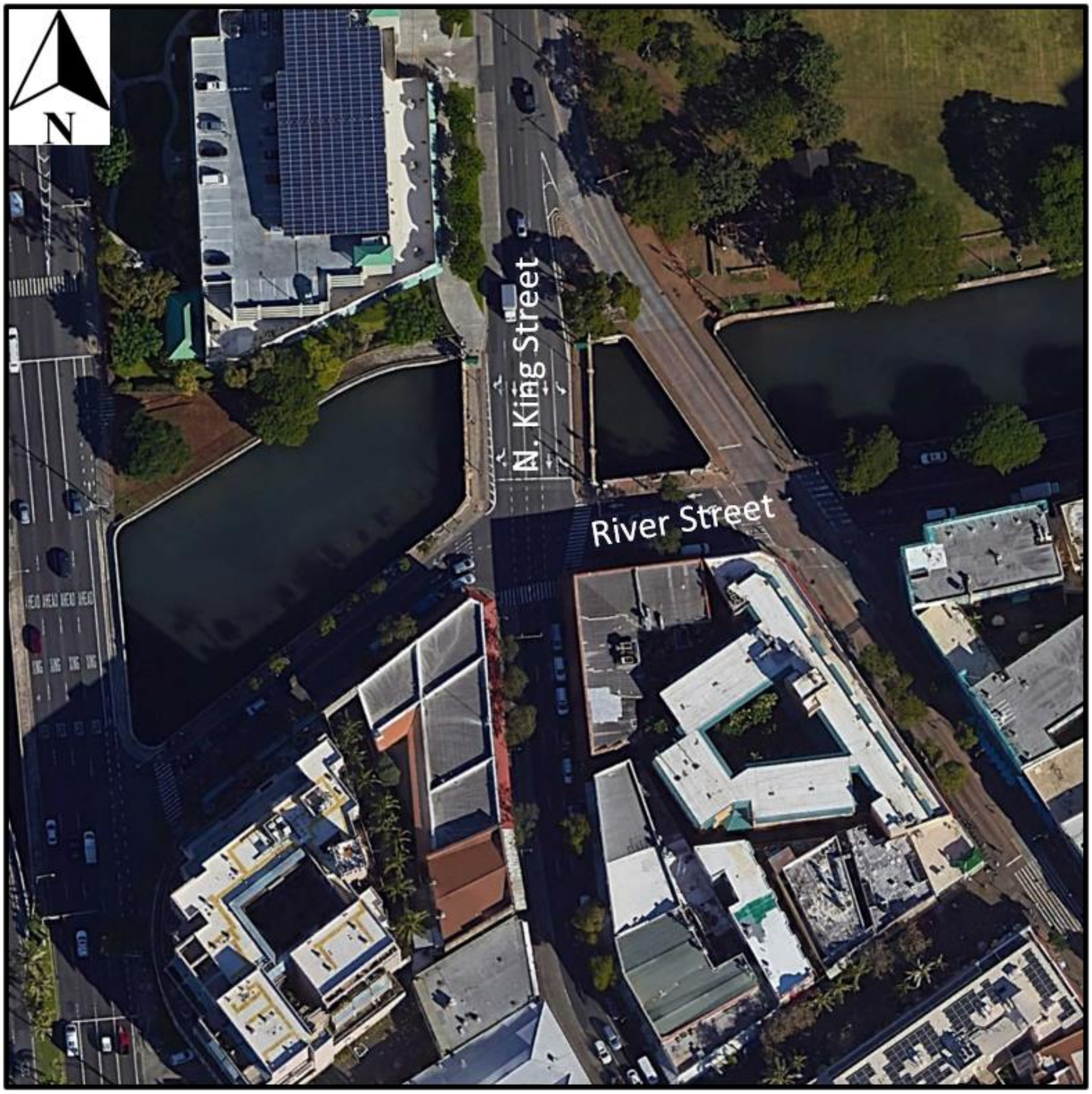

Figure 12: N. King Street at River Street

1. Intersection Summary

N. King Street at River Street is a four-leg signalized intersection in the Chinatown area.

- N. King Street is classified as an arterial and operates one-way in the SB direction.
- River Street is classified as a collector.
- The surrounding area has a mix of commercial stores, marketplaces, offices, and multi-family residences.
- There is a driveway approximately 85 feet from the stop bar on the EB approach.
- There are shared lane markings on River Street, but no marked bike facilities on N. King Street.

- There are marked crosswalks across all legs besides the north leg of N. King Street.
- Paved sidewalks exist on both sides of the roadway on all four legs.
- On-street parking is restricted along all approaches.
- There are no bus stops within 100 feet of any approach to the intersection.
- 2017 HPMS ADT volumes were not available along River Street. Instead, ADTs were estimated based on peak-hour counts taken at the intersection as part of a project from 2019.

A summary of the intersection approach conditions for N. King Street at River Street is provided in Table 19. Where an approach characteristic should be considered for mitigation prior to RLSCS installation, it has been highlighted in yellow in the table. Note the only required mitigation is ensuring standard yellow interval. Additional figures including intersection approach views, cone of vision diagrams, and the traffic signal ring and barrier diagram are included in Appendix A.

Table 19: Summary of Intersection Approach Conditions at N. King Street at River Street

	King Street SB Approach	River Street WB Approach	River Street EB Approach
Approach ADT (HPMS 2017) (veh/day)	22,707	1,194*	2,108*
Posted Speed Limit (mph)	25	25	25
Lane Configuration	↰ ↑ ↑ ↑ ↱	↰ ↑	↑ ↱
# of Signal Heads and Location	2 on mast arm, 1 on far-left pole	1 on far-left pole, 1 on far-right pole	1 on far-left pole, 1 on far-right pole
Signal Head Centered over Lanes?	No	No	No
Approach Grade	Crest hump due to bridge	Flat	Flat
Far Side Signal Distance from Stop Bar (feet)	98	85	-
Signal Lens Size (inches)	12	12	73
Backplates on Mast Arm Signal Heads?	No	No	No
Advance Vehicle Detection?	No	No	No
Cycle Length (AM, MID, PM) (seconds)		90, 90, 105	
Available Green Time (AM, MID, PM) (seconds)	52, 52, 67	28, 28, 28	28, 28, 28
Existing Yellow Interval (seconds)	4	4	4
Existing Red Clearance (seconds)	1	1	1
2 Signals in Cone of Vision?	Yes	Yes	Yes

A summary of the crash history for N. King Street and River Street from 2016 - 2020 is provided in Table 20. There was only one reported crash along WB River Street, and none along the other two approaches.

Table 20: Crash History and Baseline RLR Violations at N. King at River

	Rear End Crashes	Right Angle Crashes	Sideswipe Crashes	Pedestrian or Bicyclist Involved Crashes	Speed Involved Crashes	Red Light Running Related Crashes	Dusk or Night Time Crashes	Crashes During Times of Sunrise or Sunset	Injury Involved Crashes	Fatality Involved Crashes	Total Crashes
SB King Street	-	-	-	-	-	-	-	-	-	-	0
EB River Street	-	-	-	-	-	-	-	-	-	-	0
WB River Street	-	-	-	1	-	-	-	-	1	-	1

Notes:
1) Total Crashes was the summation of all reported crashes at each approach, including some not listed above due to them having another crash-type. Other reported contributing factors were listed, of which some crashes had multiple, while others had none.
2) This crash data was collected under the Highway Safety Improvement Program of Title 23, United States Code (U.S.C.), Section 148. This data is protected under Title 23, U.S.C., Section 407, and is intended for highway safety and educational purposes only. This information may not be used in any Federal or State court proceeding in any action for damages arising from any occurrence at a location mentioned or addressed in the information provided.

2. Engineering Mitigation

This intersection meets the minimum *MUTCD* guidelines for the number of signal heads for the primary movement for each approach and there are no observed obstructions or issues with sight line visibility within the 20˚ cone of vision. However, prior to the installation of RLSCS, necessary mitigation measures at this intersection include:

- Updating the *No Left Turn (R3-2) sign* on the near-left side for the SB River Street approach to include the supplemental *Except for Cars, Small Vans & Pick-Up Trucks* plaque which is missing.
- Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

Other mitigation measures to consider prior to the installation of RLSCS include:

- Adding an additional signal head on the near-left side for the EB River Street approach to improve visibility from the through lane.
- Installing backplates on the traffic signals mounted on the mast arm for SB N. King Street.
- Adding a *Turning Vehicles Yield to Pedestrians (R10-15)* sign on the far-right side for the EB River Street approach to draw attention to the obscured crosswalk on the south leg of the intersection.

3. Constructability Concerns

RLSCS installation for the SB N. King Street approach is problematic due to its location on a bridge deck. The installation of a red-light camera pole and associated conduit on a bridge presents constructability concerns in that a structural assessment, review, and permitting will be needed which will add extensive time to the design and construction effort. The installation of a pole on an existing bridge typically includes installation of the pole within the existing bridge railing or sidewalk, or as a cantilevered structure off the bridge deck or beam. In addition, the associated conduit would be attached along the outside of the bridge deck to a place off the deck where a separate pullbox can be installed for enabling cable connections. There are also constructability concerns with the WB/EB River Street approaches due to similar issues with electrical upgrades.

4. Recommendations

The SB N. King Street approach at the intersection of N. King Street and River Street provides a potential viable option for the installation of RLSCS. However, if extensive conduit or electrical upgrades are required for this approach, it may not be feasible. The WB/EB River Street approaches are not preferred options for the installation of RLSCS due to constructability concerns. The engineering mitigation measures should be considered prior to the installation of RLSCS for any approach.

K. N. King Street at Kohou Street

Figure 13: N. King Street at Kohou Street

1. Intersection Summary

N. King Street at Kohou Street is a four-leg signalized intersection in the Kalihi-Palama area.

- N. King Street is classified as an arterial while Kohou Street is classified as a minor street.
- The surrounding area is a mix of industrial buildings, offices, and commercial stores.
- There are some single and multi-family homes located just NE of the intersection.

- A driveway is located approximately 35 feet from the stop bar on the NW leg of N. King Street and one is located approximately 40 feet from the stop bar on the NE leg of Kohou Street.
- There are sharrow markings along N. King Street, however, there are no marked bike facilities on Kohou Street.
- There are marked crosswalks on all legs except for the SE leg of N. King Street
- Paved sidewalks exist on both sides of the roadway on all four legs, with the exception of the south side of the SW Kohou Street leg.
- On-street parking is restricted on N. King Street, however, there are no signed restrictions on Kohou Street and vehicles often park within 75 feet of the intersection.
- There is a near-side bus stop adjacent to the NW N. King Street leg, but no other stops within 100 feet of any approach to the intersection.
- It should be noted that 2017 HPMS ADT volumes were not available along Kohou Street. Instead, intersection counts from 2018 were taken from the *UrbanLogiq* database.

A summary of the intersection approach conditions for N. King Street at Kohou Street is provided in Table 21. Where an approach characteristic should be considered for mitigation prior to RLSCS installation, it has been highlighted in yellow in the table. Note the only required mitigation is ensuring standard yellow interval. Additional figures including intersection approach views, cone of vision diagrams, and the traffic signal ring and barrier diagram are included in Appendix A.

Table 21: Summary of Intersection Approach Conditions at N. King Street at Kohou Street

	Kohou Street NEB Approach	Kohou Street SWB Approach	King Street NWB Approach	King Street SEB Approach
Approach ADT (HPMS 2017) (veh/day)	3,656*	817*	13,888	13,888
Posted Speed Limit (mph)	25	25	25	25
Lane Configuration	←↑→	←↑→	↰ ↑ ↑→	←↑ ↑ ↑→
# of Signal Heads and Location	1 on far-left pole, 1 on far-right pole	1 on far-left pole, 1 on far-right pole	3 on mast arm, 1 on far-left pole, 1 on far-right pole	3 on mast arm, 1 on far-left pole, 1 on far-right pole
Signal Head Centered over Lanes?	No	No	No	Yes
Approach Grade	Flat	Slight Uphill	Flat	Flat
Far Side Signal Distance from Stop Bar (feet)	102	97	80	80
Signal Lens Size (inches)	12	12	12	12
Backplates on Mast Arm Signal Heads?	No	No	No	No
Advance Vehicle Detection?	No	No	No	No
Cycle Length (AM, MID, PM) (seconds)	90, 70, 100			
Available Green Time (AM, MID, PM) (seconds)	28, 28, 30	28, 28, 30	51, 31, 59	51, 31, 59
Existing Yellow Interval (seconds)	4	4	4	4
Existing Red Clearance (seconds)	1	1	2	2
2 Signals in Cone of Vision?	No	Yes	Yes	Yes

A summary of the crash history for N. King Street and Kohou Street from 2016 - 2020 is provided in Table 22. Crashes involving vehicles from different approaches are listed under the approach in which the offending vehicle was traveling from.

Table 22: Crash History and Baseline RLR Violations at N. King Street at Kohou Street

	Rear End Crashes	Right Angle Crashes	Sideswipe Crashes	Pedestrian or Bicyclist Involved Crashes	Speed Involved Crashes	Red Light Running Related Crashes	Dusk or Night Time Crashes	Crashes During Times of Sunrise or Sunset	Injury Involved Crashes	Fatality Involved Crashes	Total Crashes
NWB King Street	-	6	-	-	1	4	1	1	3	-	6
SEB King Street	-	-	-	-	-	-	-	-	1	-	1
NEB Kohou Street	-	2	-	3	-	2	1	-	3	-	5
SWB Kohou Street	-	1	-	-	-	1	-	-	1	-	1

Notes:
1) Total Crashes was the summation of all reported crashes at each approach, including some not listed above due to them having another crash-type. Other reported contributing factors were listed, of which some crashes had multiple, while others had none.
2) This crash data was collected under the Highway Safety Improvement Program of Title 23, United States Code (U.S.C.), Section 148. This data is protected under Title 23, U.S.C., Section 407, and is intended for highway safety and educational purposes only. This information may not be used in any Federal or State court proceeding in any action for damages arising from any occurrence at a location mentioned or addressed in the information provided.

2. Engineering Mitigation

This intersection meets the minimum *MUTCD* guidelines for the number of signal heads for the primary movement for each approach. Only one signal is within the 20˚ cone of vision for the NEB Kohou Street approach, which meets the minimum *MUTCD* guidelines, however, is not preferred by DTS. There are no apparent obstructions or issues with sight line visibility within the 20˚ cone of vision for the other three approaches. Prior to the installation of RLSCS, necessary mitigation measures at this intersection include:

- Restricting parking with signage starting at a minimum of 75 feet from the stop bar on the SWB Kohou Street approach.
- Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

Other mitigation measures to consider prior to the installation of RLSCS include:

- Installing backplates on the traffic signals mounted on the mast arms for all approaches.
    - The NWB/SEB N. King Street approaches would be of greatest need due to its location on an E/W alignment that results in potential glare issues associated with the rising/setting of the sun.
- Installing an additional signal head on the far-left side of the intersection for NEB Kohou to provide the preferred 2 signals within the 20˚ cone of vision.

3. Constructability Concerns

RLSCS installation for the NWB N. King Street approach is problematic due to its location on a bridge deck. The installation of a red-light camera pole and associated conduit on a bridge presents constructability concerns in that a structural assessment, review, and permitting will be needed which will add extensive time to the design and construction effort. The installation of a pole on an existing bridge typically includes installation of the pole within the existing bridge railing or sidewalk, or as a cantilevered structure off the bridge deck or beam. In addition, the associated conduit would be attached along the outside of the bridge deck to a place off the deck where a separate pullbox can be installed for enabling cable connections. There are no major constructability concerns with any of the other approaches.

4. Recommendations

The SEB N. King Street approach provides a potential viable option for the installation of RLSCS. There are constructability concerns with the NWB N. King Street approach due to the potential need to install additional conduit across the bridge deck, making it not a preferred option for the installation of RLSCS.

L. McCully Street at Algaroba Street

Figure 14: McCully Street at Algaroba Street

1. Intersection Summary

McCully Street at Algaroba Street is a four-leg signalized intersection in the McCully area.

- McCully Street is classified as an arterial while Algaroba Street is classified as a local street.

