Appendix C

Glare Analysis

September 2023

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MEMORANDUM

To: Eric Ruby, Ascent Environmental

From: Philip DeVita, HMMH

Date: September 15, 2023

Subject: Jacumba Airport Glare Analysis

Reference: HMMH Job No.23-0058A

Introduction

Harris Miller Miller & Hanson Inc. (HMMH) completed a glare analysis for the evaluation of the proposed solar photovoltaic (PV) projects at Jacumba Airport in the county of San Diego, California. The analysis included evaluation of glare from potential ground mount and roof mount PV locations at the airport for aircraft on final approach and on drivers along nearby Old Highway 80. The purpose of the analysis is to address the CEQA Guidelines Appendix G checklist question of; if the Project will *Create a new source of substantial light or glare which would adversely affect day or nighttime views in the area.*

To analyze the potential for glare from the project, modeling was performed using the latest version of GlareGauge to analyze glare for pilots on final approach to Jacumba Airport, and vehicles traveling along portions of nearby roadway Old Highway 80. **Figure 1** shows the Project Aerial relative to the Jacumba Airport and **Figure 2** shows the Project Site Plan.

HMMH used the latest version of the ForgeSolar GlareGauge solar glare tool to analyze potential glare at the Jacumba Airport. GlareGauge is used to assess glare impacts at airport observation locations from solar photovoltaic (PV) projects and is the best tool available for analyzing solar glare impacts from PV projects. GlareGauge also has the ability to simulate glare to observers along a continuous roadway.

Source: Adapted by Ascent Environmental

Figure 1. PV Project Aerial relative to Jacumba Airport

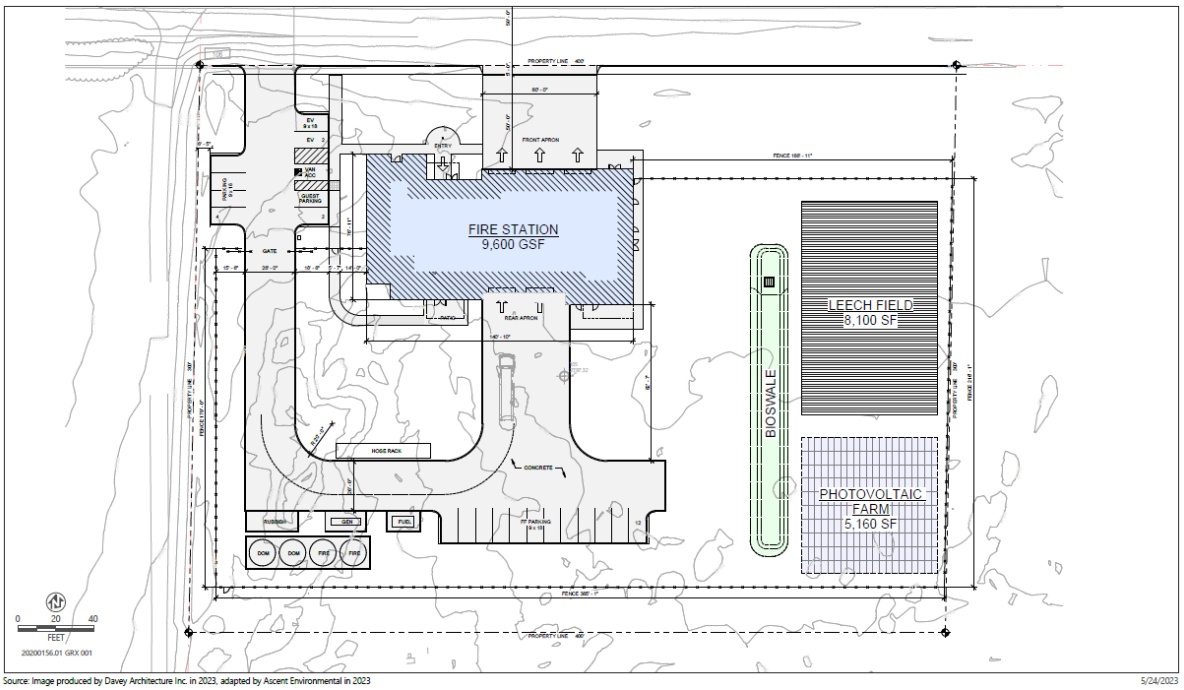


Figure 2. Project Site Plan

Source: Adapted by Ascent Environmental

Design Parameters

In deploying the model, we selected the area footprint of the solar project areas and input the project design parameters provided by Acent Environmental as shown in **Table 1.**

