

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt	Orient	"Green" Glare	"Yellow" Glare	Energy
	(°)	(°)	min	min	kWh
PV Area 1	15.0	180.0	1,278	0	-
PV Area 2-1	15.0	180.0	0	0	-
PV Area 2-2	15.0	180.0	849	0	-
PV Area 2-3	15.0	180.0	1,215	0	-
PV Area 3-1	15.0	180.0	1,253	0	-
PV Area 3-2	15.0	180.0	1,042	50	-
PV Area 3-3	15.0	180.0	466	0	-
PV Area 3-4	15.0	180.0	1,289	0	-
PV Area 4	15.0	180.0	1,798	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	1608	0
Farrington - 2	4840	0
H 1 - 1	0	0
H 1 - 2	118	0
H 1 - 3	2624	50
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Results for: PV Area 1

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	542	0
Farrington - 2	0	0
H 1 - 1	0	0
H 1 - 2	118	0
H 1 - 3	618	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 3

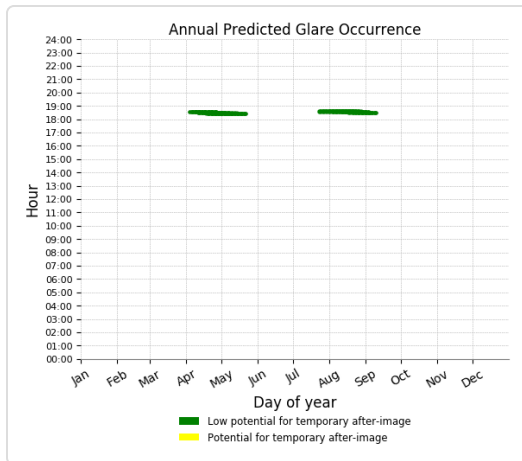
0 minutes of yellow glare

0 minutes of green glare

Route: Farrington -1

0 minutes of yellow glare

542 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 1

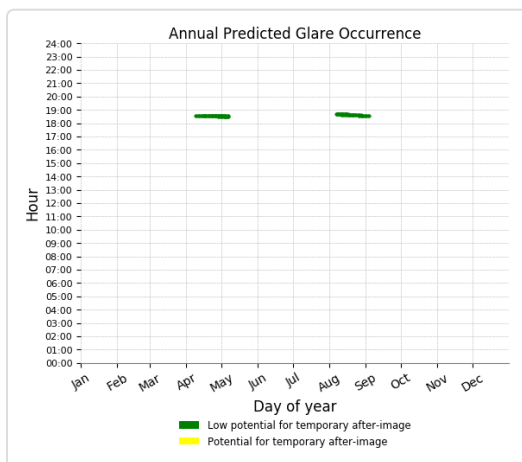
0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare

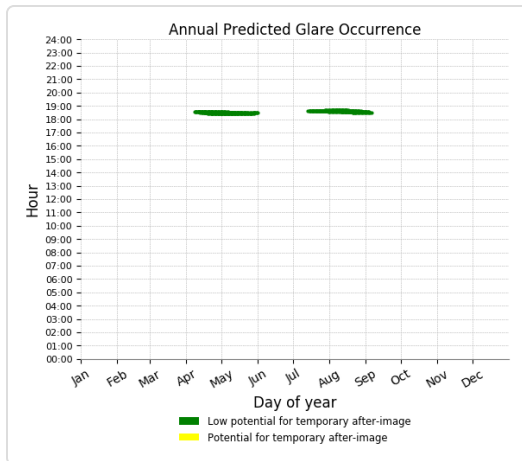
118 minutes of green glare



Route: H 1 - 3

0 minutes of yellow glare

618 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 2-1

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	0	0
Farrington - 2	0	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	0	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Route: Farrington -1

0 minutes of yellow glare
0 minutes of green glare

Route: Farrington - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 1

0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 4

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Area 2-2

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	318	0
Farrington - 2	299	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	232	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

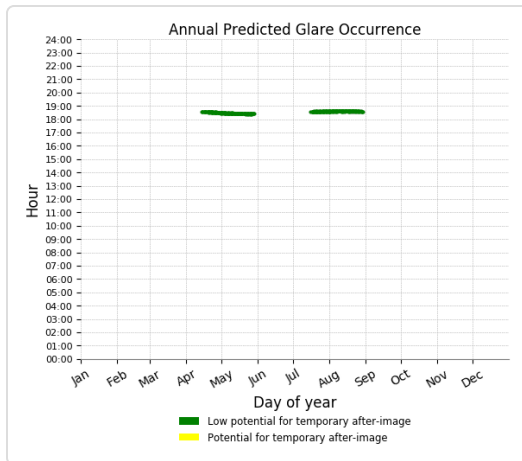
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Route: Farrington -1

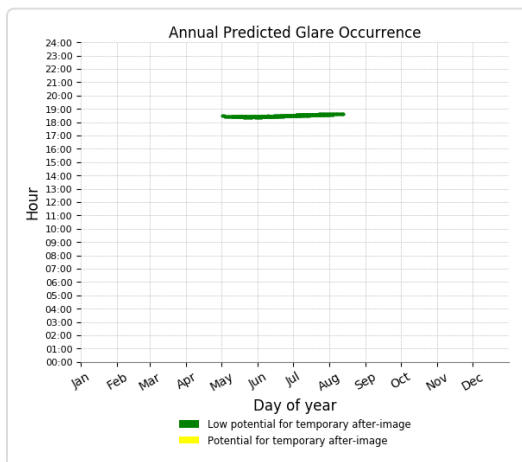
0 minutes of yellow glare
318 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare

299 minutes of green glare



Route: H 1 - 1

0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 2

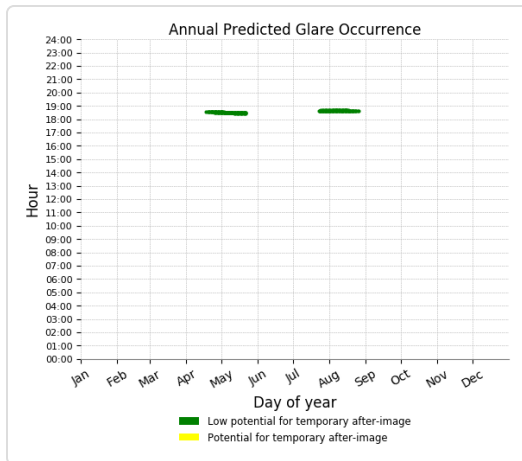
0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare

232 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 2-3

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	421	0
Farrington - 2	413	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	381	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 3

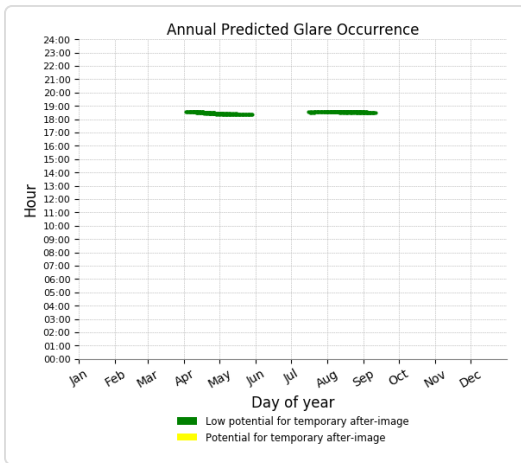
0 minutes of yellow glare

0 minutes of green glare

Route: Farrington -1

0 minutes of yellow glare

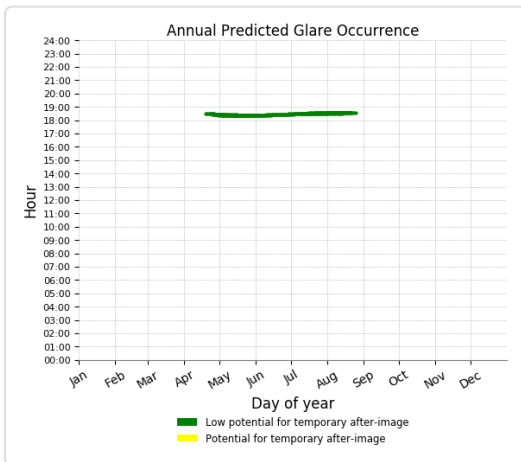
421 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare

413 minutes of green glare



Route: H 1 - 1

0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 2

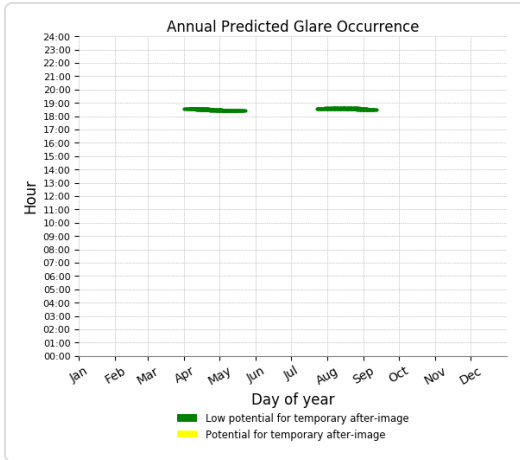
0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare

381 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 3-1

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	198	0
Farrington - 2	770	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	285	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

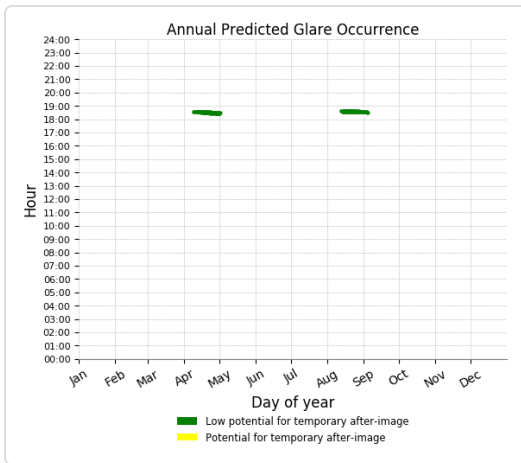
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Route: Farrington -1

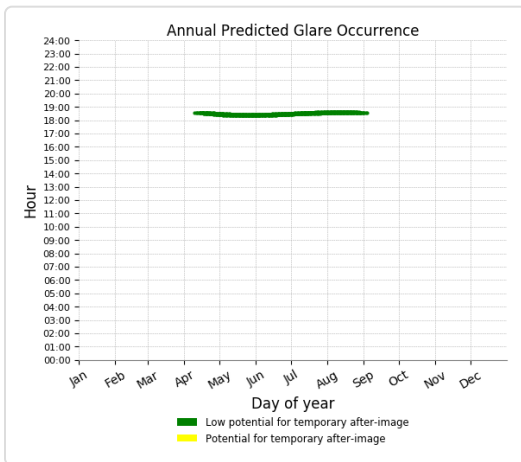
0 minutes of yellow glare
198 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare

770 minutes of green glare



Route: H 1 - 1

0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 2

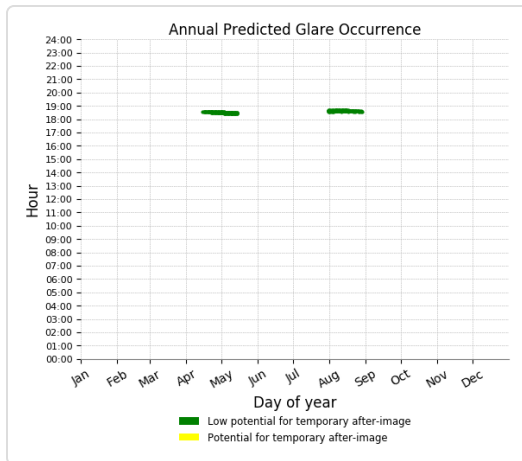
0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare

285 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Area 3-2

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	125	0
Farrington - 2	614	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	303	50
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

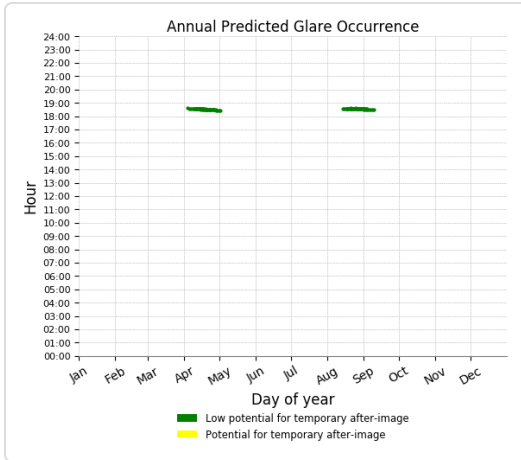
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Route: Farrington -1

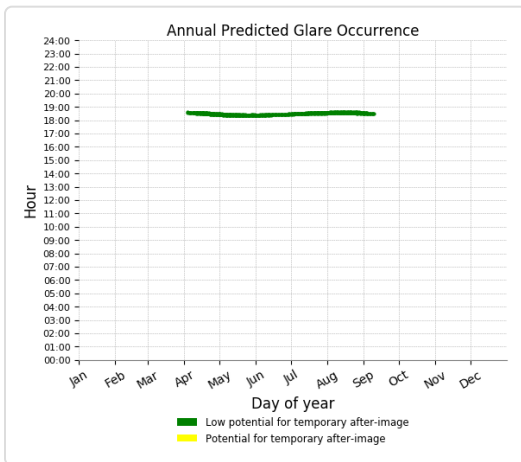
0 minutes of yellow glare
125 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare

614 minutes of green glare



Route: H 1 - 1

0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 2

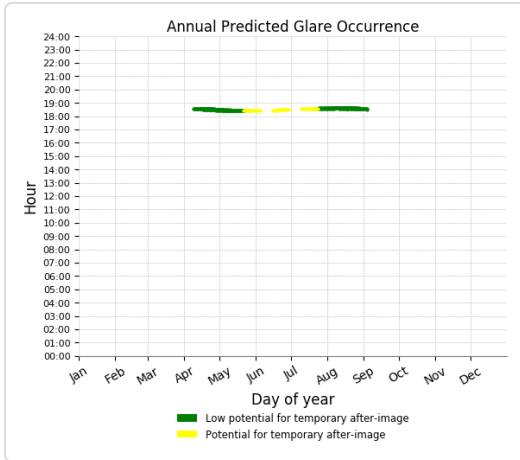
0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 3

50 minutes of yellow glare

303 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Results for: PV Area 3-3

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	0	0
Farrington - 2	442	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	24	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare

0 minutes of green glare

Route: Farrington -1

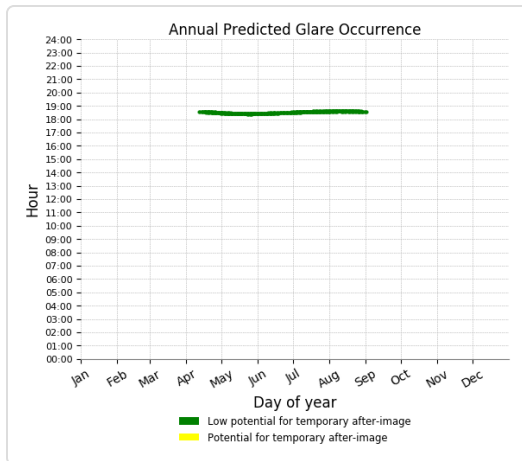
0 minutes of yellow glare

0 minutes of green glare

Route: Farrington - 2

0 minutes of yellow glare

442 minutes of green glare



Route: H 1 - 1

0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 2

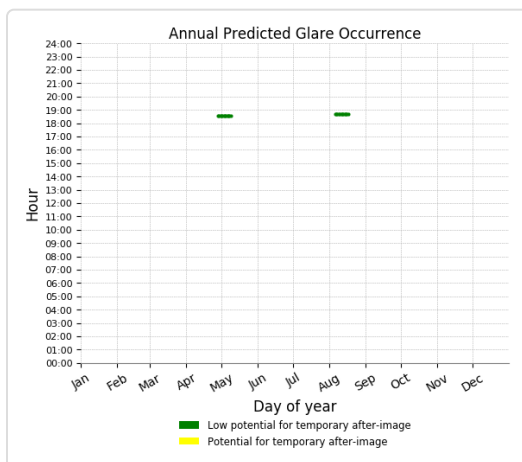
0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare

24 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Area 3-4

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	4	0
Farrington - 2	892	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	393	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

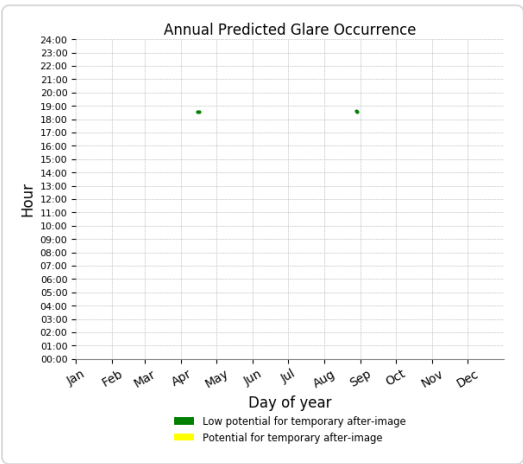
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

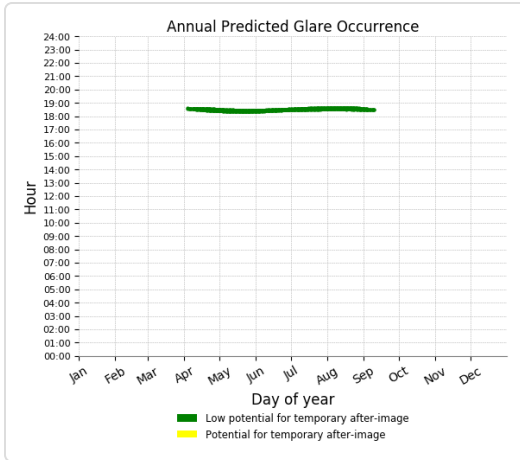
Route: Farrington -1

0 minutes of yellow glare
4 minutes of green glare



Route: Farrington - 2

0 minutes of yellow glare
892 minutes of green glare



Route: H 1 - 1

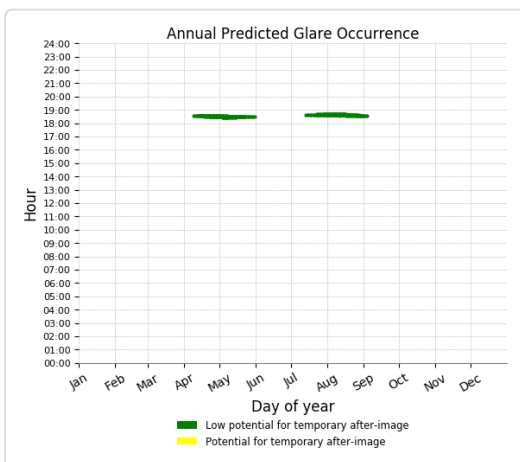
0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 2

0 minutes of yellow glare
0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
393 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare

0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare

0 minutes of green glare

Results for: PV Area 4

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
Farrington -1	0	0
Farrington - 2	1410	0
H 1 - 1	0	0
H 1 - 2	0	0
H 1 - 3	388	0
H 1 - 4	0	0
Kualakai - 1	0	0
Kualakai - 2	0	0
Kualakai - 3	0	0
Kualakai - 4	0	0
Kualakai - 5	0	0

Point Receptor: OP 1

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare

0 minutes of green glare

Route: Farrington -1

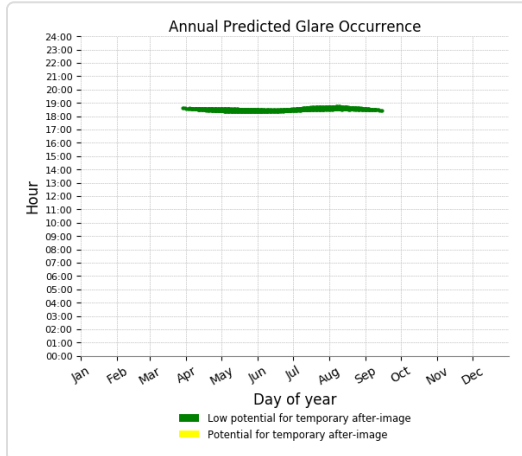
0 minutes of yellow glare

0 minutes of green glare

Route: Farrington - 2

0 minutes of yellow glare

1410 minutes of green glare



Route: H 1 - 1

0 minutes of yellow glare

0 minutes of green glare

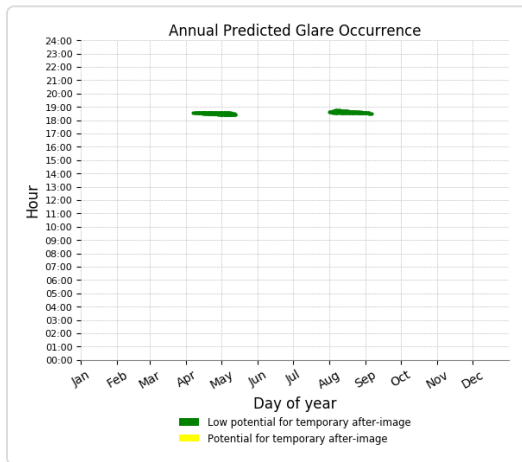
Route: H 1 - 2

0 minutes of yellow glare

0 minutes of green glare

Route: H 1 - 3

0 minutes of yellow glare
388 minutes of green glare



Route: H 1 - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 1

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 2

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 3

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 4

0 minutes of yellow glare
0 minutes of green glare

Route: Kualakai - 5

0 minutes of yellow glare
0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.

Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.

The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size.

Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.

The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.



FORGESOLAR GLARE ANALYSIS

Project: **AES - Hawaii**

Site configuration: **West Oahu - FAA**

Analysis conducted by Josh Burdett (joshua.burdett@tetrattech.com) at 16:43 on 21 Jan, 2020.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
Flight path(s)	PASS	Flight path receptor(s) do not receive yellow glare
ATCT(s)	FAIL	Receptor(s) marked as ATCT receive green and/or yellow glare

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at <https://www.federalregister.gov/d/2013-24729>

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m²
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 34872.6258



PV Array(s)

Name: PV Area 1
Axis tracking: Fixed (no rotation)
Tilt: 15.0°
Orientation: 180.0°
Rated power: -
Panel material: Smooth glass with AR coating
Reflectivity: Vary with sun
Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.378202	-158.062098	414.48	7.60	422.08
2	21.377800	-158.062280	419.04	7.60	426.64
3	21.377602	-158.062377	415.86	7.60	423.46
4	21.377450	-158.062465	411.42	7.60	419.02
5	21.377213	-158.062374	398.76	7.60	406.36
6	21.376973	-158.061441	350.35	7.60	357.96
7	21.377008	-158.060918	333.62	7.60	341.22
8	21.377120	-158.060923	338.28	7.60	345.88
9	21.377490	-158.061106	356.91	7.60	364.51
10	21.377622	-158.061476	374.30	7.60	381.90
11	21.378147	-158.061891	404.33	7.60	411.93

Name: PV Area 2-1

Axis tracking: Fixed (no rotation)

Tilt: 15.0°

Orientation: 180.0°

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.376881	-158.062833	410.48	7.60	418.08
2	21.376459	-158.063010	418.17	7.60	425.77
3	21.375907	-158.063270	403.44	7.60	411.04
4	21.375544	-158.063457	390.88	7.60	398.48
5	21.375315	-158.063565	394.11	7.60	401.71
6	21.375277	-158.063152	370.95	7.60	378.55
7	21.375227	-158.062736	356.59	7.60	364.19
8	21.375574	-158.062618	369.95	7.60	377.55
9	21.376031	-158.062454	383.79	7.60	391.39
10	21.376511	-158.062293	385.02	7.60	392.62
11	21.376713	-158.062218	382.76	7.60	390.36
12	21.376833	-158.062401	392.49	7.60	400.09

Name: PV Area 2-2

Axis tracking: Fixed (no rotation)

Tilt: 15.0°

Orientation: 180.0°

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.376711	-158.062205	381.82	7.60	389.42
2	21.376361	-158.062326	386.07	7.60	393.67
3	21.375894	-158.062492	380.15	7.60	387.75
4	21.375450	-158.062645	364.88	7.60	372.48
5	21.375217	-158.062728	355.93	7.60	363.53
6	21.375152	-158.062331	344.64	7.60	352.24
7	21.375065	-158.061803	333.62	7.60	341.22
8	21.375484	-158.061666	342.96	7.60	350.56
9	21.375989	-158.061513	354.20	7.60	361.80
10	21.376499	-158.061365	347.02	7.60	354.62
11	21.376598	-158.061776	365.54	7.60	373.14

Name: PV Area 2-3

Axis tracking: Fixed (no rotation)

Tilt: 15.0°

Orientation: 180.0°

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.376496	-158.061349	345.68	7.60	353.28
2	21.376129	-158.061451	353.34	7.60	360.94
3	21.375649	-158.061591	344.73	7.60	352.33
4	21.375267	-158.061711	337.77	7.60	345.37
5	21.375055	-158.061786	333.19	7.60	340.80
6	21.375025	-158.061175	318.48	7.60	326.08
7	21.375050	-158.060813	303.34	7.60	310.94
8	21.375095	-158.060542	290.44	7.60	298.04
9	21.375475	-158.060413	294.34	7.60	301.94
10	21.375724	-158.060362	297.35	7.60	304.95
11	21.376002	-158.060582	314.55	7.60	322.15
12	21.376299	-158.060797	321.82	7.60	329.42

Name: PV Area 3-1

Axis tracking: Fixed (no rotation)

Tilt: 15.0°

Orientation: 180.0°

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.374960	-158.063771	403.94	7.60	411.54
2	21.374550	-158.064018	409.08	7.60	416.68
3	21.374006	-158.064372	405.79	7.60	413.39
4	21.373486	-158.063921	358.12	7.60	365.72
5	21.374071	-158.063321	356.56	7.60	364.16
6	21.374800	-158.062698	341.18	7.60	348.79
7	21.375030	-158.063702	401.45	7.60	409.05

Name: PV Area 3-2

Axis tracking: Fixed (no rotation)

Tilt: 15.0°

Orientation: 180.0°

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.373471	-158.063900	356.53	7.60	364.13
2	21.373052	-158.063605	329.89	7.60	337.49
3	21.372872	-158.063063	308.33	7.60	315.93
4	21.373132	-158.062811	306.55	7.60	314.15
5	21.373511	-158.062468	302.42	7.60	310.02
6	21.373911	-158.062012	300.71	7.60	308.31
7	21.374650	-158.061711	322.58	7.60	330.18
8	21.374790	-158.062634	337.82	7.60	345.42
9	21.374361	-158.063010	346.18	7.60	353.78
10	21.373771	-158.063557	360.52	7.60	368.12
11	21.373431	-158.063927	356.09	7.60	363.69

Name: PV Area 3-3

Axis tracking: Fixed (no rotation)

Tilt: 15.0°

Orientation: 180.0°

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.373971	-158.064423	405.46	7.60	413.06
2	21.373346	-158.064702	408.59	7.60	416.19
3	21.372987	-158.064917	407.08	7.60	414.68
4	21.372597	-158.065507	390.32	7.60	397.92
5	21.372397	-158.065474	370.08	7.60	377.68
6	21.372093	-158.064670	325.30	7.60	332.90
7	21.372627	-158.064343	352.86	7.60	360.46
8	21.373376	-158.063887	352.43	7.60	360.03

Name: PV Area 3-4

Axis tracking: Fixed (no rotation)

Tilt: 15.0°

Orientation: 180.0°

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.373311	-158.063844	348.21	7.60	355.81
2	21.372912	-158.064117	354.61	7.60	362.22
3	21.372332	-158.064477	337.76	7.60	345.36
4	21.372073	-158.064616	321.88	7.60	329.48
5	21.371838	-158.064101	301.52	7.60	309.12
6	21.371713	-158.063763	289.80	7.60	297.40
7	21.371698	-158.063415	280.75	7.60	288.35
8	21.372113	-158.063200	288.24	7.60	295.85
9	21.372807	-158.063007	305.71	7.60	313.31
10	21.372967	-158.063495	325.17	7.60	332.77
11	21.373032	-158.063661	332.00	7.60	339.60
12	21.373232	-158.063774	341.54	7.60	349.14

Name: PV Area 4

Axis tracking: Fixed (no rotation)

Tilt: 15.0°

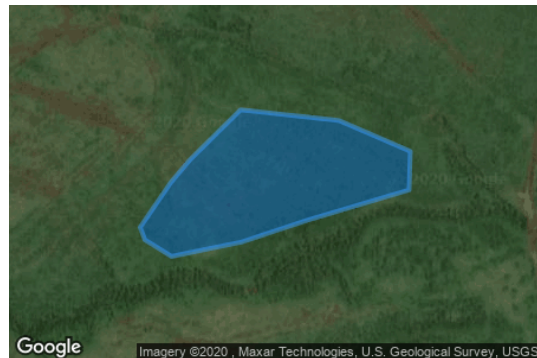
Orientation: 180.0°

Rated power: -

Panel material: Smooth glass with AR coating

Reflectivity: Vary with sun

Slope error: correlate with material



Vertex	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
1	21.371341	-158.066427	397.82	7.60	405.42
2	21.371151	-158.066598	400.08	7.60	407.68
3	21.370776	-158.066875	379.77	7.60	387.37
4	21.370671	-158.066832	364.94	7.60	372.54
5	21.370531	-158.066590	351.04	7.60	358.64
6	21.370651	-158.065957	338.58	7.60	346.18
7	21.370836	-158.065356	317.01	7.60	324.61
8	21.371091	-158.064434	293.63	7.60	301.23
9	21.371416	-158.064423	295.80	7.60	303.40
10	21.371675	-158.065072	321.71	7.60	329.31
11	21.371765	-158.065963	374.69	7.60	382.29

