# Attachment P: Glare Analysis

TETRA TECH

# Memo

**To:** Wallula Gap Solar, LLC

**From:** Drew Timmis, Tetra Tech, Inc.

**Date:** January 10, 2024

**Subject:** Glint and Glare Analysis of the Wallula Gap Solar Project in Benton County, Washington

At the request of Wallula Gap Solar, LLC (Applicant), Tetra Tech, Inc. (Tetra Tech) conducted a glint and glare analysis of the proposed Wallula Gap Solar Project (Facility). The Facility is a proposed solar photovoltaic (PV) electric generating facility that includes 60 megawatts (MW) of solar energy and occupies an approximately 392-acre area. The Facility Area primarily consists of undeveloped land and agricultural land and is generally bounded agricultural land and Washington State Route 14 (WA 14) to the south.

Topography throughout the Facility Area varies, ranging from approximately 380 feet to 508 feet above mean sea level. The nearest public airport is the Hermiston Municipal Airport, located approximately 11.5 miles southeast of the Facility.

This memorandum provides a description of the glint and glare anticipated from use of the Facility Area as a solar energy generating facility. Included are the Sandia glare analysis reports (Attachment A), and the Federal Aviation Administration (FAA) Notice Criteria Tool Report (Attachment B).

## GLARE ANALYSIS METHOD

With growing numbers of solar energy systems being proposed and installed throughout the United States, the potential impact of glint (a momentary flash of bright light) and glare (a continuous source of bright light) from solar photovoltaic modules has come under scrutiny by aviation authorities. The FAA issued an Interim Policy (78 Federal Register [FR] 63276) on October 23, 2013, describing methods for obtaining FAA review and approval of proposed solar arrays on airport property. These methods involved the use of the Sandia Laboratories Solar Glare Hazard Analysis Tool (SGHAT), a modeling/compliance analysis tool now licensed for public use within the ForgeSolar GlareGauge cloud software application. The SGHAT is considered to be an industry best practice for analysis of glare and glint related to solar energy generating facilities and is required by the FAA under 78 FR 63276 to measure ocular impacts for solar projects located on federally obligated airports and is recommended for projects located off federally obligated airports. SGHAT analysis was carried out according to the FAA technical report, "Technical Guidance for Evaluating Selected Solar Technologies on Airports" (FAA 2010).

The following statement was issued by Sandia Laboratories regarding the SGHAT technology:

> *Sandia developed SGHAT v. 3.0, a web-based tool and methodology to evaluate potential glint/glare associated with solar energy installations. The validated tool provides a quantified assessment of when and where glare will occur, as well as information about potential ocular impacts. The calculations and methods are based on analyses, test data, a database of different photovoltaic module surfaces (e.g. anti-reflective*

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> *coating, texturing), and models developed over several years at Sandia. The results are presented in a simple easy-to-interpret plot that specifies when glare will occur throughout the year, with color indicating the potential ocular hazard.* (Sandia National Laboratories 2016)

Note, however, that technology changes continue to occur to address issues such as reflectivity. The model, therefore, presents a conservative assessment based upon simplifying assumptions inherent in the model as well as industry improvements since the most recent update of such assumptions.

Based on the predicted retinal irradiance (intensity) and subtended angle (size/distance) of the glare source to receptor, the GlareGauge categorizes potential glare where it is predicted by the model to occur in accordance with three tiers of severity (ocular hazards) that are shown by different colors in the model output:

- Red glare: glare predicted with a potential for permanent eye damage (retinal burn);
- Yellow glare: glare predicted with a potential for temporary after-image; and
- Green glare: glare predicted with a low potential for temporary after-image.

These categories of glare are calculated using a typical observer's blink response time, ocular transmission coefficient (the amount of radiation absorbed in the eye prior to reaching the retina), pupil diameter, and eye focal length (the distance between where rays intersect in the eye and the retina). As a point of comparison, direct viewing of the sun without a filter is considered to be on the border between yellow glare and red glare, while typical camera flashes are considered to be lower tier yellow glare (approximately three orders of magnitude less than direct viewing of the sun). Upon exposure to yellow glare, the observer may experience a temporary spot in their vision temporarily lasting after the exposure. Upon exposure to green glare, the observer may experience a bright reflection but typically no spot lasting after exposure.

Based on this background, Tetra Tech has used the SGHAT tool as licensed for use in ForgeSolar GlareGauge cloud software application for modeling and analysis. ForgeSolar GlareGauge with SGHAT modeling provides a quantified assessment of when and where glare will occur, as well as information about potential ocular impacts.

The SGHAT was used to evaluate the potential for glint and glare when driving along 1) proximal segments of McNary Hwy, S Plymouth Rd, and WA 14; and 2) 11 nearby locations selected to represent observer views at neighboring properties. The analysis reports are included as **Attachment A**.

The FAA Notice Criteria Tool allows the user to determine if a proposed structure would require a formal submission to the FAA under Title 14 Code of Federal Regulations Part 77.9 (Safe, Efficient Use, and Preservation of the Navigable Airspace). This online tool was utilized to determine if the proposed Facility would require formal filing to the FAA. Based on the results of the FAA Notice Criteria Tool, the Facility does not exceed notice criteria; therefore, it is not required for the Facility to be formally filed with the FAA Obstruction Evaluation Group. Due to the Facility not exceeding criteria and the distance to the airport, it was not included in the glare analysis. The FAA Notice Criteria Tool Report is included as **Attachment B**.

The panels to be used on the proposed Facility are smooth glass surface material with an anti-reflection coating (ARC), which is noted in the glare analysis. Three analyses were performed to simulate single axis

tracking panels with a 52 degree tilt. The analyses were conducted for a panel height of 7 feet above ground surface (centroid height) with applicable panel specifications. Backtracking was simulated with a resting angle of 5 degrees for Analyses 1 and 2, and 10 degrees for Analysis 3. Backtracking is the programmed strategy that rotates the modules away from the sun to reduce shading to other panels. This typically is put into effect when the sun's position lies outside the range of rotation defined by the maximum tracking angle (52 degrees) of the PV panels, or when substantial shading occurs. The resting angle is the programmed in tilt that the panels stay at while the sun's position is outside the defined tracking angle. The panel orientation, location, and specifications used in the analysis were based on the Plant Layout as provided by the Applicant, dated October 17, 2023. The input features used in the analyses are summarized in Table 1.

**Table 1. Glare Analyses Input Features**

| Analysis No. | Racking Type | Module Orientation | Tilt (degrees) | Module Height 1/ (feet) | OP Height 2/ (feet) | Route Height 3/ (feet) |
|---|---|---|---|---|---|---|
| 1 | Tracking | East-facing | 60 | 5 | 6 | 5 |
| 2 | Tracking | East-facing | 60 | 5 | 16 | 9 |
| 3 | Tracking | East-facing | 60 | 5 | 16 | 9 |

1/ Average module centroid height above ground surface.
2/ Height of observation point receptor: 6 feet represents an average first floor residential/commercial point of view and 16 feet represents an average second floor residential/commercial point of view.
3/ Height of vehicular route receptor: 5 feet represents typical commuter car height and 9 feet represents typical semi-tractor-trailer truck views.

## GLARE ANALYSIS RESULTS

### Analyses 1 – First-Story Receptors

Analysis 1 analyzed five PV Array Areas for 11 first-story receptors (OP-1 through OP-11) and four proximal route receptors along segments of McNary Hwy, S Plymouth Rd, and two segments of WA 14 from the height of a standard commuter vehicle. The SGHAT GlareGauge modeled the results for the Facility. No glare was predicted.

### Analyses 2 – Second-Story Receptors

Analysis 2 analyzed five PV Array Areas for 11 second-story receptors (OP-1 through OP-11 and four proximal route receptors along segments of McNary Hwy, S Plymouth Rd, and two segments of WA 14 from the height of a typical tractor trailer. The SGHAT GlareGauge modeled the results for the Facility. The simulation predicted minor amounts of green and yellow glare along a specific section of WA 14-1. Predicted glare for WA 14 occurs from mid-May through August with a duration of less than 8 minutes between the hours of 7:00 PM and 8:00 PM.

No instances of red glare is predicted for any OP or route segments. The total amount of annual green glare predicted for Analysis 2 is 215 minutes, and the total amount of annual yellow glare for Analysis 2 is 127 minutes. This is considered a minor amount.

**Table 2. Summary of Predicted Glare**

| | Receptor | Annual Green Glare | | Annual Yellow Glare | | Annual Red Glare | |
|---|---|---|---|---|---|---|---|
| | | minutes | hours | minutes | hours | minutes | hours |
| Analysis 2 | WA 14-1 | 215 | 3.6 | 127 | 2.1 | - | - |

No instances of yellow or red glare is predicted for any OP or route segment.

**Table 3. Detailed Glare Summary**

| Receptor | Type of Glare | Minutes per Day | Time of Day | Time of Year |
|---|---|---|---|---|
| WA 14-1 | Green | Less than 8 minutes | 7:00 – 8:00 PM | Mid-May through August |
| | Yellow | Less than 5 minutes | 7:00 – 8:00 PM | Mid-May through August |

## Analyses 3 – Optimized

Analysis 3 analyzed the same components as Analysis 2. With predicted glare occurring from PV Array 5 the resting angle was increased from 5 to 10 degrees. The SGHAT GlareGauge modeled the results for the Facility. No glare was predicted.

## SUMMARY

The Facility Area layout was modeled on SGHAT GlareGauge to evaluate the potential extent of any glint and glare the proposed Facility may have upon nearby points of observation and vehicle routes. Three analyses were performed: the analyses represented a single axis tracking system with 52 degree tilt and panel specifications of smooth glass with ARC. Minor amounts of green glare (3.6 annual hours) and yellow glare (2.1 annual hours) were predicted along a segment of WA 14 from PV Array 5. Only a small section in the central portion of WA 14, which is directly adjacent to PV Array 5, is predicted to received glare. No red glare was predicted. Analysis 3 found that, if the resting angle of PV Array 5 was increased to 10 degrees, it would eliminate the predicted glare. Tetra Tech recommends setting the resting angle for the area of arrays predicted to cause glare to 10 degrees to prevent glare.