Table 1. Jacumba Airport Proposed Project Design Parameters

Solar System	*System*	*Orientation*	*Tilt Angle*	*Panel Centroid Height (AGL)[1]*
Ground Mount	***Fixed***	***180°***	***15°***	***5 feet***
Roof Mount at Proposed Fire Station	***Fixed***	***180°***	***15°[1]***	***40 feet***

Notes: 1. Panel centroid height are above ground level (agl) and assumes the height above ground for a ground-mount system as the height measured to the PV panel centroid. Maximum panel height minus half of the panel length can be used to find the centroid. For the ground mount assumes a 5 feet agl panel centroid and the Roof Mount system assumes a roof height of 40 agl.

The Project is proposing a fixed ground mount or roof mount system, or a combination of the two, at the new fire station. The potential fixed ground mount PV project would be oriented towards the south at 180 degrees, and have a tilt angle of 15 degrees and panel centroid height of 5 feet above ground level. In addition, the potential roof mount system would be oriented toward the south at a tilt angle of 15 degrees and have a roof height of 40 above ground level.

FAA Jurisdiction and Standards for Measuring Ocular Impact

Interim Policy for Solar Projects at Airports as Published on October 23, 2013

The FAA initially published an Interim Policy for Solar Projects at Airports on October 23, 2013. The policy clarified the FAA's jurisdiction in reviewing solar projects and the standards it uses to determine if a project will result in a negative glare impact to airspace safety.

Relative to its jurisdiction, the FAA affirmed that it has jurisdiction to regulate potential glare impacts as part of its responsibilities under Federal Aviation Regulations (FAR) Part 77 to any solar project proposed on the property of a Federally-obligated airport, which includes most airports in the U.S.

The FAA also clarified that it does not have jurisdiction to regulate potential glare from projects located on non-airport land. However, as stated in the Policy, "the FAA urges proponents of off-airport solar-installations to voluntarily implement the provisions in this policy."

The Policy also describes the standards for measuring ocular impact:

To obtain FAA approval and a "no objection" to a Notice of Proposed Construction Form 7460-1, the airport sponsor will be required to demonstrate that the proposed solar energy system meets the following standards: (1) no potential for glint or glare in the existing or planned Air Traffic Control Tower cab, and (2) no potential for glare or "low potential for after-image" (shown in green) along the final approach path.

Table 2 presents the airport sensitive receptors that must be evaluated, the potential results presented by the model and whether the result complies with the FAA ocular hazard standard presented in the October 2013 Policy.

Table 2. Levels of Glare and Compliance with FAA Policy

Airport Sensitive Receptor	Level of Glare	Color Result	Compliance with FAA Policy
Air Traffic Control Tower (ATCT) Cab	No glare	None	Yes
	Low Potential for After-Image	Green	No
	Potential for After-Image	Yellow	No
	Potential for Permanent Eye Damage	Red	No
Aircraft along final approach path	No glare	None	Yes
	Low Potential for After-Image	Green	Yes
	Potential for After-Image	Yellow	No
	Potential for Permanent Eye Damage	Red	No

As shown in Table 2, any glare recorded on the Air Traffic Control Tower (ATCT) is not compliant with FAA policy and will not receive a "no objection" determination from the FAA. Measurement of *no or low potential for after-image* or "Green" is acceptable for aircraft on final approach but greater levels with the potential for after image or permanent eye damage (indicated in yellow and red) are not allowed.