Flight Path Receptor(s)

Name: HHI RWY 24

Description:

Threshold height: 50 ft

Direction: 248.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.484137	-158.030623	836.65	50.00	886.65
Two-mile	21.494967	-158.001780	962.56	477.54	1440.10

Name: HHI RWY 6

Description:

Threshold height: 50 ft

Direction: 68.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.479376	-158.043476	816.49	50.00	866.49
Two-mile	21.468545	-158.072317	1132.87	287.08	1419.95

Name: HNL RWY 04L

Description:

Threshold height: 50 ft

Direction: 53.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.318627	-157.922958	6.56	50.00	56.56
Two-mile	21.301227	-157.947774	-24.77	634.79	610.02

Name: HNL RWY 04R

Description:

Threshold height: 71 ft

Direction: 53.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.314206	-157.926770	3.28	71.00	74.28
Two-mile	21.296806	-157.951585	-81.63	709.37	627.74

Name: HNL RWY 08R

Description:

Threshold height: 96 ft

Direction: 90.0°

Glide slope: 3.25°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.306817	-157.945391	3.15	96.00	99.15
Two-mile	21.306817	-157.976461	-12.57	711.39	698.82

Name: HNL RWY 22L

Description:

Threshold height: 80 ft

Direction: 233.0°

Glide slope: 3.44°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.328555	-157.906434	3.28	80.00	83.28
Two-mile	21.345955	-157.881617	98.61	619.49	718.10

Name: HNL RWY 22R

Description:

Threshold height: 50 ft

Direction: 233.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.329580	-157.907432	6.32	50.00	56.33
Two-mile	21.346980	-157.882614	113.79	495.99	609.78

Name: HNL RWY 26L

Description:

Threshold height: 75 ft

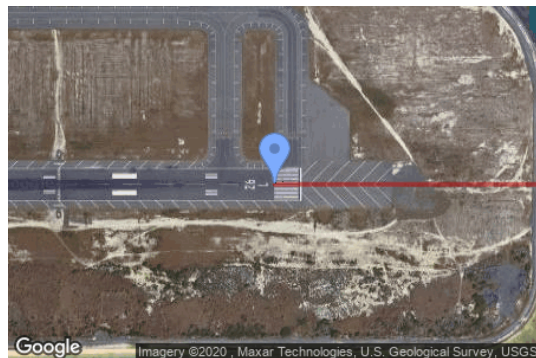
Direction: 270.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.306822	-157.911122	3.08	75.00	78.09
Two-mile	21.306827	-157.880052	8.34	623.20	631.54

Name: JRF RWY 04L

Description:

Threshold height: 35 ft

Direction: 55.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.301104	-158.080872	13.12	35.00	48.13
Two-mile	21.284521	-158.106322	-24.50	626.08	601.58

Name: JRF RWY 04R

Description:

Threshold height: 55 ft

Direction: 55.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.299691	-158.079822	13.11	55.00	68.11
Two-mile	21.283107	-158.105272	-28.50	650.06	621.56

Name: JRF RWY 11

Description:

Threshold height: 48 ft

Direction: 118.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.311555	-158.083631	35.84	48.00	83.84
Two-mile	21.325129	-158.111066	16.69	620.60	637.30

Name: JRF RWY 22L

Description:

Threshold height: 32 ft

Direction: 235.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.312291	-158.060624	26.25	32.00	58.25
Two-mile	21.328874	-158.035172	31.89	579.82	611.70

Name: JRF RWY 22R

Description:

Threshold height: 33 ft

Direction: 235.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.313722	-158.061641	29.53	33.00	62.53
Two-mile	21.330305	-158.036189	32.81	583.17	615.99

Name: JRF RWY 29

Description:

Threshold height: 52 ft

Direction: 298.0°

Glide slope: 3.0°

Pilot view restricted? Yes

Vertical view: 30.0°

Azimuthal view: 50.0°



Point	Latitude (°)	Longitude (°)	Ground elevation (ft)	Height above ground (ft)	Total elevation (ft)
Threshold	21.302899	-158.066468	9.84	52.00	61.85
Two-mile	21.289326	-158.039035	-38.09	653.40	615.30

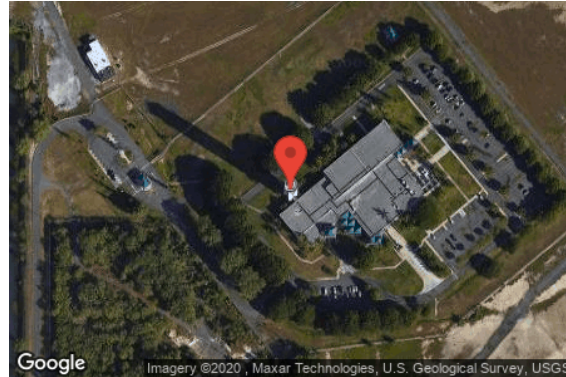
Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (ft)	Height (ft)
1-ATCT	1	21.310381	-158.070840	29.53	50.00
2-ATCT	2	21.320915	-157.927214	6.77	50.00

Map image of 1-ATCT



Map image of 2-ATCT



GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt	Orient	"Green" Glare	"Yellow" Glare	Energy
	(°)	(°)	min	min	kWh
PV Area 1	15.0	180.0	602	0	-
PV Area 2-1	15.0	180.0	266	0	-
PV Area 2-2	15.0	180.0	212	0	-
PV Area 2-3	15.0	180.0	417	0	-
PV Area 3-1	15.0	180.0	660	0	-
PV Area 3-2	15.0	180.0	451	0	-
PV Area 3-3	15.0	180.0	567	0	-
PV Area 3-4	15.0	180.0	623	0	-
PV Area 4	15.0	180.0	813	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	847	0
HNL RWY 22R	866	0
HNL RWY 26L	2149	0
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	749	0

Results for: PV Area 1

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	93	0
HNL RWY 22R	112	0
HNL RWY 26L	346	0
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	51	0

Flight Path: HHI RWY 24

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04R

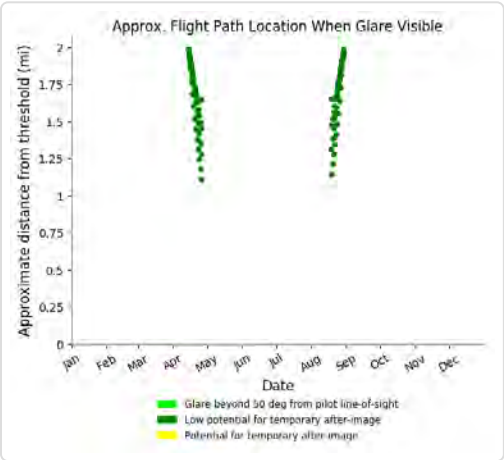
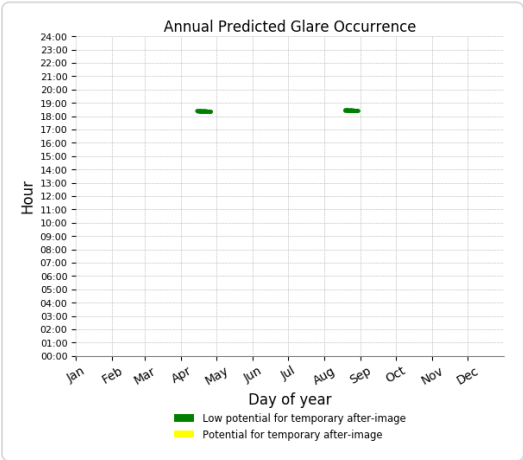
0 minutes of yellow glare
0 minutes of green glare

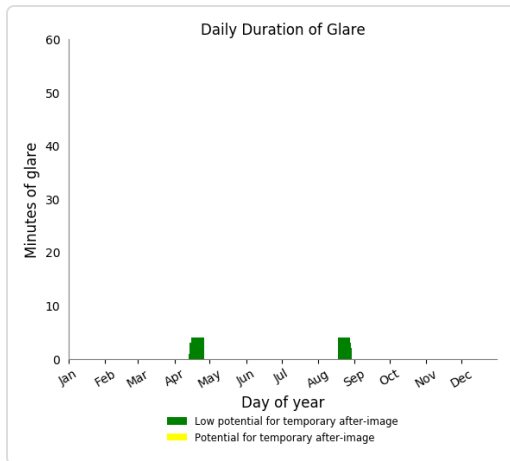
Flight Path: HNL RWY 08R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare
93 minutes of green glare

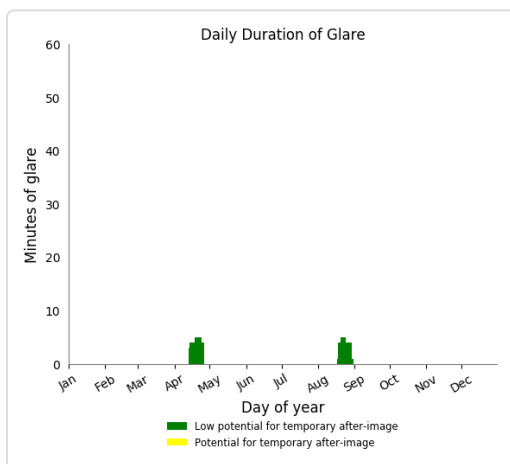
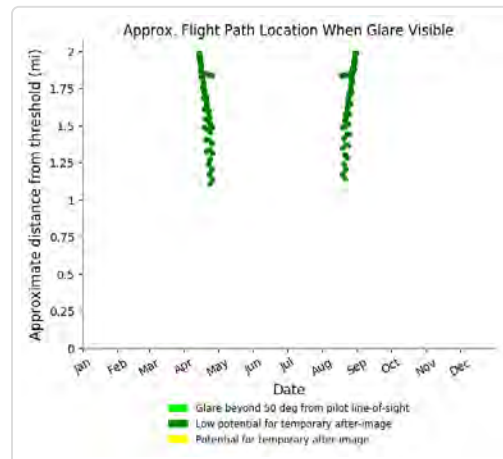
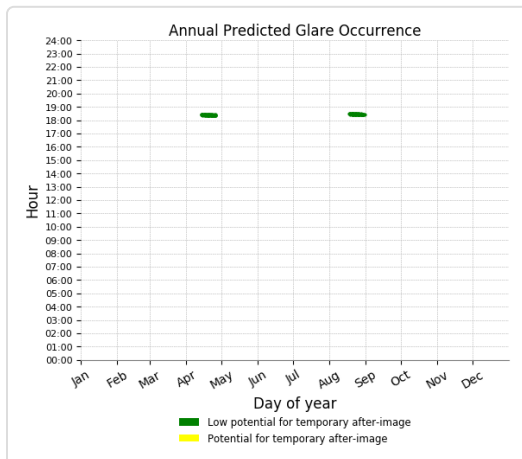




Flight Path: HNL RWY 22R

0 minutes of yellow glare

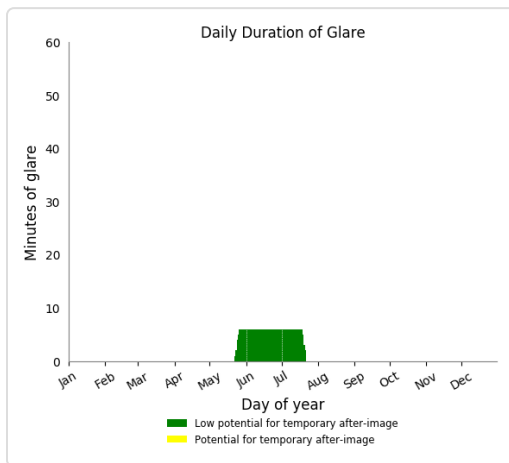
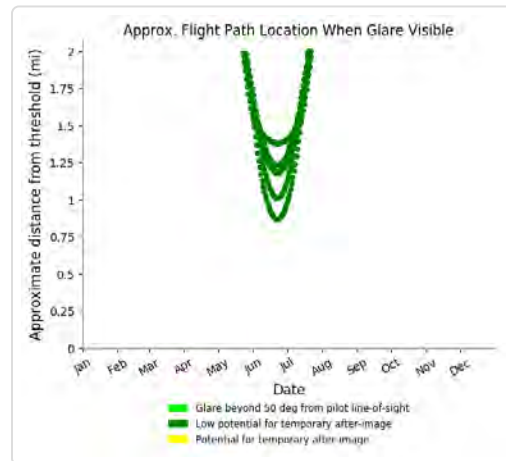
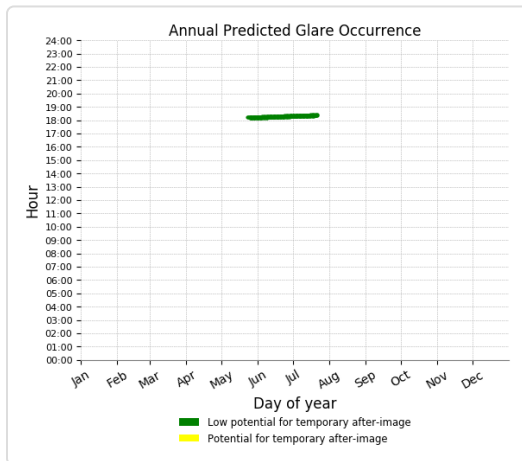
112 minutes of green glare



Flight Path: HNL RWY 26L

0 minutes of yellow glare

346 minutes of green glare



Flight Path: JRF RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 29

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 1-ATCT

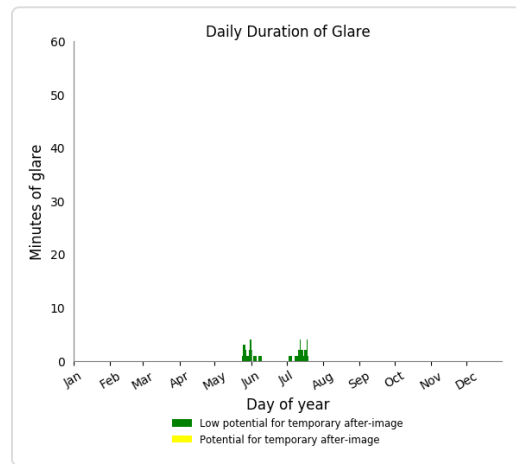
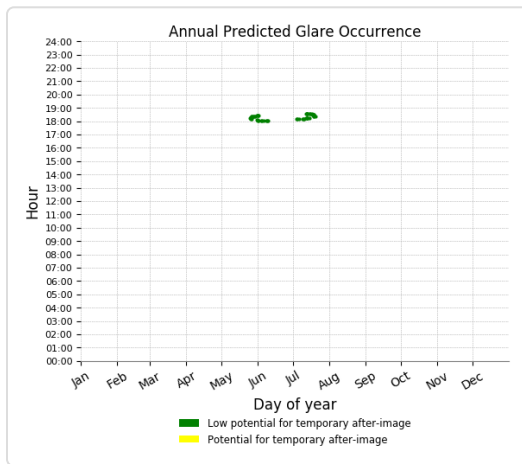
0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare

51 minutes of green glare



Results for: PV Area 2-1

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	31	0
HNL RWY 22R	29	0
HNL RWY 26L	151	0

Receptor	Green Glare (min)	Yellow Glare (min)
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	55	0

Flight Path: HHI RWY 24

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 04R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 08R

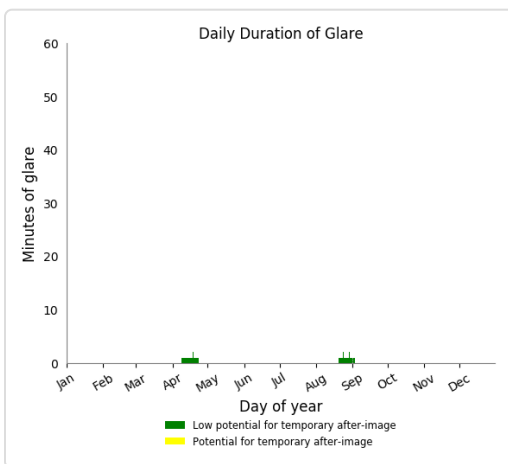
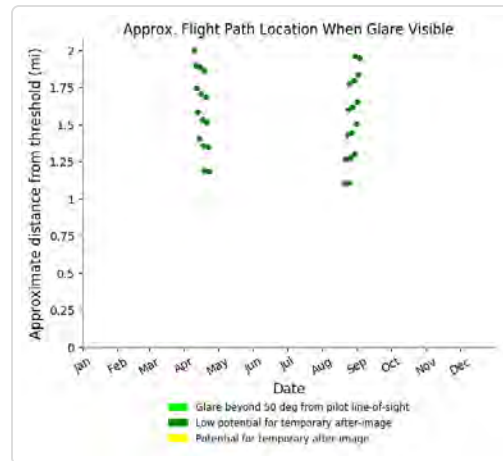
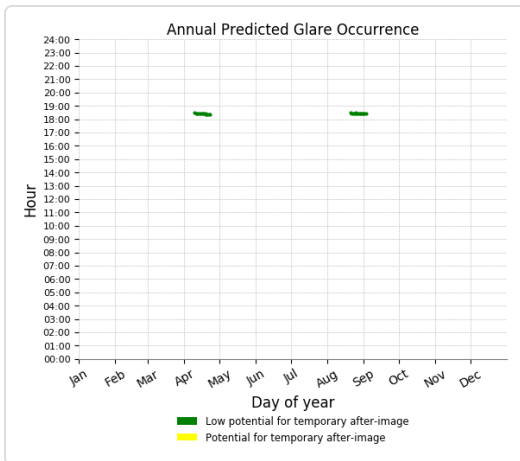
0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare

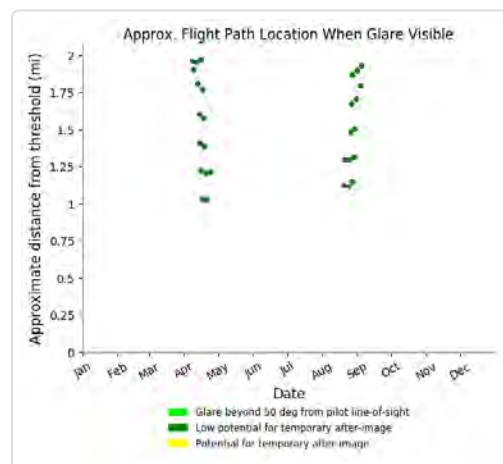
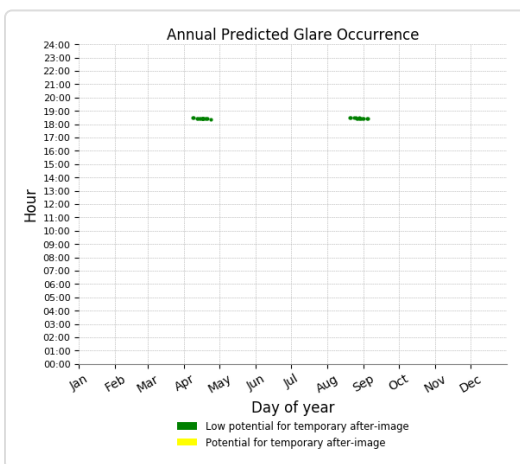
31 minutes of green glare

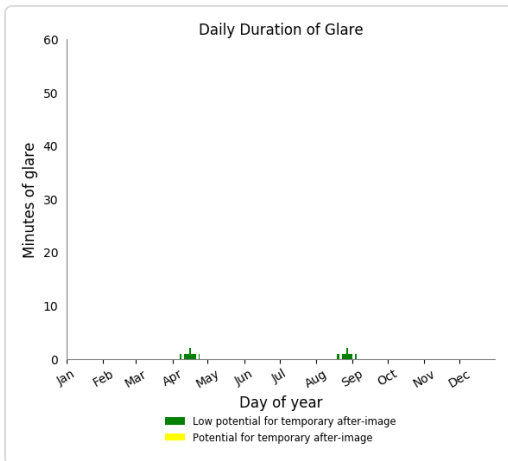


Flight Path: HNL RWY 22R

0 minutes of yellow glare

29 minutes of green glare

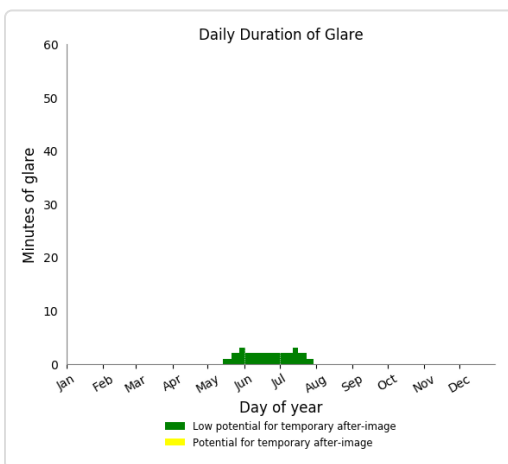
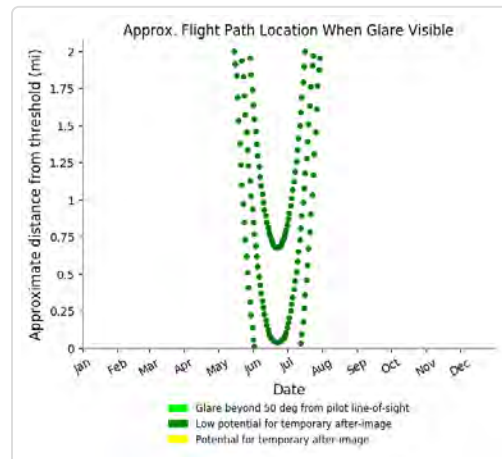
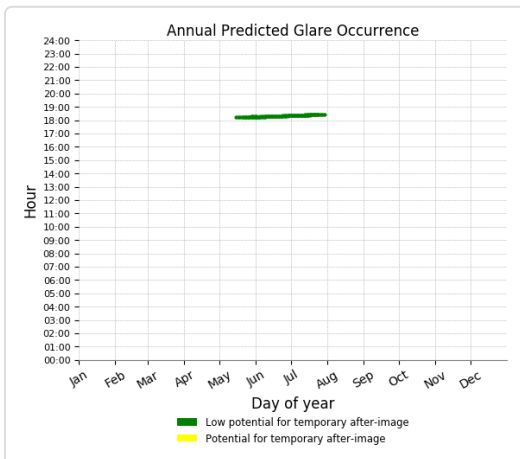




Flight Path: HNL RWY 26L

0 minutes of yellow glare

151 minutes of green glare



Flight Path: JRF RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 29

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 1-ATCT

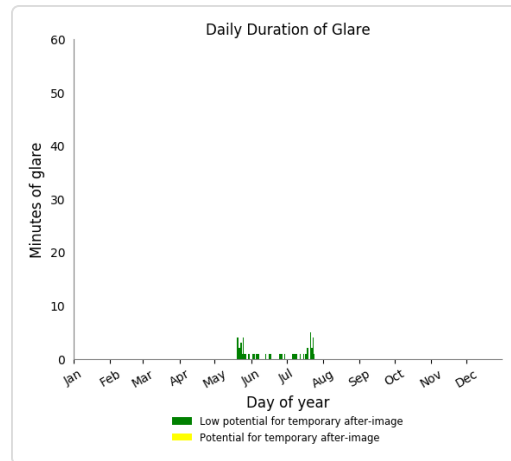
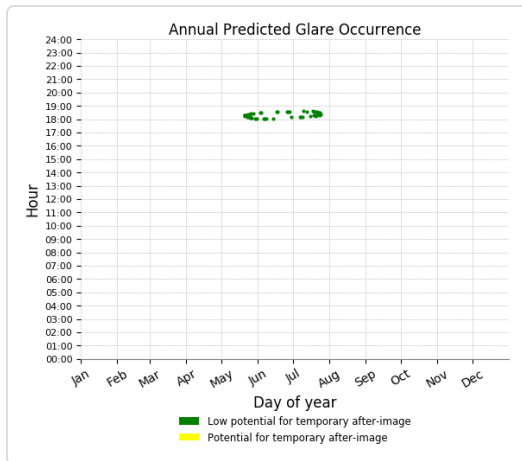
0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare

55 minutes of green glare



Results for: PV Area 2-2

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	33	0
HNL RWY 22R	32	0
HNL RWY 26L	82	0
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	65	0

Flight Path: HHI RWY 24

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 04R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 08R

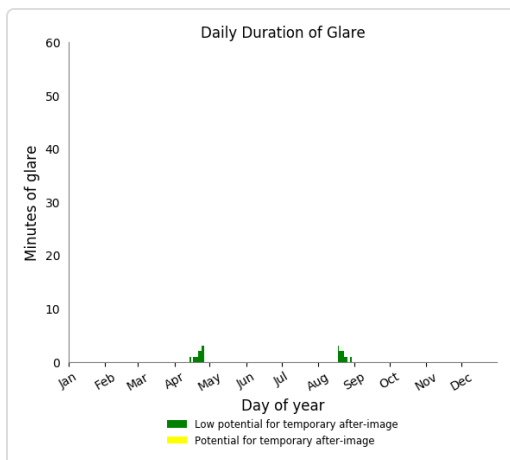
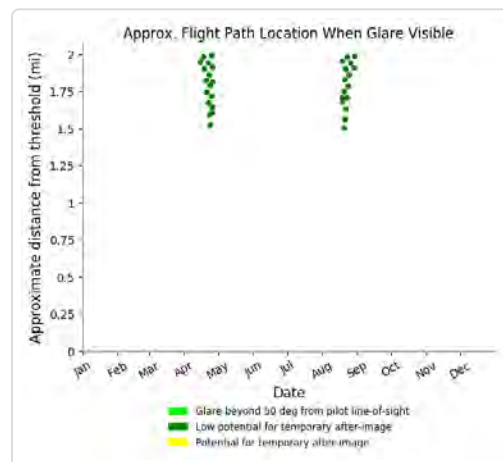
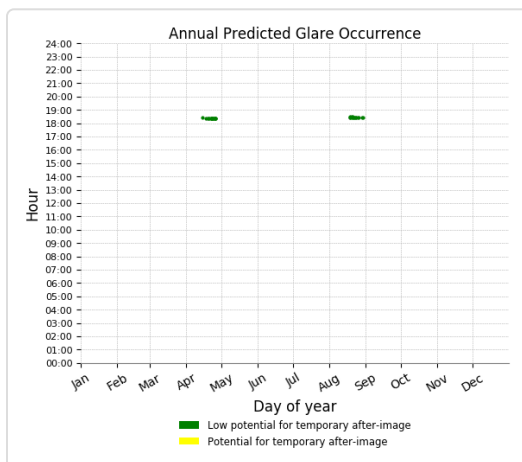
0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare

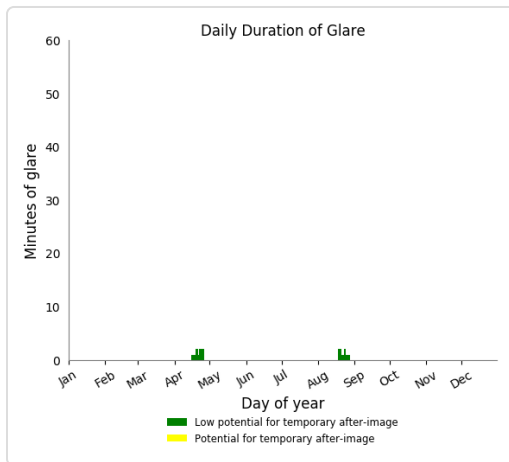
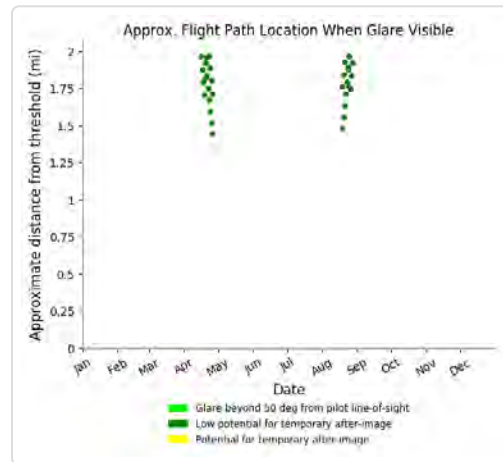
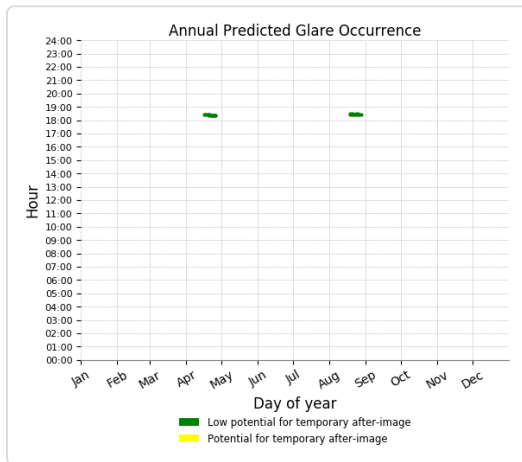
33 minutes of green glare