The GlareGauge model does not account for varying ambient conditions (i.e., cloudy days, precipitation), atmospheric attenuation, screening due to existing topography not located within the defined array layouts. As such, the predicted results are considered conservative. Lastly, based on the results of the FAA Notice Criteria Tool, the Facility does not exceed notice criteria; therefore, it is not required for the Facility to be formally filed with the FAA Obstruction Evaluation Group.

## REFERENCES

Sandia Solar Glare Hazard Analysis Tool, GlareGauge hosted by ForgeSolar. Accessed online https://www.forgesolar.com/.

Sandia National Laboratories. 2016. Solar Glare Hazard Analysis Tool (SGHAT). Accessed online https://ip.sandia.gov/opportunity/solar-glare-hazard-analysis-tool-sghat/.

Federal Aviation Administration. 2010. Technical Guidance for Evaluating Selected Solar Technologies on Airports.

# ATTACHMENT A: GLARE ANALYSIS REPORTS

# FORGESOLAR GLARE ANALYSIS

Project: **Wallula Gap Solar Project**
Site configuration: **Analysis 1- 1st Story Receptors**

**Created** 19 Dec, 2023
**Updated** 19 Dec, 2023
**Time-step** 1 minute
**Timezone offset** UTC-8
**Minimum sun altitude** 0.0 deg
**DNI** peaks at 1,000.0 W/m$^2$
**Category** 10 MW to 100 MW
**Site ID** 108342.18788

**Ocular transmission coefficient** 0.5
**Pupil diameter** 0.002 m
**Eye focal length** 0.017 m
**Sun subtended angle** 9.3 mrad
**PV analysis methodology** V2


## Summary of Results No glare predicted

| PV Array | Tilt | Orient | Annual Green Glare | | Annual Yellow Glare | | Energy |
|---|---|---|---|---|---|---|---|
| | ° | ° | min | hr | min | hr | kWh |
| PV array 1 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 2 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 3 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 4 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 5 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |

*Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

# Component Data

## PV Arrays

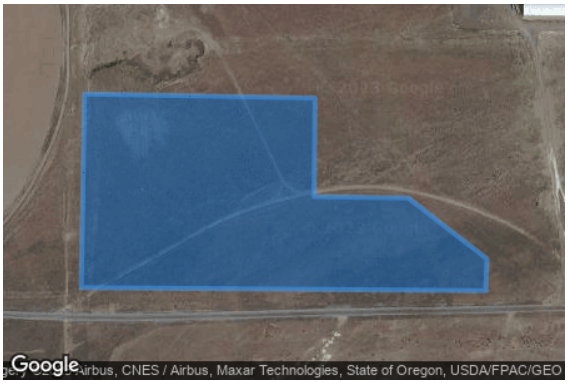
**Name**: PV array 1
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 180.0°
**Max tracking angle**: 52.0°
**Resting angle**: 5.0°
**Ground Coverage Ratio**: 0.32
**Rated power**: -
**Panel material**: Smooth glass with AR coating
**Reflectivity**: Vary with sun
**Slope error**: correlate with material


| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 45.964068 | -119.455327 | 553.14 | 7.00 | 560.14 |
| 2 | 45.964052 | -119.445861 | 556.08 | 7.00 | 563.08 |
| 3 | 45.961727 | -119.444205 | 517.24 | 7.00 | 524.24 |
| 4 | 45.960840 | -119.444014 | 509.51 | 7.00 | 516.51 |
| 5 | 45.960112 | -119.443963 | 494.04 | 7.00 | 501.04 |
| 6 | 45.958936 | -119.445297 | 481.06 | 7.00 | 488.06 |
| 7 | 45.958890 | -119.449608 | 481.92 | 7.00 | 488.92 |
| 8 | 45.957526 | -119.449699 | 481.45 | 7.00 | 488.45 |
| 9 | 45.957495 | -119.453232 | 482.82 | 7.00 | 489.82 |
| 10 | 45.958575 | -119.454870 | 490.06 | 7.00 | 497.06 |
| 11 | 45.959020 | -119.455322 | 494.29 | 7.00 | 501.29 |
| 12 | 45.959925 | -119.455611 | 501.57 | 7.00 | 508.57 |

**Name**: PV array 2
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 180.0°
**Max tracking angle**: 52.0°
**Resting angle**: 5.0°
**Ground Coverage Ratio**: 0.32
**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 | 45.956543 | -119.451151 | 476.17 | 7.00 | 483.17 |
| 2 | 45.956514 | -119.448037 | 473.89 | 7.00 | 480.89 |
| 3 | 45.956179 | -119.447920 | 467.41 | 7.00 | 474.41 |
| 4 | 45.955318 | -119.447739 | 455.05 | 7.00 | 462.05 |
| 5 | 45.954251 | -119.447765 | 437.71 | 7.00 | 444.71 |
| 6 | 45.954241 | -119.448429 | 440.29 | 7.00 | 447.29 |
| 7 | 45.954590 | -119.449000 | 450.70 | 7.00 | 457.70 |
| 8 | 45.956073 | -119.451199 | 466.69 | 7.00 | 473.69 |

**Name**: PV array 3
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 180.0°
**Max tracking angle**: 52.0°
**Resting angle**: 5.0°
**Ground Coverage Ratio**: 0.32
**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 | 45.955979 | -119.455532 | 472.53 | 7.00 | 479.53 |
| 2 | 45.955932 | -119.451570 | 465.93 | 7.00 | 472.93 |
| 3 | 45.954758 | -119.451585 | 455.74 | 7.00 | 462.74 |
| 4 | 45.954741 | -119.449968 | 454.14 | 7.00 | 461.14 |
| 5 | 45.954016 | -119.448616 | 436.89 | 7.00 | 443.89 |
| 6 | 45.953637 | -119.448636 | 433.44 | 7.00 | 440.44 |
| 7 | 45.953673 | -119.455586 | 438.50 | 7.00 | 445.50 |

**Name**: PV array 4
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 180.0°
**Max tracking angle**: 52.0°
**Resting angle**: 5.0°
**Ground Coverage Ratio**: 0.32
**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 | 45.953113 | -119.455331 | 436.36 | 7.00 | 443.36 |
| 2 | 45.953103 | -119.447321 | 429.60 | 7.00 | 436.60 |
| 3 | 45.951986 | -119.447281 | 413.49 | 7.00 | 420.49 |
| 4 | 45.951922 | -119.445424 | 414.48 | 7.00 | 421.48 |
| 5 | 45.950797 | -119.443616 | 397.01 | 7.00 | 404.01 |
| 6 | 45.949605 | -119.441998 | 390.90 | 7.00 | 397.90 |
| 7 | 45.949297 | -119.441681 | 386.38 | 7.00 | 393.38 |
| 8 | 45.948500 | -119.441678 | 384.09 | 7.00 | 391.09 |
| 9 | 45.948029 | -119.444439 | 395.66 | 7.00 | 402.66 |
| 10 | 45.947718 | -119.446575 | 387.40 | 7.00 | 394.40 |
| 11 | 45.947422 | -119.451839 | 386.14 | 7.00 | 393.14 |
| 12 | 45.947423 | -119.455493 | 387.36 | 7.00 | 394.36 |

**Name**: PV array 5
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 180.0°
**Max tracking angle**: 52.0°
**Resting angle**: 5.0°
**Ground Coverage Ratio**: 0.32
**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 | 45.952102 | -119.444247 | 416.40 | 7.00 | 423.40 |
| 2 | 45.952095 | -119.441415 | 418.83 | 7.00 | 425.83 |
| 3 | 45.953230 | -119.441391 | 429.58 | 7.00 | 436.58 |
| 4 | 45.953245 | -119.439846 | 427.97 | 7.00 | 434.97 |
| 5 | 45.951783 | -119.439792 | 419.81 | 7.00 | 426.81 |
| 6 | 45.951671 | -119.435458 | 413.12 | 7.00 | 420.12 |
| 7 | 45.950828 | -119.435318 | 400.98 | 7.00 | 407.98 |
| 8 | 45.950144 | -119.435329 | 392.41 | 7.00 | 399.41 |
| 9 | 45.949726 | -119.435908 | 394.84 | 7.00 | 401.84 |
| 10 | 45.949703 | -119.437400 | 390.65 | 7.00 | 397.65 |
| 11 | 45.949345 | -119.437453 | 388.17 | 7.00 | 395.17 |
| 12 | 45.949338 | -119.438816 | 390.69 | 7.00 | 397.69 |
| 13 | 45.948920 | -119.438870 | 384.17 | 7.00 | 391.17 |
| 14 | 45.949017 | -119.440715 | 383.44 | 7.00 | 390.44 |
| 15 | 45.949771 | -119.441639 | 389.84 | 7.00 | 396.84 |
| 16 | 45.950969 | -119.443323 | 405.20 | 7.00 | 412.20 |
| 17 | 45.951655 | -119.444278 | 407.12 | 7.00 | 414.12 |