UPDATE: Review of Solar Energy System Projects on Federally Obligated Airports on May 11, 2021

More recently, the FAA updated this policy on May 11, 2021[1]. The new policy replaces the Interim Policy published on October 23, 2013. The updated policy is pared down compared to the 2013 policy and focuses on solar glare impacts in the air traffic control tower. Also, there is no longer a need to assess glare for pilots

[1] Federal Register: Federal Aviation Administration Policy: Review of Solar Energy System Projects on Federally-Obligated Airports

approaching the airport and no specific tool is required or recommended to analyze glare impacts from the panels. In summary, the new policy:

- Only applies to solar projects on airports (same as before)
- Only applies to airports with a control tower (no longer applies to non-towered airports)
- Only applies to impacts at the tower and no longer need to evaluate pilots on final approach. FAA determined that glint and glare from solar energy systems to pilots on final approach is "similar to glint and glare pilots routinely experience from water bodies, glass-façade buildings, parking lots, and similar features".
- Sponsor does not have to submit any glare modeling results with the 7460 application. It just has to include a statement that glint/glare has been evaluated and determined that impacts will not occur.
- FAA's determination of no hazard will have a statement saying that its determination is based on sponsor's glint/glare analysis, and further stating that sponsor will be responsible for mitigating any impacts observed after construction.
- Sponsor is no longer required to use SGHAT or similar program for evaluating glare. Policy says there are many options for evaluating potential glare impacts. Sponsor may not have to model for glare in certain instances (i.e., building blocks view of solar array location).
- Statement remains similar to previous policy in that proponents of off-airport projects are encouraged to evaluate glare especially near towered airports and proponents should consult with their local airport sponsor.

Since the most recent 2021 FAA policy applies to airports with an air traffic control tower and eliminates the evaluation of glare for pilots on final approach, the new policy would not apply to Jacumba Airport since there is no ATCT at the airport. However, as part of the CEQA review for the project, the county is requesting an analysis be performed for pilots on final approach as well as for vehicles traveling along nearby Old Highway 80 to demonstrate the PV projects will not create adverse glare at either location.

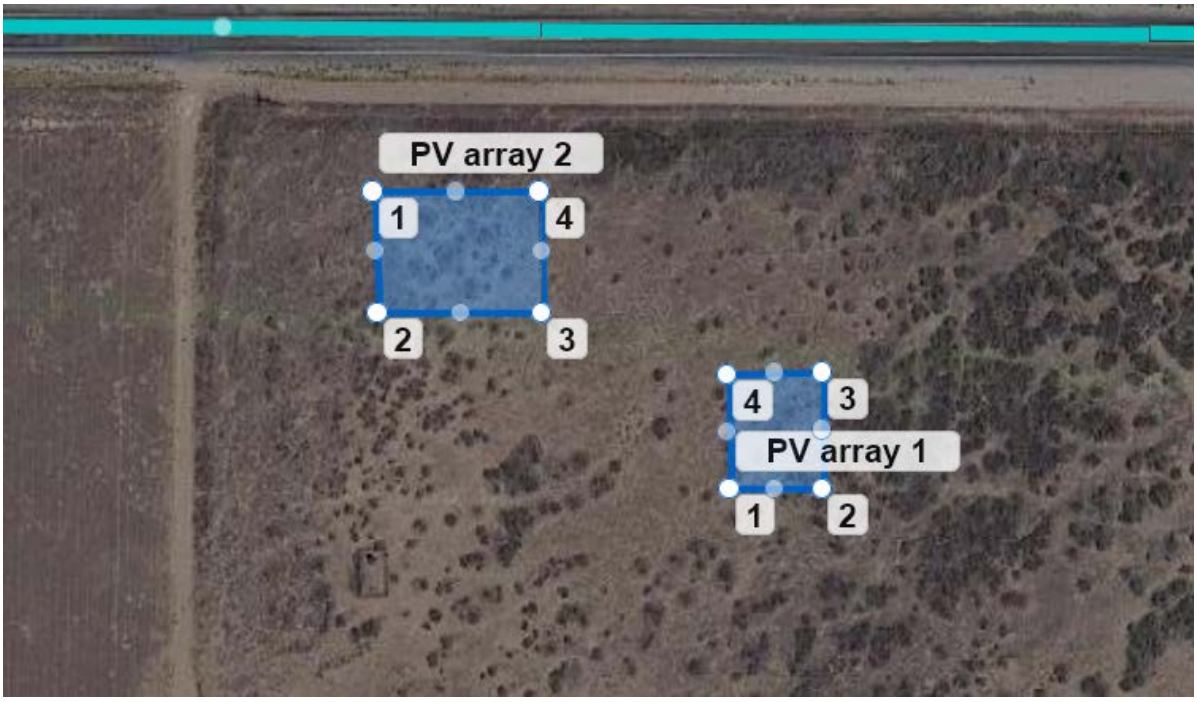
Summary of Results for Jacumba Airport

HMMH analyzed the potential for the Proposed PV Project sites to produce glare on pilots on final approach to Jacumba Airport and at nearby roadway observations. Based on the design and layout, GlareGauge modeling showed:

- Runway 07/25: Green glare (low potential of temporary after image) at observation points along the flight path for both PV sites; proposed designs meet the 2013 FAA Standard for aircraft on final approach.
- ATCT: no analysis conducted, no ATCT at the airport.
- Old Highway 80**:** No glare detected along nearby roadway segment, therefore, no adverse glare is predicted**.**

Results in Detail

To accurately model the proposed project, HMMH outlined the project array layouts on the model's interactive google map, and the GlareGauge tool analyzed the potential glare impact from the project site. **Figure 3** shows the layout of the project area as input into the model where PV Array 1 is the ground mount location and PV Array 2 is the roof mount location. The blue line segment north of the site is the nearby Old Highway 80 roadway segment.



Source: GlareGauge

Figure 3. Project Arrays as Input into the GlareGauge Model Including

We input the specifications of the array as discussed above in **Table 1** for each location. We also assumed a smooth panel surface without any anti-reflective coating to provide maximum flexibility in module selection. Modeling was then undertaken for the applicable sensitive receptors required by FAA assuming the 2013 Glare Policy: the pilots in aircraft along final descent to each runway end. [The FAA also requires an analysis of the ATCT; however there is no ATCT at Jacumba Airport, and therefore no such analysis could be conducted.] All of the modeling result output sheets are provided as **Attachment A**.

ATCT

For the Air Traffic Control Tower (ATCT) analysis, no analysis was conducted as the airport does not have an ATCT.

Arriving Aircraft

To analyze arriving aircraft, HMMH selected locational information associated with each runway individually and generated associated results to evaluate the potential impacts of the proposed project on that runway. Given there is one runway at Jacumba Airport; modeling was conducted separately for each runway end.

To model a runway approach, we selected a point at the centerline on the runway threshold which is located near the runway end. We then selected a second point away from the runway to represent the orientation of the aircraft descent (or glide) path. The model automatically plots the glide path out two miles from the runway end and evaluates potential for glare along the entire glide path. Given that Jacumba Airport has two runway ends; the model assessed the potential for glare along each of the two aircraft final approach paths landing at the airport. The model automatically plots the location and height above ground of each observation point along the glide path assuming a 3 degree glide slope for the approach. In the model's flight path window, we checked the "consider pilot visibility from cockpit" box and kept the default azimuth-viewing angle of 50° so that the model would not register glare that the pilot would not see from behind the aircraft. We also kept the default downward viewing angle of 30° to eliminate false glare results from below the aircraft. **Figure 4** shows the GlareGauge illustration of the 2-mile approach and **Figure 5** shows the flight path analyzed by the model for each runway.