- The surrounding area is predominantly residential, with a mix of single and multi-family homes. There are also numerous restaurants and commercial storefronts nearby.
- There is a driveway approximately 55 feet from the stop bar on the SW leg of McCully Street, and another located approximately 15 feet from the stop bar on the NE leg of McCully Street.
- There are also driveways located approximately 25 feet from the stop bar on the NW leg of Algaroba Street and approximately 15 feet from the stop bar on the SE leg of Algaroba Street.
- There are marked curbside bike lanes on both sides of McCully Street, but no marked bike facilities on Algaroba Street.
- There are marked crosswalks across all legs of the intersection.
- Paved sidewalks exist on both sides of the roadway on all four legs.
- On-street parking is restricted on McCully Street, however there are no signed restrictions on Algaroba Street and vehicles often park within 75 feet of the intersection.
- There is a near-side bus stop adjacent to the NE McCully Street leg, but no other stops within 100 feet of any approach to the intersection.
- HPMS 2017 did not provide ADT volumes along Algaroba Street, nor did the *UrbanLogiq* database. As a result, ADTs were conservatively set through engineering judgement.

A summary of the intersection approach conditions for McCully Street at Algaroba Street is provided in Table 23. Where an approach characteristic should be considered for mitigation prior to RLSCS installation, it has been highlighted in yellow in the table. Note the only required mitigation is ensuring standard yellow interval. Additional figures including intersection approach views, cone of vision diagrams, and the traffic signal ring and barrier diagram are included in Appendix A.

Table 23: Summary of Intersection Approach Conditions at McCully Street at Algaroba Street

	McCully Street NEB Approach	McCully Street SWB Approach	Algaroba Street NWB Approach	Algaroba Street SEB Approach
Approach ADT (HPMS 2017) (veh/day)	8,585	8,585	2,500*	2,500*
Posted Speed Limit (mph)	25	25	25	25
Lane Configuration	←↑ ↑→	←↑ ↑→	←↑→	←↑→
# of Signal Heads and Location	2 on mast arm, 1 on far-left pole, 1 on far-right pole	1 on far-left pole, 1 on far-right pole	1 on far-left pole, 1 on far-right pole	1 on far-left pole, 1 on far-right pole
Signal Head Centered over Lanes?	Yes	No	No	No
Approach Grade	Flat	Flat	Flat	Flat
Far Side Signal Distance from Stop Bar (feet)	72	60	86	80
Signal Lens Size (inches)	12	12	12	12
Backplates on Mast Arm Signal Heads?	No	No	No	No
Advance Vehicle Detection?	No	No	No	No
Cycle Length (AM, MID, PM) (seconds)	90, 90, 90			
Available Green Time (AM, MID, PM) (seconds)	49, 49, 49	49, 49, 49	29, 29, 29	29, 29, 29
Existing Yellow Interval (seconds)	4	4	4	4
Existing Red Clearance (seconds)	2	2	2	2
2 Signals in Cone of Vision?	Yes	No	Yes	Yes

A summary of the crash history for McCully Street at Algaroba Street from 2016 - 2020 is provided in Table 24. Crashes involving vehicles from different approaches are listed under the approach in which the offending vehicle was traveling from.

Table 24: Crash History and Baseline RLR Violations at McCully Street at Algaroba Street

	Rear End Crashes	Right Angle Crashes	Sideswipe Crashes	Pedestrian or Bicyclist Involved Crashes	Speed Involved Crashes	Red Light Running Related Crashes	Dusk or Night Time Crashes	Crashes During Times of Sunrise or Sunset	Injury Involved Crashes	Fatality Involved Crashes	Total Crashes
NEB McCully Street	-	-	-	-	-	-	-	-	-	-	0
SWB McCully Street	-	6	-	-	1	5	-	2	5	-	7
NWB Algaroba Street	-	4	-	-	-	4	-	1	3	-	4
SEB Algaroba Street	-	-	-	1	-	-	-	-	1	-	1

Notes:
1) Total Crashes was the summation of all reported crashes at each approach, including some not listed above due to them having another crash-type. Other reported contributing factors were listed, of which some crashes had multiple, while others had none.
2) This crash data was collected under the Highway Safety Improvement Program of Title 23, United States Code (U.S.C.), Section 148. This data is protected under Title 23, U.S.C., Section 407, and is intended for highway safety and educational purposes only. This information may not be used in any Federal or State court proceeding in any action for damages arising from any occurrence at a location mentioned or addressed in the information provided.

2. Engineering Mitigation

This intersection meets the minimum *MUTCD* guidelines for the number of signal heads for the primary movement for each approach. However, only one signal is within the 20˚ cone of vision for the SWB McCully Street approach, which meets the *MUTCD* guidelines, however, is not preferred by DTS. There are no observed obstructions or issues with sight line visibility within the 20˚ cone of vision for the other three approaches. Prior to the installation of RLSCS, necessary mitigation at this intersection includes:

- Restricting parking a minimum of 75 feet from the stop bar on the NEB and SWB Algaroba Street approaches.
- Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

Other mitigation measures to consider prior to the installation of RLSCS include:

- Installing an additional signal head on the near-right side of the SB McCully Street approach to provide the preferred 2 signals within the 20˚ cone of vision.
- Installing backplates on the traffic signals mounted on the mast arm for NEB McCully Street.

3. Constructability Concerns

There are constructability concerns with the NWB Algaroba Street approach due to numerous existing driveways and utilities that would restrict RLSCS pole placement. There are also potential constructability concerns along NEB McCully Street due to the limited space behind the curb (currently 5.5 feet including a 4-foot sidewalk). There are no major constructability concerns with the other two approaches.

4. Recommendations

The SWB McCully Street approach has a propensity for RLR crashes and does not pose constructability concerns. While the existing signal configuration with only one signal in the 20˚ cone of vision is not preferred, it still meets all minimum MUTCD requirements and provides a viable option for the installation of RLSCS. The NEB McCully Street approach is not recommended due to potential constructability concerns, and no provided crash history. The NWB/SEB Algaroba Street approaches are not preferred options due to potential constructability issues on the NWB Algaroba Street approach.

M. N. King Street at Middle Street

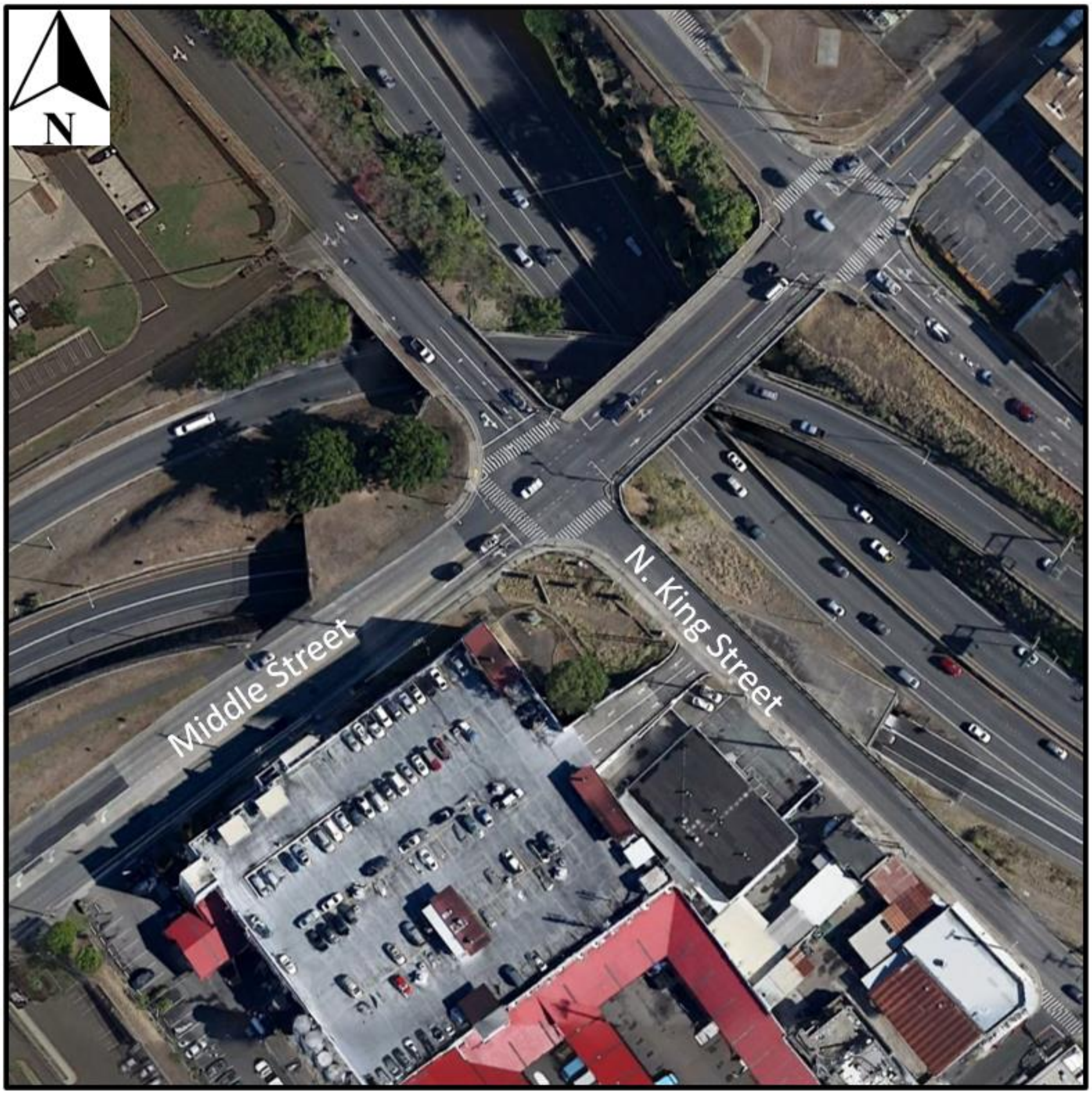

Figure 15: N. King Street at Middle Street

1. Intersection Summary

N. King Street at Middle Street is a four-leg signalized intersection in the Kalihi-Palama area.

- N. King Street runs along the Moanalua Freeway (H-201) serving as both an on and off-ramp. It operates as one-way in the SEB direction and is classified as an arterial.
- Middle Street is also classified as an arterial.
- The surrounding area is bound by the H-1/H-201 interchange, and there is limited development in the area, with the Love's Bakery located in the south corner recently having closed.
- There are no driveways within 100 feet of any approach to the intersection.

- There are no marked bike facilities at the intersection.
- There are marked crosswalks across all legs except for the NW leg of Middle Steet.
- There are sidewalks on both sides of the roadway on Middle Street and on the south side only on N. King Street.
- On-street parking is restricted on all approaches.
- There are no bus stops within 100 feet of any approach to the intersection.

A summary of the intersection approach conditions for N. King Street at Middle Street is provided in Table 25. Where an approach characteristic should be considered for mitigation prior to RLSCS installation, it has been highlighted in yellow in the table. Note the only required mitigation is ensuring standard yellow interval. Additional figures including intersection approach views, cone of vision diagrams, and the traffic signal ring and barrier diagram are included in Appendix A.

Table 25: Summary of Intersection Approach Conditions at N. King Street at Middle Street

	Middle Street NEB Approach	Middle Street SWB Approach	King Street SEB Approach
Approach ADT (HPMS 2017) (veh/day)	7,212	7,212	10,100
Posted Speed Limit (mph)	30	30	25
Lane Configuration	↑ ↱	↰ ↑	↰ ↑ ↱
# of Signal Heads and Location	2 on mast arm, 1 on far-left pole	2 on mast arm, 1 on far-left pole	1 on far-left pole, 1 on far-right pole, 1 on near-left pole
Signal Head Centered over Lanes?	Yes	Yes	No
Approach Grade	Slight Uphill	Slight Donwhill	Slight Uphill
Far Side Signal Distance from Stop Bar (feet)	72	85	70
Signal Lens Size (inches)	12	12	12
Backplates on Mast Arm Signal Heads?	No	No	No
Advance Vehicle Detection?	No	No	No
Cycle Length (AM, MID, PM) (seconds)	100, 100, 100		
Available Green Time (AM, MID, PM) (seconds)	54, 54, 54	54, 54, 54	35, 35, 35
Existing Yellow Interval (seconds)	4	4	4
Existing Red Clearance (seconds)	2	2	1
2 Signals in Cone of Vision?	Yes	Yes	Yes

A summary of the crash history for N. King Street and Middle Street from 2016 - 2020 is provided in Table 26. Crashes involving vehicles from different approaches are listed under the approach in which the offending vehicle was traveling from.

Table 26: Crash History and Baseline RLR Violations at N. King Street at Middle Street

	Rear End Crashes	Right Angle Crashes	Sideswipe Crashes	Pedestrian or Bicyclist Involved Crashes	Speed Involved Crashes	Red Light Running Related Crashes	Dusk or Night Time Crashes	Crashes During Times of Sunrise or Sunset	Injury Involved Crashes	Fatality Involved Crashes	Total Crashes
SEB King Street	-	6	-	1	-	4	2	-	4	-	7
NEB Middle Street	1	1	-	-	-	1	-	1	1	-	2
SWB Middle Street	-	13	-	-	-	11	6	2	6	-	13

Notes:
1) Total Crashes was the summation of all reported crashes at each approach, including some not listed above due to them having another crash-type. Other reported contributing factors were listed, of which some crashes had multiple, while others had none.
2) This crash data was collected under the Highway Safety Improvement Program of Title 23, United States Code (U.S.C.), Section 148. This data is protected under Title 23, U.S.C., Section 407, and is intended for highway safety and educational purposes only. This information may not be used in any Federal or State court proceeding in any action for damages arising from any occurrence at a location mentioned or addressed in the information provided.

2. Engineering Mitigation

This intersection meets the minimum *MUTCD* guidelines for the number of signal heads for the primary movement for each approach. However, only one signal is within the 20˚ cone of vision for the SEB N. King Street approach, which meets the minimum *MUTCD* guidelines, however, is not preferred by DTS. There are no observed obstructions or issues with sight line visibility within the 20˚ cone of vision for the other three approaches. Prior to the installation of RLSCS, necessary mitigation measures at this intersection include:

- Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

Other mitigation measures to consider prior to the installation of RLSCS include:

- Installing an additional traffic signal head on the far-left side of the SEB N. King Street approach within the 20˚ cone of vision.
- Adding *Intersection Warning (W3-3)* signage to the SEB N. King Street approach to warn drivers of the oncoming intersection as they exit the freeway at higher approach speeds.
- Installing backplates on the traffic signals mounted on the mast arm for all approaches.
    - The NEB/SWB Middle Street approaches would be of greatest need due to their location on an E/W alignment that results in potential glare issues associated with the rising/setting of the sun.

3. Constructability Concerns

Installation of RLSCSs for the SEB N. King Street approach and the SWB Middle Street approach are problematic due to the optimal locations being on bridge decks. The installation of a red-light camera pole and associated conduit on a bridge presents constructability concerns in that a structural assessment, review, and permitting will be needed which will add extensive time to the design and construction effort. The installation of a pole on an existing bridge typically includes installation of the pole within the existing bridge railing or sidewalk, or as a cantilevered structure off the bridge deck or beam. In addition, the associated conduit would be attached along the outside of the bridge deck to a place off the deck where a separate pullbox can be installed for enabling cable connections. There are no major constructability concerns with the NEB Middle Street approach, although it was noted that some signal faces appeared to have PVI heads.

4. Recommendations

N. King Street at Middle Street was provided as an alternative intersection, and therefore these recommendations come in the case a preferred intersection not having any viable approaches. The SWB Middle Street approach has a propensity for RLR crashes; however, there are constructability concerns that make this approach not preferrable. The SEB N. King Street approach also has a history of RLR crashes; however, it too has constructability concerns and only one signal currently located in the 20˚ cone of vision, making it not a preferred option for the installation of RLSCS. The NEB Middle Street approach offers a viable option for installation of RLSCS as it has existing sufficient visibility for vehicles.