## Route Receptors

**Name**: McNary Hwy
**Path type**: Two-way
**Observer view angle**: 50.0°


| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 45.967340 | -119.341676 | 597.10 | 5.00 | 602.10 |
| 2 | 45.965714 | -119.342298 | 573.03 | 5.00 | 578.03 |
| 3 | 45.964092 | -119.342641 | 549.28 | 5.00 | 554.28 |
| 4 | 45.962906 | -119.342759 | 533.41 | 5.00 | 538.41 |
| 5 | 45.961213 | -119.342577 | 512.60 | 5.00 | 517.60 |
| 6 | 45.959811 | -119.342256 | 498.29 | 5.00 | 503.29 |
| 7 | 45.958640 | -119.341784 | 489.83 | 5.00 | 494.83 |
| 8 | 45.957044 | -119.340981 | 487.33 | 5.00 | 492.33 |
| 9 | 45.954631 | -119.339824 | 476.83 | 5.00 | 481.83 |
| 10 | 45.952628 | -119.338860 | 470.59 | 5.00 | 475.59 |
| 11 | 45.950624 | -119.337896 | 465.65 | 5.00 | 470.65 |
| 12 | 45.948246 | -119.336728 | 458.43 | 5.00 | 463.43 |
| 13 | 45.945218 | -119.335307 | 428.60 | 5.00 | 433.60 |
| 14 | 45.943238 | -119.334350 | 408.90 | 5.00 | 413.90 |
| 15 | 45.940170 | -119.332854 | 390.85 | 5.00 | 395.85 |
| 16 | 45.935669 | -119.330670 | 328.23 | 5.00 | 333.23 |
| 17 | 45.930469 | -119.328215 | 267.60 | 5.00 | 272.60 |
| 18 | 45.928416 | -119.327182 | 273.04 | 5.00 | 278.04 |

**Name**: S Plymouth Rd
**Path type**: Two-way
**Observer view angle**: 50.0°


| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 45.934753 | -119.350942 | 291.03 | 5.00 | 296.03 |
| 2 | 45.936276 | -119.351221 | 287.35 | 5.00 | 292.35 |
| 3 | 45.937925 | -119.351538 | 280.65 | 5.00 | 285.65 |
| 4 | 45.939864 | -119.351474 | 309.05 | 5.00 | 314.05 |
| 5 | 45.947258 | -119.351380 | 446.71 | 5.00 | 451.71 |
| 6 | 45.952767 | -119.351251 | 521.11 | 5.00 | 526.11 |
| 7 | 45.984756 | -119.350582 | 754.63 | 5.00 | 759.63 |
| 8 | 45.994590 | -119.350511 | 881.89 | 5.00 | 886.89 |

**Name**: WA 14-1
**Path type**: Two-way
**Observer view angle**: 50.0°


| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 45.941191 | -119.560872 | 418.89 | 5.00 | 423.89 |
| 2 | 45.942672 | -119.546463 | 421.09 | 5.00 | 426.09 |
| 3 | 45.943112 | -119.541941 | 386.21 | 5.00 | 391.21 |
| 4 | 45.943610 | -119.531533 | 338.07 | 5.00 | 343.07 |
| 5 | 45.944239 | -119.517257 | 348.54 | 5.00 | 353.54 |
| 6 | 45.944652 | -119.508268 | 372.57 | 5.00 | 377.57 |
| 7 | 45.945122 | -119.497717 | 374.38 | 5.00 | 379.38 |
| 8 | 45.945779 | -119.482585 | 370.55 | 5.00 | 375.55 |
| 9 | 45.946608 | -119.464398 | 385.68 | 5.00 | 390.68 |
| 10 | 45.947265 | -119.448704 | 386.46 | 5.00 | 391.46 |
| 11 | 45.947474 | -119.446161 | 385.38 | 5.00 | 390.38 |
| 12 | 45.948097 | -119.441684 | 386.75 | 5.00 | 391.75 |
| 13 | 45.948984 | -119.437457 | 388.22 | 5.00 | 393.22 |
| 14 | 45.949723 | -119.434734 | 393.91 | 5.00 | 398.91 |
| 15 | 45.950935 | -119.431219 | 403.38 | 5.00 | 408.38 |
| 16 | 45.952139 | -119.427982 | 413.23 | 5.00 | 418.23 |
| 17 | 45.954825 | -119.420810 | 422.96 | 5.00 | 427.96 |
| 18 | 45.958357 | -119.410946 | 472.42 | 5.00 | 477.42 |

**Name**: WA 14-2
**Path type**: Two-way
**Observer view angle**: 50.0°


| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 45.958387 | -119.410603 | 473.05 | 5.00 | 478.05 |
| 2 | 45.958327 | -119.409530 | 474.05 | 5.00 | 479.05 |
| 3 | 45.957626 | -119.408092 | 469.76 | 5.00 | 474.76 |
| 4 | 45.954256 | -119.405466 | 421.70 | 5.00 | 426.70 |
| 5 | 45.950932 | -119.402954 | 391.49 | 5.00 | 396.49 |
| 6 | 45.950305 | -119.402224 | 382.06 | 5.00 | 387.06 |
| 7 | 45.949828 | -119.401452 | 376.69 | 5.00 | 381.69 |
| 8 | 45.949351 | -119.400336 | 370.06 | 5.00 | 375.06 |
| 9 | 45.949022 | -119.398169 | 364.21 | 5.00 | 369.21 |
| 10 | 45.947573 | -119.382693 | 375.34 | 5.00 | 380.34 |
| 11 | 45.946655 | -119.372767 | 371.27 | 5.00 | 376.27 |
| 12 | 45.945924 | -119.364917 | 384.84 | 5.00 | 389.84 |
| 13 | 45.944895 | -119.353824 | 412.19 | 5.00 | 417.19 |
| 14 | 45.943925 | -119.343364 | 425.34 | 5.00 | 430.34 |
| 15 | 45.943940 | -119.342248 | 426.82 | 5.00 | 431.82 |
| 16 | 45.944134 | -119.340982 | 428.09 | 5.00 | 433.09 |
| 17 | 45.945399 | -119.335469 | 428.07 | 5.00 | 433.07 |

## Discrete Observation Point Receptors

| Name | ID | Latitude (°) | Longitude (°) | Elevation (ft) | Height (ft) |
|---|---|---|---|---|---|
| OP 1 | 1 | 45.929734 | -119.352818 | 280.68 | 6.00 |
| OP 2 | 2 | 45.922714 | -119.334458 | 292.67 | 6.00 |
| OP 3 | 3 | 45.913082 | -119.431330 | 276.34 | 6.00 |
| OP 4 | 4 | 45.899565 | -119.489066 | 284.40 | 6.00 |
| OP 5 | 5 | 45.943722 | -119.558719 | 439.96 | 6.00 |
| OP 6 | 6 | 45.947993 | -119.352693 | 460.37 | 6.00 |
| OP 7 | 7 | 45.943148 | -119.359106 | 377.71 | 6.00 |
| OP 8 | 8 | 45.935513 | -119.359982 | 302.38 | 6.00 |
| OP 9 | 9 | 45.930614 | -119.389803 | 297.19 | 6.00 |
| OP 10 | 10 | 45.937349 | -119.413872 | 375.33 | 6.00 |
| OP 11 | 11 | 45.924596 | -119.464932 | 359.19 | 6.00 |

# Glare Analysis Results

## Summary of Results No glare predicted

| PV Array | Tilt | Orient | Annual Green Glare | | Annual Yellow Glare | | Energy |
|---|---|---|---|---|---|---|---|
| | ° | ° | min | hr | min | hr | kWh |
| PV array 1 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 2 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 3 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 4 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 5 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |

*Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

## PV: PV array 1 no glare found

*Receptor results ordered by category of glare*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

### PV array 1 and Route: McNary Hwy

No glare found

### PV array 1 and Route: S Plymouth Rd

No glare found

### PV array 1 and Route: WA 14-1

No glare found

### PV array 1 and Route: WA 14-2

No glare found

### PV array 1 and OP 1

No glare found

### PV array 1 and OP 2

No glare found

### PV array 1 and OP 3

No glare found

### PV array 1 and OP 4

No glare found

### PV array 1 and OP 5

No glare found

### PV array 1 and OP 6

No glare found

### PV array 1 and OP 7

No glare found

### PV array 1 and OP 8

No glare found

### PV array 1 and OP 9

No glare found

### PV array 1 and OP 10

No glare found

### PV array 1 and OP 11

No glare found

## PV: PV array 2 no glare found

*Receptor results ordered by category of glare*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

### PV array 2 and Route: McNary Hwy

No glare found

### PV array 2 and Route: S Plymouth Rd

No glare found

### PV array 2 and Route: WA 14-1

No glare found

### PV array 2 and Route: WA 14-2

No glare found

### PV array 2 and OP 1

No glare found

### PV array 2 and OP 2

No glare found

### PV array 2 and OP 3

No glare found

### PV array 2 and OP 4

No glare found

### PV array 2 and OP 5

No glare found

### PV array 2 and OP 6

No glare found

### PV array 2 and OP 7

No glare found

### PV array 2 and OP 8

No glare found

### PV array 2 and OP 9

No glare found

### PV array 2 and OP 10

No glare found

### PV array 2 and OP 11

No glare found

## PV: PV array 3 no glare found

*Receptor results ordered by category of glare*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

### PV array 3 and Route: McNary Hwy

No glare found

### PV array 3 and Route: S Plymouth Rd

No glare found

### PV array 3 and Route: WA 14-1

No glare found

### PV array 3 and Route: WA 14-2

No glare found

### PV array 3 and OP 1

No glare found

### PV array 3 and OP 2

No glare found

### PV array 3 and OP 3

No glare found

### PV array 3 and OP 4

No glare found

### PV array 3 and OP 5

No glare found

### PV array 3 and OP 6

No glare found

### PV array 3 and OP 7

No glare found

### PV array 3 and OP 8

No glare found

### PV array 3 and OP 9

No glare found

### PV array 3 and OP 10

No glare found

### PV array 3 and OP 11

No glare found

## PV: PV array 4 no glare found

*Receptor results ordered by category of glare*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

### PV array 4 and Route: McNary Hwy

No glare found

### PV array 4 and Route: S Plymouth Rd

No glare found

### PV array 4 and Route: WA 14-1

No glare found

### PV array 4 and Route: WA 14-2

No glare found

### PV array 4 and OP 1

No glare found

### PV array 4 and OP 2

No glare found

### PV array 4 and OP 3

No glare found

### PV array 4 and OP 4

No glare found

### PV array 4 and OP 5

No glare found

### PV array 4 and OP 6

No glare found

### PV array 4 and OP 7

No glare found

### PV array 4 and OP 8

No glare found

### PV array 4 and OP 9

No glare found

### PV array 4 and OP 10

No glare found

### PV array 4 and OP 11

No glare found

## PV: PV array 5 no glare found

*Receptor results ordered by category of glare*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

