# Draft Environmental Assessment for Photovoltaic Systems

Commander, Joint Region Marianas
Guam

May 2015

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## Commander, Joint Region Marianas, Guam

Prepared for:

Commander, Joint Region Marianas

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Naval Facilities Engineering Command Pacific

May 2015

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# COVER SHEET

**Proposed Action:** Approximately 192 acres of Department of Defense (DoD) land on Guam would be leased to the Guam Power Authority for use to build and operate eight photovoltaic (PV) systems that have a combined energy potential of approximately 43.8 megawatts (MW).

**Type of Document:** Environmental Assessment (EA)

**Lead Agency:** U.S. Department of the Navy
Commander, Joint Region Marianas

**For Further Information:** ATTN: ENV Planning and Conservation
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Nimitz Hill, Guam 96540

This EA has been developed in accordance with the National Environmental Policy Act (NEPA) of 1969 codified in Title 42 of the United States Code (U.S.C.), Section (§) 4321 et seq.; Council on Environmental Quality (CEQ) procedures for implementing NEPA codified in Title 40 of the Code of Federal Regulations (CFR), Parts 1500-1508; Department of Defense (DoD) Directive 6050.1(D), titled *Environmental Effects in the United States of DoD Actions* (July 30, 1979); DoD Instruction 4715.9, titled *Environmental Planning and Analysis* (May 3, 1996); DoN procedures for implementing NEPA (32 CFR §775), and Office of the Chief of Naval Operations (OPNAV) M-5090.1, titled *Environmental Readiness Program Manual* (January 10, 2014).

The proposed action would involve the use of 192 acres of DoD land to produce up to 43.8 MW of direct current solar-generated energy. Commander, Joint Region Marianas would lease the Guam Power Authority four PV sites in Northern Guam (South Finegayan, former Tumon Tank Farm, Harmon Booster Station, and Harmon Annex) and four PV sites at Naval Base Guam. The land underlying the PV sites would be leased for up to 37 years after which time the leases may be renewed or the facilities could be decommissioned.

The proposed action would provide clean, renewable energy and would help decrease energy costs, reduce dependency on fossil fuel, and increase energy independence. The proposed action is not expected to have an adverse effect upon air quality; noise; topography and soils; water resources; biological resources; cultural resources; visual resources; land use; roadways; electrical and water utilities; and socioeconomic conditions. Consultations with the Guam State Historic Preservation Officer (SHPO) and the Guam Bureau of Statistics and Planning (BSP) are ongoing.

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# Acronyms, Abbreviations, and Symbols

| | |
|---|---|
| ° | degrees |
| ' | minutes |
| # | number |
| % | percent |
| § | Section |
| AAFB | Andersen Air Force Base |
| AD | *anno Domini* (after date) |
| AC | alternating current |
| AMSL | above mean sea level |
| Approx. | approximately |
| BCS | battery container system |
| BESS | battery energy storage system |
| BSP | Guam Bureau of Statistics and Plans |
| C&D | Construction and Demolition |
| CDF | Confined Disposal Facility |
| CFR | Code of Federal Regulations |
| CNMI | Commonwealth of the Northern Mariana Islands |
| CJRM | Commander, Joint Region Marianas |
| CONUS | Continental United States |
| CZMA | Coastal Zone Management Act of 1972 |
| DAF | Department of the Air Force |
| DC | direct current |
| DoD | Department of Defense |
| DoN | Department of the Navy |
| EO | Executive Order |
| EOD | Explosive Ordnance Disposal |
| EPA | Environmental Protection Agency |
| EPAct | Environmental Policy Act of 2005 |
| ESA | Endangered Species Act of 1973 |
| ESS | Explosive Safety Submission |
| FAA | Federal Aviation Agency |
| ft. | feet |
| FY | fiscal year |
| GHG | greenhouse gas |
| GW | gigawatt |
| GOVGUAM | Government of Guam |
| GPA | Guam Power Authority |
| GWA | Guam Waterworks Authority |
| GTA | GTA Teleguam |
| kW | kilowatt |
| LUC | Land Use Controls |
| LEED | Leadership in Energy and Environmental Design |
| MCVB | Marianas Cable Vision Broadband |
| mph | miles per hour |
| MW | megawatt |