N. Vineyard Boulevard at Nuuanu Avenue

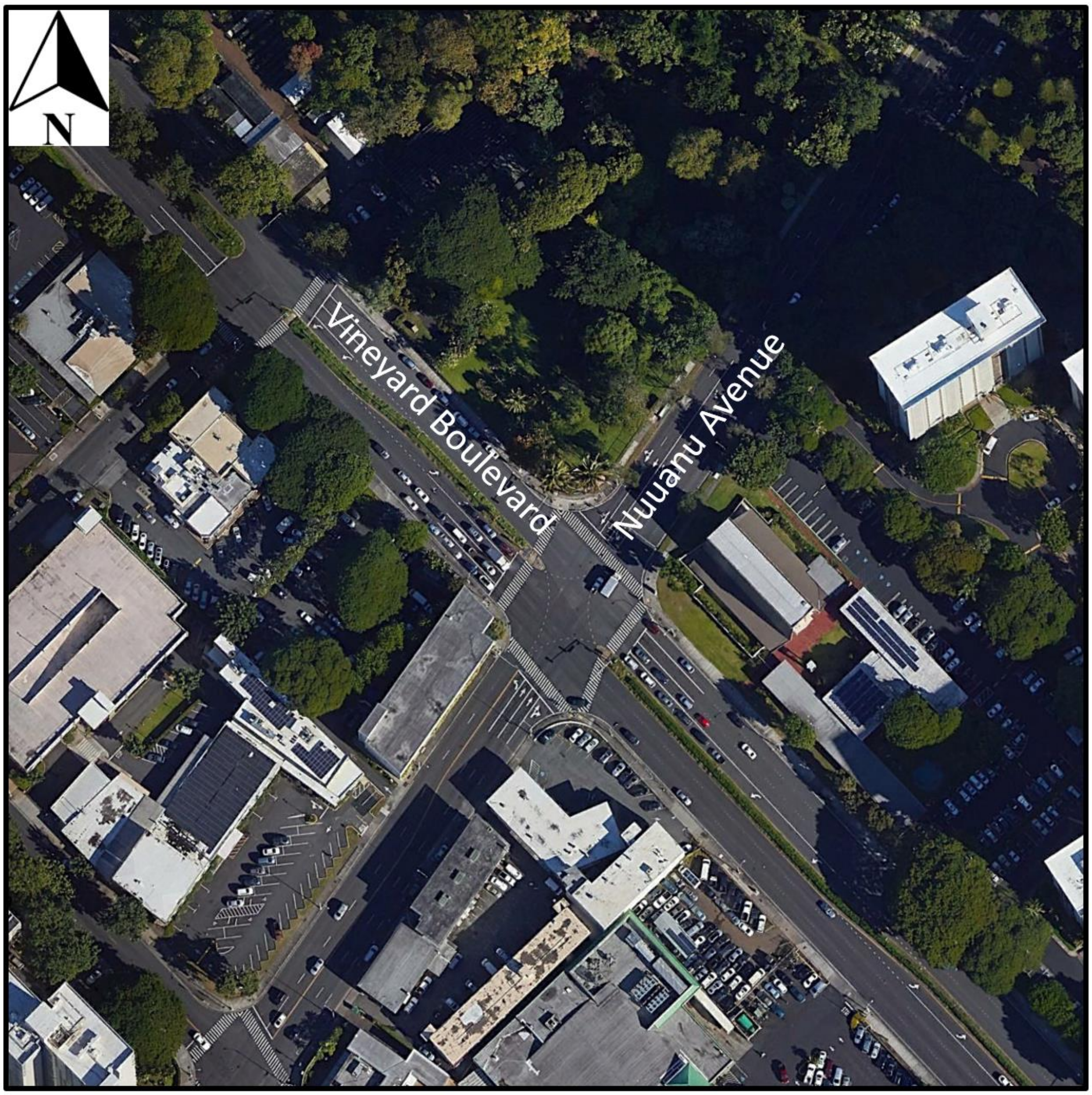

Figure 16: Vineyard Boulevard at Nuuanu Avenue

1. Intersection Summary

Vineyard Boulevard at Nuuanu Avenue is a four-leg signalized intersection in Downtown Honolulu.

- Both corridors are classified as arterials.
- Vineyard Boulevard is separated by a landscaped median of varying width.
- The surrounding area is a mix of multi-family residential and commercial, with numerous parks nearby as well.
- There is a driveway located approximately 35 feet from the stop bar on the SW leg of Nuuanu Avenue.
- Additionally, a driveway exists approximately 95 feet from the stop bar on the NW leg of Vineyard Boulevard.
- There are marked bike lanes along Nuuanu Avenue, however, there are no marked bike facilities along Vineyard Boulevard.
- There are marked crosswalks and sidewalks on both sides of the roadway on all four legs.
- On-street parking is restricted on all approaches.
- There are no bus stops within 100 feet of any approach to the intersection.

A summary of the intersection approach conditions for Vineyard Boulevard at Nuuanu Avenue is provided in Table 27. Where an approach characteristic should be considered for mitigation prior to RLSCS installation, it has been highlighted in yellow in the table. Note the only required mitigation is ensuring standard yellow interval. Additional figures including intersection approach views, cone of vision diagrams, and the traffic signal ring and barrier diagram are included in Appendix A.

Table 27: Summary of Intersection Approach Conditions at Vineyard Boulevard at Nuuanu Avenue

	Nuuanu Aveue NEB Approach	Nuuanu Avenue SWB Approach	Vineyard Boulevard NWB Approach	Vineyard Boulevard SEB Approach
Approach ADT (HPMS 2017) (veh/day)	7,450	7,450	11,527	9,850
Posted Speed Limit (mph)	25	25	30	30
Lane Configuration	↰ ↑ ↑ ↱	↰ ↑ ↱	↰ ↑ ↑ ↱	↰ ↑ ↑ ↱
# of Signal Heads and Location	3 on mast arm, 1 on far-left pole, 1 on near pole	3 on mast arm, 1 on far-left pole, 1 on near pole	2 on mast arm, 1 on far-left pole, 1 on far-center pole, 1 on far-right pole, 1 on near pole	2 on mast arm, 1 on far-left pole, 1 on far-center pole, 1 on far-right pole, 1 on near pole
Signal Head Centered over Lanes?	No	Yes	No	No
Approach Grade	Slight Uphill	Slight Downhill	Slight Uphill	Slight Uphill
Far Side Signal Distance from Stop Bar (feet)	174	148	153	130
Signal Lens Size (inches)	12	12	12	12
Backplates on Mast Arm Signal Heads?	No	No	Yes	Yes
Advance Vehicle Detection?	No	No	No	No
Cycle Length (AM, MID, PM) (seconds)	160, 160, 160			
Available Green Time (AM, MID, PM) (seconds)	65, 62, 62	65, 62, 62	86, 89, 89	86, 89, 89
Existing Yellow Interval (seconds)	4	4	4	4
Existing Red Clearance (seconds)	1	1	1	1
2 Signals in Cone of Vision?	Yes	Yes	Yes	Yes

A summary of the crash history for Vineyard Boulevard at Nuuanu Avenue from 2016 - 2020 is provided in Table 28. Crashes involving vehicles from different approaches are listed under the approach in which the offending vehicle was traveling from.

Table 28: Crash History and Baseline RLR Violations at Vineyard Boulevard at Nuuanu Avenue

	Rear End Crashes	Right Angle Crashes	Sideswipe Crashes	Pedestrian or Bicyclist Involved Crashes	Speed Involved Crashes	Red Light Running Related Crashes	Dusk or Night Time Crashes	Crashes During Times of Sunrise or Sunset	Injury Involved Crashes	Fatality Involved Crashes	Total Crashes
NWB Vineyard Boulevard	1	-	-	1	-	-	2	-	1	-	2
SEB Vineyard Boulevard	-	-	-	2	-	-	2	-	2	-	2
NEB Nuuanu Avenue	-	-	1	1	-	-	1	-	2	-	2
SWB Nuuanu Avenue	-	-	-	-	-	-	-	-	-	-	0

Notes:
1) Total Crashes was the summation of all reported crashes at each approach, including some not listed above due to them having another crash-type. Other reported contributing factors were listed, of which some crashes had multiple, while others had none.
2) This crash data was collected under the Highway Safety Improvement Program of Title 23, United States Code (U.S.C.), Section 148. This data is protected under Title 23, U.S.C., Section 407, and is intended for highway safety and educational purposes only. This information may not be used in any Federal or State court proceeding in any action for damages arising from any occurrence at a location mentioned or addressed in the information provided.

2. Engineering Mitigation

This intersection meets the minimum *MUTCD* guidelines for the number of signal heads for the primary movement for each approach and there are no observed obstructions or issues with sight line visibility within the 20˚ cone of vision. Prior to the installation of RLSCS, necessary mitigation measures at this intersection include:

- Increasing the size of the *Left on Green Arrow Only (R10-5)* signs on the NEB and SWB Nuuanu Avenue approaches to be 30 inches x 36 inches in accordance with *MUTCD* standards.
- Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

Other mitigation measures to consider prior to the installation of RLSCS include:

- Adding a third signal head to the NWB and SEB Vineyard Boulevard approaches to better align overhead with the three through-lanes in each direction.
- Trimming the overhanging trees on the SWB Nuuanu Avenue approach.
- Installing backplates on the traffic signals mounted on the mast arms for both Nuuanu Avenue approaches.

3. Constructability Concerns

There are no major constructability concerns associated with any approach at this intersection.

4. Recommendations

All approaches provide viable options for the installation of RLSCS. All approaches offer sufficient visibility for vehicles and the proximity of the intersection to retail locations such as Zippy’s and Pali Safeway make it a desirable pedestrian destination. The engineering mitigation measures should be considered prior to the installation of RLSCS for any approach

V. RLSCS INTERSECTION APPROACH REVIEW

A. Methodology

All 14 intersections were considered in the identification of viable approaches for the installation of RLSCS. The following four variables were tabulated for each intersection approach: RLR Related Crashes, ADT, Injury or Fatality Involved Crashes, and Pedestrian or Bicyclist Involved Crashes. These variables were selected based on the intersection data available and weighted using an assumed relevance ascertained from the literature review. This included the following: RLR Related Crashes (x0.333), ADT (x0.333), Injury or Fatality Involved Crashes (x0.167), and Pedestrian or Bicyclist Involved Crashes (x0.167). The average variable value across all approaches was divided into each individual approach variable and multiplied by the weighted factor to obtain a weighted variable. The sum of these four weighted variables resulted in a Weighted Priority Score. These were then sorted from highest to lowest score, representing the highest rank (#1) to lowest ranking intersection approach for inclusion of RLSCS.

Following the Weighted Priority Score rankings of approaches, those where constructability was a significant concern were removed from consideration (text made red in Table 29). Construction on bridge decks, for example, was a noted constructability concern as additional permitting and structural analysis would be required, possibly prolonging construction and delaying implementation of this pilot program. Notes were added regarding the specific constructability concerns for each approach. Similarly, where ADT was extremely low or where there was only a single monitorable through lane, the approaches were removed from consideration (text made green in Table 29). Instead, it was assumed that other engineering measures may be better suited to address the instances of high crash volume. Other approaches had outstanding concerns and/or recommended engineering mitigation measures yet were still deemed viable for the installation of a RLSCS (text made blue in Table 29). Specifics of these concerns were included in the notes.

B. Tabulated Results

The weighted approach rankings for consideration of RLSCS are shown in Table 29. Approaches with major constructability concerns are shown in red while approaches with minimal volumes are shown in green. While still shown in the order of their original ranking, these approaches were not considered in the overall prioritization of RLSCS which is reflected in the use of N/A. Approaches shown in blue have possible constructability concerns as well and may need further consideration if selected for the installation of RLSCS.

Table 29: Weighted Approach Rankings for Consideration of RLSCS

Approach	Intersection	Red Light Running Related Crashes	Injury or Fatality Involved Crashes	Pedestrian or Bicyclist Involved Crashes	Approach ADT	Weighted Priority Score	Weighted Ranking	Notes
Weighted Variable Multiplier:		0.333	0.167	0.167	0.333			
Red:	*Approaches with Significant Constructability Concerns (not considered)*							
Green:	*Approaches with Low ADT Volume (not considered)*							
Blue:	Approaches with Recommended Engineering Mitigation (considered)							
SWB Middle	*King/Middle*	*11*	*6*	*0*	*7,212*	*3.77*	*N/A*	*Major constructability concerns with location due to preferred pole placement on bridge deck.*
EB King	King/Ward	2	8	7	24,006	3.42	1	May need multiple camera systems to capture all violations due to numerous obstructions and width of roadway. Traffic signal configuration, while still compliant, is not preferred, especially for a corridor of this ADT. With Ward Avenue bikeway crossing and connection to King Street, bicycle crossing volumes are likely to be higher.
SWB McCully	McCully/Algaroba	5	5	0	8,585	2.05	2	Traffic signal configuration, while still compliant, is not preferred due to one signal head in 20-degree cone of vision.
NB Piikoi	Piikoi/Beretania	3	3	0	29,391	1.99	3	May need multiple safety camera systems to capture all violations due to width of roadway and PVI signal heads. Queen Kaahumanu Elementary School is located nearby, with potential for higher student pedestrian crossings. Beretania Street bike lane crossing may increase bicycle crossing volumes.
SEB King	*King/Middle*	*4*	*4*	*1*	*10,100*	*1.96*	*N/A*	*Major constructability concerns with location due to preferred pole placement on bridge deck in addition to identified US Army conduit in area.*
NWB King	*King/Kohou*	*4*	*3*	*0*	*13,888*	*1.78*	*N/A*	*Major constructability concerns with location due to preferred pole placement on bridge deck and unknown available spare conduits.*
NWB Vineyard	Vineyard/Liliha	2	5	2	9,850	1.67	4	Transit center along Liliha Street likely to increase pedestrian crossing volumes.
NEB Liliha	*Vineyard/Liliha*	*2*	*5*	*2*	*9,428*	*1.66*	*N/A*	*Major constructability concerns with utility pole at 70' back obstructing preferred camera view of at least one signal head. High volume of busses along approach adds additional obstruction and visibility concerns.*
SWB Pali	Pali/School	4	2	0	11,450	1.63	5	Pali Highway is currently under construction and unknown timeline may complicate implementation. Due to the nature of the intersection and proximity of the H-1 Freeway overpass, the traffic signal configuration is not as preferred, however, it meets all minimum MUTCD requirements.
SEB School	Likelike/School	1	5	3	8,356	1.56	6	Kapalama Elementary School is located nearby, with potential for higher student pedestrian crossings.
NEB Kohou	*King/Kohou*	*2*	*3*	*3*	*3,656*	*1.55*	*N/A*	*Low approach ADT with only one monitored lane with a high percentage of turning vehicles not monitored by RLC.*
NWB Algaroba	*McCully/Algaroba*	*4*	*3*	*0*	*2,500*	*1.43*	*N/A*	*Constructability concerns with numerous driveways and utility pole conflicts. Low approach ADT with only one monitored lane with a high percentage of turning vehicles not monitored by RLC.*
WB Beretania	Piikoi/Beretania	2	3	0	20,301	1.42	7	May need multiple camera systems to capture all violations due to width of roadway and PVI signal heads. Queen Kaahumanu Elementary School is located nearby, with potential for increased student pedestrian crossings.
NWB School	*Pali/School*	*2*	*3*	*1*	*6,050*	*1.19*	*N/A*	*Major constructability concerns with location due to preferred pole placement on bridge deck. Pali Highway is currently under construction and unknown timeline may complicate implementation. Due to the nature of the intersection and proximity of the H-1 Freeway overpass, the traffic signal configuration is not as preferred, however, it meets all minimum MUTCD requirements.*
NWB School	Likelike/School	1	5	1	9,999	1.18	8	Kapalama Elementary School is located nearby, with potential for increased student pedestrian crossings.
SEB Vineyard	Vineyard/Liliha	1	4	1	12,337	1.18	9	Transit center along Liliha Street likely to increase pedestrian crossing volumes.
NEB Palama	*Vineyard/Palama*	*0*	*5*	*3*	*3,700*	*1.13*	*N/A*	*Low approach ADT with only one monitored lane with a high percentage of turning vehicles not monitored by RLC. Likelike Elementary School is located nearby, with potential for higher student pedestrian crossings.*
SEB Vineyard	Vineyard/Pali	1	3	1	11,527	1.08	10	Intersection is currently under construction and unknown timeline may complicate implementation. Princess Ruth Keelikolani Middle School is located nearby, with potential for higher student pedestrian crossings.
SWB Likelike	Likelike/School	1	3	0	17,444	1.05	11	Kapalama Elementary School is located nearby, with potential for higher student pedestrian crossings.
NEB Pali	*Pali/School*	*1*	*4*	*0*	*12,019*	*0.96*	*N/A*	*Major constructability concerns with location due to preferred pole placement on bridge deck. Pali Highway is currently under construction and unknown timeline may complicate implementation. Due to the nature of the intersection and proximity of the H-1 Freeway overpass, the traffic signal configuration is not as preferred, however, it meets all minimum MUTCD requirements.*
NWB Vineyard	Vineyard/Pali	0	2	2	11,527	0.94	12	Intersection currently under construction and unknown timeline may complicate implementation. Princess Ruth Keelikolani Middle School is located nearby, with potential for increased student pedestrian crossings.
SEB Vineyard	Vineyard/Nuuanu	0	2	2	9,580	0.88	13	None.
SB Ward	King/Ward	1	2	1	6,717	0.86	14	Contraflow operations will require time of day programming. Will require tree trimming to increase signal visibility. King Street protected bike lane results in higher bicycle volumes.