Flight Path: HNL RWY 22R

0 minutes of yellow glare

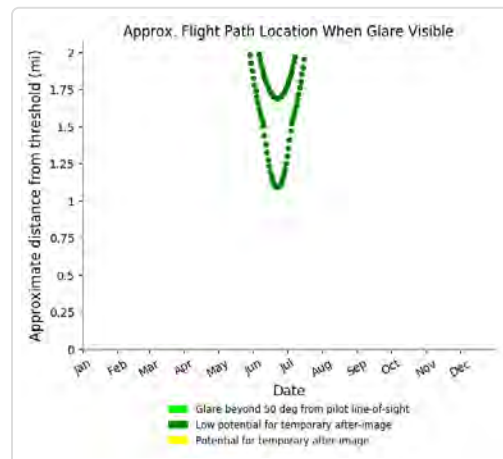
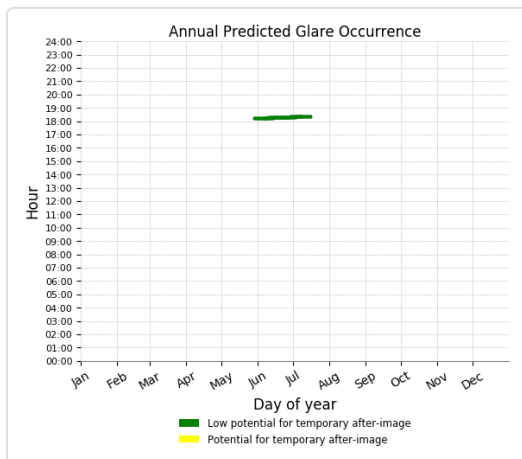
32 minutes of green glare

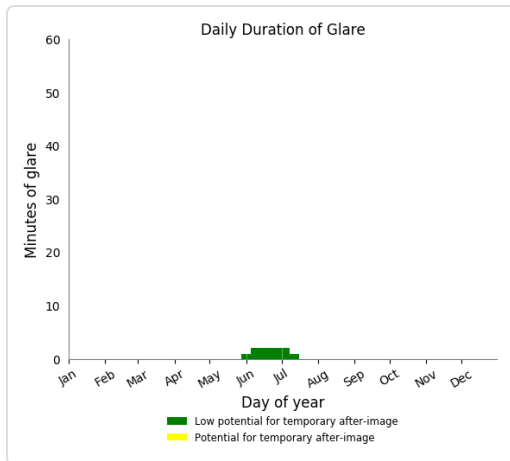


Flight Path: HNL RWY 26L

0 minutes of yellow glare

82 minutes of green glare





Flight Path: JRF RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: JRF RWY 29

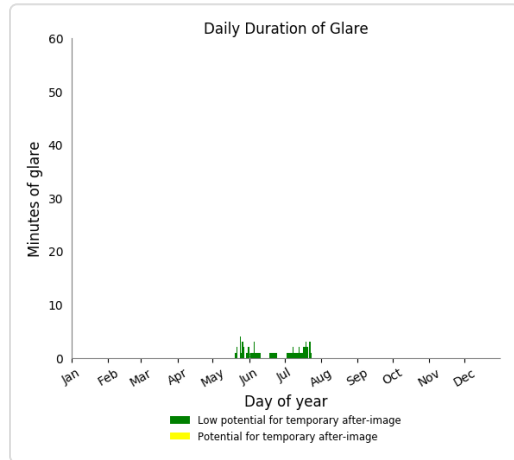
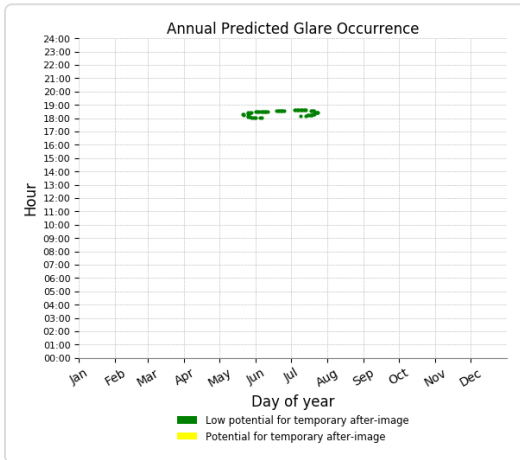
0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 1-ATCT

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare
65 minutes of green glare



Results for: PV Area 2-3

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	72	0
HNL RWY 22R	75	0
HNL RWY 26L	224	0
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	46	0

Flight Path: HHI RWY 24

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04R

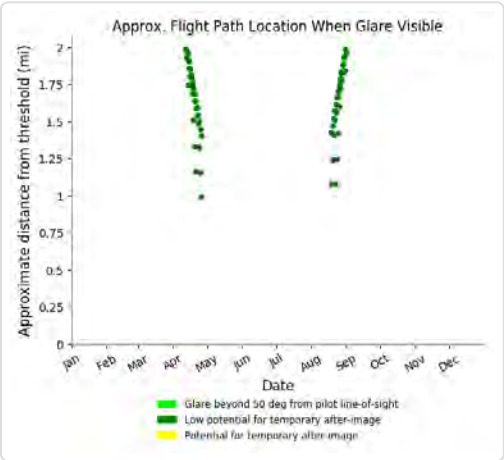
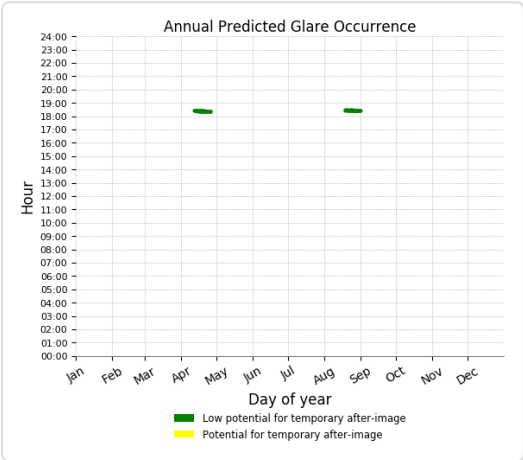
0 minutes of yellow glare
0 minutes of green glare

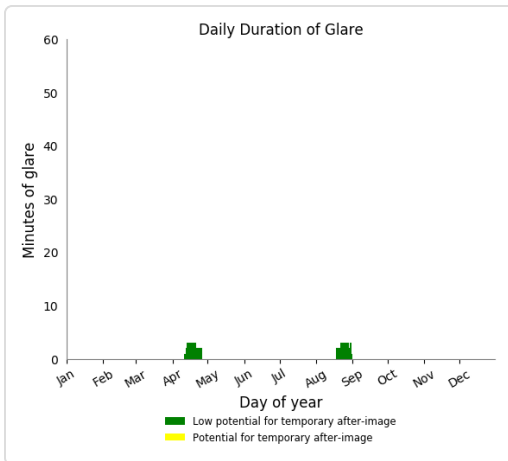
Flight Path: HNL RWY 08R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare
72 minutes of green glare

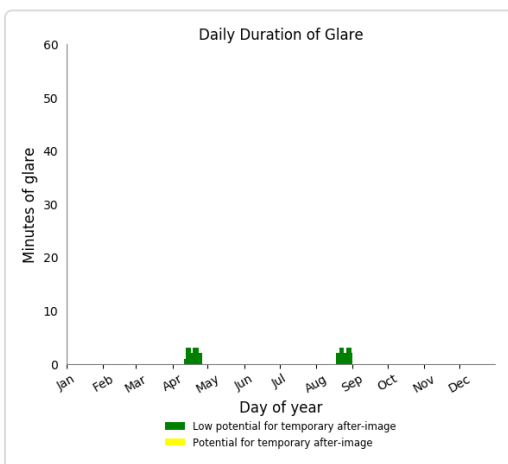
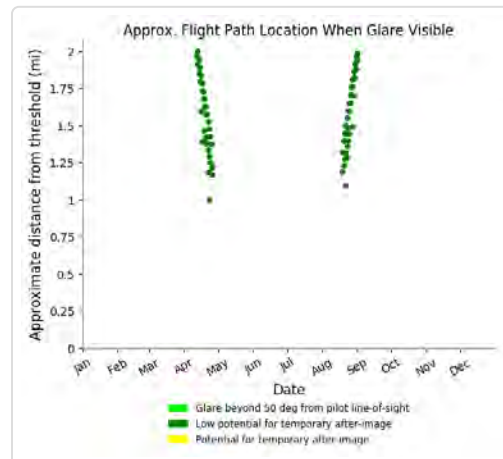
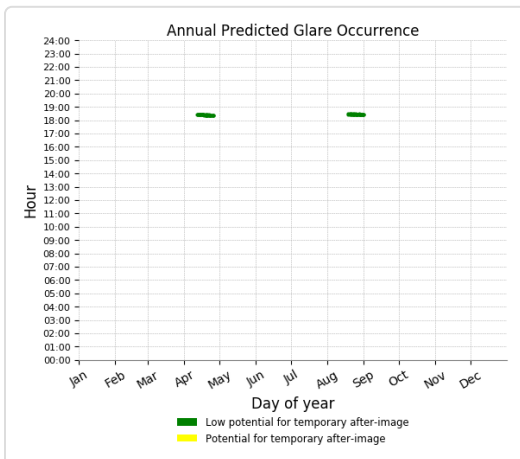




Flight Path: HNL RWY 22R

0 minutes of yellow glare

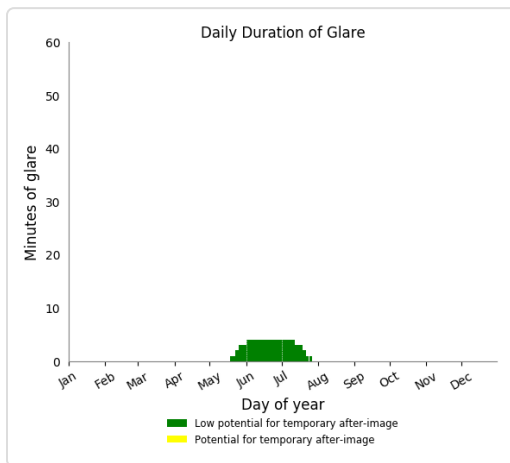
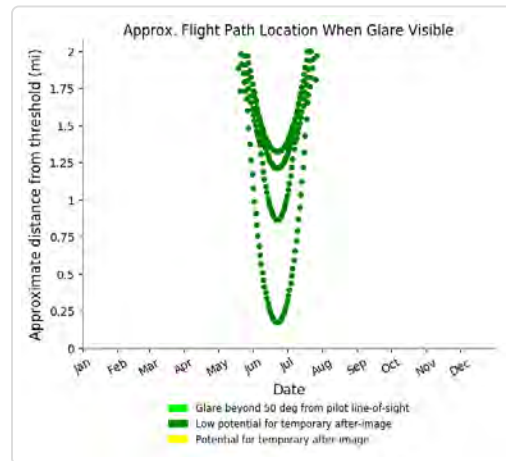
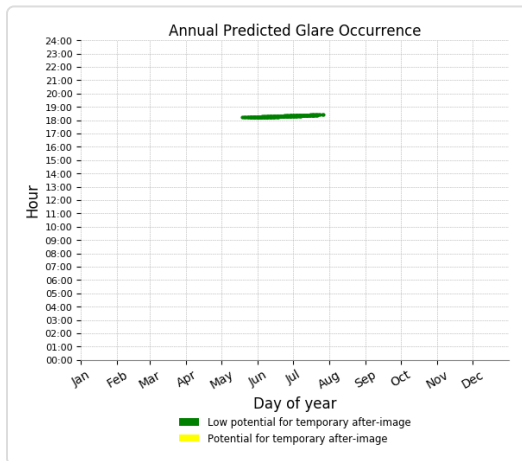
75 minutes of green glare



Flight Path: HNL RWY 26L

0 minutes of yellow glare

224 minutes of green glare



Flight Path: JRF RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 29

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 1-ATCT

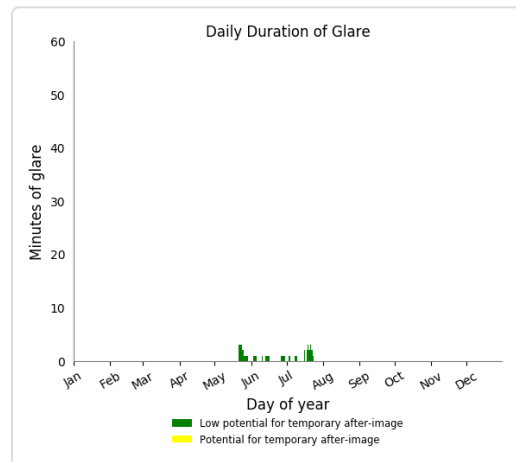
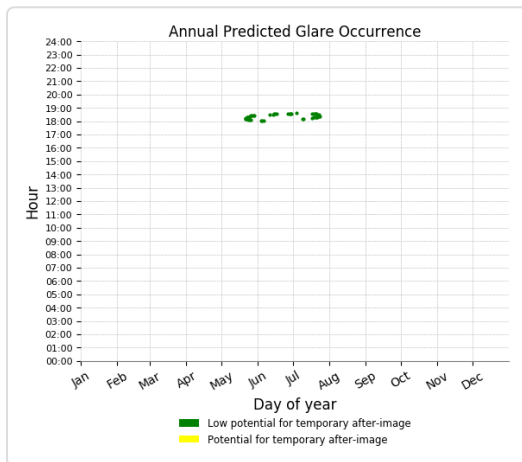
0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare

46 minutes of green glare



Results for: PV Area 3-1

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	132	0
HNL RWY 22R	133	0
HNL RWY 26L	292	0

Receptor	Green Glare (min)	Yellow Glare (min)
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	103	0

Flight Path: HHI RWY 24

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 04R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 08R

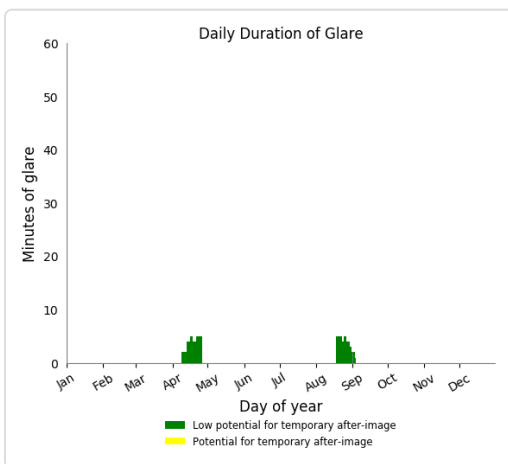
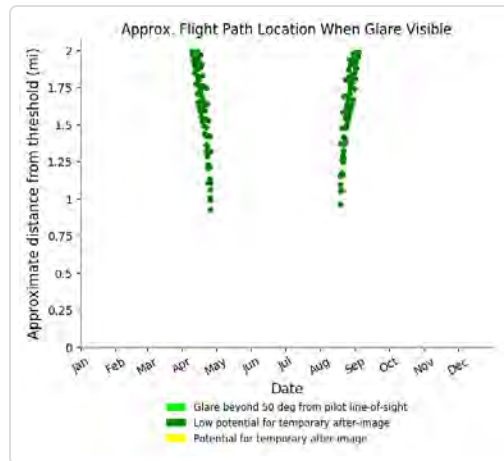
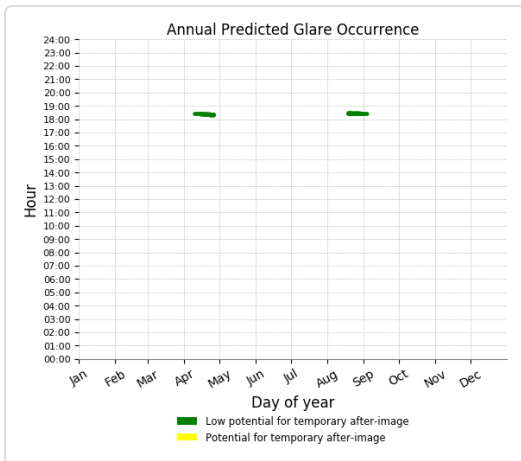
0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare

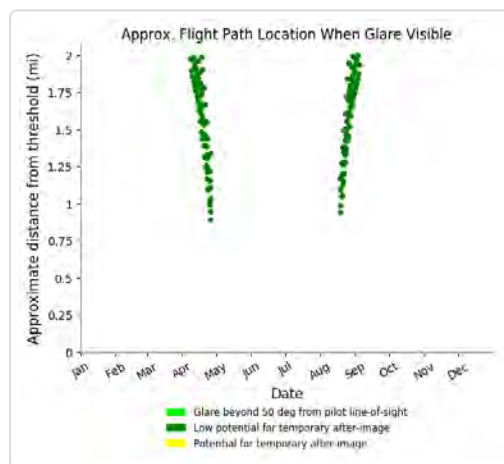
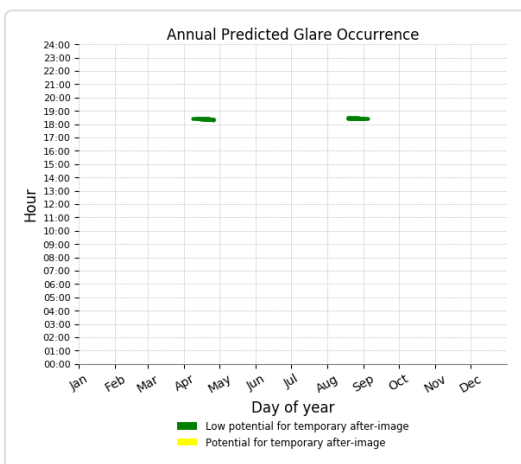
132 minutes of green glare

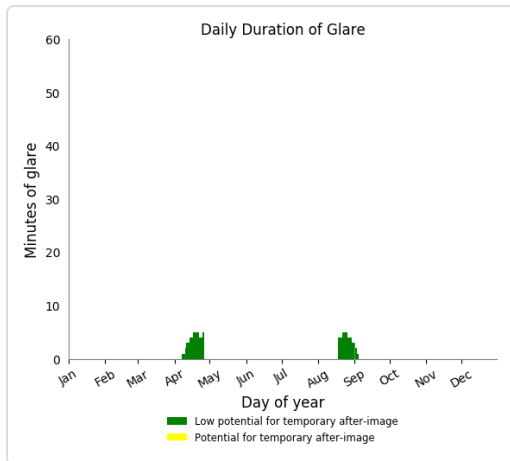


Flight Path: HNL RWY 22R

0 minutes of yellow glare

133 minutes of green glare

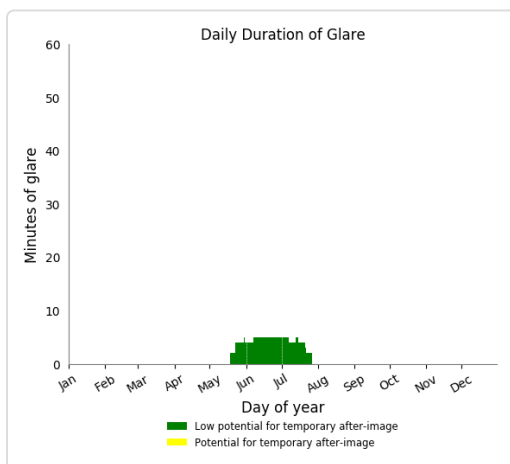
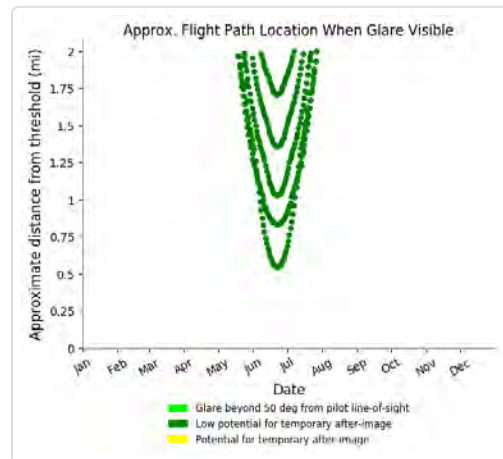
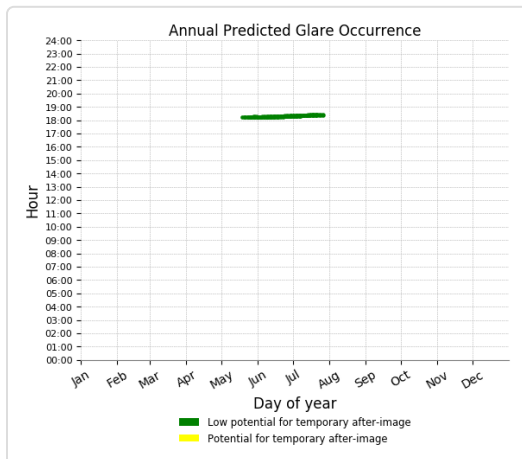




Flight Path: HNL RWY 26L

0 minutes of yellow glare

292 minutes of green glare



Flight Path: JRF RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 29

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 1-ATCT

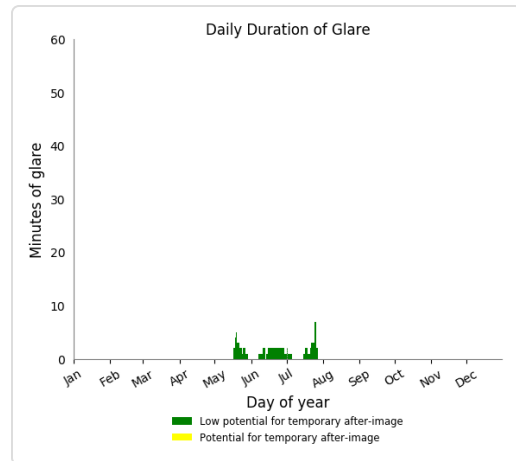
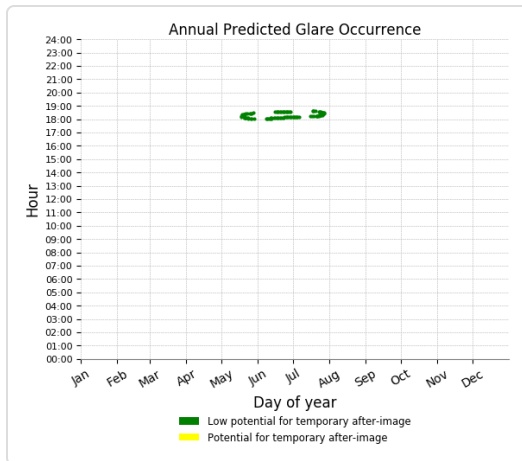
0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare

103 minutes of green glare



Results for: PV Area 3-2

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	80	0
HNL RWY 22R	81	0
HNL RWY 26L	193	0
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	97	0

Flight Path: HHI RWY 24

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 04R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 08R

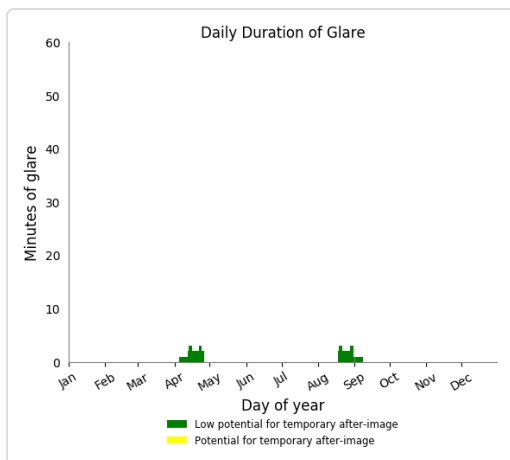
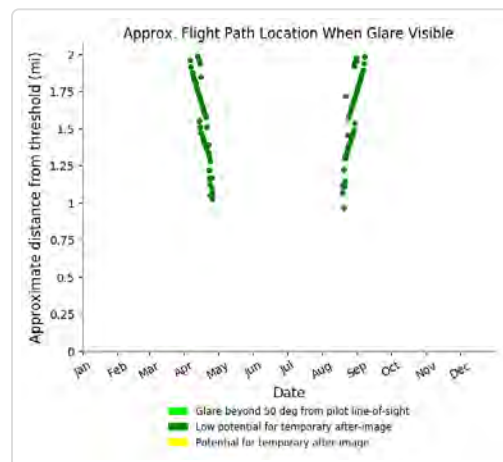
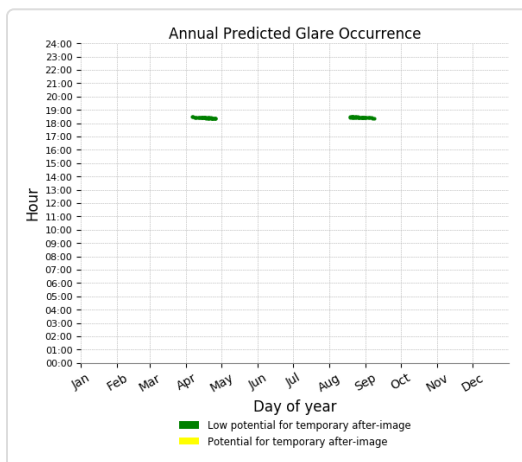
0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare

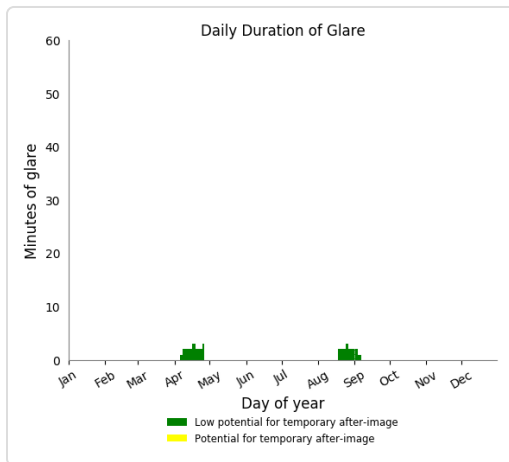
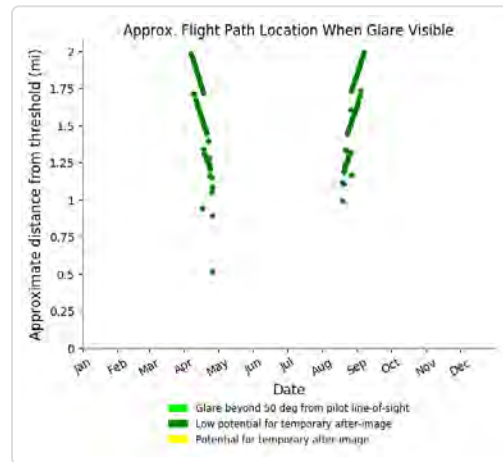
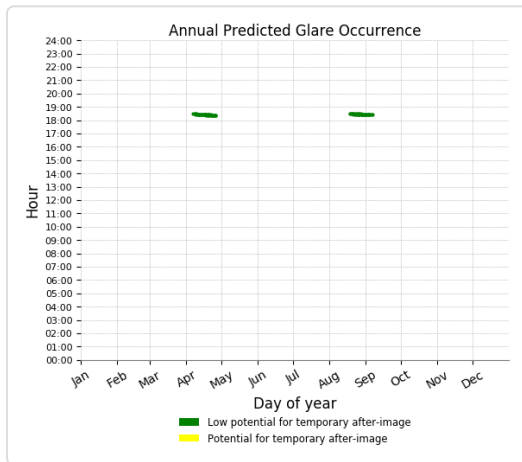
80 minutes of green glare



Flight Path: HNL RWY 22R

0 minutes of yellow glare

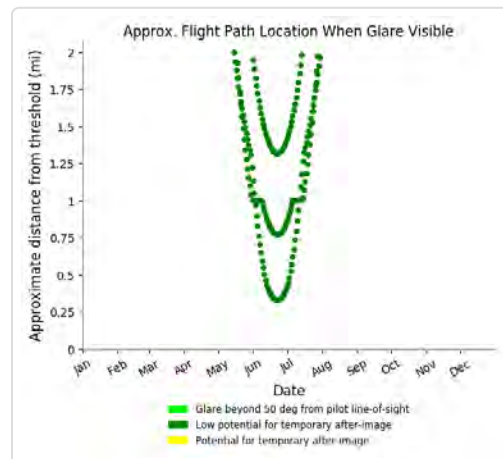
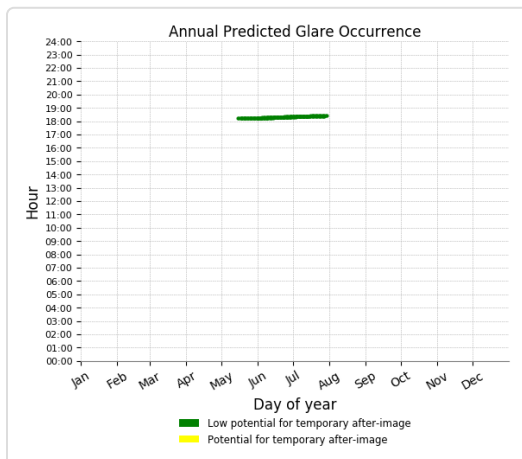
81 minutes of green glare