### PV array 5 and Route: McNary Hwy

No glare found

### PV array 5 and Route: S Plymouth Rd

No glare found

### PV array 5 and Route: WA 14-1

No glare found

### PV array 5 and Route: WA 14-2

No glare found

### PV array 5 and OP 1

No glare found

### PV array 5 and OP 2

No glare found

### PV array 5 and OP 3

No glare found

### PV array 5 and OP 4

No glare found

### PV array 5 and OP 5

No glare found

### PV array 5 and OP 6

No glare found

### PV array 5 and OP 7

No glare found

### PV array 5 and OP 8

No glare found

### PV array 5 and OP 9

No glare found

### PV array 5 and OP 10

No glare found

### PV array 5 and OP 11

No glare found

# 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.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Several V1 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. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
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.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
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.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

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

# FORGESOLAR GLARE ANALYSIS

Project: **Wallula Gap Solar Project**
Site configuration: **Analysis 2- 2nd Story Receptors**

**Created** 19 Dec, 2023
**Updated** 19 Dec, 2023
**Time-step** 1 minute
**Timezone offset** UTC-8
**Minimum sun altitude** 0.0 deg
**DNI** peaks at 1,000.0 W/m$^2$
**Category** 10 MW to 100 MW
**Site ID** 108341.18788

**Ocular transmission coefficient** 0.5
**Pupil diameter** 0.002 m
**Eye focal length** 0.017 m
**Sun subtended angle** 9.3 mrad
**PV analysis methodology** V2


## Summary of Results

Glare with potential for temporary after-image predicted

| PV Array | Tilt | Orient | Annual Green Glare | | Annual Yellow Glare | | Energy |
|---|---|---|---|---|---|---|---|
| | ° | ° | min | hr | min | hr | kWh |
| PV array 1 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 2 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 3 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 4 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 5 | SA tracking | SA tracking | 215 | 3.6 | 127 | 2.1 | - |

*Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 215 | 3.6 | 127 | 2.1 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

# Component Data

## PV Arrays

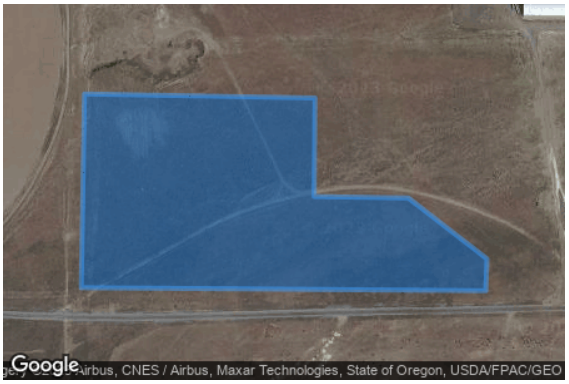
**Name**: PV array 1
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 180.0°
**Max tracking angle**: 52.0°
**Resting angle**: 5.0°
**Ground Coverage Ratio**: 0.32
**Rated power**: -
**Panel material**: Smooth glass with AR coating
**Reflectivity**: Vary with sun
**Slope error**: correlate with material


| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 45.964068 | -119.455327 | 553.14 | 7.00 | 560.14 |
| 2 | 45.964052 | -119.445861 | 556.08 | 7.00 | 563.08 |
| 3 | 45.961727 | -119.444205 | 517.24 | 7.00 | 524.24 |
| 4 | 45.960840 | -119.444014 | 509.51 | 7.00 | 516.51 |
| 5 | 45.960112 | -119.443963 | 494.04 | 7.00 | 501.04 |
| 6 | 45.958936 | -119.445297 | 481.06 | 7.00 | 488.06 |
| 7 | 45.958890 | -119.449608 | 481.92 | 7.00 | 488.92 |
| 8 | 45.957526 | -119.449699 | 481.45 | 7.00 | 488.45 |
| 9 | 45.957495 | -119.453232 | 482.82 | 7.00 | 489.82 |
| 10 | 45.958575 | -119.454870 | 490.06 | 7.00 | 497.06 |
| 11 | 45.959020 | -119.455322 | 494.29 | 7.00 | 501.29 |
| 12 | 45.959925 | -119.455611 | 501.57 | 7.00 | 508.57 |

**Name**: PV array 2
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 180.0°
**Max tracking angle**: 52.0°
**Resting angle**: 5.0°
**Ground Coverage Ratio**: 0.32
**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 | 45.956543 | -119.451151 | 476.17 | 7.00 | 483.17 |
| 2 | 45.956514 | -119.448037 | 473.89 | 7.00 | 480.89 |
| 3 | 45.956179 | -119.447920 | 467.41 | 7.00 | 474.41 |
| 4 | 45.955318 | -119.447739 | 455.05 | 7.00 | 462.05 |
| 5 | 45.954251 | -119.447765 | 437.71 | 7.00 | 444.71 |
| 6 | 45.954241 | -119.448429 | 440.29 | 7.00 | 447.29 |
| 7 | 45.954590 | -119.449000 | 450.70 | 7.00 | 457.70 |
| 8 | 45.956073 | -119.451199 | 466.69 | 7.00 | 473.69 |

**Name**: PV array 3
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 180.0°
**Max tracking angle**: 52.0°
**Resting angle**: 5.0°
**Ground Coverage Ratio**: 0.32
**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 | 45.955979 | -119.455532 | 472.53 | 7.00 | 479.53 |
| 2 | 45.955932 | -119.451570 | 465.93 | 7.00 | 472.93 |
| 3 | 45.954758 | -119.451585 | 455.74 | 7.00 | 462.74 |
| 4 | 45.954741 | -119.449968 | 454.14 | 7.00 | 461.14 |
| 5 | 45.954016 | -119.448616 | 436.89 | 7.00 | 443.89 |
| 6 | 45.953637 | -119.448636 | 433.44 | 7.00 | 440.44 |
| 7 | 45.953673 | -119.455586 | 438.50 | 7.00 | 445.50 |

**Name**: PV array 4
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 180.0°
**Max tracking angle**: 52.0°
**Resting angle**: 5.0°
**Ground Coverage Ratio**: 0.32
**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 | 45.953113 | -119.455331 | 436.36 | 7.00 | 443.36 |
| 2 | 45.953103 | -119.447321 | 429.60 | 7.00 | 436.60 |
| 3 | 45.951986 | -119.447281 | 413.49 | 7.00 | 420.49 |
| 4 | 45.951922 | -119.445424 | 414.48 | 7.00 | 421.48 |
| 5 | 45.950797 | -119.443616 | 397.01 | 7.00 | 404.01 |
| 6 | 45.949605 | -119.441998 | 390.90 | 7.00 | 397.90 |
| 7 | 45.949297 | -119.441681 | 386.38 | 7.00 | 393.38 |
| 8 | 45.948500 | -119.441678 | 384.09 | 7.00 | 391.09 |
| 9 | 45.948029 | -119.444439 | 395.66 | 7.00 | 402.66 |
| 10 | 45.947718 | -119.446575 | 387.40 | 7.00 | 394.40 |
| 11 | 45.947422 | -119.451839 | 386.14 | 7.00 | 393.14 |
| 12 | 45.947423 | -119.455493 | 387.36 | 7.00 | 394.36 |

**Name**: PV array 5
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 180.0°
**Max tracking angle**: 52.0°
**Resting angle**: 5.0°
**Ground Coverage Ratio**: 0.32
**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 | 45.952102 | -119.444247 | 416.40 | 7.00 | 423.40 |
| 2 | 45.952095 | -119.441415 | 418.83 | 7.00 | 425.83 |
| 3 | 45.953230 | -119.441391 | 429.58 | 7.00 | 436.58 |
| 4 | 45.953245 | -119.439846 | 427.97 | 7.00 | 434.97 |
| 5 | 45.951783 | -119.439792 | 419.81 | 7.00 | 426.81 |
| 6 | 45.951671 | -119.435458 | 413.12 | 7.00 | 420.12 |
| 7 | 45.950828 | -119.435318 | 400.98 | 7.00 | 407.98 |
| 8 | 45.950144 | -119.435329 | 392.41 | 7.00 | 399.41 |
| 9 | 45.949726 | -119.435908 | 394.84 | 7.00 | 401.84 |
| 10 | 45.949703 | -119.437400 | 390.65 | 7.00 | 397.65 |
| 11 | 45.949345 | -119.437453 | 388.17 | 7.00 | 395.17 |
| 12 | 45.949338 | -119.438816 | 390.69 | 7.00 | 397.69 |
| 13 | 45.948920 | -119.438870 | 384.17 | 7.00 | 391.17 |
| 14 | 45.949017 | -119.440715 | 383.44 | 7.00 | 390.44 |
| 15 | 45.949771 | -119.441639 | 389.84 | 7.00 | 396.84 |
| 16 | 45.950969 | -119.443323 | 405.20 | 7.00 | 412.20 |
| 17 | 45.951655 | -119.444278 | 407.12 | 7.00 | 414.12 |