Approach	Intersection	Red Light Running Related Crashes	Injury or Fatality Involved Crashes	Pedestrian or Bicyclist Involved Crashes	Approach ADT	Weighted Priority Score	Weighted Ranking	Notes
Weighted Variable Multiplier:		0.333	0.167	0.167	0.333			
Red:	*Approaches with Significant Constructability Concerns (not considered)*							
Green:	*Approaches with Low ADT Volume (not considered)*							
Blue:	Approaches with Recommended Engineering Mitigation (considered)							
SWB Palama	*Vineyard/Palama*	*0*	*2*	*2*	*8,447*	*0.84*	*N/A*	*Low approach ADT with only one monitored through lane with a high percentage of turning vehicles not monitored by RLC. Likelike Elementary School is located nearby, with potential for increased student pedestrian crossings.*
NEB Likelike	Likelike/School	0	1	0	24,534	0.84	16	Limited crash history does not indicate RLR related crashes, however, high approach ADT and potential for violations may still merit this approach for consideration. Kapalama Elementary School is located nearby, with potential for increased student pedestrians.
NWB Vineyard	Vineyard/Palama	1	2	0	12,337	0.82	17	Limited crash history does not indicate RLR related crashes, however, high approach ADT and potential for violations may still merit this approach for consideration. Likelike Elementary School is located nearby, with potential for increased student pedestrians.
SB King	*King/River*	*0*	*0*	*0*	*22,707*	*0.71*	*N/A*	*Major constructability concerns with location due to bridge deck and potential need for electric upgrades.*
NWB Vineyard	Vineyard/Nuuanu	0	1	1	11,527	0.65	18	None.
SB King	King/Beretania	0	0	0	20,150	0.63	19	None.
NEB Nuuanu	Vineyard/Nuuanu	0	2	1	7,450	0.60	20	None.
NEB Pali	Vineyard/Pali	0	1	0	16,261	0.58	21	Intersection currently under construction and unknown timeline may complicate implementation. Princess Ruth Keelikolani Middle School is located nearby, with potential for increased student pedestrian crossings.
NEB Middle	King/Middle	1	1	0	7,212	0.58	22	Constructability concerns due to difficulty in seeing all signal faces due to PVI heads.
NB Ward	King/Ward	1	1	0	6,717	0.57	23	Contraflow operations will require time of day programming. King Street protected bike lane crossing results in higher bicycle volumes.
SEB King	King/Kohou	0	1	0	13,888	0.51	24	None.
EB Kapiolani	Kapiolani/Kamakee	0	1	0	13,231	0.49	25	Contraflow operations will require time of day programming. McKinley High School is located nearby, with potential for increased student pedestrian crossings.
SEB Vineyard	Vineyard/Palama	0	1	0	12,337	0.46	26	Limited crash history does not indicate RLR related crashes, however, high approach ADT and potential for violations may still merit this approach for consideration. Likelike Elementary School is located nearby, with potential for increased student pedestrian crossings.
NWB Beretania	King/Beretania	0	0	0	14,191	0.44	27	Updated yellow change interval timing is required prior to any installation.
NB Kamakee	*Kapiolani/Kamakee*	*0*	*1*	*1*	*3,283*	*0.39*	*N/A*	*No through lane movements on this approach for RLC monitoring. McKinley High School is located nearby, with potential for increased student pedestrian crossings.*
SWB Kohou	*King/Kohou*	*1*	*1*	*0*	*817*	*0.38*	*N/A*	*Low approach ADT with only one monitored lane with a high percentage of turning vehicles not monitored by RLC.*
SWB Pali	Vineyard/Pali	0	0	0	12,019	0.37	28	Intersection currently under construction and unknown timeline may complicate implementation. Princess Ruth Keelikolani Middle School is located nearby, with potential for increased student pedestrian crossings.
SEB Algaroba	*McCully/Algaroba*	*0*	*1*	*1*	*2,500*	*0.37*	*N/A*	*Low approach ADT with only one monitored lane with a high percentage of turning vehicles not monitored by RLC.*
WB River	*King/River*	*0*	*1*	*1*	*1,194*	*0.33*	*N/A*	*Constructability concerns with potential need for electric upgrades. Low approach ADT with only one monitored lane.*
SWB Liliha	Vineyard/Liliha	0	0	0	9,428	0.29	29	None.
NEB McCully	McCully/Algaroba	0	0	0	8,585	0.27	30	Constructability concerns with placement of monitoring system due to narrow sidewalk on approach.
SWB Nuuanu	Vineyard/Nuuanu	0	0	0	7,450	0.23	31	None.
NB King	*King/Beretania*	*0*	*0*	*0*	*6,323*	*0.20*	*N/A*	*Low approach ADT with higher volume of transit vehicles.*
SEB School	*Pali/School*	*0*	*0*	*0*	*6,050*	*0.19*	*N/A*	*Intersection currently under construction and unknown timeline may complicate implementation. Low approach ADT with only one monitored lane.*
EB River	*King/River*	*0*	*0*	*0*	*2,108*	*0.07*	*N/A*	*Constructability concerns with potential need for electric upgrades. Low approach ADT with only one monitored through lane.*
Average Variable Value:		1.18	2.22	0.78	10,686			

C. Selected Intersections and Approaches

After ranking all intersection approaches and removing those with major constructability concerns or low volumes, the top 17 approaches for the installation of RLS were discerned. These approaches, as highlighted in green in Table 30, spanned 10 intersections.

Table 30: Top Ranked Approaches for RLSCS

Beretania Street at Piikoi Street	Kapiolani Boulevard at Kamakee Street	Vineyard Boulevard at Palama Street	Vineyard Boulevard at Pali Highway
NB Piikoi Street	WB Kapiolani Boulevard	NWB Vineyard Boulevard	NWB Vineyard Boulevard
WB Beretania Street	EB Kapiolani Boulevard	SEB Vineyard Boulevard	SEB Vineyard Boulevard
	NB Kamakee Street	NEB Palama Street	NEB Pali Highway
		SWB Palama Street	SWB Pali Highway
N. King Street at Beretania Street	**S. King Street at Ward Avenue**	**Vineyard Boulevard at Liliha Street**	**Pali Highway at School Street**
NB N. King Street	EB King Street	NWB Vineyard Boulevard	NEB Pali Highway
SB N. King Street	NB Ward Avenue	SEB Vineyard Boulevard	SWB Pali Highway
NWB Beretania Street	SB Ward Avenue	NEB Liliha Street	NWB School Street
		SWB Liliha Street	SEB School Street
Likelike Highway at School Street	**N. King Street at River Street**	**N. King Street at Kohou Street**	**McCully Street at Algaroba Street**
NEB Likelike Highway	SB N. King Street	NWB N. King Street	NEB McCully Street
SWB Likelike Highway	WB River Street	SEB N. King Street	SWB McCully Street
NWB School Street	EB River Street	NEB Kohou Street	NWB Algaroba Street
SEB School Street		SWB Kohou Street	SEB Algaroba Street
	N. King Street at Middle Street	**Vineyard Boulevard at Nuuanu Avenue**	
	SEB N. King Street	NWB Vineyard Boulevard	
	NEB Middle Street	SEB Vineyard Boulevard	
	SWB Middle Street	NEB Nuuanu Avenue	
		SWB Nuuanu Avenue	

VI. SUMMARY AND RECOMMENDATIONS

Act 30 of the Hawaii State Legislature established legal precedent regarding the implementation of RLSCS program throughout the State of Hawaii. It included a requirement for a comprehensive engineering review and study of each intersection to determine necessary and appropriate engineering, design, and traffic-control-signal timing measures. As further detailed in Chapter 151 of Title 19 of the Hawaii Administrative Rules, these mitigative countermeasures include, but are not limited to: improving signal head visibility, adding additional signal heads, ensuring appropriate yellow and all-red intervals, adding signalized intersection warning signs, adding advanced yellow flashing lights, adjusting the approach speed, improving traffic signal coordination, adding advanced vehicle detection, and removing on-street parking.

While signal timing changes, re-alignments, and other minor engineering mitigation can be implemented for most existing systems where they are determined to be needed, changes that require the addition or modification of equipment may have implications to structural loads. By adding a traffic signal, sign, or backplate to an existing mast arm, additional forces are put on older poles and foundations that weren't likely designed for these loads. The *MUTCD* acknowledges this and recommends that these mitigations be implemented when devices are no longer serviceable or when reconstruction projects occur. Similarly, where proposed RLSCS are recommended on an existing bridge deck, additional structural design, permitting, and construction are required, possibly prolonging construction and delaying implementation of this pilot program. Therefore, intersection approaches with these constraints have been omitted due to constructability concerns.

The 17 intersection approaches recommended for installation of RLSCS are provided below along with engineering mitigation measures for implementation where possible. It should be noted that no existing yellow intervals were found to be substandard per the calculation methodology used. Any all-red clearances that were found to not meet recommended guidelines have since been updated (during the writing of this report) and are therefore no longer recommended as mitigation.

A. Piikoi Street at Beretania Street

Approach 1) NB Piikoi Street Approach

- i. Necessary Mitigation:
  1. Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.
- ii. Considered Mitigation:
  1. Installing backplates on all traffic signals mounted on mast arms.
  2. Relocating the overhead utility wires from crossing in front of the NB Piikoi Street approach signals.

Approach 2) WB Beretania Street Approach

- i. Necessary Mitigation:
  1. Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.
- ii. Considered Mitigation:
  2. Installing backplates on all traffic signals mounted on mast arms.

B. Kapiolani Boulevard at Kamakee Street

Approach 3) WB Kapiolani Street Approach

i. Necessary Mitigation:
   1. Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

ii. Considered Mitigation:
   1. Installing backplates on all traffic signals mounted on mast arms.
   2. Adding a third signal head on the mast arm to better align overhead with the three through-lanes in each direction and trimming the overhanging trees to ensure these signals are visible.

C. Vineyard Boulevard at Palama Street

Approach 4) NWB Vineyard Boulevard Approach

i. Necessary Mitigation:
   1. Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

ii. Considered Mitigation:
   1. Adding a third signal head on the mast arm to better align overhead with the three through-lanes.
   2. Installing backplates on all traffic signals mounted on mast arms.

D. Vineyard Boulevard at Pali Highway

Approach 5) NWB Vineyard Boulevard Approach

i. Necessary/Considered Mitigation:
   1. None – new construction.

Approach 6) SEB Vineyard Boulevard Approach

i. Necessary/Considered Mitigation:
   1. None – new construction.

E. S. King Street at Ward Avenue

Approach 7) EB S. King Street Approach

i. Necessary Mitigation:
   1. Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

ii. Considered Mitigation:
   1. Installing an additional signal head on the near-right side of the approach to improve visibility.

Approach 8) SB Ward Avenue Approach

i. Necessary Mitigation:
   1. Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.
   2. Trimming the overhanging landscaping that obstructs visibility.

ii. Considered Mitigation:
   1. Installing backplates on all traffic signals mounted on mast arms.
   2. Replacing the existing faded No Left Turn (R3-2) sign on the near-right side of the approach.

F. Vineyard Boulevard at Liliha Street

Approach 9) NWB Vineyard Boulevard Approach

i. Necessary Mitigation:
   1. Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.
   2. Restricting parking starting at a minimum of 75 feet from the stop bar.

ii. Considered Mitigation:
   1. Adding a third signal head on the mast arm to better align overhead with the three through-lanes.

Approach 10) SEB Vineyard Boulevard Approach

i. Necessary Mitigation:
   1. Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

ii. Considered Mitigation:
   1. Adding a third signal head on the mast arm to better align overhead with the three through-lanes.

G. Pali Highway at School Street

Approach 11) SWB Pali Highway Approach

i. Necessary/Considered Mitigation:
   1. None – new construction.

H. Likelike Highway at School Street

Approach 12) NEB Likelike Highway Approach

i. Necessary Mitigation:
   1. Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

ii. Considered Mitigation:
   1. None

Approach 13) SWB Likelike Highway Approach

i. Necessary Mitigation:
   1. Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

ii. Considered Mitigation:
   1. Adding a third signal head on the mast arm to better align overhead with the three through-lanes.

Approach 14) NWB School Street Approach

i. Necessary Mitigation:
   1. Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

ii. Considered Mitigation:
   1. Installing backplates on all traffic signals mounted on mast arms.

Approach 15) SEB School Street Approach

i. Necessary Mitigation:
   1. Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

ii. Considered Mitigation:
   1. Adding an additional traffic signal head to the mast arm to improve visibility.
   2. Installing backplates on all traffic signals mounted on mast arms.

I. McCully Street at Algaroba Street

Approach 16) SWB McCully Street Approach

i. Necessary Mitigation:
   1. Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

ii. Considered Mitigation:
   1. Installing an additional signal head on the near-right side of the approach.

J. Vineyard Boulevard at Nuuanu Avenue

Approach 17) SEB Vineyard Boulevard Approach

i. Necessary Mitigation:
   1. Refreshing stop bar and crosswalk pavement markings to provide the highest visibility.

ii. Considered Mitigation:
   1. Adding a third signal head on the mast arm to better align overhead with the three through-lanes.