Flight Path: HNL RWY 26L

0 minutes of yellow glare

193 minutes of green glare

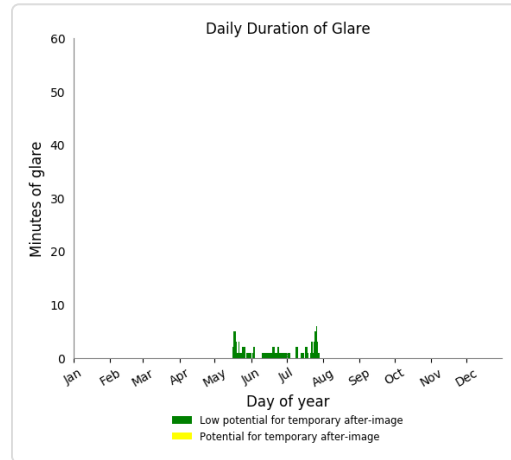
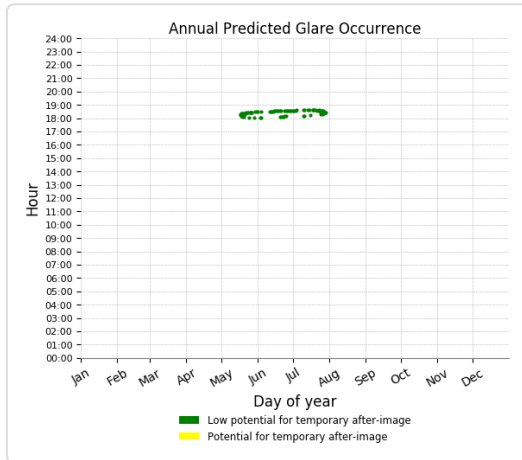


Flight Path: JRF RWY 04L

Point Receptor: 2-ATCT

0 minutes of yellow glare

97 minutes of green glare



Results for: PV Area 3-3

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	108	0
HNL RWY 22R	110	0
HNL RWY 26L	284	0
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	65	0

Flight Path: HHI RWY 24

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04R

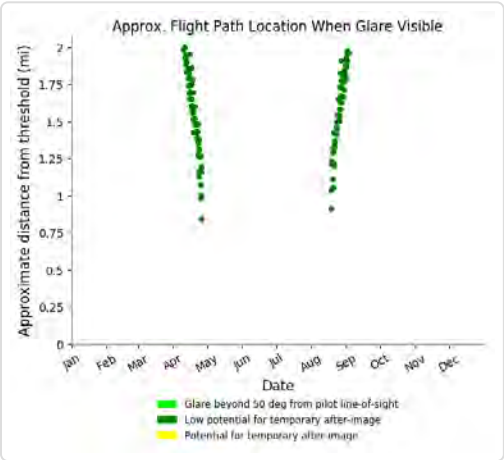
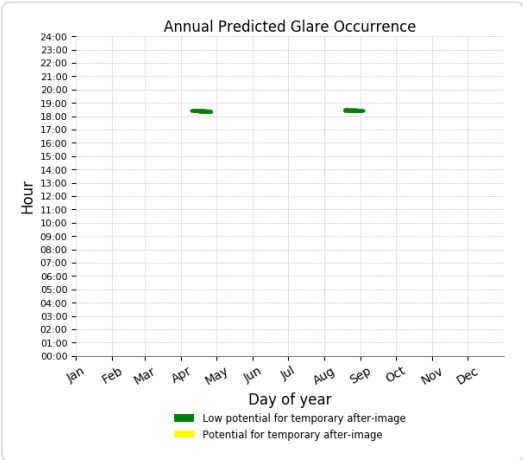
0 minutes of yellow glare
0 minutes of green glare

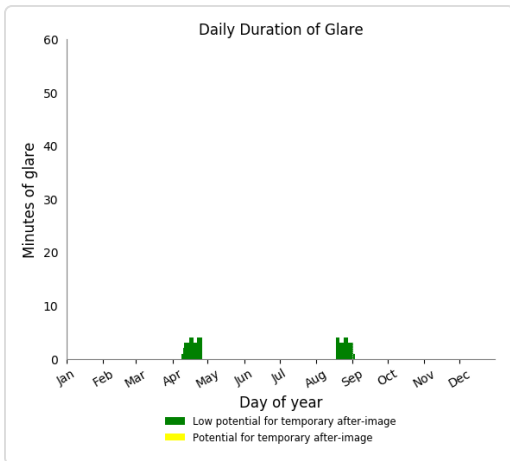
Flight Path: HNL RWY 08R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare
108 minutes of green glare

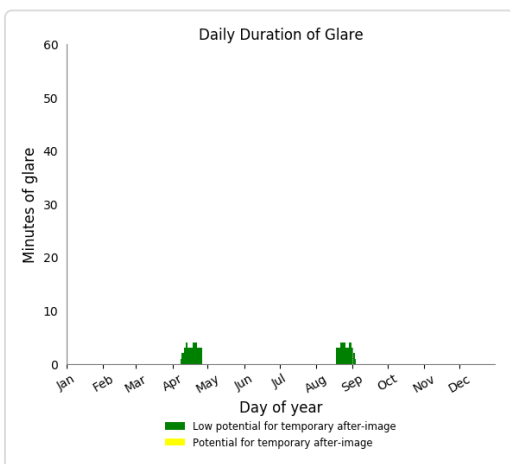
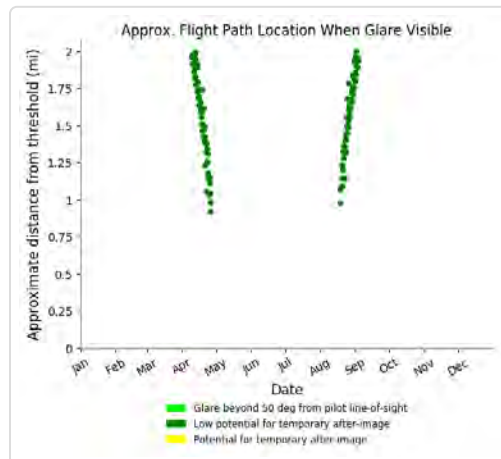
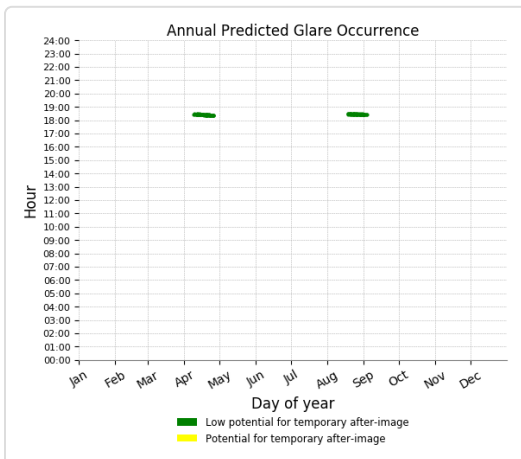




Flight Path: HNL RWY 22R

0 minutes of yellow glare

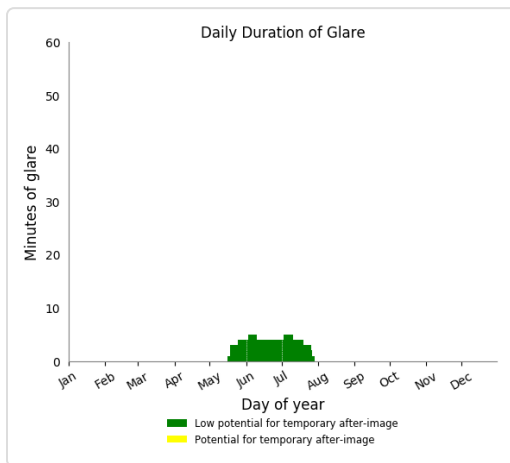
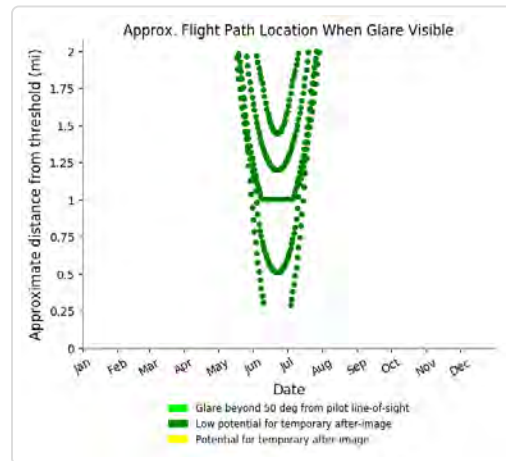
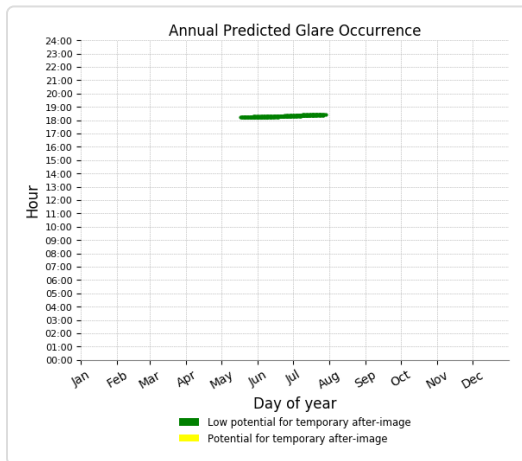
110 minutes of green glare



Flight Path: HNL RWY 26L

0 minutes of yellow glare

284 minutes of green glare



Flight Path: JRF RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 29

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 1-ATCT

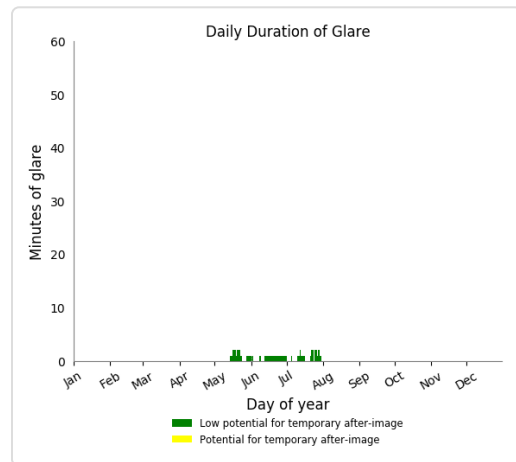
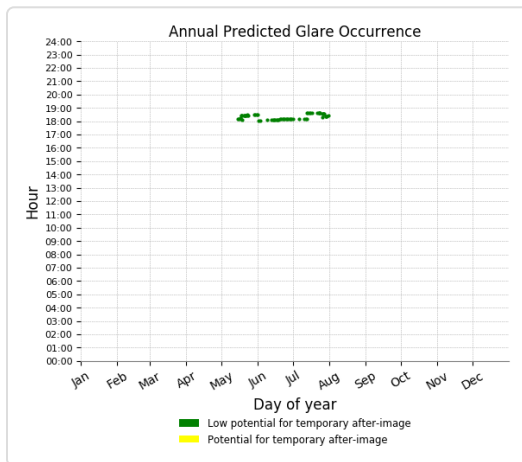
0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare

65 minutes of green glare



Results for: PV Area 3-4

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	142	0
HNL RWY 22R	135	0
HNL RWY 26L	266	0

Receptor	Green Glare (min)	Yellow Glare (min)
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	80	0

Flight Path: HHI RWY 24

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 04R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 08R

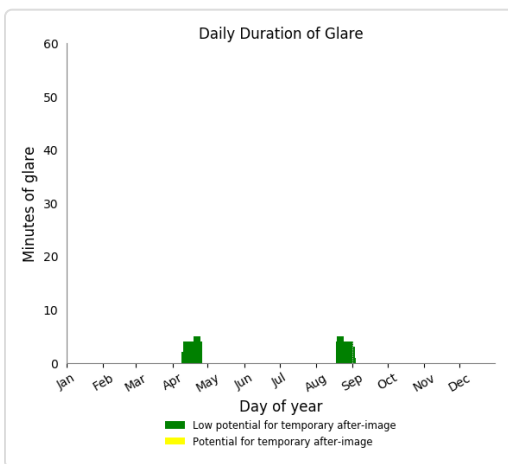
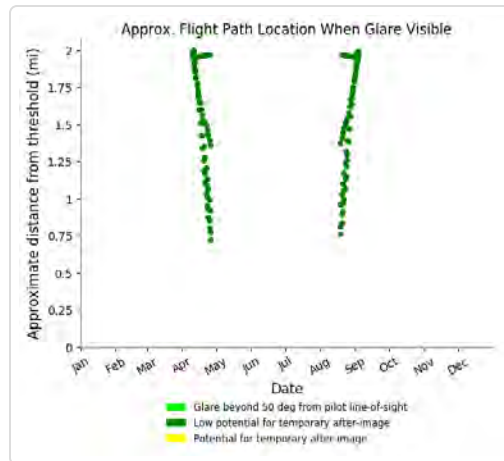
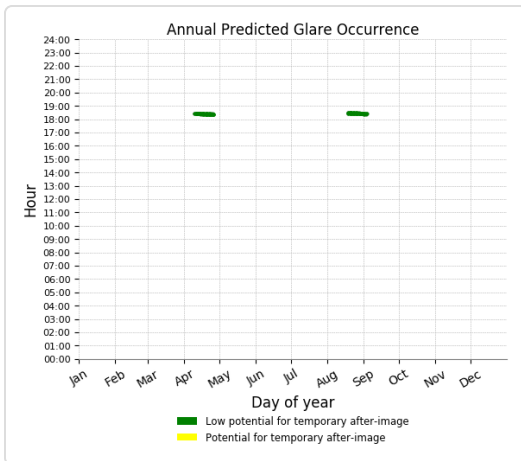
0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 22L

0 minutes of yellow glare

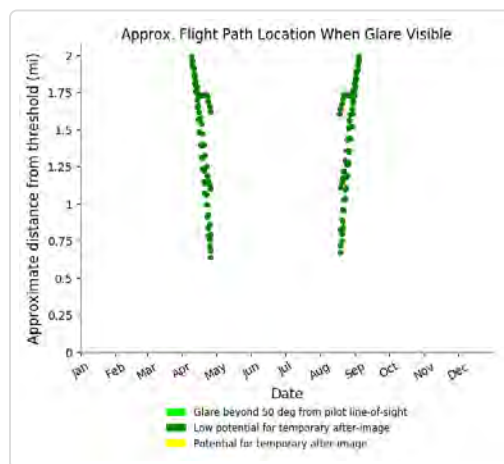
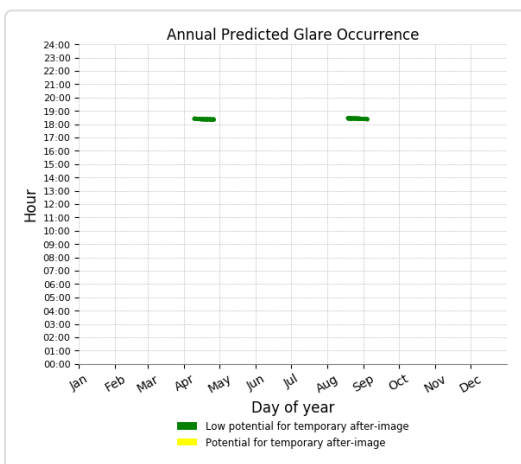
142 minutes of green glare

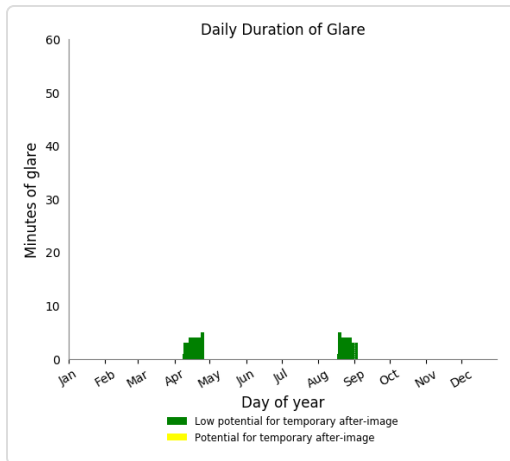


Flight Path: HNL RWY 22R

0 minutes of yellow glare

135 minutes of green glare

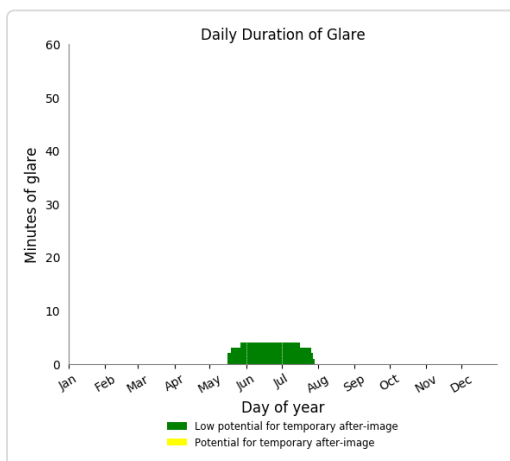
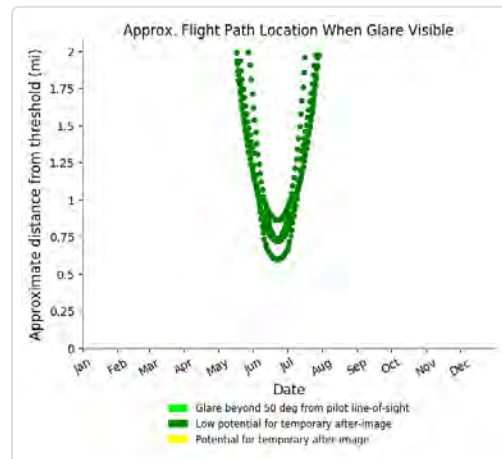
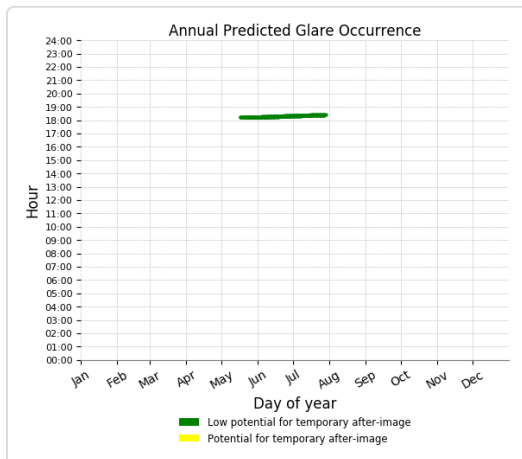




Flight Path: HNL RWY 26L

0 minutes of yellow glare

266 minutes of green glare



Flight Path: JRF RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 29

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 1-ATCT

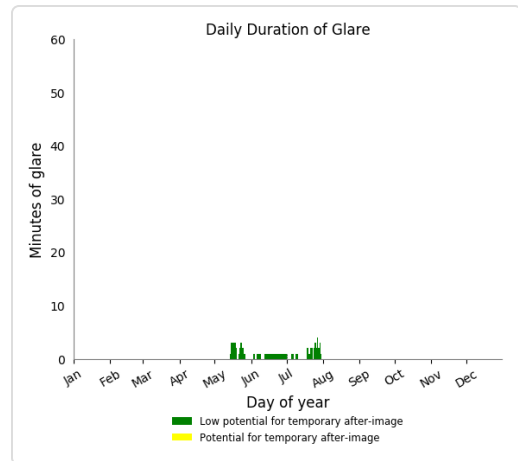
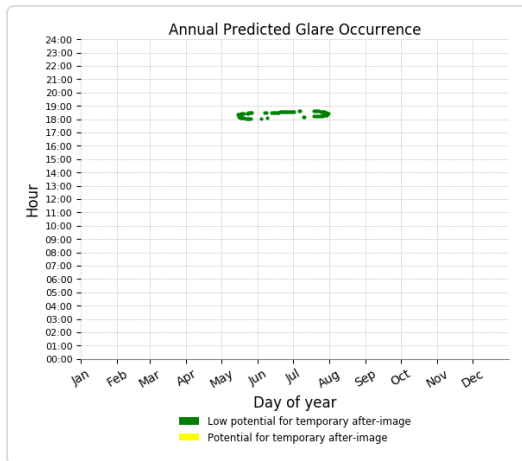
0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare

80 minutes of green glare



Results for: PV Area 4

Receptor	Green Glare (min)	Yellow Glare (min)
HHI RWY 24	0	0
HHI RWY 6	0	0
HNL RWY 04L	0	0
HNL RWY 04R	0	0
HNL RWY 08R	0	0
HNL RWY 22L	156	0
HNL RWY 22R	159	0
HNL RWY 26L	311	0
JRF RWY 04L	0	0
JRF RWY 04R	0	0
JRF RWY 11	0	0
JRF RWY 22L	0	0
JRF RWY 22R	0	0
JRF RWY 29	0	0
1-ATCT	0	0
2-ATCT	187	0

Flight Path: HHI RWY 24

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HHI RWY 6

0 minutes of yellow glare

0 minutes of green glare

Flight Path: HNL RWY 04L

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 04R

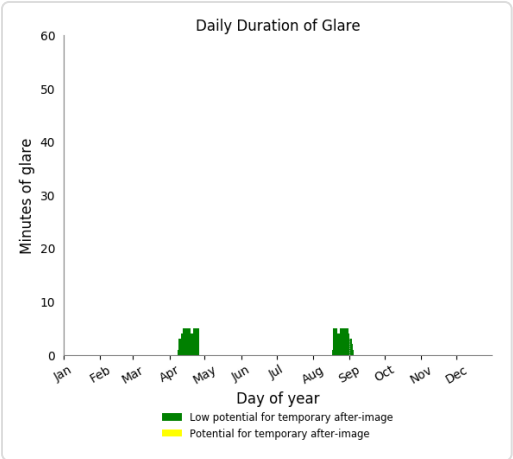
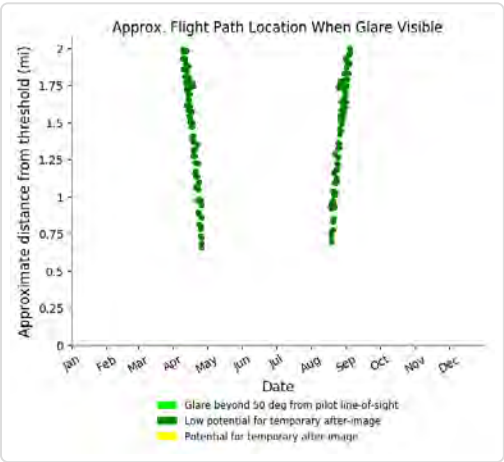
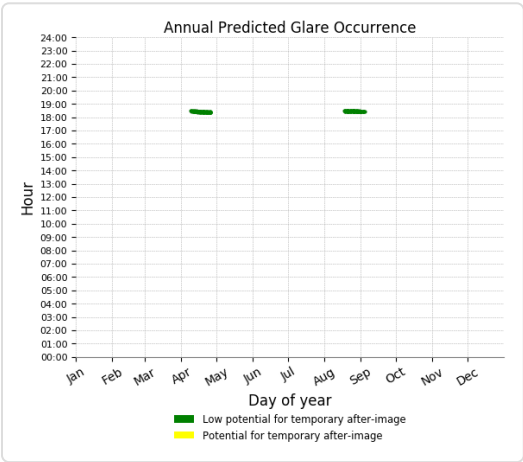
0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 08R

0 minutes of yellow glare
0 minutes of green glare

Flight Path: HNL RWY 22L

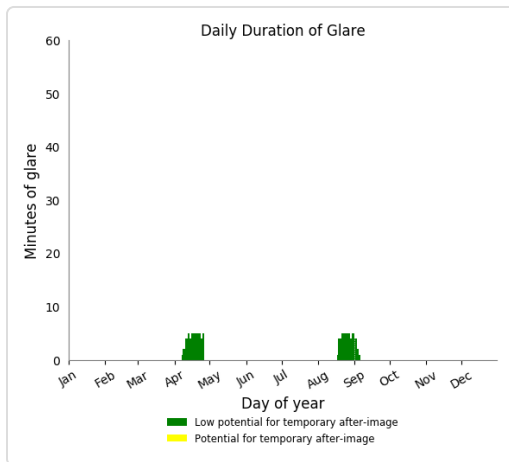
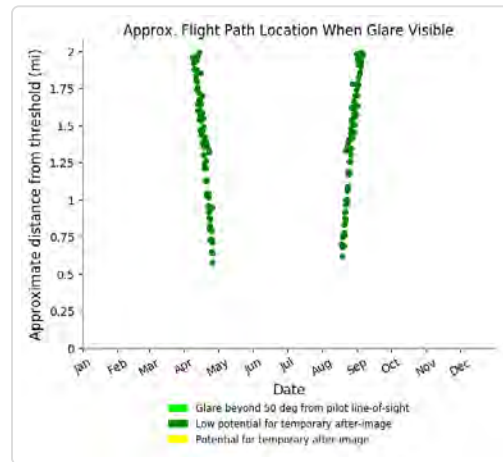
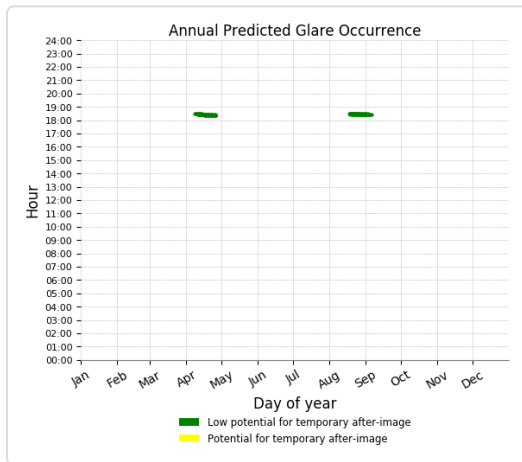
0 minutes of yellow glare
156 minutes of green glare



Flight Path: HNL RWY 22R

0 minutes of yellow glare

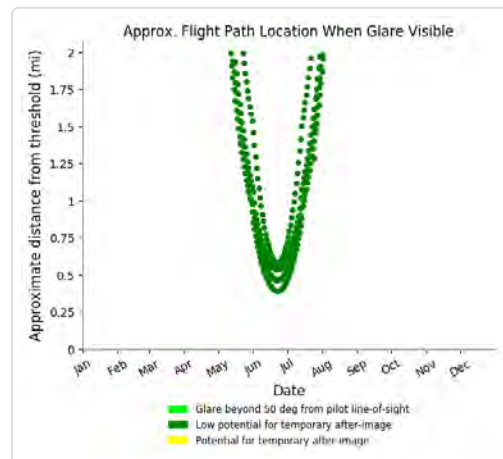
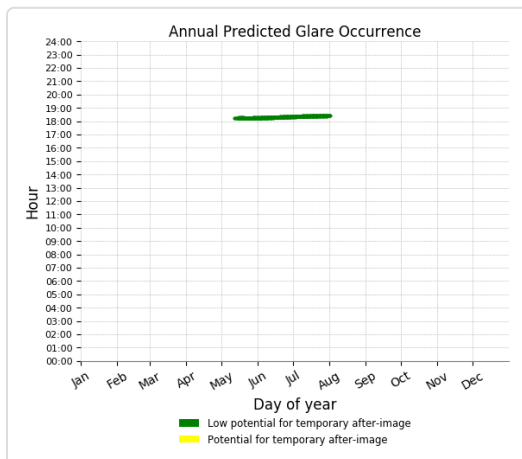
159 minutes of green glare

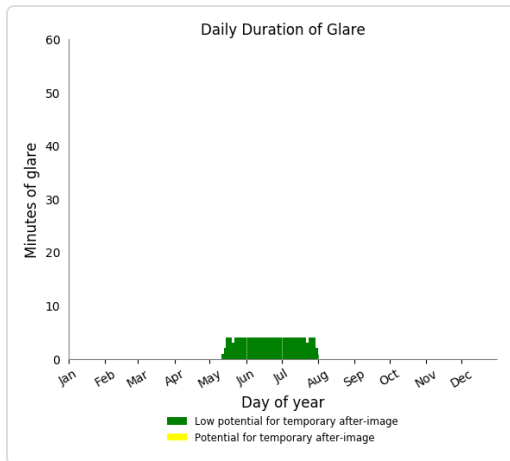


Flight Path: HNL RWY 26L

0 minutes of yellow glare

311 minutes of green glare





Flight Path: JRF RWY 04L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 04R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 11

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22L

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 22R

0 minutes of yellow glare

0 minutes of green glare

Flight Path: JRF RWY 29

0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 1-ATCT

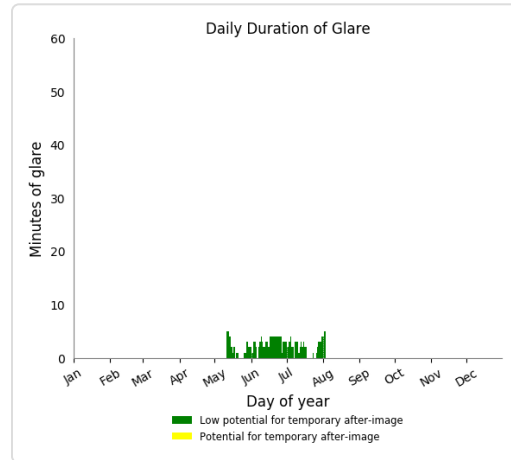
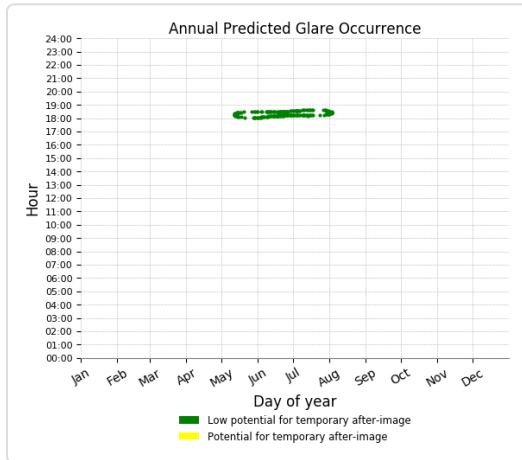
0 minutes of yellow glare

0 minutes of green glare

Point Receptor: 2-ATCT

0 minutes of yellow glare

187 minutes of green glare



Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.

Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.

Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.

Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.

The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)

Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.

Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.

The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.

Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.

Attachment Q
Traffic Impact Analysis Report

AES WEST OAHU SOLAR PLUS STORAGE PROJECT

TRAFFIC IMPACT ANALYSIS REPORT KAPOLEI, OAHU, HAWAII

February 18, 2020

Prepared for:
AES Distributed Energy
282 Century Place, Suite 200
Louisville, CO 80027



Austin, Tsutsumi & Associates, Inc.

Civil Engineers • Surveyors
501 Sumner Street, Suite 521
Honolulu, Hawaii 96817-5031
Telephone: (808) 533-3646
Facsimile: (808) 526-1267
E-mail: atahnl@atahawaii.com
Honolulu • Wailuku • Hilo, Hawaii

AES WEST OAHU SOLAR PLUS STORAGE PROJECT TRAFFIC IMPACT ANALYSIS REPORT

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- B. LEVEL OF SERVICE CRITERIA
- C. LEVEL OF SERVICE CALCULATIONS



TERRANCE S. ARASHIRO, P.E.

ADRIENNE W.L.H. WONG, P.E., LEED AP

DEANNA M.R. HAYASHI, P.E.

PAUL K. ARITA, P.E.

ERIK S. KANESHIRO, L.P.L.S., LEED AP

MATT K. NAKAMOTO, P.E.

GARRETT K. TOKUOKA, P.E.

TRAFFIC IMPACT ANALYSIS REPORT

AES West Oahu Solar Plus Storage Project

Kapolei, Oahu, Hawaii

1. INTRODUCTION

This report documents the findings of a traffic study conducted by Austin, Tsutsumi, and Associates, Inc. (ATA) to evaluate the traffic impacts resulting from the proposed AES West Oahu Solar Plus Storage Project (hereinafter referred to as the “Project”) located in Kapolei, Oahu, Hawaii.

1.1 Project Location

The Project is located in Kapolei on the island of Oahu on parcels of land more specifically identified as TMK: (1) 9-2-002:007. The Project will be located on approximately 80 acres of land within the larger mauka lands parcel owned by the University of Hawaii (UH) West Oahu near Makakilo, mauka (mountain side) of the H-1 freeway (H-1).

See Figure 1.1 for Project Location.

1.2 Project Description

The Project is envisioned to develop a solar and battery storage facility on an approximately 80 acre area within the currently undeveloped UH West Oahu mauka lands parcel. The Project will host a 12.5 megawatt (MW) ground-mounted solar photovoltaic (PV) system, 50 MW-hour battery energy storage system, and related interconnection and ancillary facilities. The site will be accessed from Palehua Road at an existing gated entry located north of the Kualakai Parkway intersection with the H-1 westbound on- and off-ramps. The Project is anticipated to be completed by the end of Year 2021.

See Figure 1.2 for a Preliminary Project Site Plan.

AES WEST OAHU SOLAR PLUS STORAGE PROJECT

NOTE:

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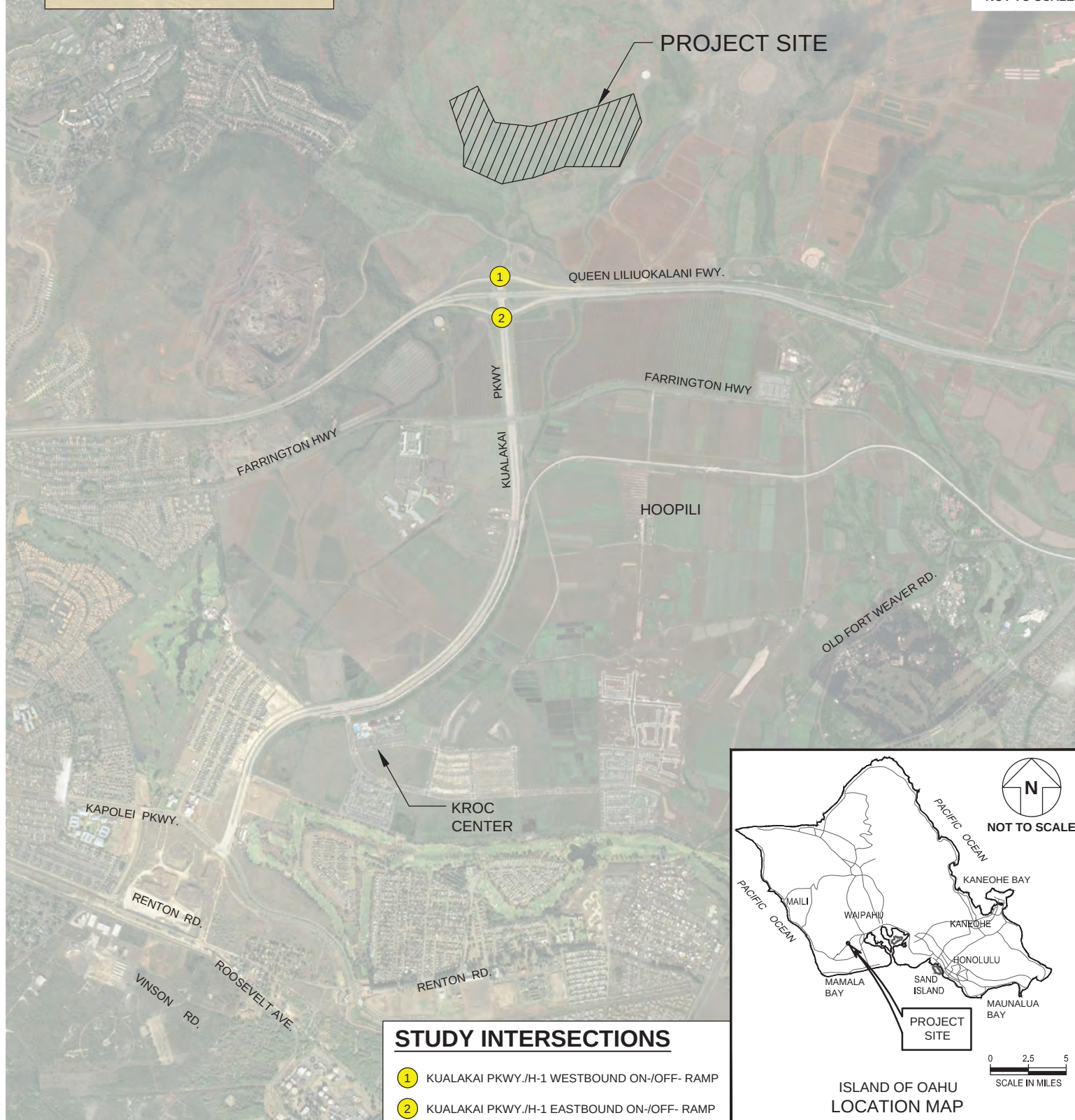


FIGURE 1.1

PROJECT LOCATION

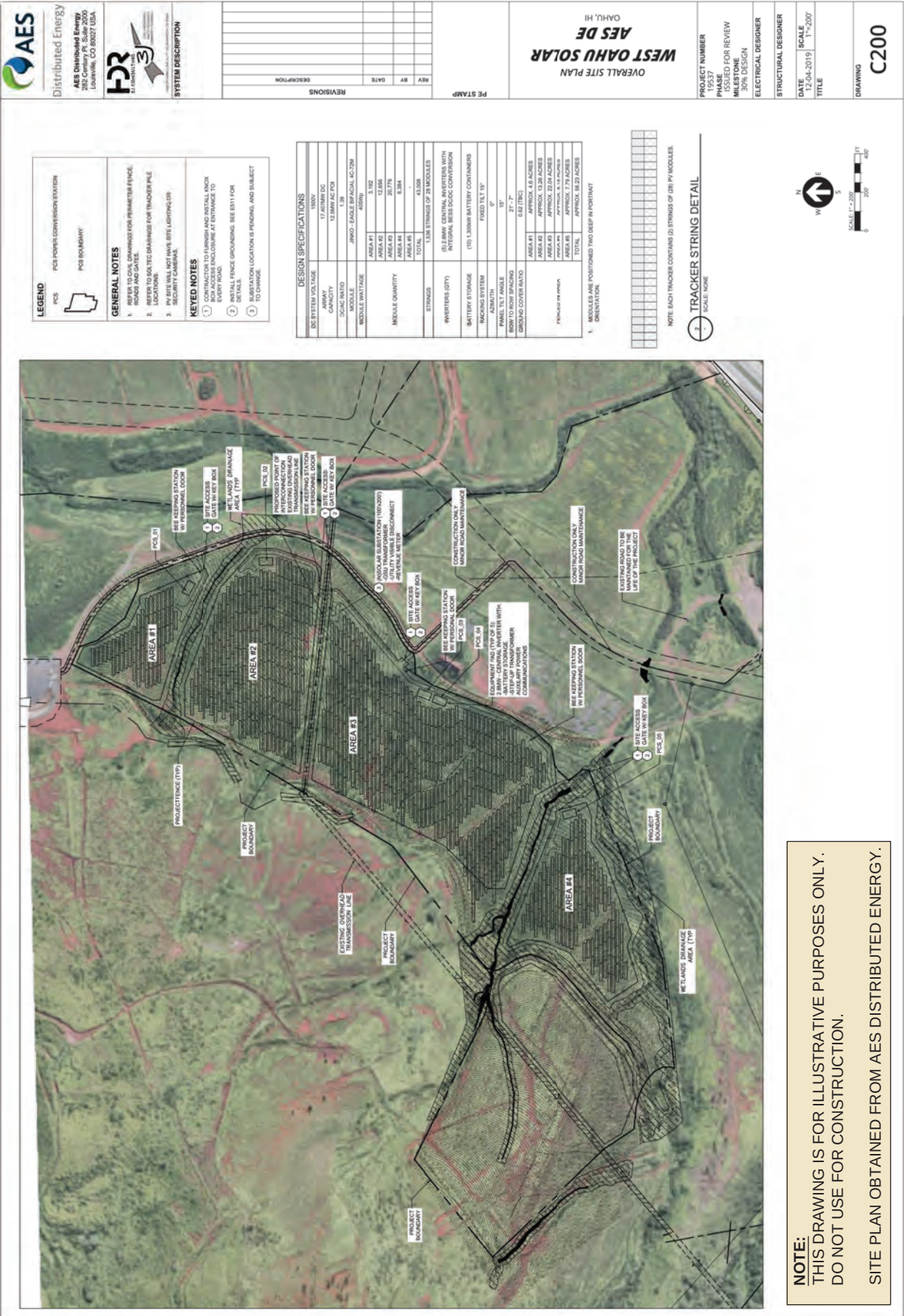


FIGURE 1.2

PRELIMINARY SITE PLAN



2. METHODOLOGY

2.1 Study Methodology

This study will address the following:

- Assess existing traffic operating conditions at key intersections during the weekday morning (AM) and afternoon (PM) peak hours of traffic within the study area.
- Traffic projections for Year 2021 without the Project including traffic generated by other known developments in the vicinity of the Project in addition to an ambient growth rate. These other known developments are projects that are currently under construction or known new/future developments that are anticipated to affect traffic demand and operations within the study area.
- Trip generation and traffic assignment characteristics during and after construction for the proposed Project.
- Traffic projections for Year 2021 during Project construction, which includes Year 2021 without Project traffic volumes in addition to traffic volumes generated during construction.
- Traffic projections for Year 2021 with the Project, which includes Year 2021 without Project traffic volumes in addition to traffic volumes generated by the Project.
- Recommendations as needed to mitigate any impacts resulting from Year 2021 conditions during construction or at Project completion.

2.2 Intersection Analysis

Level of Service (LOS) is a qualitative measure used to describe the conditions of traffic flow at intersections, with values ranging from free-flow conditions at LOS A to congested conditions at LOS F. The Highway Capacity Manual (HCM), 6th Edition, includes methods for calculating volume to capacity ratios, delays, and corresponding Levels of Service that were utilized in this study. LOS definitions for signalized and unsignalized intersections are provided in Appendix B.

Analyses for the study intersections were performed using the traffic analysis software Synchro, which is able to prepare reports based on the methodologies described in the HCM. These reports contain control delay results as based on intersection lane geometry, signal timing, and hourly traffic volumes. Based on the vehicular delay at each intersection, a LOS is assigned to each approach and intersection movement as a qualitative measure of performance. These results, as confirmed or refined by field observations, constitute the technical analysis that will form the basis of the recommendations outlined in this report.

2.3 Study Area Intersection Analysis

Intersection analysis within the Project's study area was performed on the following intersections due to their proximity to the Project:

- Palehua Road/H-1 Freeway Westbound on-/off-ramp (Signalized)
- Kualakai Parkway/H-1 Freeway Eastbound on-/off-ramp (Signalized)



3. EXISTING TRAFFIC CONDITIONS

The existing conditions scenario represents the traffic conditions within the Project area as it currently stands, with no build-out of the Project.

3.1 Roadway System

The following are brief descriptions of the studied roadways within the vicinity of the Project:

Palehua Road is generally a two-way, two-lane, undivided, east-west private roadway that begins at its intersection with the H-1 Westbound on-/off-ramps and terminates to the west as the entrance to Makakilo Quarry. The portion of the roadway nearest the Project Access serves as a haul road for Makakilo Quarry and is used exclusively by local traffic. Currently, there is no posted speed limit.

Kualakai Parkway is generally a two-way, 4-6 lane, divided, north-south State roadway that begins at its intersection with the H-1 Westbound on-/off-ramps and terminates to the south at its intersection with Kapolei Parkway. Kualakai Parkway provides regional access to and from locations such as Hoopili, Ka Makana Alii, and the Kroc Center. The posted speed limit is 35 miles per hour (mph).

H-1 Freeway is generally an east-west, two-way divided freeway which begins to the west in the vicinity of the Palailai Interchange then extends through Kapolei, Ewa, Waipahu, Airport Industrial Area and Central Honolulu before terminating to the east and continuing on as Kalanianaʻole Highway. The H-1 Freeway is approximately 27.1 miles long.

In the vicinity of the Project the H-1 Freeway is a two-way, six lane divided highway which provides three lanes in each direction with a posted speed limit of 60 miles per hour (mph).

3.2 Existing Traffic Volumes

Traffic data utilized in this report was collected on Thursday, October 24, 2019. Traffic count data is provided in Appendix A. Based on the traffic count data, the weekday AM and PM peak hours of traffic were determined to occur between 6:30 AM and 7:30 AM and between 3:45 PM to 4:45 PM, respectively.

3.3 Existing Observations and Intersection Analysis

Traffic along Kualakai Parkway is generally higher in the northbound direction during the AM peak hour and higher in the southbound direction during the PM peak hour largely due to commuter traffic.

Palehua Road & H-1 Freeway Westbound on-/off-ramp – The signalized intersection operates at LOS B or better during both AM and PM peak hours and does not experience significant delays or queuing during either peak period. All individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

Kualakai Parkway & H-1 Freeway Eastbound on-/off-ramp – The signalized intersection operates at overall LOS A and does not experience significant delays or queuing during the AM or PM peak hours. All individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.



No pedestrians were observed during the AM or PM peak hours.

See Figure 3.1 for existing lane configuration, traffic volumes, and LOS for the study intersections. See Table 4.1 for a LOS comparison between Existing Conditions and Year 2021 without Project conditions.

AES WEST OAHU SOLAR PLUS STORAGE PROJECT



NOT TO SCALE

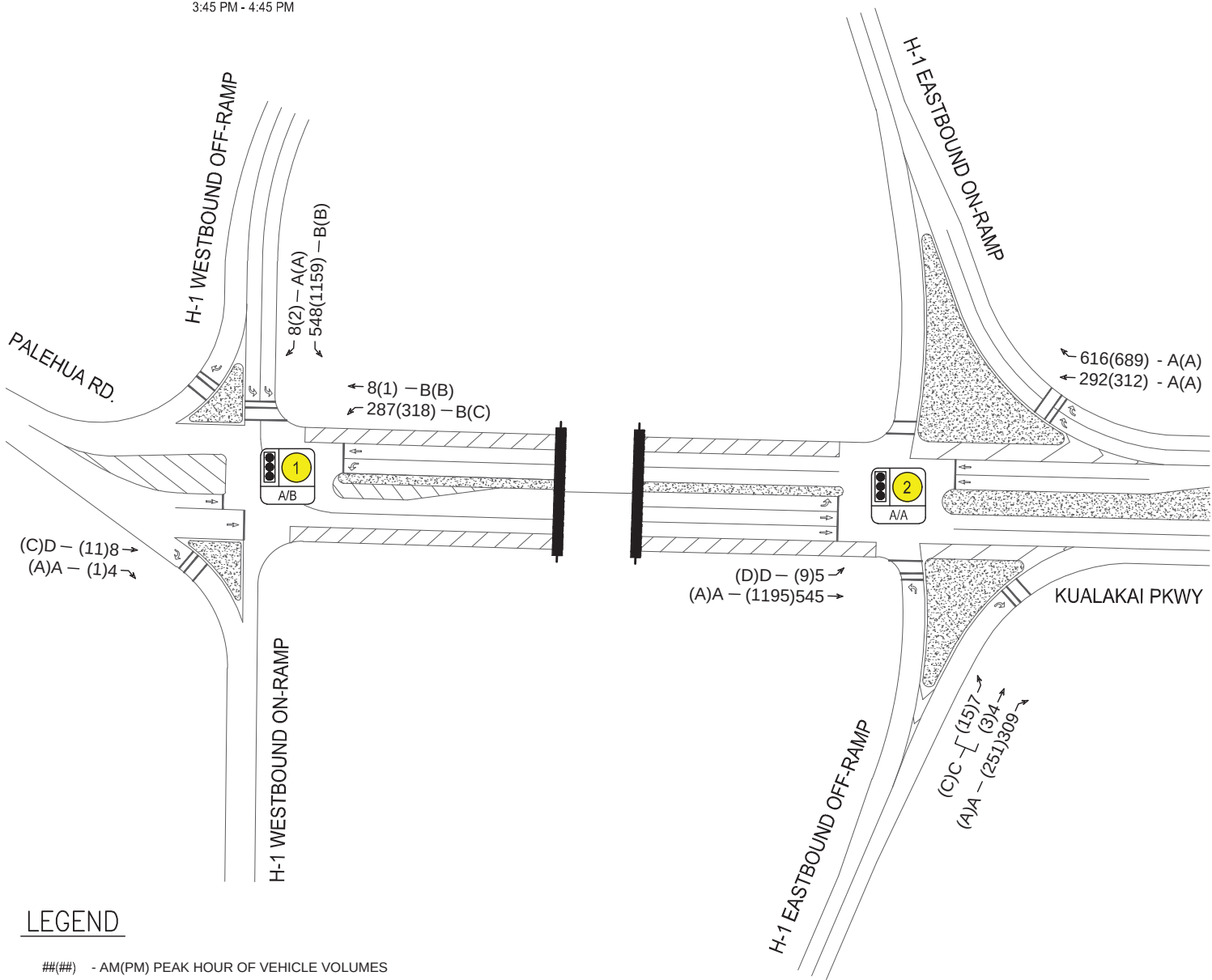
NOTE:

THIS DRAWING IS FOR
ILLUSTRATIVE PURPOSES ONLY.
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DATE OF COUNTS:
OCTOBER 24, 2019

AM PEAK HOUR:
6:30 AM - 7:30 AM

PM PEAK HOUR:
3:45 PM - 4:45 PM



LEGEND

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



SIGNALIZED INTERSECTION Y, OVERALL AM/PM LOS

X(X) - AM(PM) LOS

FIGURE 3.1

EXISTING CONDITIONS, LANE CONFIGURATIONS,
TRAFFIC VOLUMES AND LOS



**TABLE 3.1: LOS SUMMARY TABLE
EXISTING CONDITIONS**

Intersection	Existing Conditions					
	AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1. Kualakai Pkwy./Palehua Rd./H1 WB Ramps						
NB LT	15.8	0.75	B	27.8	0.84	C
NB TH	10.9	0.02	B	17.1	0.00	B
WB LT	12.8	0.65	B	15.8	0.82	B
WB RT	-	-	A	-	-	A
SB TH	30.2	0.41	C	39.9	0.45	D
SB RT	-	-	A	-	-	A
OVERALL	13.9	-	A	18.6	-	B
2. Kualakai Pkwy./H1 EB Ramps						
NB TH	7.9	0.36	A	5.6	0.20	A
NB RT	-	-	A	-	-	A
EB LT/TH	28.8	0.52	C	30.7	0.55	C
EB RT	-	-	A	-	-	A
SB LT	48.4	0.51	D	39.2	0.53	D
SB TH	3.8	0.33	A	3.7	0.56	A
OVERALL	5.8	-	A	4.6	-	A

Directions

NB = Northbound approach

SB = Southbound approach

EB = Eastbound approach

WB = Westbound approach



4. YEAR 2021 TRAFFIC CONDITIONS WITHOUT PROJECT

The Year 2021 was selected to reflect the Project completion year. The Base Year 2021 scenario represents the traffic conditions within the study area without the Project. Traffic projections were formulated by applying a defacto growth rate to the existing 2019 traffic count volumes as well as trips generated by known future developments in the vicinity of the Project.

4.1 Defacto Growth Rate

Projections for Year 2021 traffic were based upon the Hawaii Department of Transportation (HDOT) statewide annual count data and Hoopili TIAR, which was revised in 2014 by ATA. This defacto growth rate takes into account the continued development of the Ewa-Kapolei region, including Hoopili. By the Year 2021, Hoopili is anticipated to have completed Phase 1A and be in the process of finishing Phases 1B and 1C. These phases are anticipated to introduce over 3,000 new housing units including single-family housing, multi-family housing, and apartments, as well as neighborhood businesses, a new elementary school and a new high school.

- Kualakai Parkway – From 2014-2019 the annual growth rate was found to be 8% from the HDOT annual count data. This increase was likely due to the completion of Ka Makana Alii (2016), continued expansion of the University of Hawaii West Oahu, as well as other developments in the area. Traffic is anticipated to continue to grow at this rate as Hoopili and other developments are constructed.
- H-1 Eastbound & Westbound Freeway on-/off-ramps – Assumed the same annual growth rate of 8% as Kualakai Parkway during AM(PM) peak hours since all traffic going to and from the on-/off-ramps utilize Kualakai Parkway.

4.2 Planned Roadway Improvements

By Year 2021 without the Project, no major roadway improvements are planned to be constructed in the area. The following roadway improvements have been identified in the ORTP as future roadway improvements that may be constructed beyond Year 2021 and were therefore, not included in this TIAR.

Makakilo Drive Extension – In the vicinity of Palehua Road, Makakilo Drive is to be extended south to the Kualakai Interchange as a four-lane roadway, connecting Makakilo Drive to Kualakai Parkway between 2019-2029. At the time of this report, no information regarding the completion date of the Makakilo Drive Extension was available and was therefore not assumed to be completed prior to the Project.

Kualakai Parkway Extension – Kualakai Parkway is anticipated to be extended from Kapolei Parkway to Franklin D Roosevelt Avenue.

4.3 Year 2021 Analysis without Project

Palehua Road & H-1 Freeway Westbound on-/off-ramp – With the projection of the 8% annual growth rate from 2019 to 2021, the signalized intersection is anticipated to operate at an overall LOS B(C) during AM(PM) peak hours of traffic, respectively. Degradation of LOS from existing conditions can be attributed to background traffic growth in the region as a result of continued



development of West Oahu. However, all movements at the intersection are expected to continue operating at LOS D or better during the AM and PM peak hours of traffic.

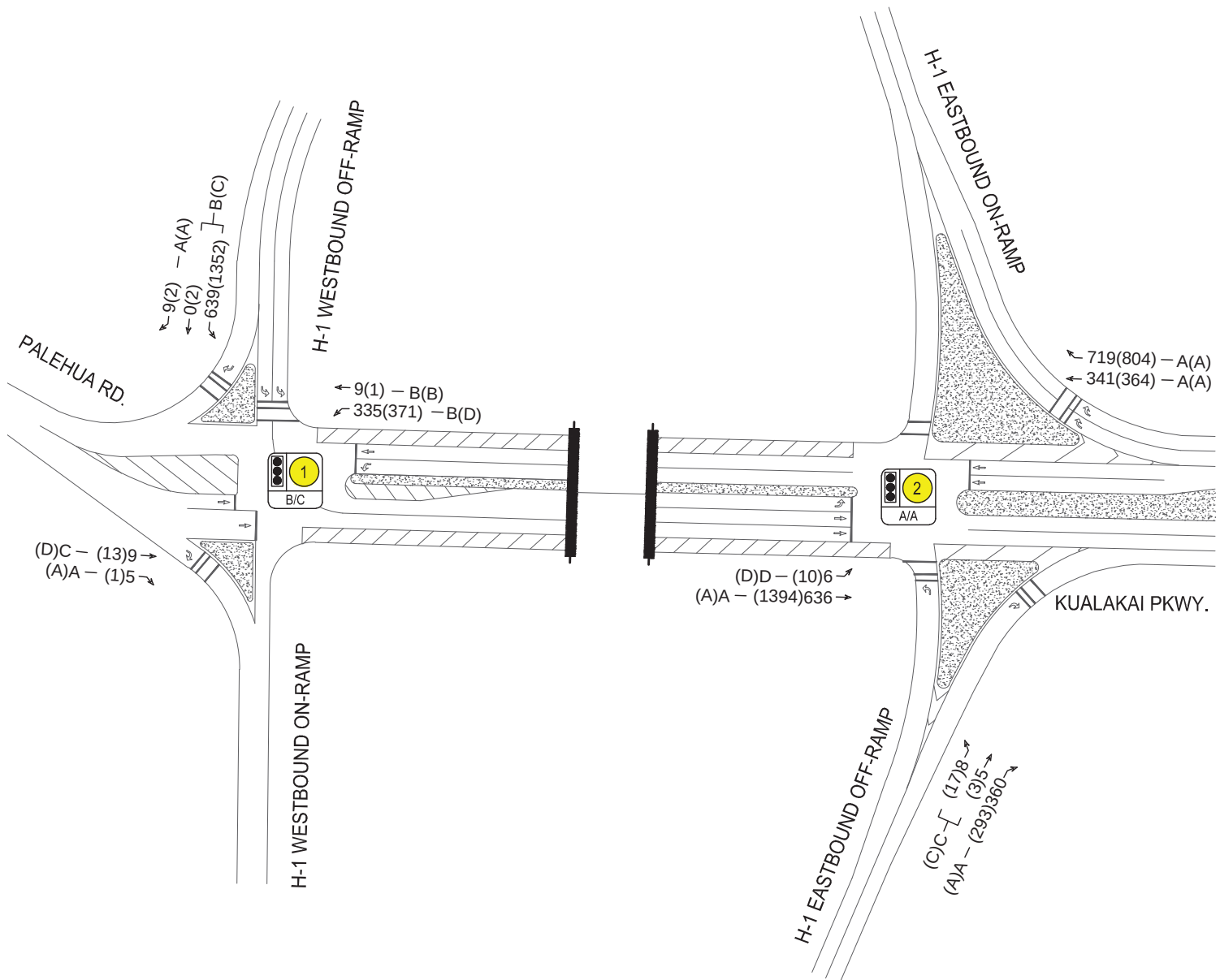
Kualakai Parkway & H-1 Freeway Eastbound on-/off-ramp – The signalized intersection is anticipated to continue operating at overall LOS A during the AM and PM peak hours. In addition, all individual movement LOS are expected to remain the same as existing LOS with all approaches operating at LOS D or better during both AM and PM peak hours of traffic.