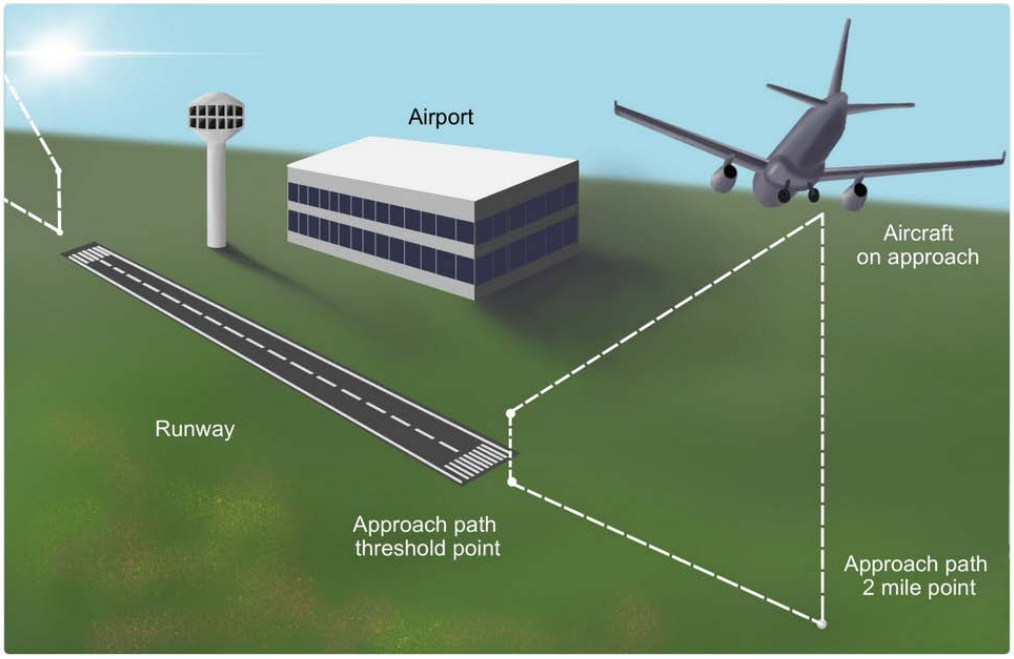


Illustration of aircraft utilizing 2-mile approach path toward airport

Source: GlareGauge

Figure 4. GlareGauge 2-Mile Approach

Source: GlareGauge

Figure 5. Flight Path Analyzed by GlareGauge

The model shows component results in time for the aircraft along a continuous route. **Table 3** presents the GlareGauge modeling results for each runway in terms of predicted minutes of green, yellow, or red glare.

As shown in **Table 3**, green glare or low potential for temporary after image was detected by the model for both runway approaches from both PV locations. A total of 2,352 minutes and 6,066 minutes of green glare is predicted for approach to RWY 25 and RWY 7, respectively. As shown in the model plots in **Attachment A**, most of the glare along the path to RWY 25 occurs in the afternoon when the sun sets during March and April and again in September and October. Similarly for the RWY 7 approach path, glare occurs during the morning hours from April thru September when the sun is rising. The green glare result on aircraft on approach to each runway complies with the FAA's ocular impact standard as published in the Federal Register on October 23, 2013 and shown in above **Table 2**.

Table 3 – GlareGauge Results (in minutes per year) for the Proposed PV Solar Projects at Jacumba Airport

Site	Fixed/Tracker System	(orientation/tilt)	ATCT	RWY 07[1]	RWY 25[1]	Comply with 2013 FAA Thresholds
Ground Mount	Fixed	180°/15°	N/A	3,384	1,055	Yes
Roof Mount	Fixed	180°/15°	N/A	2,682	1,297	Yes

1. Model results represent a panel centroid height of 5 feet for the ground mount and 40 for the roof mount.

Notes:

G (Green) = Low Potential for Temporary After-Image
Y (Yellow) = Potential for Temporary After-Image
R (Red) = Potential for Permanent Eye-Damage

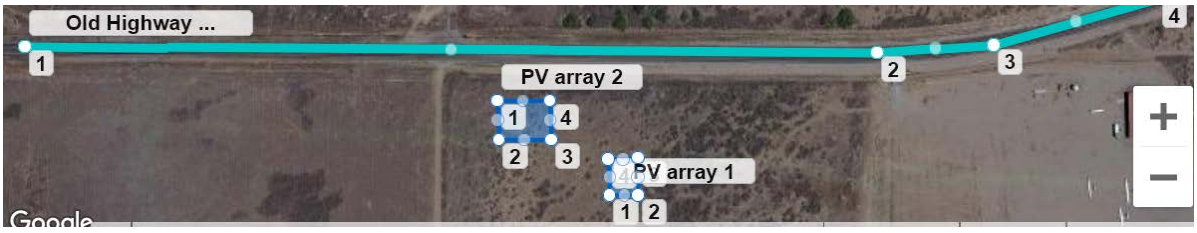
N/A = Not applicable, no analysis conducted.

GlareGauge Modeling Nearby Roadway Observation Locations

In addition to the pilot approaches, HMMH analyzed the potential for the two proposed solar PV locations to produce glare at nearby roadway observation locations using GlareGauge. As discussed, the GlareGauge model is currently the best tool available for analyzing solar glare impacts from PV projects and is able to simulate glare from proposed solar PV projects to observers along a continuous roadway segment.