## Route Receptors

**Name**: McNary Hwy
**Path type**: Two-way
**Observer view angle**: 50.0°


| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 45.967340 | -119.341676 | 597.10 | 9.00 | 606.10 |
| 2 | 45.965714 | -119.342298 | 573.03 | 9.00 | 582.03 |
| 3 | 45.964092 | -119.342641 | 549.28 | 9.00 | 558.28 |
| 4 | 45.962906 | -119.342759 | 533.41 | 9.00 | 542.41 |
| 5 | 45.961213 | -119.342577 | 512.60 | 9.00 | 521.60 |
| 6 | 45.959811 | -119.342256 | 498.29 | 9.00 | 507.29 |
| 7 | 45.958640 | -119.341784 | 489.83 | 9.00 | 498.83 |
| 8 | 45.957044 | -119.340981 | 487.33 | 9.00 | 496.33 |
| 9 | 45.954631 | -119.339824 | 476.83 | 9.00 | 485.83 |
| 10 | 45.952628 | -119.338860 | 470.59 | 9.00 | 479.59 |
| 11 | 45.950624 | -119.337896 | 465.65 | 9.00 | 474.65 |
| 12 | 45.948246 | -119.336728 | 458.43 | 9.00 | 467.43 |
| 13 | 45.945218 | -119.335307 | 428.60 | 9.00 | 437.60 |
| 14 | 45.943238 | -119.334350 | 408.90 | 9.00 | 417.90 |
| 15 | 45.940170 | -119.332854 | 390.85 | 9.00 | 399.85 |
| 16 | 45.935669 | -119.330670 | 328.23 | 9.00 | 337.23 |
| 17 | 45.930469 | -119.328215 | 267.60 | 9.00 | 276.60 |
| 18 | 45.928416 | -119.327182 | 273.04 | 9.00 | 282.04 |

**Name**: S Plymouth Rd
**Path type**: Two-way
**Observer view angle**: 50.0°


| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 45.934753 | -119.350942 | 291.03 | 9.00 | 300.03 |
| 2 | 45.936276 | -119.351221 | 287.35 | 9.00 | 296.35 |
| 3 | 45.937925 | -119.351538 | 280.65 | 9.00 | 289.65 |
| 4 | 45.939864 | -119.351474 | 309.05 | 9.00 | 318.05 |
| 5 | 45.947258 | -119.351380 | 446.71 | 9.00 | 455.71 |
| 6 | 45.952767 | -119.351251 | 521.11 | 9.00 | 530.11 |
| 7 | 45.984756 | -119.350582 | 754.63 | 9.00 | 763.63 |
| 8 | 45.994590 | -119.350511 | 881.89 | 9.00 | 890.89 |

**Name**: WA 14-1
**Path type**: Two-way
**Observer view angle**: 50.0°


| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 45.941191 | -119.560872 | 418.89 | 9.00 | 427.89 |
| 2 | 45.942672 | -119.546463 | 421.09 | 9.00 | 430.09 |
| 3 | 45.943112 | -119.541941 | 386.21 | 9.00 | 395.21 |
| 4 | 45.943610 | -119.531533 | 338.07 | 9.00 | 347.07 |
| 5 | 45.944239 | -119.517257 | 348.54 | 9.00 | 357.54 |
| 6 | 45.944652 | -119.508268 | 372.57 | 9.00 | 381.57 |
| 7 | 45.945122 | -119.497717 | 374.38 | 9.00 | 383.38 |
| 8 | 45.945779 | -119.482585 | 370.55 | 9.00 | 379.55 |
| 9 | 45.946608 | -119.464398 | 385.68 | 9.00 | 394.68 |
| 10 | 45.947265 | -119.448704 | 386.46 | 9.00 | 395.46 |
| 11 | 45.947474 | -119.446161 | 385.38 | 9.00 | 394.38 |
| 12 | 45.948097 | -119.441684 | 386.75 | 9.00 | 395.75 |
| 13 | 45.948984 | -119.437457 | 388.22 | 9.00 | 397.22 |
| 14 | 45.949723 | -119.434734 | 393.91 | 9.00 | 402.91 |
| 15 | 45.950935 | -119.431219 | 403.38 | 9.00 | 412.38 |
| 16 | 45.952139 | -119.427982 | 413.23 | 9.00 | 422.23 |
| 17 | 45.954825 | -119.420810 | 422.96 | 9.00 | 431.96 |
| 18 | 45.958357 | -119.410946 | 472.42 | 9.00 | 481.42 |

**Name**: WA 14-2
**Path type**: Two-way
**Observer view angle**: 50.0°


| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 45.958387 | -119.410603 | 473.05 | 9.00 | 482.05 |
| 2 | 45.958327 | -119.409530 | 474.05 | 9.00 | 483.05 |
| 3 | 45.957626 | -119.408092 | 469.76 | 9.00 | 478.76 |
| 4 | 45.954256 | -119.405466 | 421.70 | 9.00 | 430.70 |
| 5 | 45.950932 | -119.402954 | 391.49 | 9.00 | 400.49 |
| 6 | 45.950305 | -119.402224 | 382.06 | 9.00 | 391.06 |
| 7 | 45.949828 | -119.401452 | 376.69 | 9.00 | 385.69 |
| 8 | 45.949351 | -119.400336 | 370.06 | 9.00 | 379.06 |
| 9 | 45.949022 | -119.398169 | 364.21 | 9.00 | 373.21 |
| 10 | 45.947573 | -119.382693 | 375.34 | 9.00 | 384.34 |
| 11 | 45.946655 | -119.372767 | 371.27 | 9.00 | 380.27 |
| 12 | 45.945924 | -119.364917 | 384.84 | 9.00 | 393.84 |
| 13 | 45.944895 | -119.353824 | 412.19 | 9.00 | 421.19 |
| 14 | 45.943925 | -119.343364 | 425.34 | 9.00 | 434.34 |
| 15 | 45.943940 | -119.342248 | 426.82 | 9.00 | 435.82 |
| 16 | 45.944134 | -119.340982 | 428.09 | 9.00 | 437.09 |
| 17 | 45.945399 | -119.335469 | 428.07 | 9.00 | 437.07 |

## Discrete Observation Point Receptors

| Name | ID | Latitude (°) | Longitude (°) | Elevation (ft) | Height (ft) |
|---|---|---|---|---|---|
| OP 1 | 1 | 45.929734 | -119.352818 | 280.68 | 16.00 |
| OP 2 | 2 | 45.922714 | -119.334458 | 292.67 | 16.00 |
| OP 3 | 3 | 45.913082 | -119.431330 | 276.34 | 16.00 |
| OP 4 | 4 | 45.899565 | -119.489066 | 284.40 | 16.00 |
| OP 5 | 5 | 45.943722 | -119.558719 | 439.96 | 16.00 |
| OP 6 | 6 | 45.947993 | -119.352693 | 460.37 | 16.00 |
| OP 7 | 7 | 45.943148 | -119.359106 | 377.71 | 16.00 |
| OP 8 | 8 | 45.935513 | -119.359982 | 302.38 | 16.00 |
| OP 9 | 9 | 45.930614 | -119.389803 | 297.19 | 16.00 |
| OP 10 | 10 | 45.937349 | -119.413872 | 375.33 | 16.00 |
| OP 11 | 11 | 45.924596 | -119.464932 | 359.19 | 16.00 |

# Glare Analysis Results

## Summary of Results

Glare with potential for temporary after-image predicted

| PV Array | Tilt | Orient | Annual Green Glare | | Annual Yellow Glare | | Energy |
|---|---|---|---|---|---|---|---|
| | ° | ° | min | hr | min | hr | kWh |
| PV array 1 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 2 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 3 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 4 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 5 | SA tracking | SA tracking | 215 | 3.6 | 127 | 2.1 | - |

*Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 215 | 3.6 | 127 | 2.1 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

## PV: PV array 1 no glare found

*Receptor results ordered by category of glare*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

### PV array 1 and Route: McNary Hwy

No glare found

### PV array 1 and Route: S Plymouth Rd

No glare found

### PV array 1 and Route: WA 14-1

No glare found

### PV array 1 and Route: WA 14-2

No glare found

### PV array 1 and OP 1

No glare found

### PV array 1 and OP 2

No glare found

### PV array 1 and OP 3

No glare found

### PV array 1 and OP 4

No glare found

### PV array 1 and OP 5

No glare found

### PV array 1 and OP 6

No glare found

### PV array 1 and OP 7

No glare found

### PV array 1 and OP 8

No glare found

### PV array 1 and OP 9

No glare found

### PV array 1 and OP 10

No glare found

### PV array 1 and OP 11

No glare found

## PV: PV array 2 no glare found

*Receptor results ordered by category of glare*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

### PV array 2 and Route: McNary Hwy

No glare found

### PV array 2 and Route: S Plymouth Rd

No glare found

### PV array 2 and Route: WA 14-1

No glare found

### PV array 2 and Route: WA 14-2

No glare found

### PV array 2 and OP 1

No glare found

### PV array 2 and OP 2

No glare found

### PV array 2 and OP 3

No glare found

### PV array 2 and OP 4

No glare found

### PV array 2 and OP 5

No glare found

### PV array 2 and OP 6

No glare found

### PV array 2 and OP 7

No glare found

### PV array 2 and OP 8

No glare found

### PV array 2 and OP 9

No glare found

### PV array 2 and OP 10

No glare found

### PV array 2 and OP 11

No glare found

## PV: PV array 3 no glare found

*Receptor results ordered by category of glare*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

### PV array 3 and Route: McNary Hwy

No glare found

### PV array 3 and Route: S Plymouth Rd

No glare found

### PV array 3 and Route: WA 14-1

No glare found

### PV array 3 and Route: WA 14-2

No glare found

### PV array 3 and OP 1

No glare found

### PV array 3 and OP 2

No glare found

### PV array 3 and OP 3

No glare found

### PV array 3 and OP 4

No glare found

### PV array 3 and OP 5

No glare found

### PV array 3 and OP 6

No glare found

### PV array 3 and OP 7

No glare found

### PV array 3 and OP 8

No glare found

### PV array 3 and OP 9

No glare found

### PV array 3 and OP 10

No glare found

### PV array 3 and OP 11

No glare found

## PV: PV array 4 no glare found

*Receptor results ordered by category of glare*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