See Figure 4.1 for base year lane configuration, traffic volumes, and LOS for the study intersections. See Table 4.1 for a LOS comparison between Existing Conditions and Year 2021 without Project conditions.

AES WEST OAHU SOLAR PLUS STORAGE PROJECT



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LEGEND

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



X(X) - AM(PM) LOS

FIGURE 4.1

YEAR 2021 WITHOUT PROJECT, LANE
CONFIGURATIONS, TRAFFIC VOLUMES AND LOS



TABLE 4.1: LOS SUMMARY TABLE
EXISTING CONDITIONS VS YEAR 2021 WITHOUT PROJECT CONDITIONS

Intersection	Existing Conditions						Year 2021 without Project					
	AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1. Kualakai Pkwy./Palehua Rd./H1 WB Ramps												
NB LT	15.8	0.75	B	27.8	0.84	C	17.0	0.78	B	42.3	0.90	D
NB TH	10.9	0.02	B	17.1	0.00	B	11.3	0.02	B	19.6	0.00	B
WB LT	12.8	0.65	B	15.8	0.82	B	13.9	0.70	B	22.6	0.90	C
WB RT	-	-	A	-	-	A	-	-	A	-	-	A
SB TH	30.2	0.41	C	39.9	0.45	D	32.0	0.43	C	45.9	0.48	D
SB RT	-	-	A	-	-	A	-	-	A	-	-	A
OVERALL	13.9	-	A	18.6	-	B	15.1	-	B	27.0	-	C
2. Kualakai Pkwy./H1 EB Ramps												
NB TH	7.9	0.36	A	5.6	0.20	A	7.8	0.38	A	4.9	0.20	A
NB RT	-	-	A	-	-	A	-	-	A	-	-	A
EB LT/TH	28.8	0.52	C	30.7	0.55	C	27.3	0.52	C	34.1	0.57	C
EB RT	-	-	A	-	-	A	-	-	A	-	-	A
SB LT	48.4	0.51	D	39.2	0.53	D	40.0	0.52	D	41.8	0.54	D
SB TH	3.8	0.33	A	3.7	0.56	A	3.9	0.38	A	3.6	0.61	A
OVERALL	5.8	-	A	4.6	-	A	5.7	-	A	4.4	-	A

Directions

NB = Northbound approach

SB = Southbound approach

EB = Eastbound approach

WB = Westbound approach



5. YEAR 2021 TRAFFIC CONDITIONS WITH PROJECT

The Year 2021 with project scenario represents the traffic conditions within the Project study area with the full build-out of the Project.

5.1 Background

The Project is envisioned to be a solar and battery storage facility on approximately 80 acres of land. The Project will consist of a 12.5 MW ground-mounted solar PV system with a 50 MW-hour battery energy storage system. The Project is planning to begin construction in late 2020 and complete construction by the end of 2021.

5.2 Trip Distribution

Trips generated during construction or by the Project were assigned throughout the study area generally based upon existing and projected Base Year 2021 travel patterns. The traffic generated by the Project was added to the forecast Base Year 2021 traffic volumes within the vicinity of the Project to constitute the traffic volumes for the Future Year 2021 traffic conditions.

5.3 Year 2021 During Project Construction Conditions

5.3.1 Trip Generation

Information provided by the Client indicates that during construction daily workers on site will range from 10 to 160 workers with an average of 55 daily workers throughout the anticipated 1-year construction schedule.

During construction, an estimated 500 tractor trailer loads (mixture of flat bed and enclosed) will make deliveries to the Project site over the course of the 1-year construction schedule. In addition to the typical tractor trailer loads, a single heavy and wide load delivery will need to be made to the Project site. Due to the size of trailer required as well as its impact to typical traffic patterns, it is assumed that this special transport will be done outside of daily peak hours of traffic and will have no effect on commuter traffic.

Due to the nature of trailer deliveries and its dependence on construction progression and manpower, a worst-case scenario was assumed for the purposes of this study. It is assumed that a maximum of 40 tractor trailers, 20 during both the AM and PM peak hours of traffic, will arrive, unload and depart the project site.

See Table 5.1 below for a summary of construction trip generation and Figure 5.1 for the assignment of construction-generated traffic.



Table 5.1: Construction Trip Generation

	Weekday AM Peak Hour		Weekday PM Peak Hour	
	Enter	Exit	Enter	Exit
Construction Workers	55	0	0	55
Tractor Trailers	20	20	20	20
Total	75	20	20	75

5.3.2 Year 2021 During Project Construction Analysis

Palehua Road & H-1 Freeway Westbound on-/off-ramp – Under worst-case assumptions as stated above, the intersection is expected to continue operating at LOS B(C) during the AM(PM) peak hours, respectively. In addition, all individual movements are expected to continue operating at LOS D or better.

Kualakai Parkway & H-1 Freeway Eastbound on-/off-ramp – The signalized intersection is anticipated to continue operating at overall LOS A during the AM and PM peak hours. In addition, all individual movement LOS are expected to remain the same as existing LOS with all approaches operating at LOS D or better during both AM and PM peak hours of traffic.

The Project site is approximately 80 acres with access off of Palehua Road (private). Due to the ample size of the property as well as the long driveway between Palehua Road and the Project site, it is not expected that any vehicle queues will spill back to the H-1 Westbound intersection and adversely affect traffic operations.

See Figure 5.2 for construction conditions lane configuration, traffic volumes, and LOS for the study intersections. See Table 5.2 for a LOS comparison between Year 2021 without Project conditions and Year 2021 During Project Construction conditions.

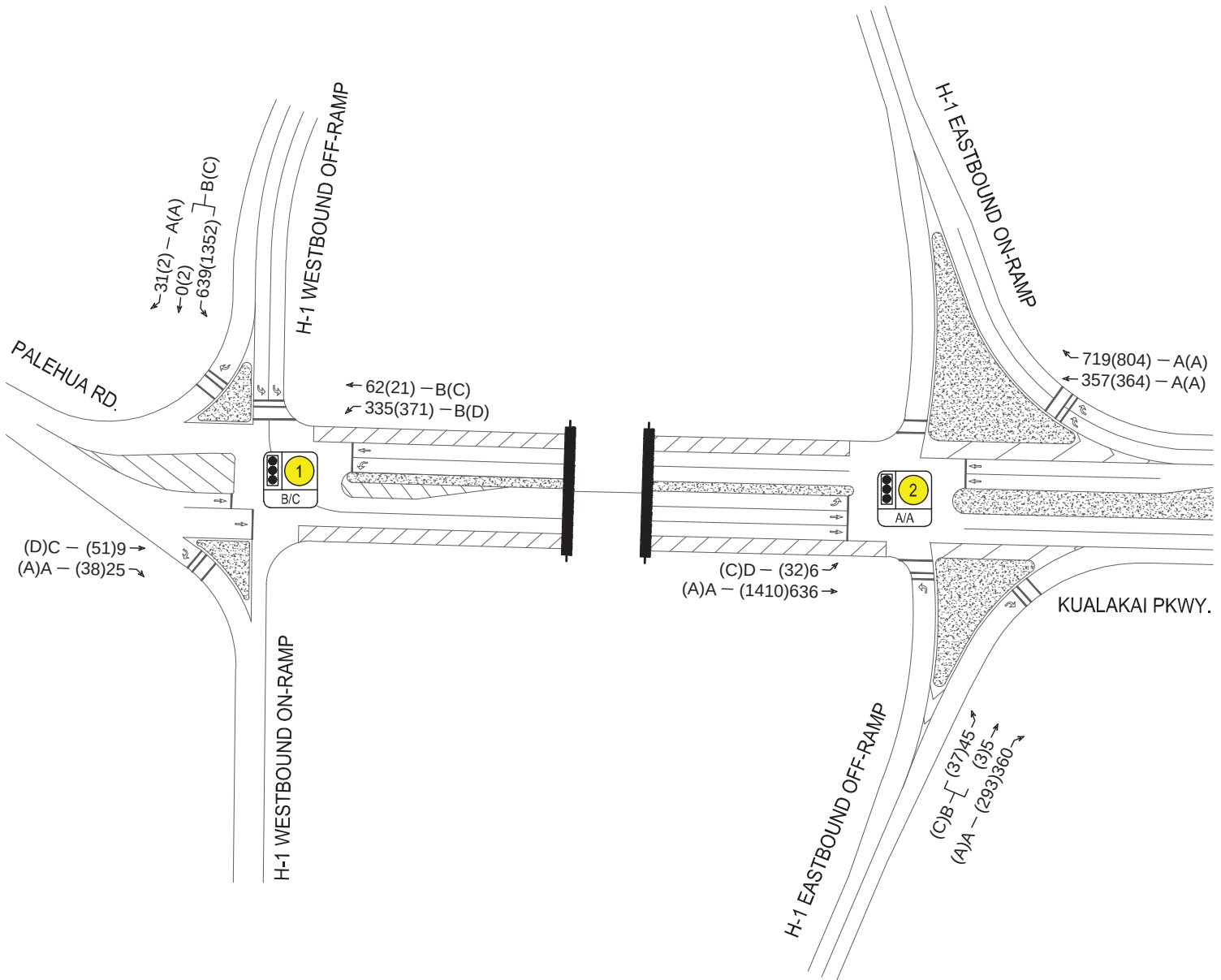
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LEGEND

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



- SIGNALIZED INTERSECTION Y

FIGURE 5.1

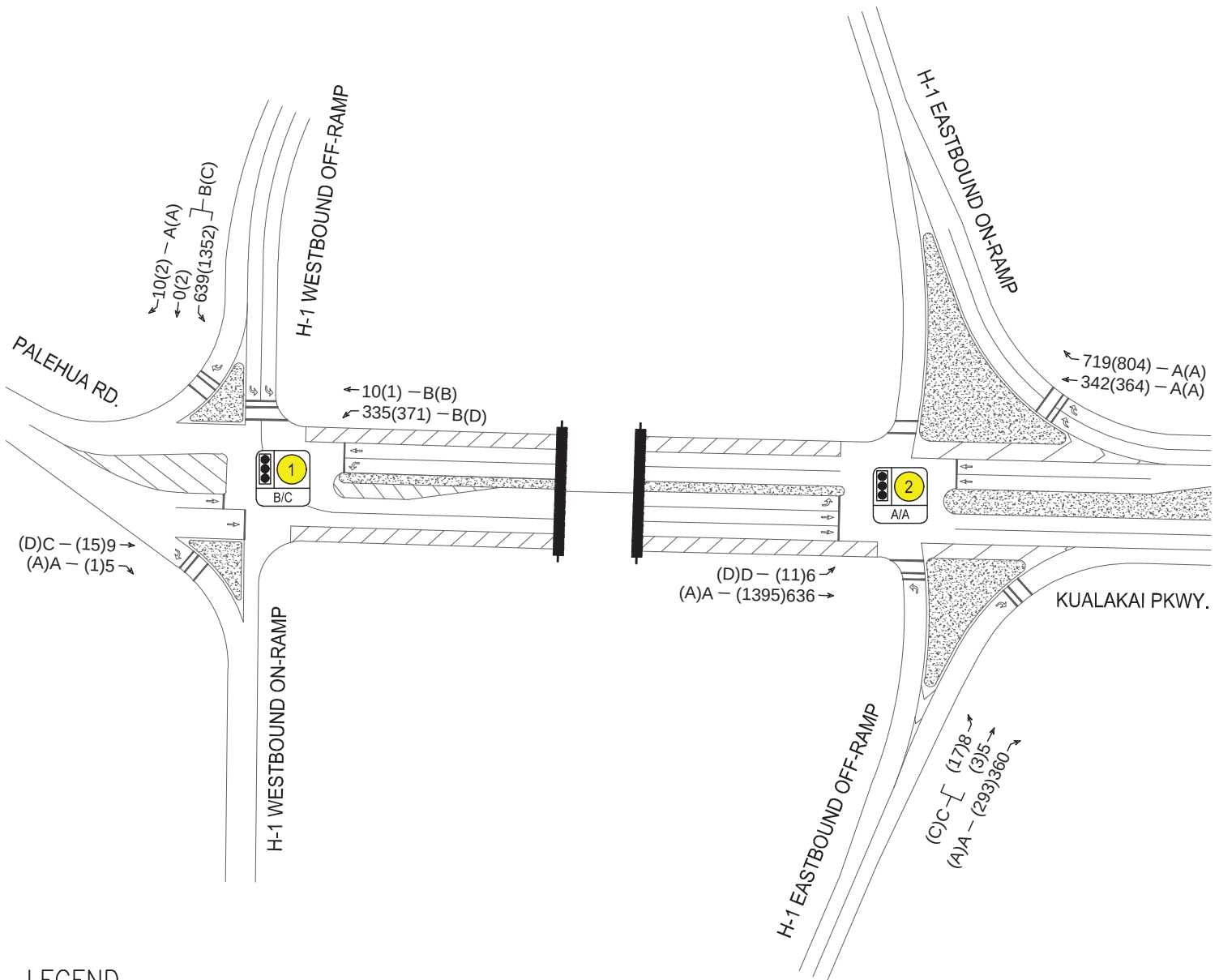
YEAR 2021 CONSTRUCTION, LANE
CONFIGURATIONS, TRAFFIC VOLUMES AND LOS

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LEGEND

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



SIGNALIZED INTERSECTION Y, OVERALL AM/PM LOS

X(X) - AM(PM) LOS

FIGURE 5.2

YEAR 2021 WITH PROJECT, LANE CONFIGURATIONS,
TRAFFIC VOLUMES AND LOS



5.4 Year 2021 with Project Conditions

5.4.1 Trip Generation

Based upon information provided by the client it is expected that during typical weekday operations of the Project, only two full-time employees will be on site during daytime hours. Therefore, the Project is forecast to only generate 2(2) trips during the AM(PM) peak hours of traffic.

5.4.2 Year 2021 with Project Analysis

Upon completion of the Project, with the inclusion of both the 8% annual growth rate from 2019 to 2021 and the new traffic as a result of the Project, all study intersections are projected to operate at the same overall and individual movement LOS as Year 2021 without Project traffic conditions during the AM and PM peak hours of traffic.

Palehua Road & H-1 Freeway Westbound on-/off-ramp –The signalized intersection is anticipated to operate at an overall LOS B(C) during AM(PM) peak hours of traffic, respectively. All movements at the intersection are expected to continue operating at LOS D or better during the AM and PM peak hours of traffic.

Kualakai Parkway & H-1 Freeway Eastbound on-/off-ramp – The signalized intersection is anticipated to continue operating at overall LOS A during the AM and PM peak hours. In addition, all individual movement LOS are expected to remain the same as existing LOS with all approaches operating at LOS D or better during both AM and PM peak hours of traffic.

See Figure 5.2 for Future Year 2021 with project lane configuration, traffic volumes, and LOS for the study intersections. See Table 5.3 for a LOS comparison between Year 2021 without Project conditions and Year 2021 with Project conditions

TABLE 5.2: LOS SUMMARY TABLE
YEAR 2021 WITHOUT PROJECT VS YEAR 2021 DURING PROJECT CONSTRUCTION CONDITIONS

Intersection	Year 2021 without Project						Year 2021 During Project Construction					
	AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1. Kualakai Pkwy./Palehua Rd./H1 WB Ramps												
NB LT	17.0	0.78	B	42.3	0.90	D	16.6	0.76	B	46.5	0.90	D
NB TH	11.3	0.02	B	19.6	0.00	B	11.7	0.13	B	21.1	0.05	C
WB LT	13.9	0.70	B	22.6	0.90	C	14.2	0.70	B	25.9	0.91	C
WB RT	-	-	A	-	-	A	-	-	A	-	-	A
SB TH	32.0	0.43	C	45.9	0.48	D	32.3	0.43	C	47.1	0.72	D
SB RT	-	-	A	-	-	A	-	-	A	-	-	A
OVERALL	15.1	-	B	27.0	-	C	14.9	-	B	30.7	-	C
2. Kualakai Pkwy./H1 EB Ramps												
NB TH	7.8	0.38	A	4.9	0.20	A	8.3	0.40	A	5.6	0.21	A
NB RT	-	-	A	-	-	A	-	-	A	-	-	A
EB LT/TH	27.3	0.52	C	34.1	0.57	C	19.1	0.61	B	32.0	0.65	C
EB RT	-	-	A	-	-	A	-	-	A	-	-	A
SB LT	40.0	0.52	D	41.8	0.54	D	40.8	0.52	D	32.7	0.63	C
SB TH	3.9	0.38	A	3.6	0.61	A	4.2	0.39	A	3.9	0.62	A
OVERALL	5.7	-	A	4.4	-	A	6.5	-	A	5.3	-	A

Directions

NB = Northbound approach

SB = Southbound approach

EB = Eastbound approach

WB = Westbound approach



TABLE 5.3: LOS SUMMARY TABLE
YEAR 2021 WITHOU PROJECT VS YEAR 2021 WITH PROJECT CONDITIONS

Intersection	Year 2021 without Project						Year 2021 with Project					
	AM			PM			AM			PM		
	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS	HCM Delay	v/c Ratio	LOS
1. Kualakai Pkwy./Palehua Rd./H1 WB Ramps												
NB LT	17.0	0.78	B	42.3	0.90	D	17.0	0.78	B	42.6	0.90	D
NB TH	11.3	0.02	B	19.6	0.00	B	11.3	0.02	B	19.7	0.00	B
WB LT	13.9	0.70	B	22.6	0.90	C	13.9	0.70	B	22.8	0.90	C
WB RT	-	-	A	-	-	A	-	-	A	-	-	A
SB TH	32.0	0.43	C	45.9	0.48	D	32.0	0.43	C	45.6	0.50	D
SB RT	-	-	A	-	-	A	-	-	A	-	-	A
OVERALL	15.1	-	B	27.0	-	C	15.1	-	B	27.0	-	C
2. Kualakai Pkwy./H1 EB Ramps												
NB TH	7.8	0.38	A	4.9	0.20	A	7.8	0.39	A	4.9	0.20	A
NB RT	-	-	A	-	-	A	-	-	A	-	-	A
EB LT/TH	27.3	0.52	C	34.1	0.57	C	27.3	0.52	C	34.2	0.57	C
EB RT	-	-	A	-	-	A	-	-	A	-	-	A
SB LT	40.0	0.52	D	41.8	0.54	D	40.0	0.52	D	40.5	0.54	D
SB TH	3.9	0.38	A	3.6	0.61	A	3.9	0.38	A	3.6	0.61	A
OVERALL	5.7	-	A	4.4	-	A	5.7	-	A	4.4	-	A

Directions

NB = Northbound approach

SB = Southbound approach

EB = Eastbound approach

WB = Westbound approach



6. CONCLUSIONS

The Project is envisioned to be a solar and battery storage facility within the currently undeveloped UH West Oahu mauka lands parcel in Kapolei. Vehicular access to the Project will be provided via Palehua Road at an existing gated entry located north of the Kualakai Parkway intersection with the H-1 westbound on- and off-ramps. The Project is anticipated to be completed by the end of Year 2021.

6.1 Existing Conditions

- Palehua Road & H-1 Westbound on-/off-ramp currently operates at LOS A(B) during the AM(PM) peak hours of traffic, respectively. Additionally, all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.
- Kualakai Parkway & H-1 Eastbound on-/off-ramp currently operates at LOS A during both the AM and PM peak hours of traffic. Additionally, all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

6.2 Year 2021 without Project Conditions

Based upon HDOT annual traffic data, the Hoopili TIAR and Traffic Counts taken by ATA, the annual growth rate for the study roadways was determined to be 8%. This growth rate takes into account the continued development of the West Oahu including Hoopili and the University of Hawaii West Oahu campus as well as other developments.

With the inclusion of the 8% annual growth rate from 2019 to 2021,

- Palehua Road & H-1 Westbound on-/off-ramp intersection is projected to operate at LOS B(C) during the AM(PM) peak hours of traffic. Similar to existing conditions all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.
- Kualakai Parkway & H-1 Eastbound on-/off-ramp intersection is projected to operate at LOS A during both AM and PM peak hours. Similar to existing conditions all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

6.3 Year 2021 During Project Construction Conditions

During construction, information provided by the client indicates that construction worker presence will vary from 10-160 daily workers with a daily average of 55 workers. In addition, tractor trailers will also be making deliveries to the Project site. A worst-case scenario was assumed for tractor trailer deliveries with 20 deliveries occurring in both the AM and PM peak hours of traffic.

With the inclusion of construction traffic into Year 2021 without Project volumes,

- Palehua Road & H-1 Westbound on-/off-ramp intersection is projected to operate at LOS B(C) during the AM(PM) peak hours of traffic. Similar to Year 2021 without Project



conditions all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

- Kualakai Parkway & H-1 Eastbound on-/off-ramp intersection is projected to operate at LOS A during both AM and PM peak hours. Similar to Year 2021 without Project conditions all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

Due to the large amount of on-site space and driveway length, it is not expected that vehicle queues will spill back to the H-1 Westbound intersection and adversely affect traffic operations.

6.4 Year 2021 with Project Conditions

Upon completion the Project will only have 2 full-time employees on site during typical weekday operations. Therefore, the Project is forecast to only generate 2(2) trips during the AM(PM) peak hours of traffic. These additional trips are anticipated to have no impact on Year 2021 without Project traffic. Therefore, upon completion of the Project, all study intersections are anticipated to operate with the same LOS as Year 2021 without Project traffic conditions.

With the inclusion of the 8% annual growth rate from 2019 to 2021,

- Palehua Road & H-1 Westbound on-/off-ramp intersection is projected to operate at LOS B(C) during the AM(PM) peak hours of traffic. Similar to Year 2021 without Project conditions all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.
- Kualakai Parkway & H-1 Eastbound on-/off-ramp intersection is projected to operate at LOS A during both AM and PM peak hours. Similar to Year 2021 without Project conditions all individual movements currently operate at LOS D or better during the AM and PM peak hours of traffic.

As a result of this report, it is found that the Project during construction or upon completion will have no significant impact on the surrounding facilities.



7. REFERENCES

1. Austin Tsutsumi & Associates, Roadway Master Plan Report Hoopili, August 31, 2016.
2. Austin Tsutsumi & Associates, Traffic Impact Analysis Report Hoopili, Updated May 30, 2014.



APPENDICES



APPENDIX A

TRAFFIC COUNT DATA

	KUALAKAI PKWY SOUTHBOUND				H-1 WEST OFF-RAMP WESTBOUND				KUALAKAI PKWY NORTHBOUND				H-1 WEST ON-RAMP EASTBOUND					
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Int. Total	
06:00	0	0	0	0	137	0	4	0	31	5	0	0	0	0	0	0	0	177
06:15	0	0	0	0	131	0	5	0	48	4	0	0	0	0	0	0	0	188
06:30	0	0	1	0	160	0	4	0	65	3	0	0	0	0	0	0	0	233
06:45	0	3	0	0	149	0	1	0	74	3	0	0	0	0	0	0	0	230
Total	0	3	1	0	577	0	14	0	218	15	0	0	0	0	0	0	0	828
07:00	0	4	1	0	116	0	2	0	69	0	0	0	0	0	1	0	0	193
07:15	0	1	2	0	123	0	1	0	79	2	0	0	0	0	0	0	0	208
07:30	0	1	3	0	148	0	2	0	104	3	0	0	0	0	0	0	0	261
07:45	0	3	2	0	148	0	2	0	60	1	0	0	0	0	0	0	0	216
Total	0	9	8	0	535	0	7	0	312	6	0	0	0	0	1	0	0	878
08:00	0	1	2	0	140	0	1	0	76	1	0	0	0	0	0	0	0	221
08:15	0	1	2	0	129	0	2	0	53	3	0	0	0	0	0	0	0	190
08:30	0	3	2	0	133	0	3	0	46	3	0	0	0	0	0	0	0	190
08:45	0	3	5	0	119	1	3	0	32	4	0	0	0	0	0	0	0	167
Total	0	8	11	0	521	1	9	0	207	11	0	0	0	0	0	0	0	768
Grand Total	0	20	20	0	1633	1	30	0	737	32	0	0	0	0	1	0	0	2474
Apprch %	0	50	50	0	98.1	0.1	1.8	0	95.8	4.2	0	0	0	0	100	0	0	
Total %	0	0.8	0.8	0	66	0	1.2	0	29.8	1.3	0	0	0	0	0	0	0	
Motorcycles	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	2
% Motorcycles	0	0	0	0	0.1	0	0	0	0.1	0	0	0	0	0	0	0	0	0.1
Cars & Light Goods	0	3	5	0	1589	1	14	0	686	12	0	0	0	0	0	0	0	2310
% Cars & Light Goods	0	15	25	0	97.3	100	46.7	0	93.1	37.5	0	0	0	0	0	0	0	93.4
Buses	0	0	0	0	2	0	0	0	6	0	0	0	0	0	0	0	0	8
% Buses	0	0	0	0	0.1	0	0	0	0.8	0	0	0	0	0	0	0	0	0.3
Single-Unit Trucks	0	13	9	0	36	0	11	0	39	15	0	0	0	0	1	0	0	124
% Single-Unit Trucks	0	65	45	0	2.2	0	36.7	0	5.3	46.9	0	0	0	0	100	0	0	5
Articulated Trucks	0	3	6	0	5	0	5	0	5	5	0	0	0	0	0	0	0	29
% Articulated Trucks	0	15	30	0	0.3	0	16.7	0	0.7	15.6	0	0	0	0	0	0	0	1.2
Bicycles on Road	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
% Bicycles on Road	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bicycles on Crosswalk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Bicycles on Crosswalk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Austin Tsutsumi & Associates

501 Sumner Street, Suite 521

Honolulu, HI 96817-5031

Phone: 533-3646 Fax: 526-1267

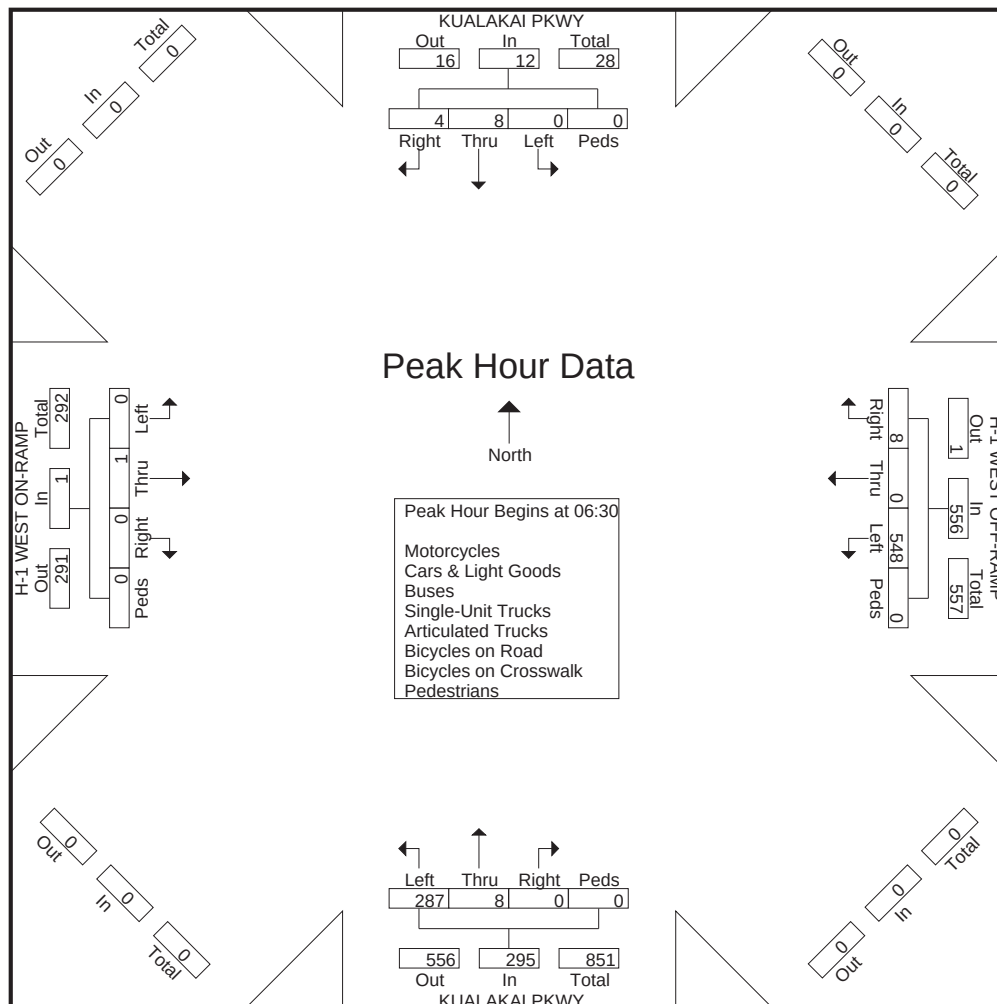
File Name : Kualakai Pkwy - H-1 West On and Off-Ramp