Methodology

For the analysis, the nearby Old Highway 80 roadway segment was analyzed as it traverses near the airport property boundary to the north. **Figure 6** shows the Project array layouts and roadway segment locations from the GlareGauge model selected for analysis. The Old Highway 80 roadway segment (denoted as Old Highway) as depicted in light green/blue (teal) in **Figure 6.**

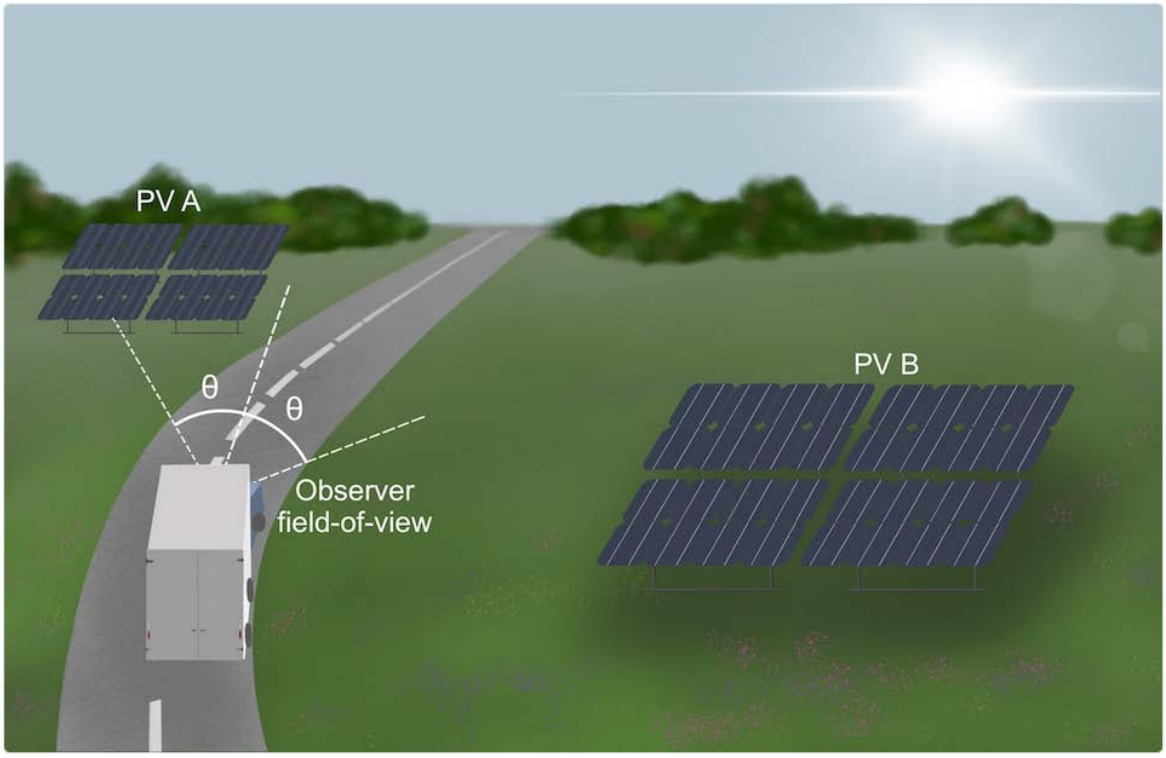


Source: GlareGauge

Figure 6. Roadway Segment Analyzed in GlareGauge

HMMH input the specifications of the project array design parameters as described above in **Table 1**. A smooth panel surface without any anti-reflective coating was assumed to provide maximum flexibility in module selection.

The model was run for a full calendar year to calculate information for every sun position scenario over a typical year and the model assessed potential for glare at one-minute intervals. The roadway analysis assumes a two-way viewing meaning the observers travel along the route in both directions as a conservative approach. A viewer default angle of 50° was chosen as the field of view where the observer can see 50 degrees to the left and right for a total field of view of 100°. **Figure 7** shows a depiction of the route field of view in GlareGauge. A total of one nearby roadway segment along Old Highway 80 traveling eastward in one direction and westward in the other direction were input into GlareGauge assuming a viewing height of 6 feet above ground level for roadway observers.