### PV array 4 and Route: McNary Hwy

No glare found

### PV array 4 and Route: S Plymouth Rd

No glare found

### PV array 4 and Route: WA 14-1

No glare found

### PV array 4 and Route: WA 14-2

No glare found

### PV array 4 and OP 1

No glare found

### PV array 4 and OP 2

No glare found

### PV array 4 and OP 3

No glare found

### PV array 4 and OP 4

No glare found

### PV array 4 and OP 5

No glare found

### PV array 4 and OP 6

No glare found

### PV array 4 and OP 7

No glare found

### PV array 4 and OP 8

No glare found

### PV array 4 and OP 9

No glare found

### PV array 4 and OP 10

No glare found

### PV array 4 and OP 11

No glare found

## PV: PV array 5 potential temporary after-image

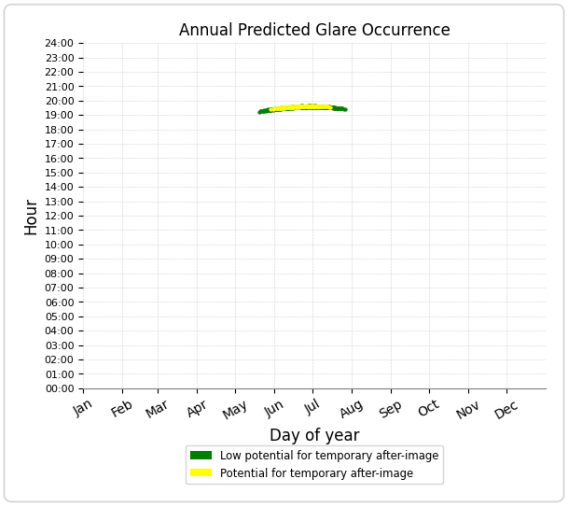
*Receptor results ordered by category of glare*

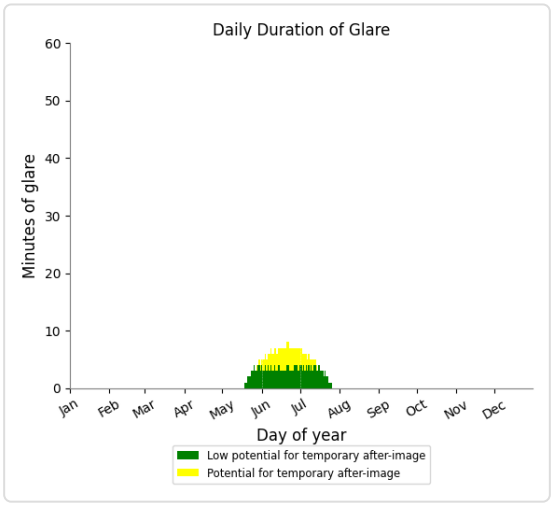
| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| WA 14-1 | 215 | 3.6 | 127 | 2.1 |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

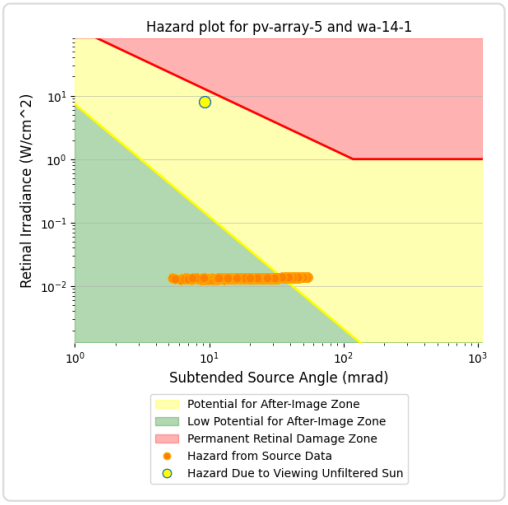
## PV array 5 and Route: WA 14-1

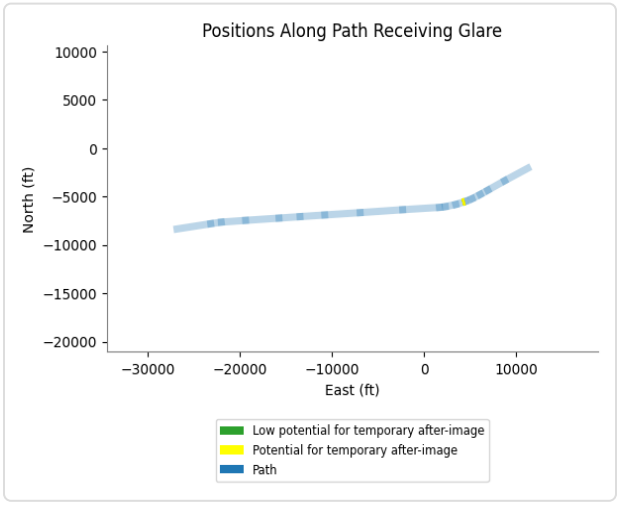
Yellow glare: 127 min.

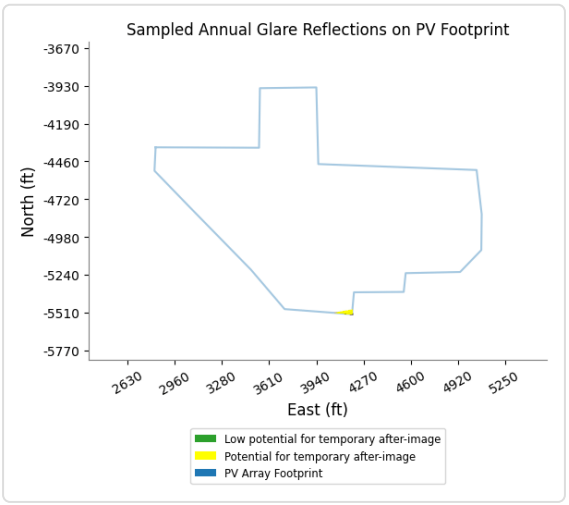
Green glare: 215 min.




## PV array 5 and Route: McNary Hwy

No glare found

### PV array 5 and Route: S Plymouth Rd

No glare found

### PV array 5 and Route: WA 14-2

No glare found

### PV array 5 and OP 1

No glare found

### PV array 5 and OP 2

No glare found

### PV array 5 and OP 3

No glare found

### PV array 5 and OP 4

No glare found

### PV array 5 and OP 5

No glare found

### PV array 5 and OP 6

No glare found

### PV array 5 and OP 7

No glare found

### PV array 5 and OP 8

No glare found

### PV array 5 and OP 9

No glare found

### PV array 5 and OP 10

No glare found

### PV array 5 and OP 11

No glare found

# 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.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Several V1 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. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
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.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
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.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

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

# FORGESOLAR GLARE ANALYSIS

Project: **Wallula Gap Solar Project**
Site configuration: **Analysis 3- Optimized**

**Created** 08 Jan, 2024
**Updated** 09 Jan, 2024
**Time-step** 1 minute
**Timezone offset** UTC-8
**Minimum sun altitude** 0.0 deg
**DNI** peaks at 1,000.0 W/m$^2$
**Category** 10 MW to 100 MW
**Site ID** 109370.18788

**Ocular transmission coefficient** 0.5
**Pupil diameter** 0.002 m
**Eye focal length** 0.017 m
**Sun subtended angle** 9.3 mrad
**PV analysis methodology** V2


## Summary of Results No glare predicted

| PV Array | Tilt | Orient | Annual Green Glare | | Annual Yellow Glare | | Energy |
|---|---|---|---|---|---|---|---|
| | ° | ° | min | hr | min | hr | kWh |
| PV array 1 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 2 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 3 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 4 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 5 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |

*Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

# Component Data

## PV Arrays

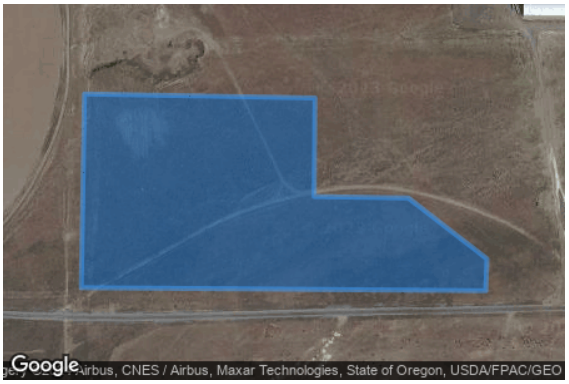
**Name**: PV array 1
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 180.0°
**Max tracking angle**: 52.0°
**Resting angle**: 5.0°
**Ground Coverage Ratio**: 0.32
**Rated power**: -
**Panel material**: Smooth glass with AR coating
**Reflectivity**: Vary with sun
**Slope error**: correlate with material


| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 45.964068 | -119.455327 | 553.14 | 7.00 | 560.14 |
| 2 | 45.964052 | -119.445861 | 556.08 | 7.00 | 563.08 |
| 3 | 45.961727 | -119.444205 | 517.24 | 7.00 | 524.24 |
| 4 | 45.960840 | -119.444014 | 509.51 | 7.00 | 516.51 |
| 5 | 45.960112 | -119.443963 | 494.04 | 7.00 | 501.04 |
| 6 | 45.958936 | -119.445297 | 481.06 | 7.00 | 488.06 |
| 7 | 45.958890 | -119.449608 | 481.92 | 7.00 | 488.92 |
| 8 | 45.957526 | -119.449699 | 481.45 | 7.00 | 488.45 |
| 9 | 45.957495 | -119.453232 | 482.82 | 7.00 | 489.82 |
| 10 | 45.958575 | -119.454870 | 490.06 | 7.00 | 497.06 |
| 11 | 45.959020 | -119.455322 | 494.29 | 7.00 | 501.29 |
| 12 | 45.959925 | -119.455611 | 501.57 | 7.00 | 508.57 |