Site Code : West Oahu Solar

Start Date : 10/24/2019

Page No : 2

	KUALAKAI PKWY SOUTHBOUND					H-1 WEST OFF-RAMP WESTBOUND					KUALAKAI PKWY NORTHBOUND					H-1 WEST ON-RAMP EASTBOUND					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 06:30 to 07:15 - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 06:30																					
06:30	0	0	1	0	1	160	0	4	0	164	65	3	0	0	68	0	0	0	0	0	233
06:45	0	3	0	0	3	149	0	1	0	150	74	3	0	0	77	0	0	0	0	0	230
07:00	0	4	1	0	5	116	0	2	0	118	69	0	0	0	69	0	1	0	0	1	193
07:15	0	1	2	0	3	123	0	1	0	124	79	2	0	0	81	0	0	0	0	0	208
Total Volume	0	8	4	0	12	548	0	8	0	556	287	8	0	0	295	0	1	0	0	1	864
% App. Total	0	66.7	33.3	0		98.6	0	1.4	0		97.3	2.7	0	0		0	100	0	0		
PHF	.000	.500	.500	.000	.600	.856	.000	.500	.000	.848	.908	.667	.000	.000	.910	.000	.250	.000	.000	.250	.927



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Austin Tsutsumi & Associates

501 Sumner Street, Suite 521

Honolulu, HI 96817-5031

Phone: 533-3646 Fax: 526-1267

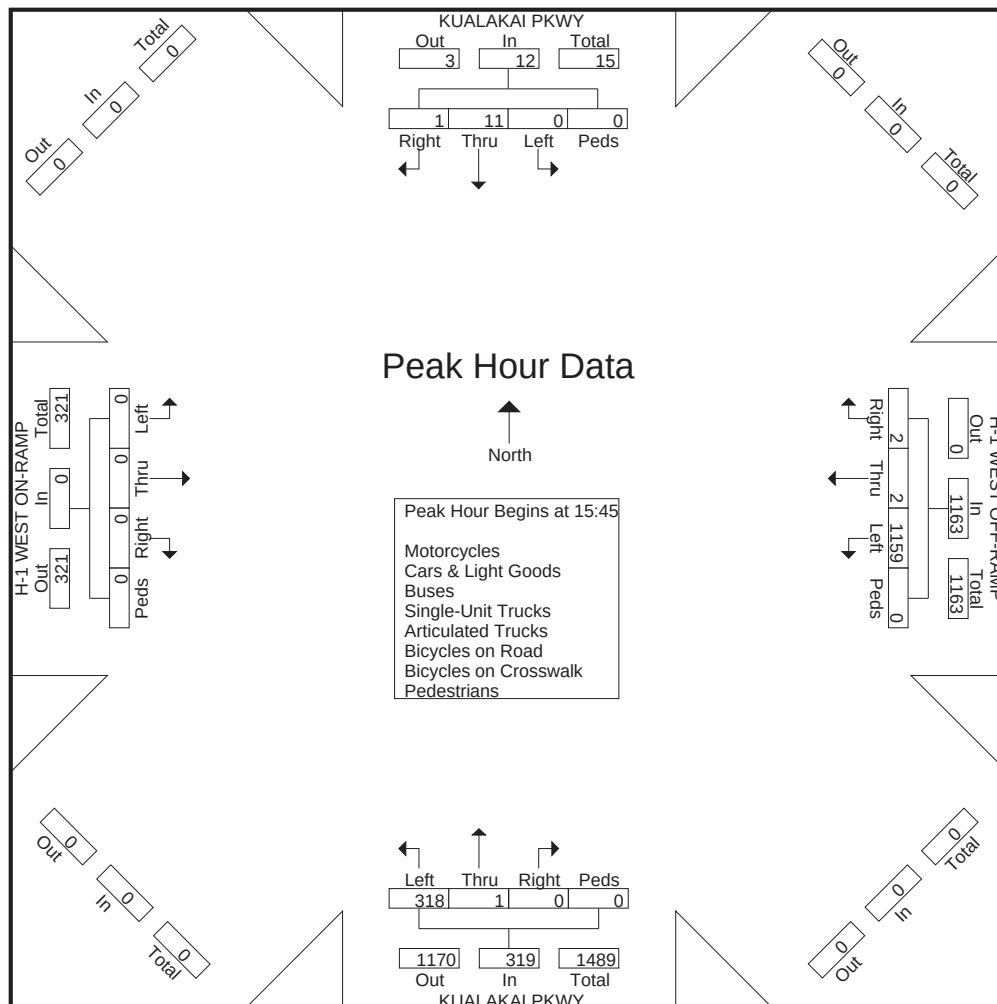
File Name : Kualakai Pkwy - H-1 West On and Off-Ramp

Site Code : West Oahu Solar

Start Date : 10/24/2019

Page No : 2

	KUALAKAI PKWY SOUTHBOUND					H-1 WEST OFF-RAMP WESTBOUND					KUALAKAI PKWY NORTHBOUND					H-1 WEST ON-RAMP EASTBOUND					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 15:00 to 17:45 - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 15:45																					
15:45	0	4	0	0	4	300	0	0	0	300	112	0	0	0	112	0	0	0	0	0	416
16:00	0	2	0	0	2	256	1	2	0	259	62	1	0	0	63	0	0	0	0	0	324
16:15	0	0	1	0	1	295	1	0	0	296	77	0	0	0	77	0	0	0	0	0	374
16:30	0	5	0	0	5	308	0	0	0	308	67	0	0	0	67	0	0	0	0	0	380
Total Volume	0	11	1	0	12	1159	2	2	0	1163	318	1	0	0	319	0	0	0	0	0	1494
% App. Total	0	91.7	8.3	0		99.7	0.2	0.2	0		99.7	0.3	0	0		0	0	0	0		
PHF	.000	.550	.250	.000	.600	.941	.500	.250	.000	.944	.710	.250	.000	.000	.712	.000	.000	.000	.000	.000	.898



	KUALAKAI PKWY SOUTHBOUND				H-1 EAST ON-RAMP WESTBOUND				KUALAKAI PKWY NORTHBOUND				H-1 EAST OFF-RAMP EASTBOUND				
Start Time	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Left	Thru	Right	Peds	Int. Total
06:00	0	138	0	0	0	0	0	0	0	29	223	0	5	0	46	0	441
06:15	0	134	0	0	0	0	0	0	0	50	181	0	3	2	66	0	436
06:30	0	158	0	0	0	0	0	0	0	73	174	0	3	1	91	0	500
06:45	1	156	0	0	0	0	0	0	0	66	166	0	3	1	74	0	467
Total	1	586	0	0	0	0	0	0	0	218	744	0	14	4	277	0	1844
07:00	4	108	0	0	0	0	0	0	0	69	110	0	0	1	65	0	357
07:15	0	123	0	0	0	0	0	0	0	84	166	0	1	1	79	0	454
07:30	1	149	0	0	0	0	0	0	0	102	137	0	3	0	69	0	461
07:45	4	148	0	0	0	0	0	0	0	61	138	0	1	0	61	0	413
Total	9	528	0	0	0	0	0	0	0	316	551	0	5	2	274	0	1685
08:00	1	131	0	0	0	0	0	0	0	75	170	0	3	0	62	0	442
08:15	4	135	0	0	0	0	0	0	0	51	167	0	3	0	47	0	407
08:30	3	135	0	0	0	0	0	0	0	45	132	0	6	0	34	0	355
08:45	3	122	0	0	0	0	0	0	0	32	121	0	5	0	42	0	325
Total	11	523	0	0	0	0	0	0	0	203	590	0	17	0	185	0	1529
Grand Total	21	1637	0	0	0	0	0	0	0	737	1885	0	36	6	736	0	5058
Apprch %	1.3	98.7	0	0	0	0	0	0	0	28.1	71.9	0	4.6	0.8	94.6	0	
Total %	0.4	32.4	0	0	0	0	0	0	0	14.6	37.3	0	0.7	0.1	14.6	0	
Motorcycles	0	1	0	0	0	0	0	0	0	4	8	0	0	0	0	0	13
% Motorcycles	0	0.1	0	0	0	0	0	0	0	0.5	0.4	0	0	0	0	0	0.3
Cars & Light Goods	9	1595	0	0	0	0	0	0	0	678	1851	0	20	4	697	0	4854
% Cars & Light Goods	42.9	97.4	0	0	0	0	0	0	0	92	98.2	0	55.6	66.7	94.7	0	96
Buses	0	2	0	0	0	0	0	0	0	6	8	0	0	0	7	0	23
% Buses	0	0.1	0	0	0	0	0	0	0	0.8	0.4	0	0	0	1	0	0.5
Single-Unit Trucks	9	32	0	0	0	0	0	0	0	42	16	0	13	0	29	0	141
% Single-Unit Trucks	42.9	2	0	0	0	0	0	0	0	5.7	0.8	0	36.1	0	3.9	0	2.8
Articulated Trucks	3	5	0	0	0	0	0	0	0	6	2	0	3	2	3	0	24
% Articulated Trucks	14.3	0.3	0	0	0	0	0	0	0	0.8	0.1	0	8.3	33.3	0.4	0	0.5
Bicycles on Road	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	3
% Bicycles on Road	0	0.1	0	0	0	0	0	0	0	0.1	0	0	0	0	0	0	0.1
Bicycles on Crosswalk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Bicycles on Crosswalk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
% Pedestrians	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Austin Tsutsumi & Associates

501 Sumner Street, Suite 521

Honolulu, HI 96817-5031

Phone: 533-3646 Fax: 526-1267

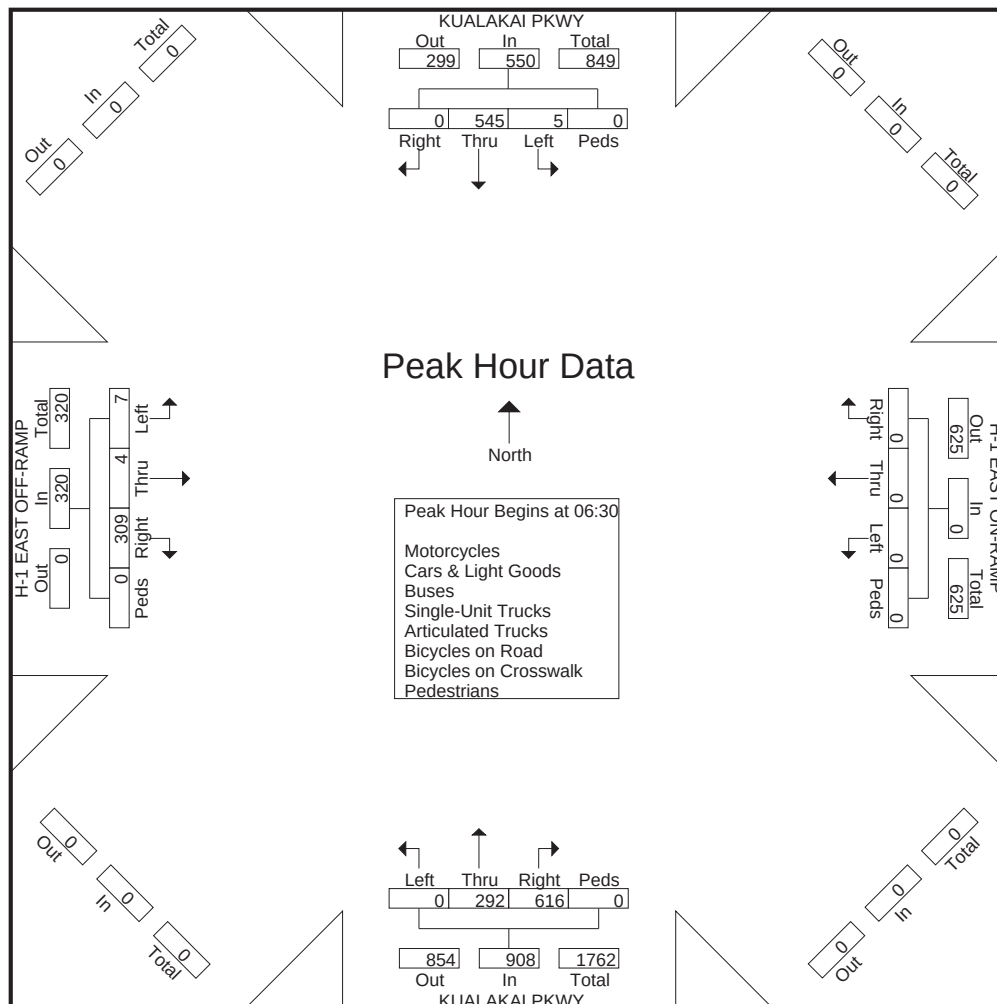
File Name : Kualakai Pkwy - H-1 East On and Off-Ramp

Site Code : West Oahu Solar

Start Date : 10/24/2019

Page No : 2

	KUALAKAI PKWY SOUTHBOUND					H-1 EAST ON-RAMP WESTBOUND					KUALAKAI PKWY NORTHBOUND					H-1 EAST OFF-RAMP EASTBOUND					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 06:30 to 07:15 - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 06:30																					
06:30	0	158	0	0	158	0	0	0	0	0	0	73	174	0	247	3	1	91	0	95	500
06:45	1	156	0	0	157	0	0	0	0	0	0	66	166	0	232	3	1	74	0	78	467
07:00	4	108	0	0	112	0	0	0	0	0	0	69	110	0	179	0	1	65	0	66	357
07:15	0	123	0	0	123	0	0	0	0	0	0	84	166	0	250	1	1	79	0	81	454
Total Volume	5	545	0	0	550	0	0	0	0	0	0	292	616	0	908	7	4	309	0	320	1778
% App. Total	0.9	99.1	0	0		0	0	0	0		0	32.2	67.8	0		2.2	1.2	96.6	0		
PHF	.313	.862	.000	.000	.870	.000	.000	.000	.000	.000	.000	.869	.885	.000	.908	.583	1.00	.849	.000	.842	.889



[illegible]

Austin Tsutsumi & Associates

501 Sumner Street, Suite 521

Honolulu, HI 96817-5031

Phone: 533-3646 Fax: 526-1267

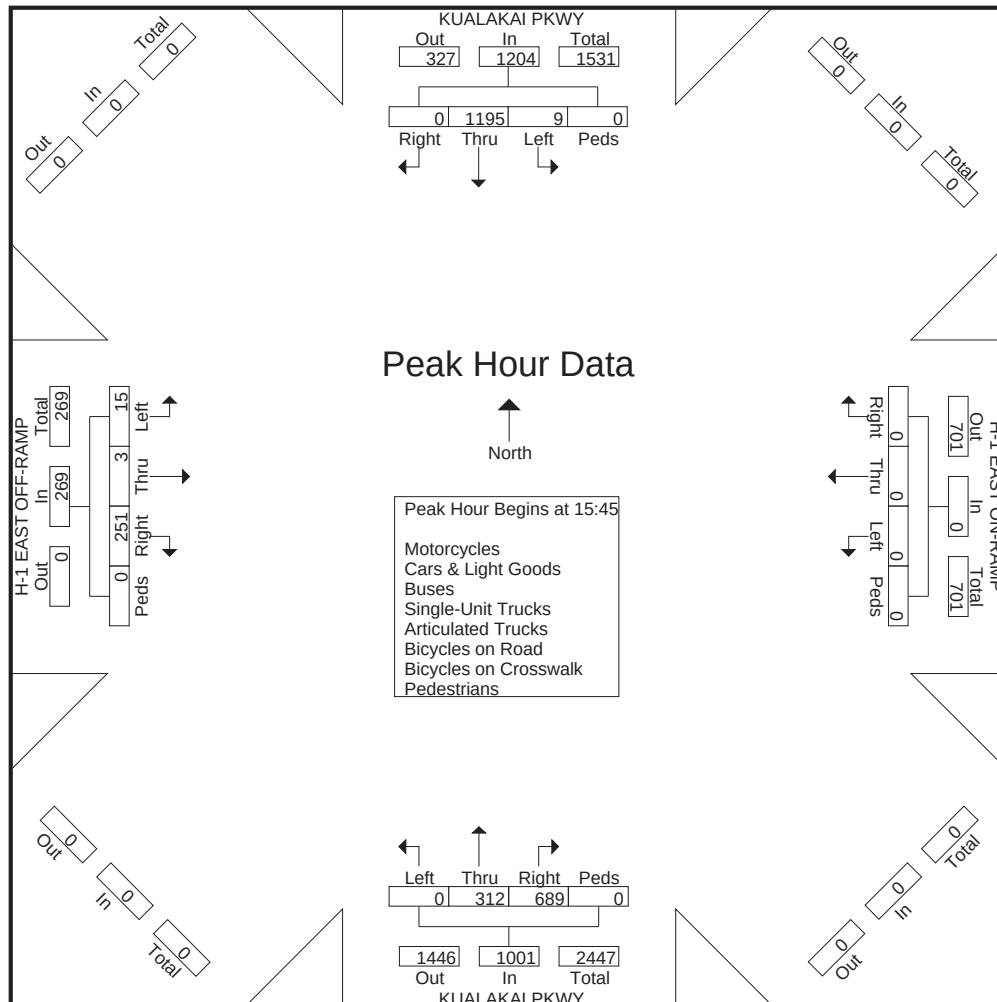
File Name : Kualakai Pkwy - H-1 East On and Off-Ramp

Site Code : West Oahu Solar

Start Date : 10/24/2019

Page No : 2

	KUALAKAI PKWY SOUTHBOUND					H-1 EAST ON-RAMP WESTBOUND					KUALAKAI PKWY NORTHBOUND					H-1 EAST OFF-RAMP EASTBOUND					
Start Time	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Left	Thru	Right	Peds	App. Total	Int. Total
Peak Hour Analysis From 15:45 to 16:30 - Peak 1 of 1																					
Peak Hour for Entire Intersection Begins at 15:45																					
15:45	2	305	0	0	307	0	0	0	0	0	0	111	193	0	304	4	1	55	0	60	671
16:00	2	263	0	0	265	0	0	0	0	0	0	59	161	0	220	4	0	59	0	63	548
16:15	0	302	0	0	302	0	0	0	0	0	0	72	165	0	237	2	2	60	0	64	603
16:30	5	325	0	0	330	0	0	0	0	0	0	70	170	0	240	5	0	77	0	82	652
Total Volume	9	1195	0	0	1204	0	0	0	0	0	0	312	689	0	1001	15	3	251	0	269	2474
% App. Total	0.7	99.3	0	0		0	0	0	0		0	31.2	68.8	0		5.6	1.1	93.3	0		
PHF	.450	.919	.000	.000	.912	.000	.000	.000	.000	.000	.000	.703	.892	.000	.823	.750	.375	.815	.000	.820	.922





APPENDIX B

LEVEL OF SERVICE CRITERIA

APPENDIX B – LEVEL OF SERVICE (LOS) CRITERIA

VEHICULAR LEVEL OF SERVICE FOR SIGNALIZED INTERSECTIONS (HCM 6th EDITION)

Level of service for vehicles at signalized intersections is directly related to delay values and is assigned on that basis. Level of Service is a measure of the acceptability of delay values to motorists at a given intersection. The criteria are given in the table below.

Level-of Service Criteria for Signalized Intersections

Level of Service	Control Delay per Vehicle (sec./veh.)
A	< 10.0
B	>10.0 and ≤ 20.0
C	>20.0 and ≤ 35.0
D	>35.0 and ≤ 55.0
E	>55.0 and ≤ 80.0
F	> 80.0

Delay is a complex measure, and is dependent on a number of variables, including the quality of progression, the cycle length, the green ratio, and the v/c ratio for the lane group or approach in question.

VEHICULAR LEVEL OF SERVICE CRITERIA FOR UNSIGNALIZED INTERSECTIONS (HCM 6th EDITION)

The level of service criteria for vehicles at unsignalized intersections is defined as the average control delay, in seconds per vehicle.

LOS delay threshold values are lower for two-way stop-controlled (TWSC) and all-way stop-controlled (AWSC) intersections than those of signalized intersections. This is because more vehicles pass through signalized intersections, and therefore, drivers expect and tolerate greater delays. While the criteria for level of service for TWSC and AWSC intersections are the same, procedures to calculate the average total delay may differ.

Level of Service Criteria for Two-Way Stop-Controlled Intersections

Level of Service	Average Control Delay (sec/veh)
A	≤ 10
B	>10 and ≤15
C	>15 and ≤25
D	>25 and ≤35
E	>35 and ≤50
F	> 50

PEDESTRIAN AND BICYCLE LEVEL OF SERVICE FOR SIGNALIZED INTERSECTIONS (HCM 6th EDITION)

Level of service for pedestrians and bicycles at signalized intersections is determined by calculating an LOS Score for each approach at a signalized intersection, and is assigned on that basis. Level of Service for non-automobile modes at signalized intersections is associated with a score value based on traveler perception research, considering factors of performance measures and intersection characteristics. The criteria are given in the table below.

Level-of Service Criteria for Signalized Intersections

Level of Service	LOS Score
A	< 1.50
B	>1.50 and ≤ 2.50
C	>2.50 and ≤ 3.50
D	>3.50 and ≤ 4.50
E	>4.50 and ≤ 5.50
F	> 5.50

PEDESTRIAN LEVEL OF SERVICE CRITERIA FOR UNCONTROLLED CROSSINGS (HCM 6th EDITION)

The level of service criteria for pedestrians at uncontrolled crossings is defined as the average control delay, in seconds per pedestrian.

LOS delay threshold values for two-way stop-controlled (TWSC) intersections are defined for pedestrians crossing a traffic stream not controlled by a STOP sign; it also applies to midblock pedestrian crossings and crossings at with special treatments such as flashing beacons and signage. Factors such as vehicle and pedestrian volumes, geometric conditions, motorist yield rates, and multiple-stage crossings affect the control delay for pedestrians.

Level of Service Criteria for Two-Way Stop-Controlled Intersections

Level of Service	Average Control Delay (sec/veh)
A	≤ 5
B	>5 and ≤10
C	>10 and ≤20
D	>20 and ≤30
E	>30 and ≤45
F	> 45



APPENDIX C

LEVEL OF SERVICE CALCULATIONS



APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Existing Conditions AM Peak Hour
-

HCM 6th Signalized Intersection Summary

1: Kualakai Pkwy & H-1 WB

Existing AM
11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	548	0	8	287	8	0	0	8	4
Future Volume (veh/h)	0	0	0	548	0	8	287	8	0	0	8	4
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach				No			No				No	
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				596	0	0	312	9	0	0	9	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				918	0		418	439	0	0	22	
Arrive On Green				0.27	0.00	0.00	0.23	0.23	0.00	0.00	0.01	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				596	0	0	312	9	0	0	9	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				5.6	0.0	0.0	6.0	0.1	0.0	0.0	0.2	0.0
Cycle Q Clear(g_c), s				5.6	0.0	0.0	6.0	0.1	0.0	0.0	0.2	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				918	0		418	439	0	0	22	
V/C Ratio(X)				0.65	0.00		0.75	0.02	0.00	0.00	0.41	
Avail Cap(c_a), veh/h				2623	0		1400	1470	0	0	760	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				12.0	0.0	0.0	13.1	10.9	0.0	0.0	18.1	0.0
Incr Delay (d2), s/veh				0.8	0.0	0.0	2.7	0.0	0.0	0.0	12.1	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				1.8	0.0	0.0	2.2	0.0	0.0	0.0	0.1	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				12.8	0.0	0.0	15.8	10.9	0.0	0.0	30.2	0.0
LnGrp LOS				B	A		B	B	A	A	C	
Approach Vol, veh/h					596	A		321			9	A
Approach Delay, s/veh					12.8			15.6			30.2	
Approach LOS					B			B			C	
Timer - Assigned Phs				4		6		8				
Phs Duration (G+Y+Rc), s				6.4		15.8		14.7				
Change Period (Y+Rc), s				6.0		6.0		6.0				
Max Green Setting (Gmax), s				15.0		28.0		29.0				
Max Q Clear Time (g_c+I1), s				2.2		7.6		8.0				
Green Ext Time (p_c), s				0.0		2.2		0.9				
Intersection Summary												
HCM 6th Ctrl Delay				13.9								
HCM 6th LOS				B								
Notes												
Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.												

HCM 6th Signalized Intersection Summary

2: Kualakai Pkwy & H-1 EB

Existing AM
11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰	↰					↱	↱	↰	↱	
Traffic Volume (veh/h)	7	4	309	0	0	0	0	292	616	5	545	0
Future Volume (veh/h)	7	4	309	0	0	0	0	292	616	5	545	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No						No			No		
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	8	4	0				0	317	0	5	592	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	15	8					0	884		10	1772	0
Arrive On Green	0.01	0.01	0.00				0.00	0.25	0.00	0.01	0.50	0.00
Sat Flow, veh/h	1207	603	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	12	0	0				0	317	0	5	592	0
Grp Sat Flow(s),veh/h/ln	1810	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	0.2	0.0	0.0				0.0	1.8	0.0	0.1	2.5	0.0
Cycle Q Clear(g_c), s	0.2	0.0	0.0				0.0	1.8	0.0	0.1	2.5	0.0
Prop In Lane	0.67		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	23	0					0	884		10	1772	0
V/C Ratio(X)	0.52	0.00					0.00	0.36		0.51	0.33	0.00
Avail Cap(c_a), veh/h	1106	0					0	6078		1088	9116	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	12.0	0.0	0.0				0.0	7.6	0.0	12.2	3.7	0.0
Incr Delay (d2), s/veh	16.7	0.0	0.0				0.0	0.2	0.0	36.3	0.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.0	0.0				0.0	0.4	0.0	0.1	0.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	28.8	0.0	0.0				0.0	7.9	0.0	48.4	3.8	0.0
LnGrp LOS	C	A					A	A		D	A	A
Approach Vol, veh/h		12	A					317	A		597	
Approach Delay, s/veh		28.8						7.9			4.2	
Approach LOS		C						A			A	
Timer - Assigned Phs	1	2		4		6						
Phs Duration (G+Y+Rc), s	6.1	12.1		6.3		18.2						
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0						
Max Green Setting (Gmax), s	15.0	42.0		15.0		63.0						
Max Q Clear Time (g_c+I1), s	2.1	3.8		2.2		4.5						
Green Ext Time (p_c), s	0.0	2.3		0.0		4.7						

Intersection Summary

HCM 6th Ctrl Delay	5.8
HCM 6th LOS	A

Notes

User approved pedestrian interval to be less than phase max green.

Unsignalized Delay for [NBR, EBR] is excluded from calculations of the approach delay and intersection delay.



APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Existing Conditions PM Peak Hour
-

HCM 6th Signalized Intersection Summary

1: Kualakai Pkwy & H-1 WB

Existing PM

11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	1159	0	2	318	1	0	0	11	1
Future Volume (veh/h)	0	0	0	1159	0	2	318	1	0	0	11	1
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach				No			No				No	
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				1260	0	0	346	1	0	0	12	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				1531	0		412	432	0	0	26	
Arrive On Green				0.44	0.00	0.00	0.23	0.23	0.00	0.00	0.01	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				1260	0	0	346	1	0	0	12	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				18.5	0.0	0.0	10.7	0.0	0.0	0.0	0.4	0.0
Cycle Q Clear(g_c), s				18.5	0.0	0.0	10.7	0.0	0.0	0.0	0.4	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				1531	0		412	432	0	0	26	
V/C Ratio(X)				0.82	0.00		0.84	0.00	0.00	0.00	0.45	
Avail Cap(c_a), veh/h				2214	0		617	648	0	0	486	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				14.1	0.0	0.0	21.2	17.1	0.0	0.0	28.2	0.0
Incr Delay (d2), s/veh				1.7	0.0	0.0	6.6	0.0	0.0	0.0	11.6	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				6.4	0.0	0.0	4.8	0.0	0.0	0.0	0.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				15.8	0.0	0.0	27.8	17.1	0.0	0.0	39.9	0.0
LnGrp LOS				B	A		C	B	A	A	D	
Approach Vol, veh/h					1260	A		347			12	A
Approach Delay, s/veh					15.8			27.7			39.9	
Approach LOS					B			C			D	
Timer - Assigned Phs				4		6		8				
Phs Duration (G+Y+Rc), s				6.8		31.6		19.4				
Change Period (Y+Rc), s				6.0		6.0		6.0				
Max Green Setting (Gmax), s				15.0		37.0		20.0				
Max Q Clear Time (g_c+I1), s				2.4		20.5		12.7				
Green Ext Time (p_c), s				0.0		5.1		0.7				
Intersection Summary												
HCM 6th Ctrl Delay				18.6								
HCM 6th LOS				B								
Notes												
Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.												