*Route receptor field-of-view is defined by view angle (theta) to left and right. Default FOV is 100° (i.e. 2 * 50° view angle).*

Source: GlareGauge

Figure 7. Route Receptor Field of View in GlareGauge

The modeling result output sheets for the roadway locations are provided as **Attachment A** and denoted as "Old Highway 80" in the model output**.**

GlareGauge Results

A summary of the model output is presented in **Table 4** for the nearby roadway observer segments. As shown in **Table 4**, no glare was detected by the model for any of the PV locations to the nearby roadway observer locations. The GlareGauage results were also compared to the 2013 FAA Glare Standards for Pilots on Final Approach to determine significant impacts.

As discussed above and shown if **Figure 2**, measurement of no or Low Potential for After-Image or Green is acceptable for aircraft on final approach, but greater levels (indicated in yellow and red) are not allowed.

Any potential solar glare to the vehicles traveling along the nearby roadways is very similar or representative to aircraft along final approach in the 2013 FAA standards. Therefore in lieu of CEQA or county specific glare standards, the standards of acceptable ocular impact as contained in the FAA policy for aircraft on final approach were applied to the vehicles traveling along this section of Old Highway 80 to determine significant impacts. It should be noted that the GlareGauge model does not consider potential obstacles associated with the landscape such as trees, buildings or hills which could block a direct view of the solar panels to the nearby observer locations.

Table 4 – GlareGauge Results (in minutes per year) for the Proposed PV Solar Projects at Nearby Roadways Observer Locations Compared to FAA Glare Standards for Pilots to Determine Significant Impacts

Site	Fixed/Tracker System	(orientation/tilt)	Old Highway 80	Comply with FAA Glare Standards ATCT/Pilot [1]
Ground Mount	Fixed	180°/15°	0	Yes
Roof Mount	Fixed	180°/15°	0	Yes

Notes:

1. In lieu of CEQA or county specific glare standards, the standards of acceptable ocular impact as contained in the FAA policy for aircraft on final approach were applied to the vehicles traveling along this section of Old Highway 80 to determine significant impacts.

Based on the design array locations of the Proposed Project as modeled, the GlareGauge modeling showed no glare detected at the nearby roadway segments. *Therefore, there is no evidence based upon our modeling of the potential array locations that glare from the Project will cause an adverse impact for drivers along analyzed segments or of the adjacent public properties and/or right of ways.*

Conclusions

HMMH utilized the GlareGauge model developed by the Department of Energy's Sandia National Laboratories to evaluate potential glare from two proposed solar PV locations at Jacumba Airport. The analysis evaluated potential glare from the proposed project for pilots on final approach to the airports two runway ends and nearby roadway observer locations.

The most recent 2021 FAA policy applies to airports with an air traffic control tower and eliminates the evaluation of glare for pilots on final approach, the new policy would not apply to Jacumba Airport since there is no ATCT at the airport. However at the request of the county under the CEQA process, HMMH evaluated pilot glare on final approach *with the 2013 FAA ocular hazard standards published in the FAA's Interim Policy.* The model results provided in **Attachment A** show that minutes of green glare, or low potential for temporary after image was detected at both the approach to Runway 07 and Runway 25 from both proposed PV locations. These results comply with 2013 FAA standards for pilots on final approach and no adverse glare is predicted.

In addition, GlareGauge is currently the best tool available for analyzing solar glare impacts from PV projects and has the ability to simulate glare to observers along a continuous roadway segment. In lieu of CEQA or county specific glare standards, the GlareGauge model results were compared to the FAA standards for pilots on final approach as shown in **Table 2**. **Attachment A** show the GlareGauge modeling results for the nearby roadway segments. The GlareGauge modeling showed no glare detected at the nearby Old Highway 80 roadway segment.,

Therefore, there is no evidence based upon our modeling of the proposed array locations that glare from the Project will cause an adverse impact for pilots on final approach at Jacumba Airport, and/or drivers along analyzed roadway segments as modeled. These results *comply* with the FAA standards described in the FAA 2013 and 2021 policy and should not *create a new source of substantial light or glare which would adversely affect day or nighttime views in the area. It should be noted that this glare analysis is based on when the sun's position during the year and does not evaluate glare at nighttime as the sun is not shining at night.*

Attachment A

GlareGauge Modeling Results – Jacumba Airport Proposed Solar PV Sites