**Name**: PV array 2
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 180.0°
**Max tracking angle**: 52.0°
**Resting angle**: 5.0°
**Ground Coverage Ratio**: 0.32
**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 | 45.956543 | -119.451151 | 476.17 | 7.00 | 483.17 |
| 2 | 45.956514 | -119.448037 | 473.89 | 7.00 | 480.89 |
| 3 | 45.956179 | -119.447920 | 467.41 | 7.00 | 474.41 |
| 4 | 45.955318 | -119.447739 | 455.05 | 7.00 | 462.05 |
| 5 | 45.954251 | -119.447765 | 437.71 | 7.00 | 444.71 |
| 6 | 45.954241 | -119.448429 | 440.29 | 7.00 | 447.29 |
| 7 | 45.954590 | -119.449000 | 450.70 | 7.00 | 457.70 |
| 8 | 45.956073 | -119.451199 | 466.69 | 7.00 | 473.69 |

**Name**: PV array 3
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 180.0°
**Max tracking angle**: 52.0°
**Resting angle**: 5.0°
**Ground Coverage Ratio**: 0.32
**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 | 45.955979 | -119.455532 | 472.53 | 7.00 | 479.53 |
| 2 | 45.955932 | -119.451570 | 465.93 | 7.00 | 472.93 |
| 3 | 45.954758 | -119.451585 | 455.74 | 7.00 | 462.74 |
| 4 | 45.954741 | -119.449968 | 454.14 | 7.00 | 461.14 |
| 5 | 45.954016 | -119.448616 | 436.89 | 7.00 | 443.89 |
| 6 | 45.953637 | -119.448636 | 433.44 | 7.00 | 440.44 |
| 7 | 45.953673 | -119.455586 | 438.50 | 7.00 | 445.50 |

**Name**: PV array 4
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 180.0°
**Max tracking angle**: 52.0°
**Resting angle**: 5.0°
**Ground Coverage Ratio**: 0.32
**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 | 45.953113 | -119.455331 | 436.36 | 7.00 | 443.36 |
| 2 | 45.953103 | -119.447321 | 429.60 | 7.00 | 436.60 |
| 3 | 45.951986 | -119.447281 | 413.49 | 7.00 | 420.49 |
| 4 | 45.951922 | -119.445424 | 414.48 | 7.00 | 421.48 |
| 5 | 45.950797 | -119.443616 | 397.01 | 7.00 | 404.01 |
| 6 | 45.949605 | -119.441998 | 390.90 | 7.00 | 397.90 |
| 7 | 45.949297 | -119.441681 | 386.38 | 7.00 | 393.38 |
| 8 | 45.948500 | -119.441678 | 384.09 | 7.00 | 391.09 |
| 9 | 45.948029 | -119.444439 | 395.66 | 7.00 | 402.66 |
| 10 | 45.947718 | -119.446575 | 387.40 | 7.00 | 394.40 |
| 11 | 45.947422 | -119.451839 | 386.14 | 7.00 | 393.14 |
| 12 | 45.947423 | -119.455493 | 387.36 | 7.00 | 394.36 |

**Name**: PV array 5
**Axis tracking**: Single-axis rotation
**Backtracking**: Shade-slope
**Tracking axis orientation**: 180.0°
**Max tracking angle**: 52.0°
**Resting angle**: 10.0°
**Ground Coverage Ratio**: 0.32
**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 | 45.952102 | -119.444247 | 416.40 | 7.00 | 423.40 |
| 2 | 45.952095 | -119.441415 | 418.83 | 7.00 | 425.83 |
| 3 | 45.953230 | -119.441391 | 429.58 | 7.00 | 436.58 |
| 4 | 45.953245 | -119.439846 | 427.97 | 7.00 | 434.97 |
| 5 | 45.951783 | -119.439792 | 419.81 | 7.00 | 426.81 |
| 6 | 45.951671 | -119.435458 | 413.12 | 7.00 | 420.12 |
| 7 | 45.950828 | -119.435318 | 400.98 | 7.00 | 407.98 |
| 8 | 45.950144 | -119.435329 | 392.41 | 7.00 | 399.41 |
| 9 | 45.949726 | -119.435908 | 394.84 | 7.00 | 401.84 |
| 10 | 45.949703 | -119.437400 | 390.65 | 7.00 | 397.65 |
| 11 | 45.949345 | -119.437453 | 388.17 | 7.00 | 395.17 |
| 12 | 45.949338 | -119.438816 | 390.69 | 7.00 | 397.69 |
| 13 | 45.948920 | -119.438870 | 384.17 | 7.00 | 391.17 |
| 14 | 45.949017 | -119.440715 | 383.44 | 7.00 | 390.44 |
| 15 | 45.949771 | -119.441639 | 389.84 | 7.00 | 396.84 |
| 16 | 45.950969 | -119.443323 | 405.20 | 7.00 | 412.20 |
| 17 | 45.951655 | -119.444278 | 407.12 | 7.00 | 414.12 |

## Route Receptors

**Name**: McNary Hwy
**Path type**: Two-way
**Observer view angle**: 50.0°


| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 45.967340 | -119.341676 | 597.10 | 9.00 | 606.10 |
| 2 | 45.965714 | -119.342298 | 573.03 | 9.00 | 582.03 |
| 3 | 45.964092 | -119.342641 | 549.28 | 9.00 | 558.28 |
| 4 | 45.962906 | -119.342759 | 533.41 | 9.00 | 542.41 |
| 5 | 45.961213 | -119.342577 | 512.60 | 9.00 | 521.60 |
| 6 | 45.959811 | -119.342256 | 498.29 | 9.00 | 507.29 |
| 7 | 45.958640 | -119.341784 | 489.83 | 9.00 | 498.83 |
| 8 | 45.957044 | -119.340981 | 487.33 | 9.00 | 496.33 |
| 9 | 45.954631 | -119.339824 | 476.83 | 9.00 | 485.83 |
| 10 | 45.952628 | -119.338860 | 470.59 | 9.00 | 479.59 |
| 11 | 45.950624 | -119.337896 | 465.65 | 9.00 | 474.65 |
| 12 | 45.948246 | -119.336728 | 458.43 | 9.00 | 467.43 |
| 13 | 45.945218 | -119.335307 | 428.60 | 9.00 | 437.60 |
| 14 | 45.943238 | -119.334350 | 408.90 | 9.00 | 417.90 |
| 15 | 45.940170 | -119.332854 | 390.85 | 9.00 | 399.85 |
| 16 | 45.935669 | -119.330670 | 328.23 | 9.00 | 337.23 |
| 17 | 45.930469 | -119.328215 | 267.60 | 9.00 | 276.60 |
| 18 | 45.928416 | -119.327182 | 273.04 | 9.00 | 282.04 |

**Name**: S Plymouth Rd
**Path type**: Two-way
**Observer view angle**: 50.0°


| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 45.934753 | -119.350942 | 291.03 | 9.00 | 300.03 |
| 2 | 45.936276 | -119.351221 | 287.35 | 9.00 | 296.35 |
| 3 | 45.937925 | -119.351538 | 280.65 | 9.00 | 289.65 |
| 4 | 45.939864 | -119.351474 | 309.05 | 9.00 | 318.05 |
| 5 | 45.947258 | -119.351380 | 446.71 | 9.00 | 455.71 |
| 6 | 45.952767 | -119.351251 | 521.11 | 9.00 | 530.11 |
| 7 | 45.984756 | -119.350582 | 754.63 | 9.00 | 763.63 |
| 8 | 45.994590 | -119.350511 | 881.89 | 9.00 | 890.89 |

**Name**: WA 14-1
**Path type**: Two-way
**Observer view angle**: 50.0°


| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 45.941191 | -119.560872 | 418.89 | 9.00 | 427.89 |
| 2 | 45.942672 | -119.546463 | 421.09 | 9.00 | 430.09 |
| 3 | 45.943112 | -119.541941 | 386.21 | 9.00 | 395.21 |
| 4 | 45.943610 | -119.531533 | 338.07 | 9.00 | 347.07 |
| 5 | 45.944239 | -119.517257 | 348.54 | 9.00 | 357.54 |
| 6 | 45.944652 | -119.508268 | 372.57 | 9.00 | 381.57 |
| 7 | 45.945122 | -119.497717 | 374.38 | 9.00 | 383.38 |
| 8 | 45.945779 | -119.482585 | 370.55 | 9.00 | 379.55 |
| 9 | 45.946608 | -119.464398 | 385.68 | 9.00 | 394.68 |
| 10 | 45.947265 | -119.448704 | 386.46 | 9.00 | 395.46 |
| 11 | 45.947474 | -119.446161 | 385.38 | 9.00 | 394.38 |
| 12 | 45.948097 | -119.441684 | 386.75 | 9.00 | 395.75 |
| 13 | 45.948984 | -119.437457 | 388.22 | 9.00 | 397.22 |
| 14 | 45.949723 | -119.434734 | 393.91 | 9.00 | 402.91 |
| 15 | 45.950935 | -119.431219 | 403.38 | 9.00 | 412.38 |
| 16 | 45.952139 | -119.427982 | 413.23 | 9.00 | 422.23 |
| 17 | 45.954825 | -119.420810 | 422.96 | 9.00 | 431.96 |
| 18 | 45.958357 | -119.410946 | 472.42 | 9.00 | 481.42 |