HCM 6th Signalized Intersection Summary

2: Kualakai Pkwy & H-1 EB

Existing PM

11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	15	3	251	0	0	0	0	312	689	9	1195	0
Future Volume (veh/h)	15	3	251	0	0	0	0	312	689	9	1195	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach		No						No			No	
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	16	3	0				0	339	0	10	1299	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	29	5					0	1689		19	2313	0
Arrive On Green	0.02	0.02	0.00				0.00	0.48	0.00	0.01	0.65	0.00
Sat Flow, veh/h	1511	283	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	19	0	0				0	339	0	10	1299	0
Grp Sat Flow(s),veh/h/ln	1795	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	0.4	0.0	0.0				0.0	2.0	0.0	0.2	7.3	0.0
Cycle Q Clear(g_c), s	0.4	0.0	0.0				0.0	2.0	0.0	0.2	7.3	0.0
Prop In Lane	0.84		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	34	0					0	1689		19	2313	0
V/C Ratio(X)	0.55	0.00					0.00	0.20		0.53	0.56	0.00
Avail Cap(c_a), veh/h	740	0					0	4105		735	6157	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	17.7	0.0	0.0				0.0	5.5	0.0	17.9	3.5	0.0
Incr Delay (d2), s/veh	13.0	0.0	0.0				0.0	0.1	0.0	21.3	0.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	0.0	0.0				0.0	0.5	0.0	0.2	0.7	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	30.7	0.0	0.0				0.0	5.6	0.0	39.2	3.7	0.0
LnGrp LOS	C	A					A	A		D	A	A
Approach Vol, veh/h		19	A					339	A		1309	
Approach Delay, s/veh		30.7						5.6			4.0	
Approach LOS		C						A			A	
Timer - Assigned Phs	1	2		4		6						
Phs Duration (G+Y+Rc), s	6.4	23.3		6.7		29.7						
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0						
Max Green Setting (Gmax), s	15.0	42.0		15.0		63.0						
Max Q Clear Time (g_c+I1), s	2.2	4.0		2.4		9.3						
Green Ext Time (p_c), s	0.0	2.4		0.0		14.3						
Intersection Summary												
HCM 6th Ctrl Delay			4.6									
HCM 6th LOS			A									
Notes												
Unsignalized Delay for [NBR, EBR] is excluded from calculations of the approach delay and intersection delay.												



APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2021 Without Project Conditions AM Peak Hour
-

HCM 6th Signalized Intersection Summary

BY 2021 AM

1: Kualakai Pkwy & H-1 WB

11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations				↔		↔	↔	↑			↑	↔
Traffic Volume (veh/h)	0	0	0	639	0	9	335	9	0	0	9	5
Future Volume (veh/h)	0	0	0	639	0	9	335	9	0	0	9	5
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach				No			No				No	
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				695	0	0	364	10	0	0	10	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				1000	0		467	491	0	0	23	
Arrive On Green				0.29	0.00	0.00	0.26	0.26	0.00	0.00	0.01	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				695	0	0	364	10	0	0	10	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				7.4	0.0	0.0	7.8	0.2	0.0	0.0	0.2	0.0
Cycle Q Clear(g_c), s				7.4	0.0	0.0	7.8	0.2	0.0	0.0	0.2	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				1000	0		467	491	0	0	23	
V/C Ratio(X)				0.70	0.00		0.78	0.02	0.00	0.00	0.43	
Avail Cap(c_a), veh/h				2343	0		1251	1313	0	0	679	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				13.1	0.0	0.0	14.1	11.3	0.0	0.0	20.2	0.0
Incr Delay (d2), s/veh				0.9	0.0	0.0	2.9	0.0	0.0	0.0	11.7	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				2.4	0.0	0.0	2.9	0.1	0.0	0.0	0.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				13.9	0.0	0.0	17.0	11.3	0.0	0.0	32.0	0.0
LnGrp LOS				B	A		B	B	A	A	C	
Approach Vol, veh/h					695	A		374			10	A
Approach Delay, s/veh					13.9			16.8			32.0	
Approach LOS					B			B			C	
Timer - Assigned Phs				4		6		8				
Phs Duration (G+Y+Rc), s				6.5		17.9		16.8				
Change Period (Y+Rc), s				6.0		6.0		6.0				
Max Green Setting (Gmax), s				15.0		28.0		29.0				
Max Q Clear Time (g_c+I1), s				2.2		9.4		9.8				
Green Ext Time (p_c), s				0.0		2.6		1.1				
Intersection Summary												
HCM 6th Ctrl Delay				15.1								
HCM 6th LOS				B								
Notes												
Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.												

HCM 6th Signalized Intersection Summary

2: Kualakai Pkwy & H-1 EB

BY 2021 AM

11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations		↰	↱					↰	↱	↰	↱	
Traffic Volume (veh/h)	8	5	360	0	0	0	0	341	719	6	636	0
Future Volume (veh/h)	8	5	360	0	0	0	0	341	719	6	636	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No						No			No		
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	9	5	0				0	371	0	7	691	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	17	10					0	964		14	1828	0
Arrive On Green	0.01	0.01	0.00				0.00	0.27	0.00	0.01	0.51	0.00
Sat Flow, veh/h	1165	647	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	14	0	0				0	371	0	7	691	0
Grp Sat Flow(s),veh/h/ln	1812	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	0.2	0.0	0.0				0.0	2.2	0.0	0.1	3.0	0.0
Cycle Q Clear(g_c), s	0.2	0.0	0.0				0.0	2.2	0.0	0.1	3.0	0.0
Prop In Lane	0.64		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	27	0					0	964		14	1828	0
V/C Ratio(X)	0.52	0.00					0.00	0.38		0.52	0.38	0.00
Avail Cap(c_a), veh/h	995	0					0	6135		979	8924	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	12.5	0.0	0.0				0.0	7.6	0.0	12.6	3.7	0.0
Incr Delay (d2), s/veh	14.8	0.0	0.0				0.0	0.3	0.0	27.4	0.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.0	0.0				0.0	0.5	0.0	0.1	0.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	27.3	0.0	0.0				0.0	7.8	0.0	40.0	3.9	0.0
LnGrp LOS	C	A					A	A		D	A	A
Approach Vol, veh/h		14	A					371	A		698	
Approach Delay, s/veh		27.3						7.8			4.2	
Approach LOS		C						A			A	
Timer - Assigned Phs	1	2		4		6						
Phs Duration (G+Y+Rc), s	6.2	12.9		6.4		19.1						
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0						
Max Green Setting (Gmax), s	14.0	44.0		14.0		64.0						
Max Q Clear Time (g_c+I1), s	2.1	4.2		2.2		5.0						
Green Ext Time (p_c), s	0.0	2.7		0.0		5.7						

Intersection Summary

HCM 6th Ctrl Delay	5.7
HCM 6th LOS	A

Notes

Unsignalized Delay for [NBR, EBR] is excluded from calculations of the approach delay and intersection delay.



APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2021 Without Project Conditions PM Peak Hour
-

HCM 6th Signalized Intersection Summary

BY 2021 PM

1: Kualakai Pkwy & H-1 WB

11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	1352	0	2	371	1	0	0	13	1
Future Volume (veh/h)	0	0	0	1352	0	2	371	1	0	0	13	1
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach				No			No				No	
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				1470	0	0	403	1	0	0	14	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				1641	0		450	472	0	0	29	
Arrive On Green				0.47	0.00	0.00	0.25	0.25	0.00	0.00	0.02	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				1470	0	0	403	1	0	0	14	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				27.2	0.0	0.0	15.3	0.0	0.0	0.0	0.5	0.0
Cycle Q Clear(g_c), s				27.2	0.0	0.0	15.3	0.0	0.0	0.0	0.5	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				1641	0		450	472	0	0	29	
V/C Ratio(X)				0.90	0.00		0.90	0.00	0.00	0.00	0.48	
Avail Cap(c_a), veh/h				1825	0		508	534	0	0	400	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				16.8	0.0	0.0	25.3	19.6	0.0	0.0	34.2	0.0
Incr Delay (d2), s/veh				5.8	0.0	0.0	17.0	0.0	0.0	0.0	11.7	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				10.7	0.0	0.0	8.2	0.0	0.0	0.0	0.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				22.6	0.0	0.0	42.3	19.6	0.0	0.0	45.9	0.0
LnGrp LOS				C	A		D	B	A	A	D	
Approach Vol, veh/h					1470	A		404			14	A
Approach Delay, s/veh					22.6			42.3			45.9	
Approach LOS					C			D			D	
Timer - Assigned Phs				4		6		8				
Phs Duration (G+Y+Rc), s				7.1		39.3		23.7				
Change Period (Y+Rc), s				6.0		6.0		6.0				
Max Green Setting (Gmax), s				15.0		37.0		20.0				
Max Q Clear Time (g_c+I1), s				2.5		29.2		17.3				
Green Ext Time (p_c), s				0.0		4.0		0.4				
Intersection Summary												
HCM 6th Ctrl Delay				27.0								
HCM 6th LOS				C								
Notes												
Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.												

HCM 6th Signalized Intersection Summary

2: Kualakai Pkwy & H-1 EB

BY 2021 PM

11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	17	3	293	0	0	0	0	364	804	10	1394	0
Future Volume (veh/h)	17	3	293	0	0	0	0	364	804	10	1394	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No						No			No		
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	18	3	0				0	396	0	11	1515	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	32	5					0	1972		20	2502	0
Arrive On Green	0.02	0.02	0.00				0.00	0.56	0.00	0.01	0.70	0.00
Sat Flow, veh/h	1537	256	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	21	0	0				0	396	0	11	1515	0
Grp Sat Flow(s),veh/h/ln	1793	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	0.5	0.0	0.0				0.0	2.4	0.0	0.3	9.6	0.0
Cycle Q Clear(g_c), s	0.5	0.0	0.0				0.0	2.4	0.0	0.3	9.6	0.0
Prop In Lane	0.86		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	37	0					0	1972		20	2502	0
V/C Ratio(X)	0.57	0.00					0.00	0.20		0.54	0.61	0.00
Avail Cap(c_a), veh/h	370	0					0	4647		245	5625	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	21.2	0.0	0.0				0.0	4.9	0.0	21.4	3.3	0.0
Incr Delay (d2), s/veh	13.0	0.0	0.0				0.0	0.0	0.0	20.4	0.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	0.0	0.0				0.0	0.6	0.0	0.2	1.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	34.1	0.0	0.0				0.0	4.9	0.0	41.8	3.6	0.0
LnGrp LOS	C	A					A	A		D	A	A
Approach Vol, veh/h		21	A					396	A		1526	
Approach Delay, s/veh		34.1						4.9			3.8	
Approach LOS		C						A			A	
Timer - Assigned Phs	1	2		4		6						
Phs Duration (G+Y+Rc), s	6.5	30.2		6.9		36.7						
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0						
Max Green Setting (Gmax), s	6.0	57.0		9.0		69.0						
Max Q Clear Time (g_c+I1), s	2.3	4.4		2.5		11.6						
Green Ext Time (p_c), s	0.0	2.9		0.0		19.1						
Intersection Summary												
HCM 6th Ctrl Delay			4.4									
HCM 6th LOS			A									
Notes												
User approved pedestrian interval to be less than phase max green.												
Unsignalized Delay for [NBR, EBR] is excluded from calculations of the approach delay and intersection delay.												



APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2021 During Project Construction Conditions AM Peak Hour
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HCM 6th Signalized Intersection Summary

1: Kualakai Pkwy & H-1 WB

Construction AM

11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	639	0	31	335	62	0	0	9	25
Future Volume (veh/h)	0	0	0	639	0	31	335	62	0	0	9	25
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach				No			No			No		
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				695	0	0	364	67	0	0	10	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				996	0		479	503	0	0	23	
Arrive On Green				0.29	0.00	0.00	0.27	0.27	0.00	0.00	0.01	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				695	0	0	364	67	0	0	10	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				7.5	0.0	0.0	7.9	1.1	0.0	0.0	0.2	0.0
Cycle Q Clear(g_c), s				7.5	0.0	0.0	7.9	1.1	0.0	0.0	0.2	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				996	0		479	503	0	0	23	
V/C Ratio(X)				0.70	0.00		0.76	0.13	0.00	0.00	0.43	
Avail Cap(c_a), veh/h				2314	0		1236	1297	0	0	671	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				13.3	0.0	0.0	14.0	11.6	0.0	0.0	20.5	0.0
Incr Delay (d2), s/veh				0.9	0.0	0.0	2.5	0.1	0.0	0.0	11.8	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				2.5	0.0	0.0	2.9	0.4	0.0	0.0	0.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				14.2	0.0	0.0	16.6	11.7	0.0	0.0	32.3	0.0
LnGrp LOS				B	A		B	B	A	A	C	
Approach Vol, veh/h					695	A		431			10	A
Approach Delay, s/veh					14.2			15.8			32.3	
Approach LOS					B			B			C	
Timer - Assigned Phs				4		6		8				
Phs Duration (G+Y+Rc), s				6.5		18.0		17.2				
Change Period (Y+Rc), s				6.0		6.0		6.0				
Max Green Setting (Gmax), s				15.0		28.0		29.0				
Max Q Clear Time (g_c+I1), s				2.2		9.5		9.9				
Green Ext Time (p_c), s				0.0		2.6		1.4				
Intersection Summary												
HCM 6th Ctrl Delay				14.9								
HCM 6th LOS				B								
Notes												
Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.												

HCM 6th Signalized Intersection Summary

2: Kualakai Pkwy & H-1 EB

Construction AM

11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	45	5	360	0	0	0	0	357	719	6	636	0
Future Volume (veh/h)	45	5	360	0	0	0	0	357	719	6	636	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No						No			No		
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	49	5	0				0	388	0	7	691	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	80	8					0	965		13	1787	0
Arrive On Green	0.05	0.05	0.00				0.00	0.27	0.00	0.01	0.50	0.00
Sat Flow, veh/h	1624	166	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	54	0	0				0	388	0	7	691	0
Grp Sat Flow(s),veh/h/ln	1789	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	0.8	0.0	0.0				0.0	2.4	0.0	0.1	3.2	0.0
Cycle Q Clear(g_c), s	0.8	0.0	0.0				0.0	2.4	0.0	0.1	3.2	0.0
Prop In Lane	0.91		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	88	0					0	965		13	1787	0
V/C Ratio(X)	0.61	0.00					0.00	0.40		0.52	0.39	0.00
Avail Cap(c_a), veh/h	934	0					0	5833		930	8484	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	12.5	0.0	0.0				0.0	8.0	0.0	13.3	4.1	0.0
Incr Delay (d2), s/veh	6.7	0.0	0.0				0.0	0.3	0.0	27.5	0.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.0	0.0				0.0	0.6	0.0	0.1	0.4	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	19.1	0.0	0.0				0.0	8.3	0.0	40.8	4.2	0.0
LnGrp LOS	B	A					A	A		D	A	A
Approach Vol, veh/h	54		A				388		A	698		
Approach Delay, s/veh	19.1						8.3			4.6		
Approach LOS	B						A			A		
Timer - Assigned Phs	1	2		4		6						
Phs Duration (G+Y+Rc), s	6.2	13.3		7.3		19.5						
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0						
Max Green Setting (Gmax), s	14.0	44.0		14.0		64.0						
Max Q Clear Time (g_c+I1), s	2.1	4.4		2.8		5.2						
Green Ext Time (p_c), s	0.0	2.8		0.1		5.7						
Intersection Summary												
HCM 6th Ctrl Delay			6.5									
HCM 6th LOS			A									



APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2021 During Project Construction Conditions AM Peak Hour
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HCM 6th Signalized Intersection Summary

1: Kualakai Pkwy & H-1 WB

Construction PM

11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	1352	0	2	371	21	0	0	51	38
Future Volume (veh/h)	0	0	0	1352	0	2	371	21	0	0	51	38
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach				No			No				No	
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				1470	0	0	403	23	0	0	55	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				1610	0		446	468	0	0	76	
Arrive On Green				0.47	0.00	0.00	0.25	0.25	0.00	0.00	0.04	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				1470	0	0	403	23	0	0	55	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				29.3	0.0	0.0	16.2	0.7	0.0	0.0	2.2	0.0
Cycle Q Clear(g_c), s				29.3	0.0	0.0	16.2	0.7	0.0	0.0	2.2	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				1610	0		446	468	0	0	76	
V/C Ratio(X)				0.91	0.00		0.90	0.05	0.00	0.00	0.72	
Avail Cap(c_a), veh/h				1726	0		481	505	0	0	379	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				18.4	0.0	0.0	26.9	21.1	0.0	0.0	35.1	0.0
Incr Delay (d2), s/veh				7.5	0.0	0.0	19.6	0.0	0.0	0.0	12.0	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				12.1	0.0	0.0	9.0	0.3	0.0	0.0	1.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				25.9	0.0	0.0	46.5	21.1	0.0	0.0	47.1	0.0
LnGrp LOS				C	A		D	C	A	A	D	
Approach Vol, veh/h					1470	A		426			55	A
Approach Delay, s/veh					25.9			45.1			47.1	
Approach LOS					C			D			D	
Timer - Assigned Phs				4		6		8				
Phs Duration (G+Y+Rc), s				9.0		40.5		24.5				
Change Period (Y+Rc), s				6.0		6.0		6.0				
Max Green Setting (Gmax), s				15.0		37.0		20.0				
Max Q Clear Time (g_c+I1), s				4.2		31.3		18.2				
Green Ext Time (p_c), s				0.1		3.2		0.3				
Intersection Summary												
HCM 6th Ctrl Delay				30.7								
HCM 6th LOS				C								
Notes												
Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.												

HCM 6th Signalized Intersection Summary

2: Kualakai Pkwy & H-1 EB

Construction PM

11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	37	3	293	0	0	0	0	364	804	32	1410	0
Future Volume (veh/h)	37	3	293	0	0	0	0	364	804	32	1410	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No						No			No		
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	40	3	0				0	396	0	35	1533	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	61	5					0	1906		56	2486	0
Arrive On Green	0.04	0.04	0.00				0.00	0.54	0.00	0.03	0.70	0.00
Sat Flow, veh/h	1663	125	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	43	0	0				0	396	0	35	1533	0
Grp Sat Flow(s),veh/h/ln	1787	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	1.1	0.0	0.0				0.0	2.6	0.0	0.9	10.4	0.0
Cycle Q Clear(g_c), s	1.1	0.0	0.0				0.0	2.6	0.0	0.9	10.4	0.0
Prop In Lane	0.93		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	66	0					0	1906		56	2486	0
V/C Ratio(X)	0.65	0.00					0.00	0.21		0.63	0.62	0.00
Avail Cap(c_a), veh/h	353	0					0	4451		235	5388	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	21.6	0.0	0.0				0.0	5.5	0.0	21.8	3.6	0.0
Incr Delay (d2), s/veh	10.4	0.0	0.0				0.0	0.1	0.0	10.9	0.3	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	0.0	0.0				0.0	0.7	0.0	0.5	1.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	32.0	0.0	0.0				0.0	5.6	0.0	32.7	3.9	0.0
LnGrp LOS	C	A					A	A		C	A	A
Approach Vol, veh/h	43		A					396	A	1568		
Approach Delay, s/veh	32.0							5.6		4.5		
Approach LOS	C							A		A		
Timer - Assigned Phs	1	2	4		6							
Phs Duration (G+Y+Rc), s	7.4	30.4	7.7		37.8							
Change Period (Y+Rc), s	6.0	6.0	6.0		6.0							
Max Green Setting (Gmax), s	6.0	57.0	9.0		69.0							
Max Q Clear Time (g_c+I1), s	2.9	4.6	3.1		12.4							
Green Ext Time (p_c), s	0.0	2.9	0.1		19.5							
Intersection Summary												
HCM 6th Ctrl Delay			5.3									
HCM 6th LOS			A									



APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2021 With Project Conditions AM Peak Hour
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HCM 6th Signalized Intersection Summary

1: Kualakai Pkwy & H-1 WB

Future Year 2021 AM

11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	639	0	10	335	10	0	0	9	5
Future Volume (veh/h)	0	0	0	639	0	10	335	10	0	0	9	5
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach				No			No				No	
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				695	0	0	364	11	0	0	10	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				1000	0		467	491	0	0	23	
Arrive On Green				0.29	0.00	0.00	0.26	0.26	0.00	0.00	0.01	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				695	0	0	364	11	0	0	10	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				7.4	0.0	0.0	7.8	0.2	0.0	0.0	0.2	0.0
Cycle Q Clear(g_c), s				7.4	0.0	0.0	7.8	0.2	0.0	0.0	0.2	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				1000	0		467	491	0	0	23	
V/C Ratio(X)				0.70	0.00		0.78	0.02	0.00	0.00	0.43	
Avail Cap(c_a), veh/h				2343	0		1251	1313	0	0	679	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				13.1	0.0	0.0	14.1	11.3	0.0	0.0	20.2	0.0
Incr Delay (d2), s/veh				0.9	0.0	0.0	2.8	0.0	0.0	0.0	11.7	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				2.4	0.0	0.0	2.9	0.1	0.0	0.0	0.2	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				13.9	0.0	0.0	17.0	11.3	0.0	0.0	32.0	0.0
LnGrp LOS				B	A		B	B	A	A	C	
Approach Vol, veh/h					695	A		375			10	A
Approach Delay, s/veh					13.9			16.8			32.0	
Approach LOS					B			B			C	
Timer - Assigned Phs				4		6		8				
Phs Duration (G+Y+Rc), s				6.5		17.9		16.8				
Change Period (Y+Rc), s				6.0		6.0		6.0				
Max Green Setting (Gmax), s				15.0		28.0		29.0				
Max Q Clear Time (g_c+I1), s				2.2		9.4		9.8				
Green Ext Time (p_c), s				0.0		2.6		1.1				
Intersection Summary												
HCM 6th Ctrl Delay				15.1								
HCM 6th LOS				B								
Notes												
Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.												

HCM 6th Signalized Intersection Summary 2: Kualakai Pkwy & H-1 EB

Future Year 2021 AM

11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	8	5	360	0	0	0	0	342	719	6	636	0
Future Volume (veh/h)	8	5	360	0	0	0	0	342	719	6	636	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No						No			No		
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	9	5	0				0	372	0	7	691	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	17	10					0	966		14	1829	0
Arrive On Green	0.01	0.01	0.00				0.00	0.27	0.00	0.01	0.51	0.00
Sat Flow, veh/h	1165	647	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	14	0	0				0	372	0	7	691	0
Grp Sat Flow(s),veh/h/ln	1812	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	0.2	0.0	0.0				0.0	2.2	0.0	0.1	3.0	0.0
Cycle Q Clear(g_c), s	0.2	0.0	0.0				0.0	2.2	0.0	0.1	3.0	0.0
Prop In Lane	0.64		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	27	0					0	966		14	1829	0
V/C Ratio(X)	0.52	0.00					0.00	0.39		0.52	0.38	0.00
Avail Cap(c_a), veh/h	995	0					0	6132		978	8919	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	12.5	0.0	0.0				0.0	7.6	0.0	12.6	3.7	0.0
Incr Delay (d2), s/veh	14.8	0.0	0.0				0.0	0.3	0.0	27.4	0.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.0	0.0				0.0	0.5	0.0	0.1	0.3	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	27.3	0.0	0.0				0.0	7.8	0.0	40.0	3.9	0.0
LnGrp LOS	C	A					A	A		D	A	A
Approach Vol, veh/h	14		A				372		A	698		
Approach Delay, s/veh	27.3						7.8			4.2		
Approach LOS	C						A			A		
Timer - Assigned Phs	1	2		4		6						
Phs Duration (G+Y+Rc), s	6.2	12.9		6.4		19.1						
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0						
Max Green Setting (Gmax), s	14.0	44.0		14.0		64.0						
Max Q Clear Time (g_c+I1), s	2.1	4.2		2.2		5.0						
Green Ext Time (p_c), s	0.0	2.7		0.0		5.7						
Intersection Summary												
HCM 6th Ctrl Delay			5.7									
HCM 6th LOS			A									



APPENDIX C

LEVEL OF SERVICE CALCULATIONS

- Year 2021 With Project Conditions PM Peak Hour
-

HCM 6th Signalized Intersection Summary

1: Kualakai Pkwy & H-1 WB

Future Year 2021 PM

11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	0	0	0	1352	0	2	371	1	0	0	15	1
Future Volume (veh/h)	0	0	0	1352	0	2	371	1	0	0	15	1
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach				No			No				No	
Adj Sat Flow, veh/h/ln				1870	0	1870	1870	1870	0	0	1870	1870
Adj Flow Rate, veh/h				1470	0	0	403	1	0	0	16	0
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	2	2
Cap, veh/h				1639	0		450	472	0	0	32	
Arrive On Green				0.47	0.00	0.00	0.25	0.25	0.00	0.00	0.02	0.00
Sat Flow, veh/h				3456	0	1585	1781	1870	0	0	1870	1585
Grp Volume(v), veh/h				1470	0	0	403	1	0	0	16	0
Grp Sat Flow(s),veh/h/ln				1728	0	1585	1781	1870	0	0	1870	1585
Q Serve(g_s), s				27.4	0.0	0.0	15.4	0.0	0.0	0.0	0.6	0.0
Cycle Q Clear(g_c), s				27.4	0.0	0.0	15.4	0.0	0.0	0.0	0.6	0.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				1639	0		450	472	0	0	32	
V/C Ratio(X)				0.90	0.00		0.90	0.00	0.00	0.00	0.50	
Avail Cap(c_a), veh/h				1818	0		507	532	0	0	399	
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	0.00	1.00	1.00	0.00	0.00	1.00	0.00
Uniform Delay (d), s/veh				16.9	0.0	0.0	25.4	19.7	0.0	0.0	34.3	0.0
Incr Delay (d2), s/veh				5.9	0.0	0.0	17.2	0.0	0.0	0.0	11.3	0.0
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				10.8	0.0	0.0	8.2	0.0	0.0	0.0	0.4	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh				22.8	0.0	0.0	42.6	19.7	0.0	0.0	45.6	0.0
LnGrp LOS				C	A		D	B	A	A	D	
Approach Vol, veh/h					1470	A		404			16	A
Approach Delay, s/veh					22.8			42.5			45.6	
Approach LOS					C			D			D	
Timer - Assigned Phs				4		6		8				
Phs Duration (G+Y+Rc), s				7.2		39.4		23.7				
Change Period (Y+Rc), s				6.0		6.0		6.0				
Max Green Setting (Gmax), s				15.0		37.0		20.0				
Max Q Clear Time (g_c+I1), s				2.6		29.4		17.4				
Green Ext Time (p_c), s				0.0		4.0		0.4				
Intersection Summary												
HCM 6th Ctrl Delay				27.2								
HCM 6th LOS				C								
Notes												
Unsignalized Delay for [WBR, SBR] is excluded from calculations of the approach delay and intersection delay.												

HCM 6th Signalized Intersection Summary 2: Kualakai Pkwy & H-1 EB

Future Year 2021 PM

11/14/2019

												
Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (veh/h)	17	3	293	0	0	0	0	364	804	11	1395	0
Future Volume (veh/h)	17	3	293	0	0	0	0	364	804	11	1395	0
Initial Q (Qb), veh	0	0	0				0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Work Zone On Approach	No						No			No		
Adj Sat Flow, veh/h/ln	1870	1870	1870				0	1870	1870	1870	1870	0
Adj Flow Rate, veh/h	18	3	0				0	396	0	12	1516	0
Peak Hour Factor	0.92	0.92	0.92				0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	2	2	2				0	2	2	2	2	0
Cap, veh/h	32	5					0	1970		22	2503	0
Arrive On Green	0.02	0.02	0.00				0.00	0.55	0.00	0.01	0.70	0.00
Sat Flow, veh/h	1537	256	1585				0	3647	2790	1781	3647	0
Grp Volume(v), veh/h	21	0	0				0	396	0	12	1516	0
Grp Sat Flow(s),veh/h/ln	1793	0	1585				0	1777	1395	1781	1777	0
Q Serve(g_s), s	0.5	0.0	0.0				0.0	2.4	0.0	0.3	9.6	0.0
Cycle Q Clear(g_c), s	0.5	0.0	0.0				0.0	2.4	0.0	0.3	9.6	0.0
Prop In Lane	0.86		1.00				0.00		1.00	1.00		0.00
Lane Grp Cap(c), veh/h	37	0					0	1970		22	2503	0
V/C Ratio(X)	0.57	0.00					0.00	0.20		0.54	0.61	0.00
Avail Cap(c_a), veh/h	370	0					0	4643		245	5621	0
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00				0.00	1.00	0.00	1.00	1.00	0.00
Uniform Delay (d), s/veh	21.2	0.0	0.0				0.0	4.9	0.0	21.4	3.3	0.0
Incr Delay (d2), s/veh	13.0	0.0	0.0				0.0	0.0	0.0	19.1	0.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	0.0	0.0				0.0	0.6	0.0	0.2	1.0	0.0
Unsig. Movement Delay, s/veh												
LnGrp Delay(d),s/veh	34.2	0.0	0.0				0.0	4.9	0.0	40.5	3.6	0.0
LnGrp LOS	C	A					A	A		D	A	A
Approach Vol, veh/h	21		A				396		A	1528		
Approach Delay, s/veh	34.2						4.9			3.9		
Approach LOS	C						A			A		
Timer - Assigned Phs	1	2		4		6						
Phs Duration (G+Y+Rc), s	6.5	30.2		6.9		36.7						
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0						
Max Green Setting (Gmax), s	6.0	57.0		9.0		69.0						
Max Q Clear Time (g_c+I1), s	2.3	4.4		2.5		11.6						
Green Ext Time (p_c), s	0.0	2.9		0.0		19.1						
Intersection Summary												
HCM 6th Ctrl Delay			4.4									
HCM 6th LOS			A									