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APPENDIX

Appendix A -
Intersection Approach Views, Ring and Barrier Diagrams, and Cone of Vision

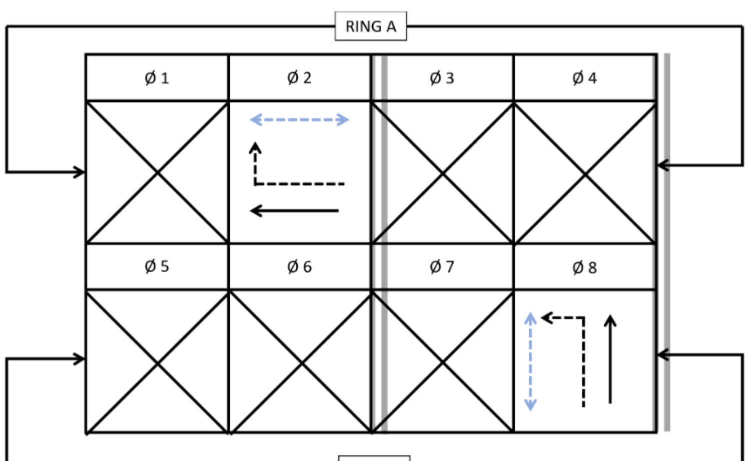
A. Beretania Street at Piikoi Street

a. Approach View

NB Piikoi Street

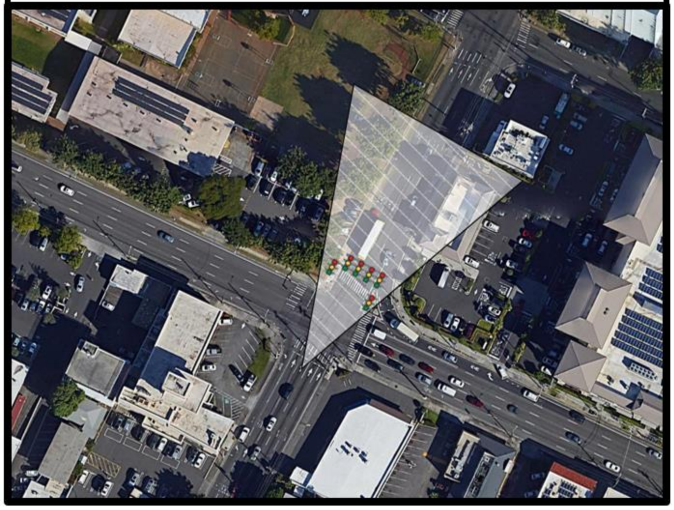
WB Beretania Street

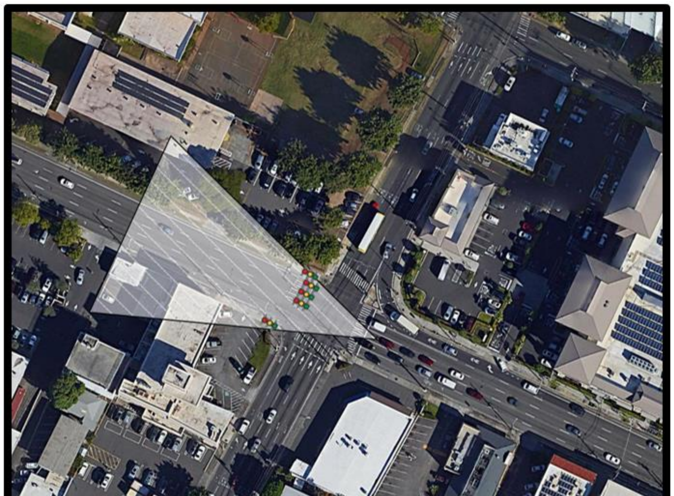
b. Ring and Barrier Diagram



c. Cone of Vision

NB Piikoi Street





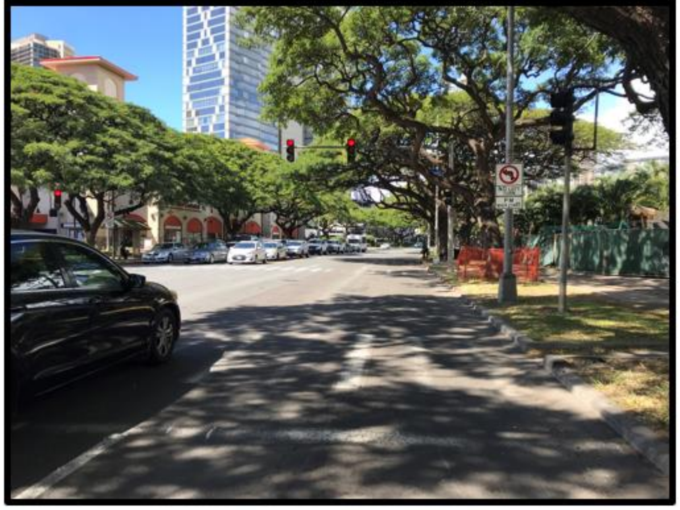
WB Beretania Street

B. Kapiolani Boulevard at Kamakee Street

a. Approach View

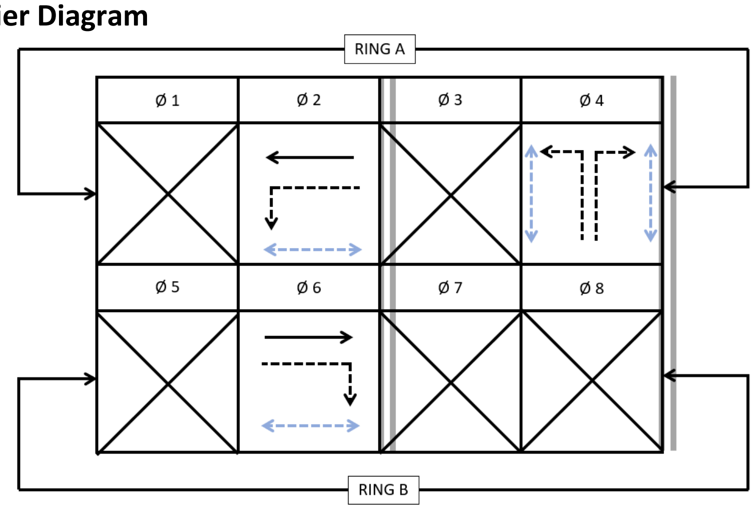
WB Kapiolani Boulevard

EB Kapiolani Boulevard

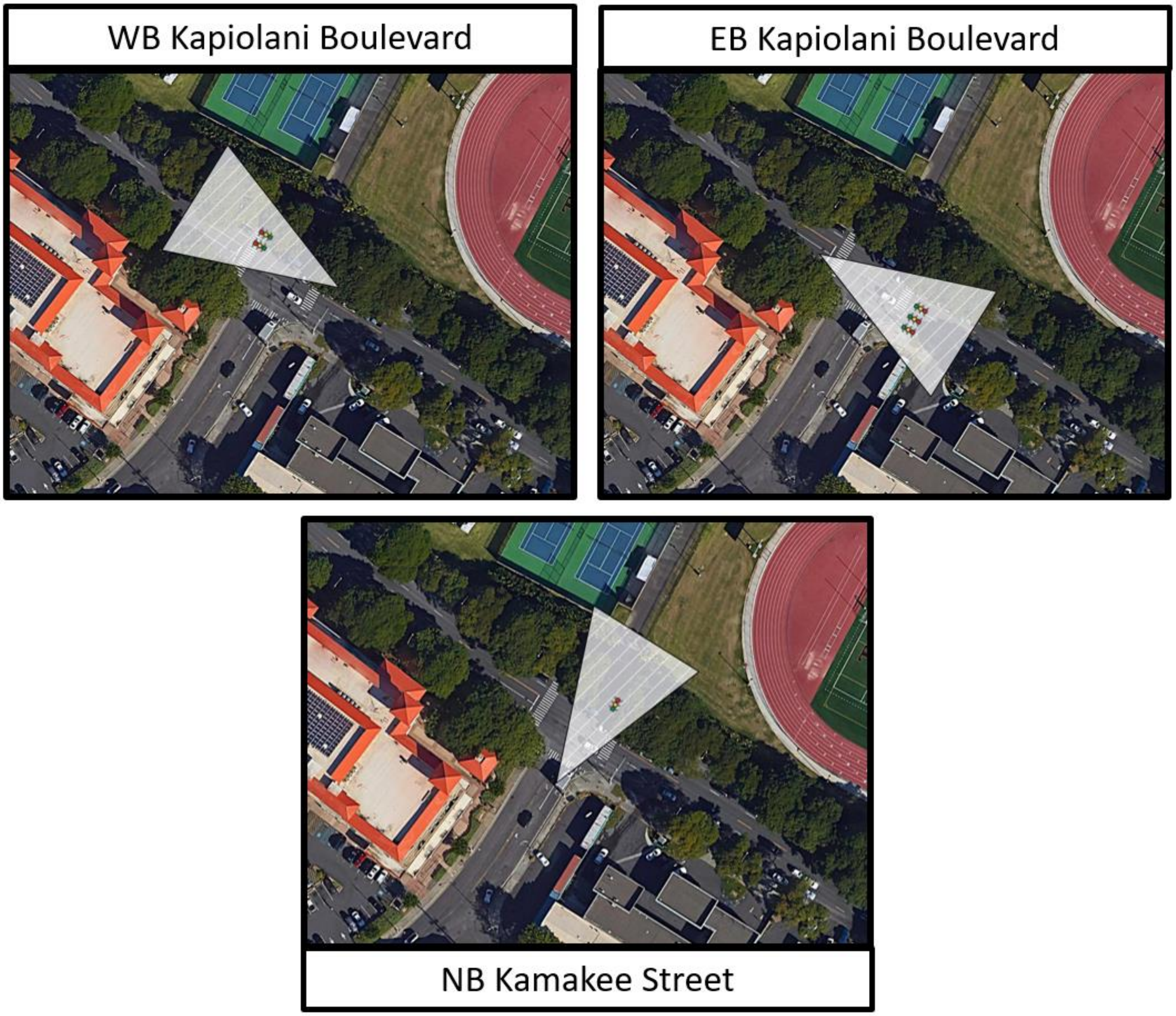


NB Kamakee Street

b. Ring and Barrier Diagram



c. Cone of Vision



C. Vineyard Boulevard & Palama Street

a. Approach View

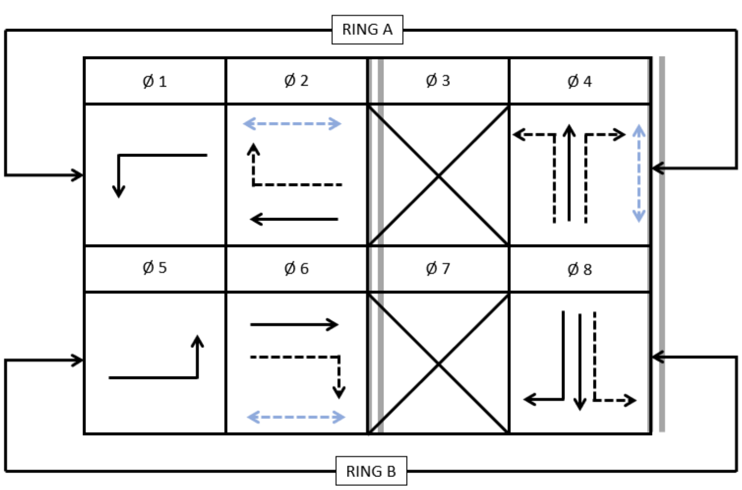
SEB Vineyard Boulevard

SWB Palama Street

NEB Palama Street

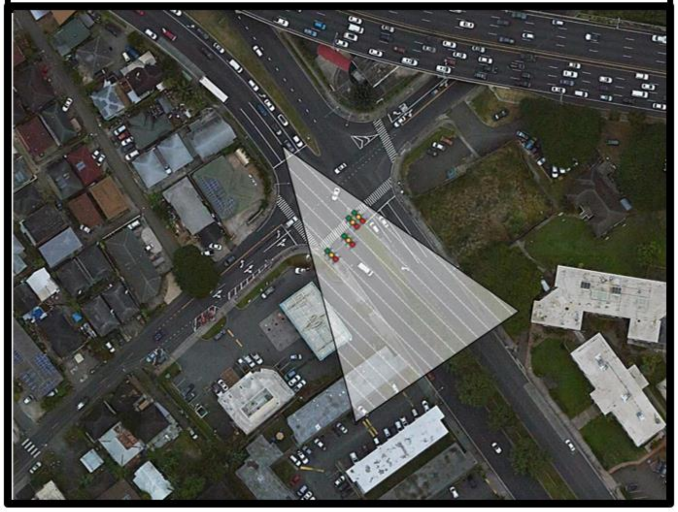
NWB Vineyard Boulevard

b. Ring and Barrier Diagram

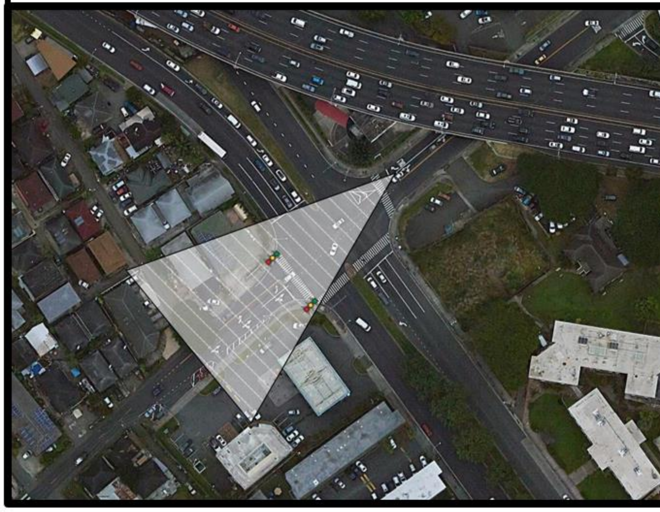


c. Cone of Vision

SEB Vineyard Boulevard



SWB Palama Street



NEB Palama Street

NWB Vineyard Boulevard

D. Vineyard Boulevard & Pali Highway

a. Approach View

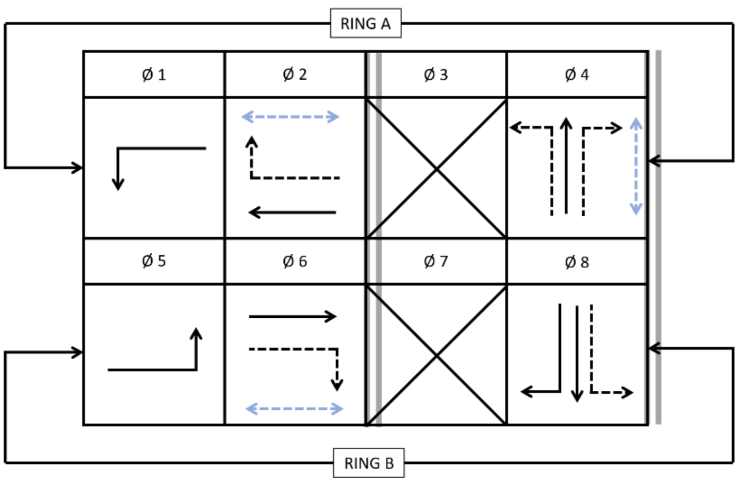
SEB Vineyard Boulevard

SWB Pali Highway

NEB Pali Highway

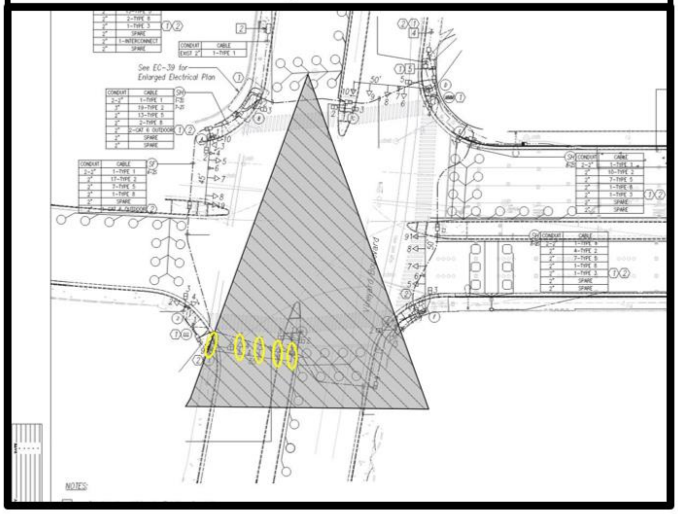
NWB Vineyard Boulevard

b. Ring and Barrier Diagram

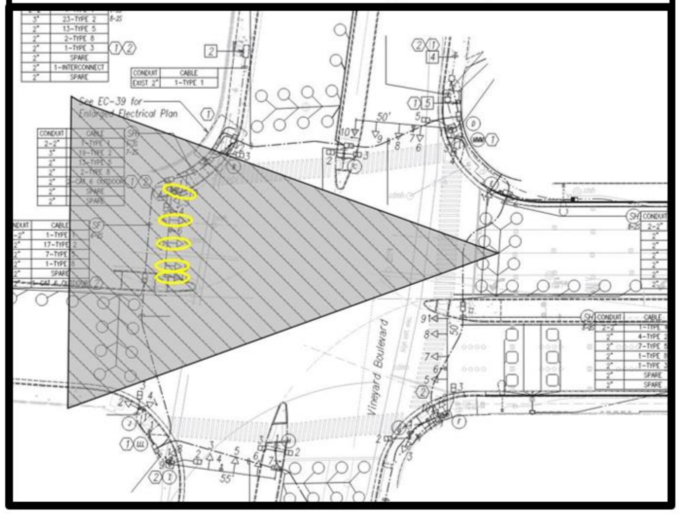


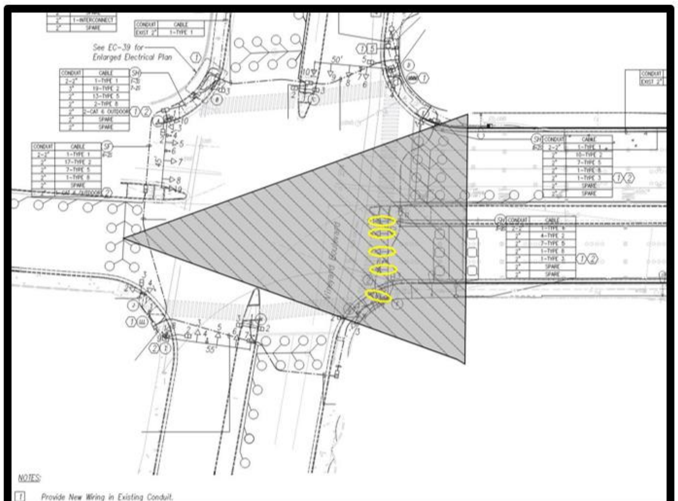
c. Cone of Vision

SEB Vineyard Boulevard

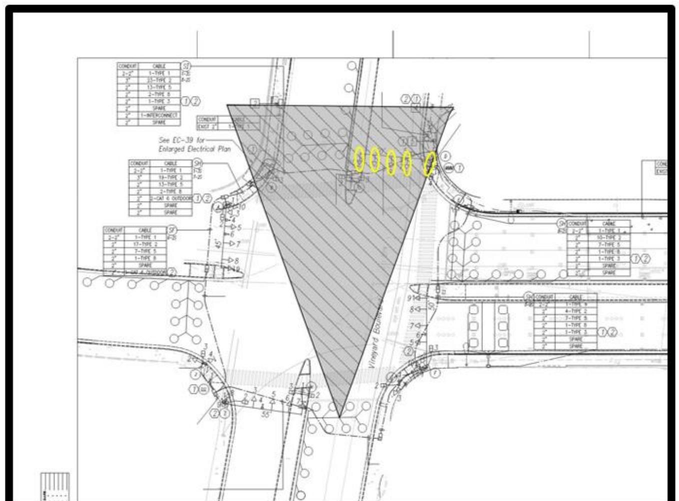


SWB Pali Highway





NEB Pali Highway



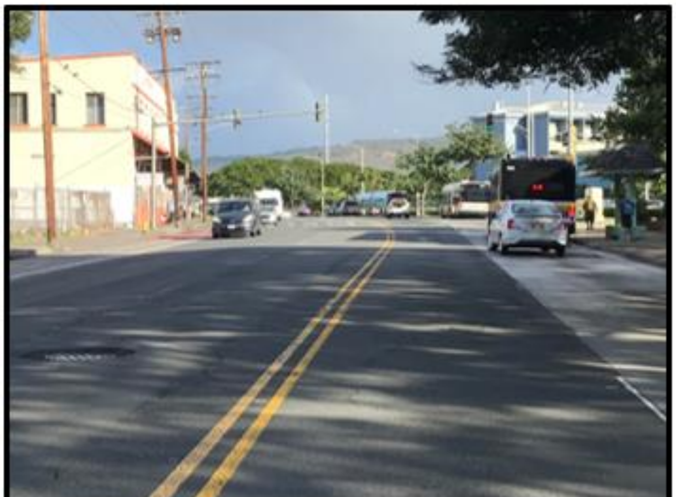
NWB Vineyard Boulevard

E. N. King Street & Beretania Street

a. Approach View

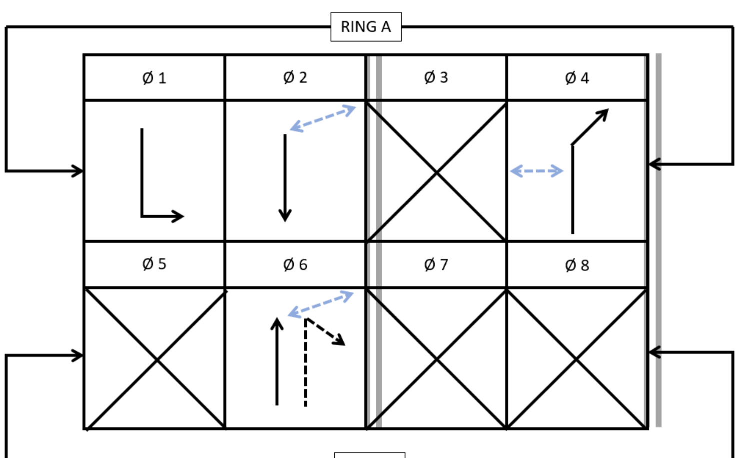
SB N. King Street

NWB Beretania Street



NB N. King Street

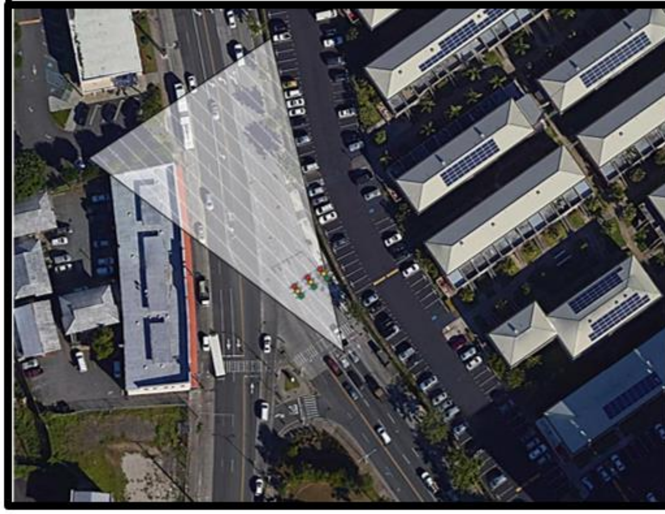
b. Ring and Barrier Diagram

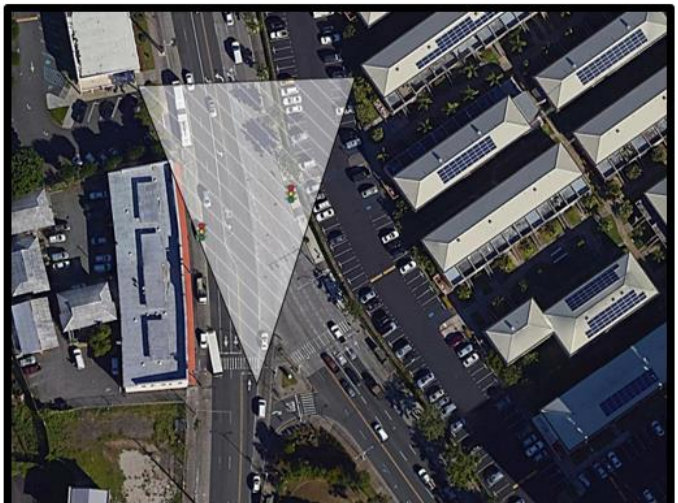


c. Cone of Vision

SB N. King Street

NWB Beretania Street