**Name**: WA 14-2
**Path type**: Two-way
**Observer view angle**: 50.0°


| Vertex | Latitude (°) | Longitude (°) | Ground elevation (ft) | Height above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 45.958387 | -119.410603 | 473.05 | 9.00 | 482.05 |
| 2 | 45.958327 | -119.409530 | 474.05 | 9.00 | 483.05 |
| 3 | 45.957626 | -119.408092 | 469.76 | 9.00 | 478.76 |
| 4 | 45.954256 | -119.405466 | 421.70 | 9.00 | 430.70 |
| 5 | 45.950932 | -119.402954 | 391.49 | 9.00 | 400.49 |
| 6 | 45.950305 | -119.402224 | 382.06 | 9.00 | 391.06 |
| 7 | 45.949828 | -119.401452 | 376.69 | 9.00 | 385.69 |
| 8 | 45.949351 | -119.400336 | 370.06 | 9.00 | 379.06 |
| 9 | 45.949022 | -119.398169 | 364.21 | 9.00 | 373.21 |
| 10 | 45.947573 | -119.382693 | 375.34 | 9.00 | 384.34 |
| 11 | 45.946655 | -119.372767 | 371.27 | 9.00 | 380.27 |
| 12 | 45.945924 | -119.364917 | 384.84 | 9.00 | 393.84 |
| 13 | 45.944895 | -119.353824 | 412.19 | 9.00 | 421.19 |
| 14 | 45.943925 | -119.343364 | 425.34 | 9.00 | 434.34 |
| 15 | 45.943940 | -119.342248 | 426.82 | 9.00 | 435.82 |
| 16 | 45.944134 | -119.340982 | 428.09 | 9.00 | 437.09 |
| 17 | 45.945399 | -119.335469 | 428.07 | 9.00 | 437.07 |

## Discrete Observation Point Receptors

| Name | ID | Latitude (°) | Longitude (°) | Elevation (ft) | Height (ft) |
|---|---|---|---|---|---|
| OP 1 | 1 | 45.929734 | -119.352818 | 280.68 | 16.00 |
| OP 2 | 2 | 45.922714 | -119.334458 | 292.67 | 16.00 |
| OP 3 | 3 | 45.913082 | -119.431330 | 276.34 | 16.00 |
| OP 4 | 4 | 45.899565 | -119.489066 | 284.40 | 16.00 |
| OP 5 | 5 | 45.943722 | -119.558719 | 439.96 | 16.00 |
| OP 6 | 6 | 45.947993 | -119.352693 | 460.37 | 16.00 |
| OP 7 | 7 | 45.943148 | -119.359106 | 377.71 | 16.00 |
| OP 8 | 8 | 45.935513 | -119.359982 | 302.38 | 16.00 |
| OP 9 | 9 | 45.930614 | -119.389803 | 297.19 | 16.00 |
| OP 10 | 10 | 45.937349 | -119.413872 | 375.33 | 16.00 |
| OP 11 | 11 | 45.924596 | -119.464932 | 359.19 | 16.00 |

# Glare Analysis Results

## Summary of Results No glare predicted

| PV Array | Tilt | Orient | Annual Green Glare | | Annual Yellow Glare | | Energy |
|---|---|---|---|---|---|---|---|
| | ° | ° | min | hr | min | hr | kWh |
| PV array 1 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 2 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 3 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 4 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |
| PV array 5 | SA tracking | SA tracking | 0 | 0.0 | 0 | 0.0 | - |

*Total glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

## PV: PV array 1 no glare found

*Receptor results ordered by category of glare*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

### PV array 1 and Route: McNary Hwy

No glare found

### PV array 1 and Route: S Plymouth Rd

No glare found

### PV array 1 and Route: WA 14-1

No glare found

### PV array 1 and Route: WA 14-2

No glare found

### PV array 1 and OP 1

No glare found

### PV array 1 and OP 2

No glare found

### PV array 1 and OP 3

No glare found

### PV array 1 and OP 4

No glare found

### PV array 1 and OP 5

No glare found

### PV array 1 and OP 6

No glare found

### PV array 1 and OP 7

No glare found

### PV array 1 and OP 8

No glare found

### PV array 1 and OP 9

No glare found

### PV array 1 and OP 10

No glare found

### PV array 1 and OP 11

No glare found

## PV: PV array 2 no glare found

*Receptor results ordered by category of glare*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

### PV array 2 and Route: McNary Hwy

No glare found

### PV array 2 and Route: S Plymouth Rd

No glare found

### PV array 2 and Route: WA 14-1

No glare found

### PV array 2 and Route: WA 14-2

No glare found

### PV array 2 and OP 1

No glare found

### PV array 2 and OP 2

No glare found

### PV array 2 and OP 3

No glare found

### PV array 2 and OP 4

No glare found

### PV array 2 and OP 5

No glare found

### PV array 2 and OP 6

No glare found

### PV array 2 and OP 7

No glare found

### PV array 2 and OP 8

No glare found

### PV array 2 and OP 9

No glare found

### PV array 2 and OP 10

No glare found

### PV array 2 and OP 11

No glare found

## PV: PV array 3 no glare found

*Receptor results ordered by category of glare*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

### PV array 3 and Route: McNary Hwy

No glare found

### PV array 3 and Route: S Plymouth Rd

No glare found

### PV array 3 and Route: WA 14-1

No glare found

### PV array 3 and Route: WA 14-2

No glare found

### PV array 3 and OP 1

No glare found

### PV array 3 and OP 2

No glare found

### PV array 3 and OP 3

No glare found

### PV array 3 and OP 4

No glare found

### PV array 3 and OP 5

No glare found

### PV array 3 and OP 6

No glare found

### PV array 3 and OP 7

No glare found

### PV array 3 and OP 8

No glare found

### PV array 3 and OP 9

No glare found

### PV array 3 and OP 10

No glare found

### PV array 3 and OP 11

No glare found

## PV: PV array 4 no glare found

*Receptor results ordered by category of glare*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

### PV array 4 and Route: McNary Hwy

No glare found

### PV array 4 and Route: S Plymouth Rd

No glare found

### PV array 4 and Route: WA 14-1

No glare found

### PV array 4 and Route: WA 14-2

No glare found

### PV array 4 and OP 1

No glare found

### PV array 4 and OP 2

No glare found

### PV array 4 and OP 3

No glare found

### PV array 4 and OP 4

No glare found

### PV array 4 and OP 5

No glare found

### PV array 4 and OP 6

No glare found

### PV array 4 and OP 7

No glare found

### PV array 4 and OP 8

No glare found

### PV array 4 and OP 9

No glare found

### PV array 4 and OP 10

No glare found

### PV array 4 and OP 11

No glare found

## PV: PV array 5 no glare found

*Receptor results ordered by category of glare*

| Receptor | Annual Green Glare | | Annual Yellow Glare | |
|---|---|---|---|---|
| | min | hr | min | hr |
| McNary Hwy | 0 | 0.0 | 0 | 0.0 |
| S Plymouth Rd | 0 | 0.0 | 0 | 0.0 |
| WA 14-1 | 0 | 0.0 | 0 | 0.0 |
| WA 14-2 | 0 | 0.0 | 0 | 0.0 |
| OP 1 | 0 | 0.0 | 0 | 0.0 |
| OP 2 | 0 | 0.0 | 0 | 0.0 |
| OP 3 | 0 | 0.0 | 0 | 0.0 |
| OP 4 | 0 | 0.0 | 0 | 0.0 |
| OP 5 | 0 | 0.0 | 0 | 0.0 |
| OP 6 | 0 | 0.0 | 0 | 0.0 |
| OP 7 | 0 | 0.0 | 0 | 0.0 |
| OP 8 | 0 | 0.0 | 0 | 0.0 |
| OP 9 | 0 | 0.0 | 0 | 0.0 |
| OP 10 | 0 | 0.0 | 0 | 0.0 |
| OP 11 | 0 | 0.0 | 0 | 0.0 |

### PV array 5 and Route: McNary Hwy

No glare found

### PV array 5 and Route: S Plymouth Rd

No glare found

### PV array 5 and Route: WA 14-1

No glare found

### PV array 5 and Route: WA 14-2

No glare found

### PV array 5 and OP 1

No glare found

### PV array 5 and OP 2

No glare found

### PV array 5 and OP 3

No glare found

### PV array 5 and OP 4

No glare found

### PV array 5 and OP 5

No glare found

### PV array 5 and OP 6

No glare found

### PV array 5 and OP 7

No glare found

### PV array 5 and OP 8

No glare found

### PV array 5 and OP 9

No glare found

### PV array 5 and OP 10

No glare found

### PV array 5 and OP 11

No glare found

# 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.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Several V1 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. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not automatically consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
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.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
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.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

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

# ATTACHMENT B: FAA NOTICE CRITERIA TOOL

Federal Aviation Administration

« OE/AAA

# Notice Criteria Tool

Notice Criteria Tool - Desk Reference Guide V_2018.2.0

The requirements for filing with the Federal Aviation Administration for proposed structures vary based on a number of factors: height, proximity to an airport, location, and frequencies emitted from the structure, etc. For more details, please reference CFR Title 14 Part 77.9.

You must file with the FAA at least 45 days prior to construction if:

- your structure will exceed 200ft above ground level
- your structure will be in proximity to an airport and will exceed the slope ratio
- your structure involves construction of a traverseway (i.e. highway, railroad, waterway etc...) and once adjusted upward with the appropriate vertical distance would exceed a standard of 77.9(a) or (b)
- your structure will emit frequencies, and does not meet the conditions of the FAA Co-location Policy
- your structure will be in an instrument approach area and might exceed part 77 Subpart C
- your proposed structure will be in proximity to a navigation facility and may impact the assurance of navigation signal reception
- your structure will be on an airport or heliport
- filing has been requested by the FAA

If you require additional information regarding the filing requirements for your structure, please identify and contact the appropriate FAA representative using the Air Traffic Areas of Responsibility map for Off Airport construction, or contact the FAA Airports Region / District Office for On Airport construction.

The tool below will assist in applying Part 77 Notice Criteria.

| | |
|---|---|
| * **Structure Type:** | SOLAR \| Solar Panel<br>Please select structure type and complete location point information. |
| **Latitude:** | 45 Deg 57 M 10.39 S N |
| **Longitude:** | 119 Deg 27 M 4.35 S W |
| **Horizontal Datum:** | NAD83 |
| **Site Elevation (SE):** | 464 (nearest foot) |
| **Structure Height :** | 10 (nearest foot) |
| **Is structure on airport:** | (●) No<br>( ) Yes |

## Results

You do not exceed Notice Criteria.