NB N. King Street

F. S. King Street & Ward Avenue

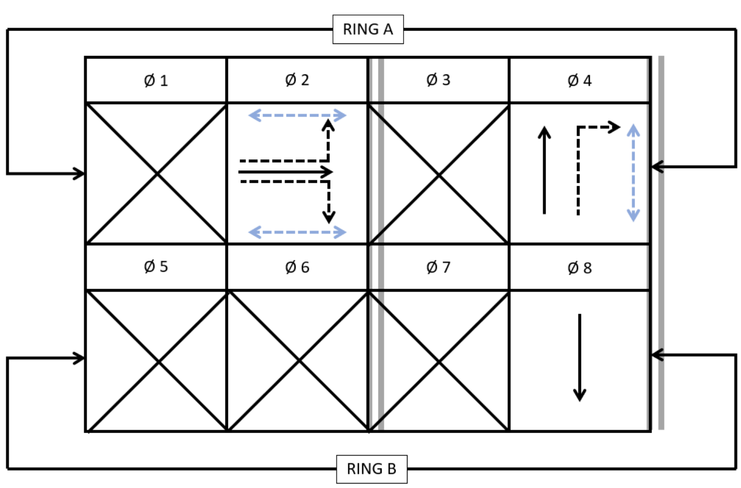
a. Approach View

SEB S. King Street

SWB Ward Avenue

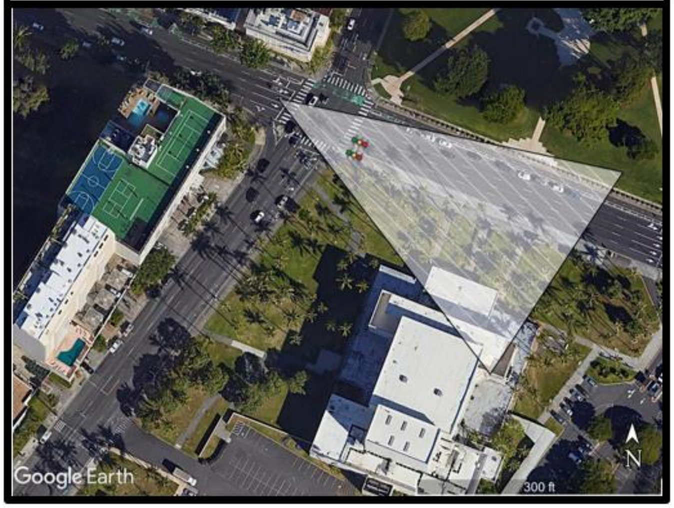
NEB Ward Avenue

b. Ring and Barrier Diagram

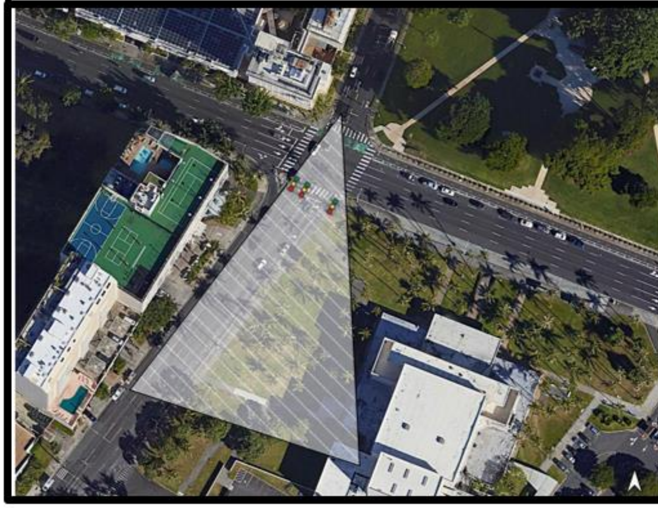


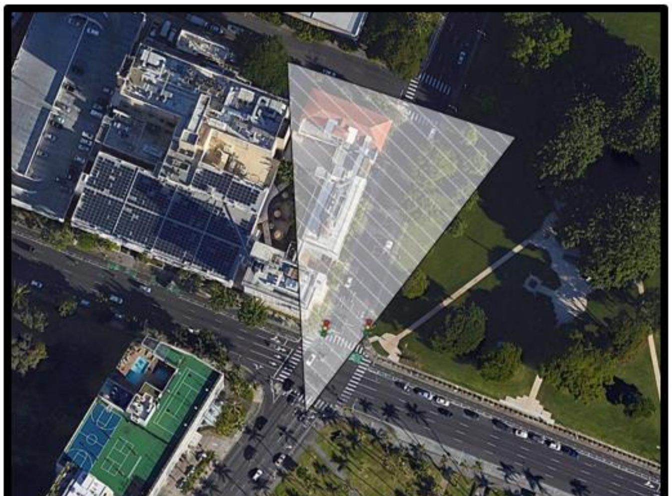
c. **Cone of Vision**

SEB S. King Street



SWB Ward Avenue





NEB Ward Avenue

G. Vineyard Boulevard & Liliha Street

a. Approach View

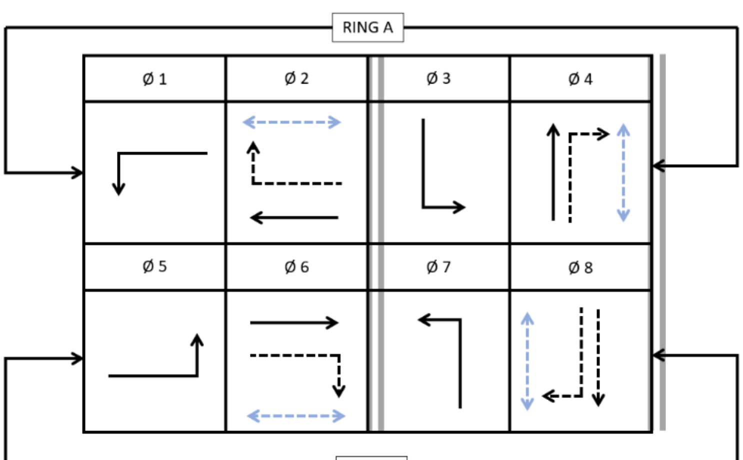
SEB Vineyard Boulevard

SWB Liliha Street

NEB Liliha Street

NWB Vineyard Boulevard

b. Ring and Barrier Diagram



c. Cone of Vision

H. Pali Highway & School Street

a. Approach View

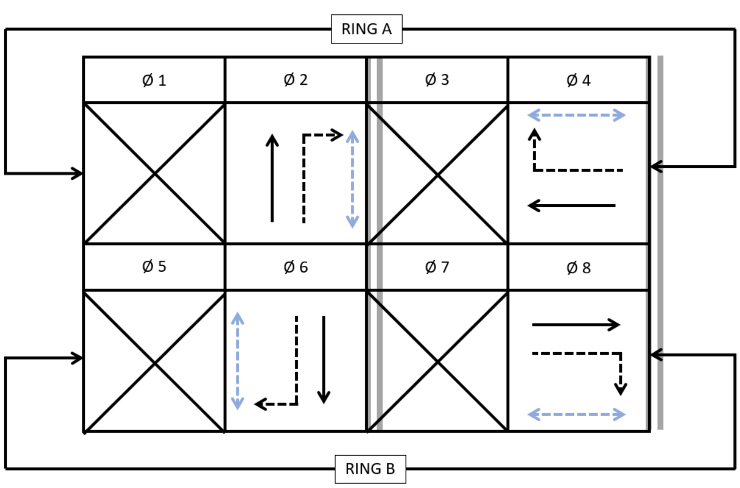
SEB School Street

SWB Pali Highway

NEB Pali Highway

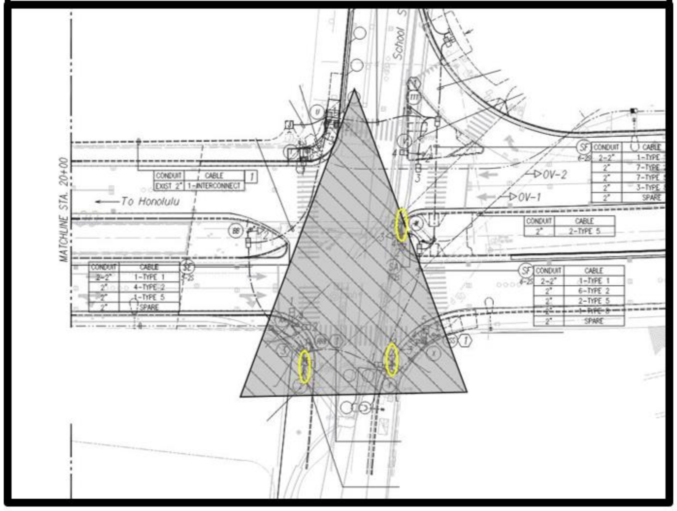
NWB School Street

b. Ring and Barrier Diagram

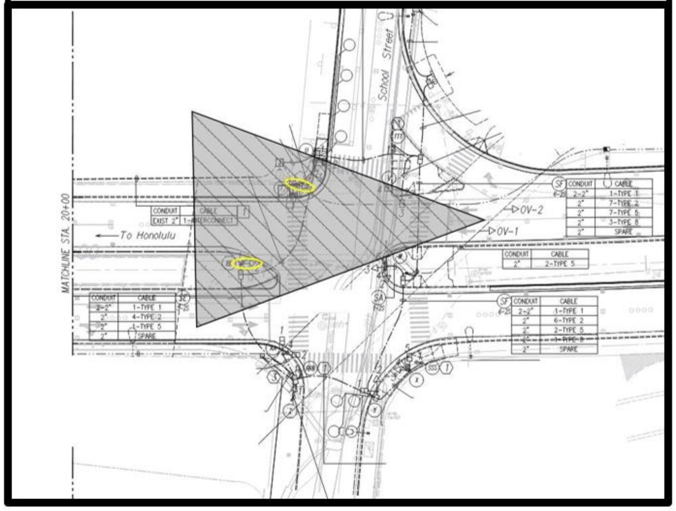


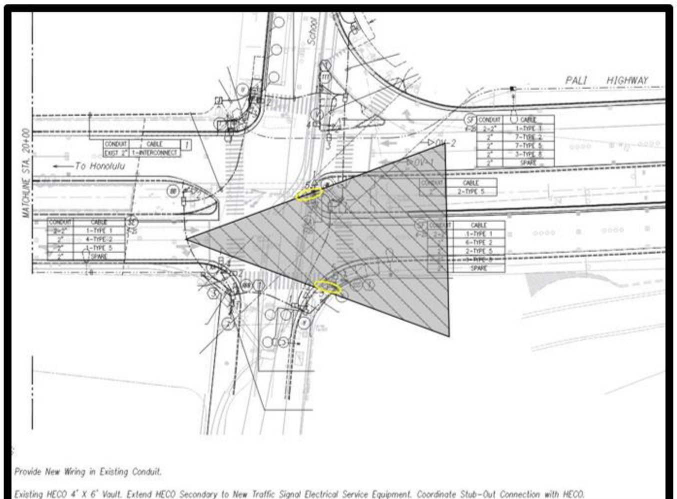
c. Cone of Vision

SEB School Street

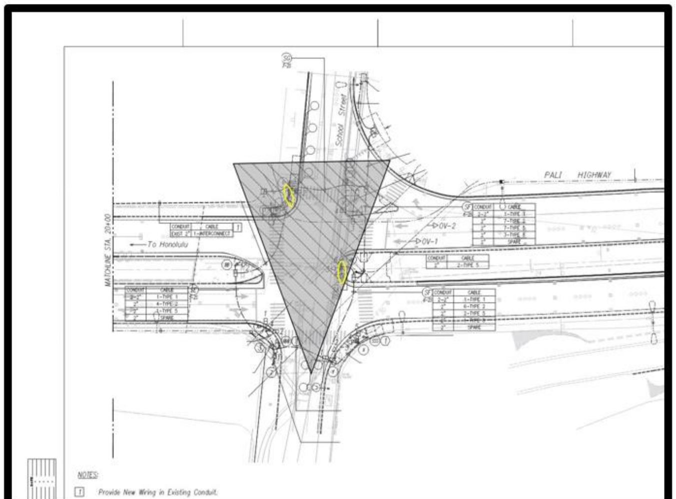


SWB Pali Highway





NEB Pali Highway



NWB School Street

I. Likelike Highway & School Street

a. Approach View

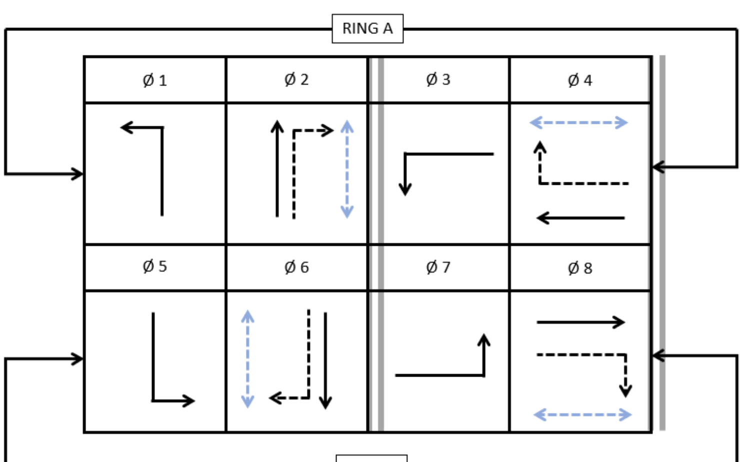
SEB School Street

SWB Likelike Highway

NEB Likelike Highway

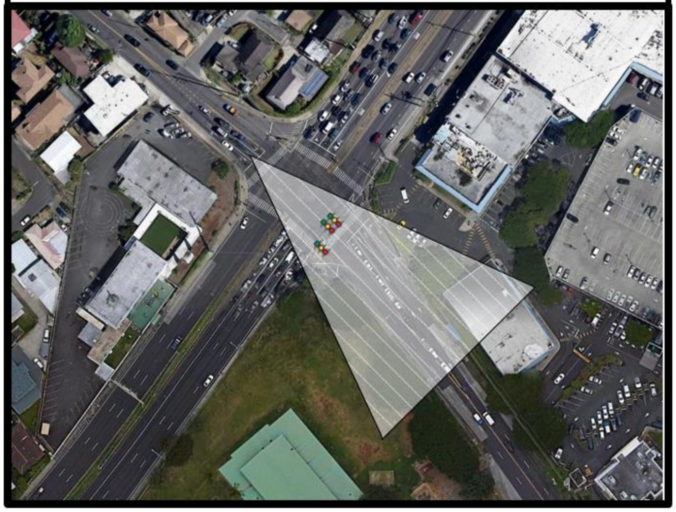
NWB School Street

b. Ring and Barrier Diagram

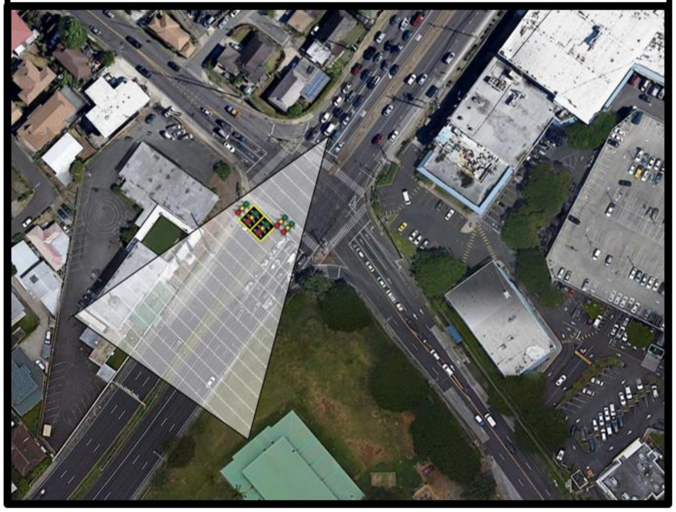


c. Cone of Vision

SEB School Street



SWB Likelike Highway



NEB Likelike Highway

NWB School Street

J. N. King Street & River Street

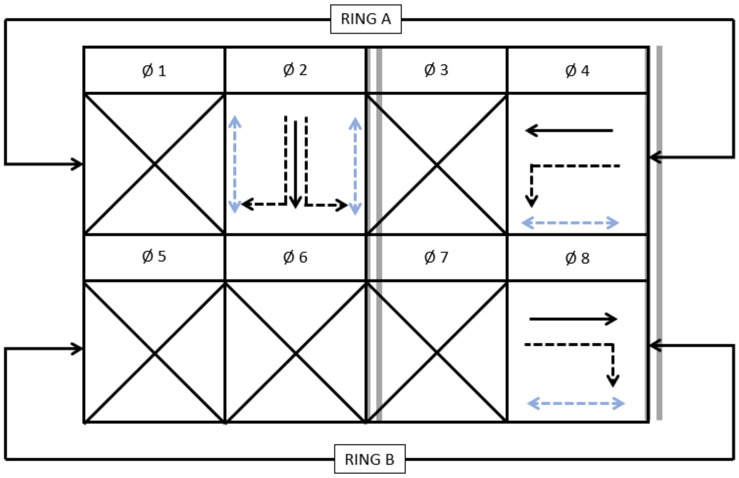
a. Approach View

EB River Street

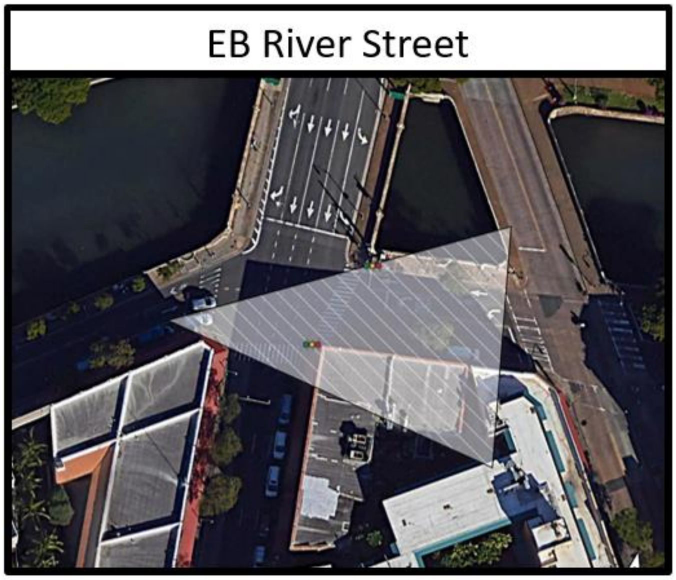
SB N. King Street

WB River Street

b. Ring and Barrier Diagram



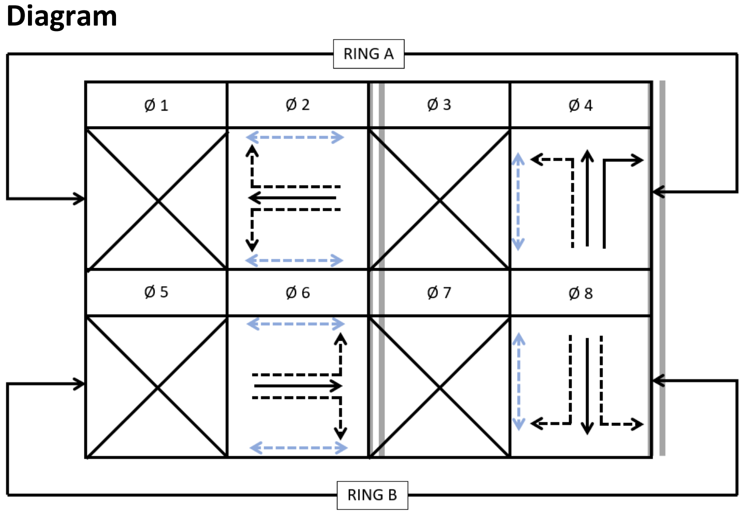
c. Cone of Vision



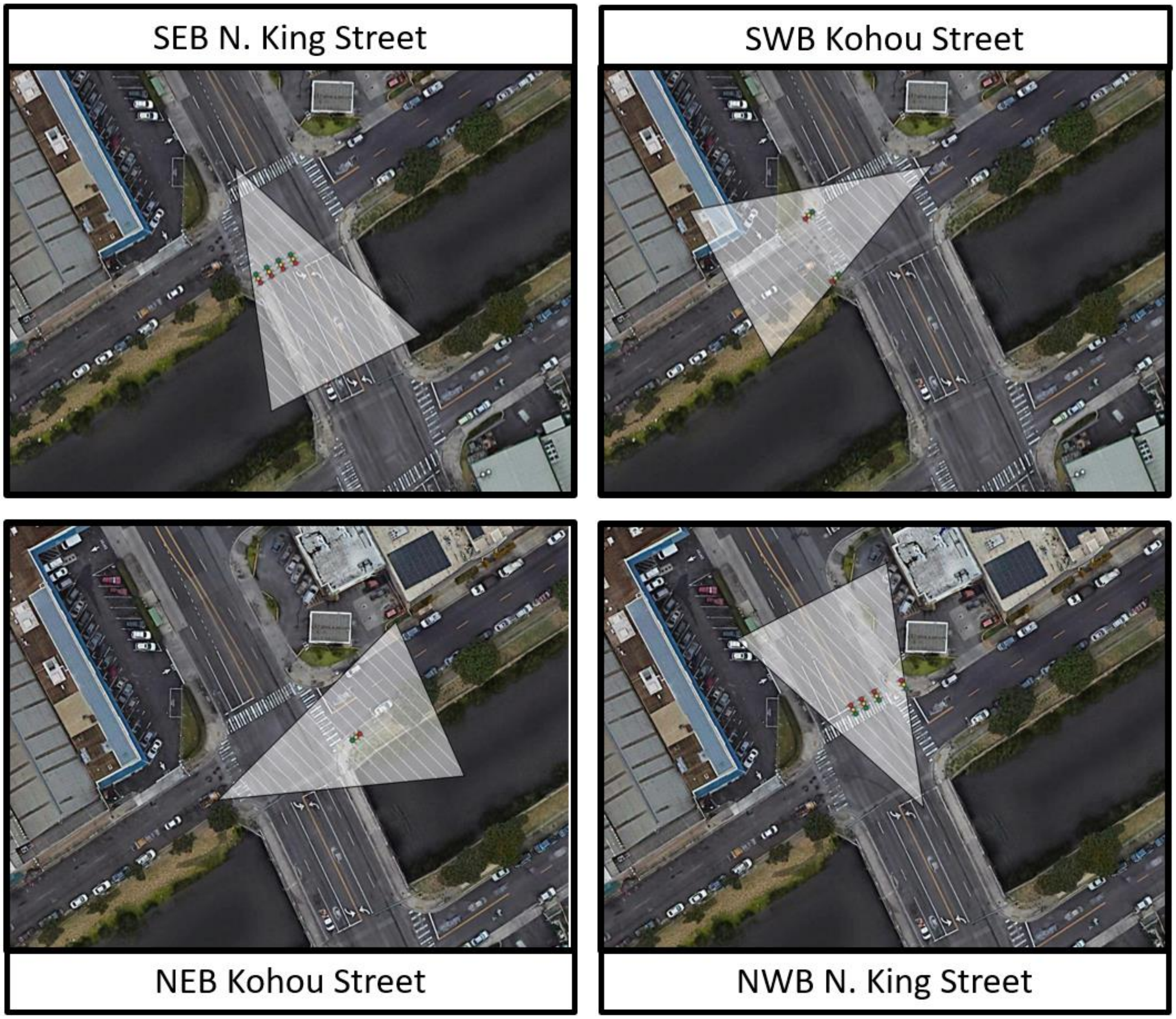
K. N. King Street & Kohou Street

a. Approach View

b. Ring and Barrier Diagram



c. Cone of Vision

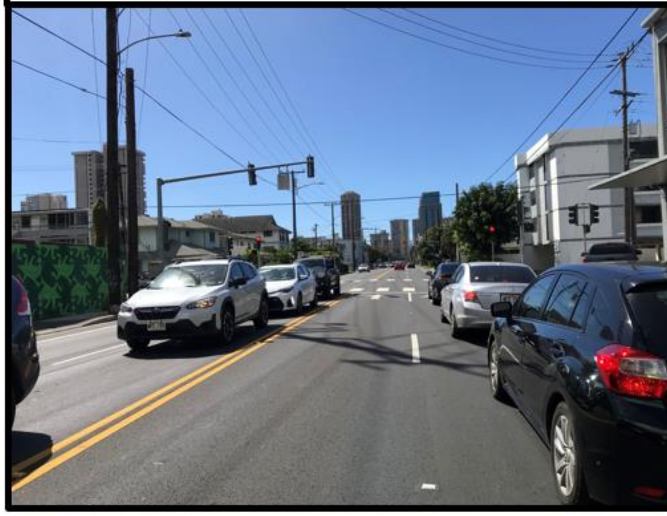


L. McCully Street & Algaroba Street

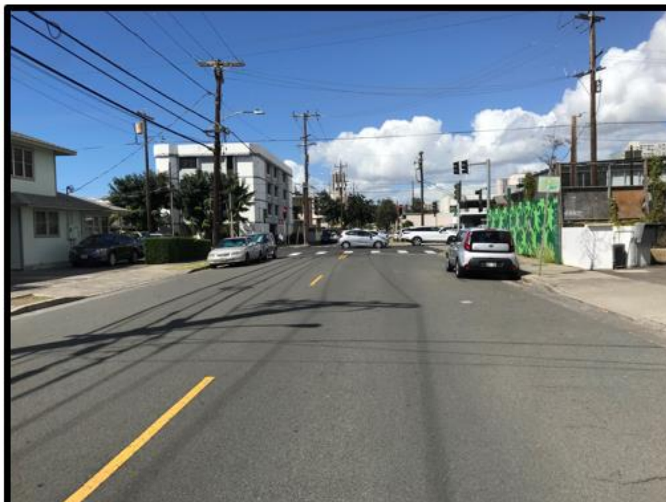
a. Approach View

SEB Algaroba Street

SWB McCully Street

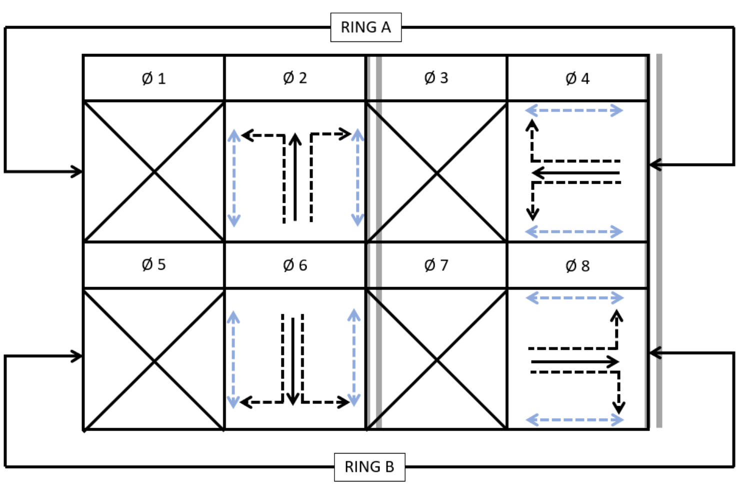


NEB McCully Street

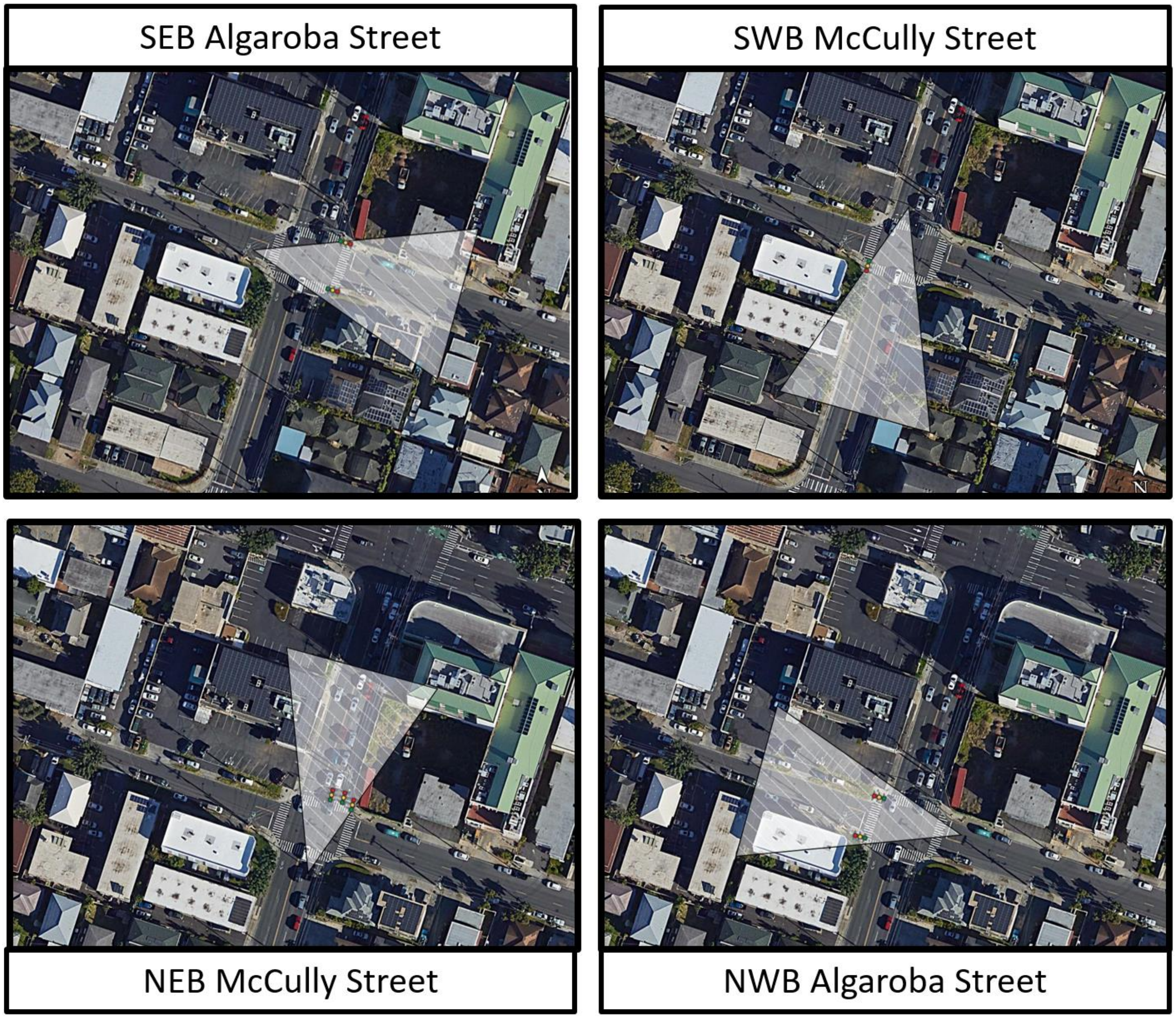


NWB Algaroba Street

b. Ring and Barrier Diagram



c. Cone of Vision



M. N. King Street & Middle Street

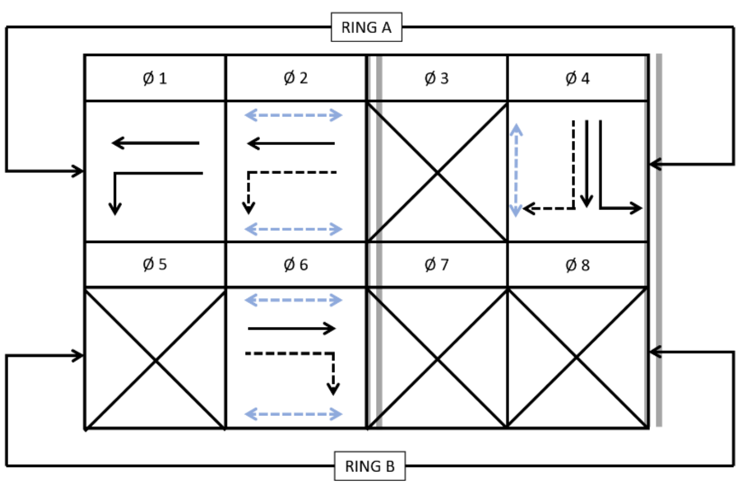
a. Approach View

SEB N. King Street

SWB Middle Street

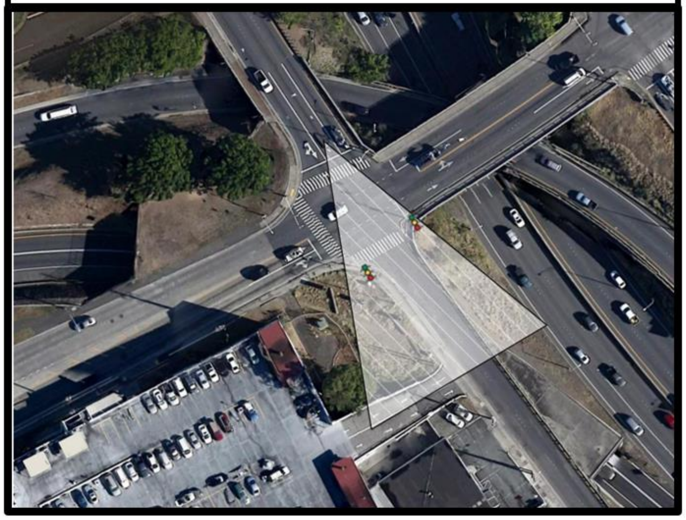
NEB Middle Street

b. Ring and Barrier Diagram



c. Cone of Vision

SEB N. King Street



SWB Middle Street

NEB Middle Street

N. Vineyard Boulevard & Nuuanu Avenue

a. Approach View

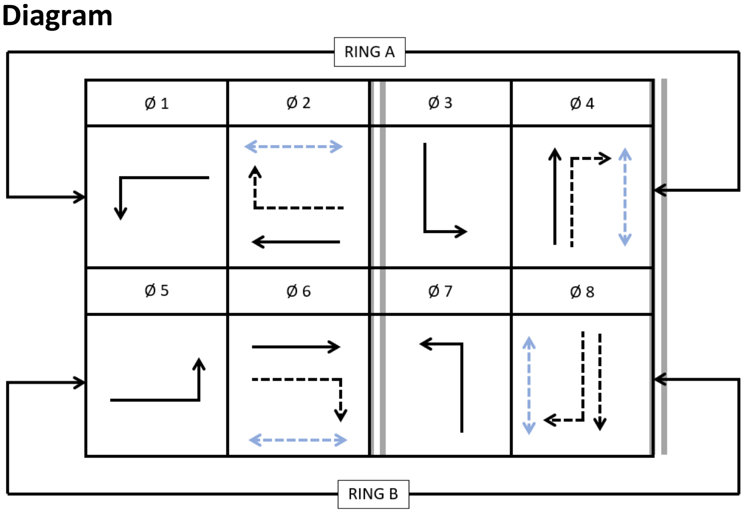
SEB Vineyard Boulevard

SWB Nuuanu Avenue

NEB Nuuanu Avenue

NWB Vineyard Boulevard

b. Ring and Barrier Diagram

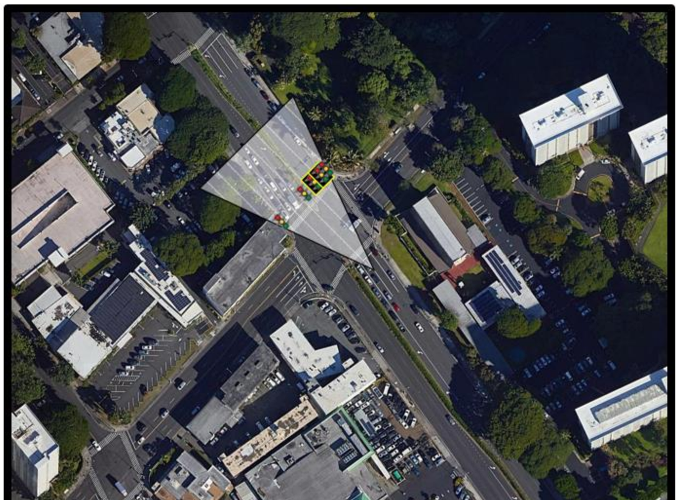


c. Cone of Vision

SEB Vineyard Boulevard

SWB Nuuanu Avenue

NEB Nuuanu Avenue



NWB Vineyard Boulevard

Appendix B –
Yellow Change and Red Clearance Interval Signal Timing Calculations

	Width (feet)	Grade (%)	Velocity (Speed Limit, mph)	Yellow Change Interval - ITE	Yellow Change Interval (rounded) - ITE	Existing Yellow	Yellow Difference	Red Clearance Interval - ITE	Red Clearance Interval (rounded) - ITE	Existing Red	Red Difference
Beretania Street and Piikoi Street											
WB Beretania Traffic	58	0.0%	30	3.2	4.0	4	0.0	0.8	1.0	1	0.0
NB Piikoi Traffic	76	0.0%	25	2.8	3.0	4	1.0	1.6	2.0	1	-1.0
Kapiolani Boulevard and Kamakee Street											
WB/EB Kapiolani Traffic	72	0.0%	35	3.6	4.0	4	0.0	0.8	1.0	1	0.0
NB Kamakee Traffic	0	0.0%	25	2.8	3.0	4	1.0	-0.5	0.0	1	1.0
Vineyard Boulevard and Palama Street											
NWB/SEB Vineyard Traffic	96	0.0%	30	3.2	4.0	4	0.0	1.6	2.0	1	-1.0
NEB/SWB Palama Traffic	152	-2.5%	25	3.0	3.0	4	1.0	3.7	4.0	2	-2.0
Vineyard Boulevard and Pali Highway											
NWB/SEB Vineyard Traffic	142	2.5%	30	3.0	4.0	4	0.0	2.7	3.0	2	-1.0
NEB/SWB Pali Traffic	137	-2.5%	25	3.0	3.0	4	1.0	3.3	4.0	2	-2.0
King Street and Beretania Street											
NB N. King Traffic	108	2.5%	25	2.7	3.0	4	1.0	2.5	3.0	2	-1.0
SB N. King Traffic	0	-2.5%	25	3.0	3.0	3	0.0	-0.5	0.0	0	0.0
NWB Beretania Traffic	108	0.0%	25	2.8	3.0	4	1.0	2.5	3.0	2	-1.0
King Street and Ward Avenue											
NB/SB Ward Traffic	88	0.0%	30	3.2	4.0	4	0.0	1.4	2.0	1	-1.0
EB S. King Traffic	80	0.0%	25	2.8	3.0	4	1.0	1.7	2.0	1	-1.0
Vineyard Boulevard and Liliha Street											
NWB/SEB Vineyard Traffic	117	-2.5%	30	3.4	4.0	5	1.0	2.1	3.0	1	-2.0
NEB/SWB Liliha Traffic	144	-2.5%	25	3.0	3.0	4	1.0	3.5	4.0	1	-3.0
Pali Highway and School Street											
NWB/SEB School Traffic	104	0.0%	25	2.8	3.0	4	1.0	2.4	3.0	2	-1.0
NEB/SWB Pali Traffic	63	0.0%	25	2.8	3.0	4	1.0	1.3	2.0	2	0.0
Likelike Highway and School Street											
NWB/SEB School Traffic	133	-2.5%	30	3.4	4.0	5	1.0	2.5	3.0	2	-1.0
NEB/SWB Likelike Traffic	99	-2.5%	25	3.0	3.0	4	1.0	2.2	3.0	2	-1.0
King Street and River Street											
SB N. King Traffic	58	0.0%	25	2.8	3.0	4	1.0	1.1	2.0	1	-1.0
WB/EB River Traffic	77	0.0%	25	2.8	3.0	4	1.0	1.6	2.0	1	-1.0
King Street and Kohou Street											
NB/SB N. King Traffic	69	0.0%	25	2.8	3.0	4	1.0	1.4	2.0	2	0.0
EB/WB Kohou Traffic	82	0.0%	25	2.8	3.0	4	1.0	1.8	2.0	1	-1.0
McCully Street and Algaroba Street											
NB/SB McCully Traffic	55	0.0%	25	2.8	3.0	4	1.0	1.0	1.0	2	1.0
WB/EB Algaroba Traffic	71	0.0%	25	2.8	3.0	4	1.0	1.5	2.0	2	0.0
King Street and Middle Street											
SEB N. King Traffic	72	2.5%	25	2.7	3.0	4	1.0	1.5	2.0	1	-1.0
NEB/SWB Middle Traffic	66	-2.5%	30	3.4	4.0	4	0.0	1.0	1.0	2	1.0
Vineyard Boulevard and Nuuanu Avenue											
NWB/SEB Vineyard Traffic	126	2.5%	30	3.0	4.0	4	0.0	2.3	3.0	1	-2.0
NEB/SWB Nuuanu Traffic	125	-2.5%	25	3.0	3.0	4	1.0	2.9	3.0	1	-2.0

Notes:

1) Yellow and red differences represent the variation between existing intervals and the calculated ITE intervals. In cases where the calculated ITE interval is greater than the existing interval, corresponding differences have been highlighted in red.

2) Corresponding differences that have been highlighted in red will be corrected by State and County prior to implementation.