| | | |
|---|---|---|
| NAAQS | National Ambient Air Quality Standards |
| NBG | Naval Base Guam |
| NAVFAC | Naval Facilities Engineering Command |
| NAVFACINST | NAVFAC Instruction |
| NEX | Navy Exchange |
| NHPA | National Historic Preservation Act of 1966 |
| NMS | Naval Munitions Site |
| No. | Number |
| Nos. | Numbers |
| NPDES | National Pollutant Discharge Elimination System |
| NRHP | National Register of Historic Places |
| OPNAV | Office of the Chief of Naval Operations |
| POC | point of connection |
| PV | photovoltaic |
| REPO | Renewable Energy Program Office |
| ROW | right(s)-of-way |
| Rte | Route |
| SECNAV | Secretary of the Navy |
| SHPO | Guam State Historic Preservation Office |
| SCADA | supervisory control and data acquisition |
| SEIS | Supplemental Environmental Impact Statement |
| SGHAT | Solar Glare Hazard Analysis Tool |
| U.S. | United States |
| U.S.C. | United States Code |
| UXO | Unexploded Ordnance |
| WWII | World War II |
| WWTP | wastewater treatment plant |

# Chapter 1 Purpose and Need for the Proposed Action

## 1.1 Introduction

The U.S. Department of the Navy (DoN) has prepared this Environmental Assessment (EA) to evaluate the potential environmental effects of the construction, operation, and decommissioning of ground-mounted photovoltaic (PV) systems on the island of Guam.

To facilitate the development of the PV systems, the Commander, Joint Region Marianas (CJRM) would lease approximately 192 acres of U.S. Department of Defense (DoD) land to the Guam Power Authority (GPA), the local electrical utility company. GPA would then select a renewable energy contractor(s) to build and operate the solar PV systems which are expected to generate approximately 43.8 megawatts (MW) of direct current (DC) electrical power and would feed into GPA's electrical grid for public and military use. The land underlying the PV sites would be leased for up to 37 years after which time the leases may be renewed or the facilities could be decommissioned.

This EA has been developed in accordance with the National Environmental Policy Act (NEPA) of 1969 codified in Title 42 of the United States Code (U.S.C.), Section (§) 4321 et seq.; Council on Environmental Quality (CEQ) procedures for implementing NEPA codified in Title 40 of the Code of Federal Regulations (CFR), Parts 1500-1508; Department of Defense (DoD) Directive 6050.1(D), titled *Environmental Effects in the United States of DoD Actions* (July 30, 1979); DoD Instruction 4715.9, titled *Environmental Planning and Analysis* (May 3, 1996); DoN procedures for implementing NEPA (32 CFR §775), and Office of the Chief of Naval Operations (OPNAV) M-5090.1, titled *Environmental Readiness Program Manual* (January 10, 2014).

The DoN is the lead agency for the proposed action, and CJRM is the action proponent.

## 1.2 Background

The DoN's energy strategy is centered on energy security, energy efficiency, and sustainability while remaining the pre-eminent maritime power.

- Energy efficiency increases mission effectiveness. Efficiency improvements minimize operational risks while saving time, money, and lives.
- Energy security is critical to mission success. Energy security safeguards our energy infrastructure and shields the DoN from a volatile energy supply.
- Sustainable energy efforts protect mission capabilities. Investment in environmentally responsible technologies afloat and ashore reduces greenhouse gas (GHG) emissions and lessens dependence on fossil fuels (DoN, not dated).

In October 2009, the Secretary of the Navy (SECNAV) established renewable energy goals for the DoN's shore-based installations to meet by 2015. These goals include:

1. The DoN will produce or procure at least 50% of the total quantity of electric energy consumed by shore-based facilities and activities each fiscal year (FY) from alternative energy sources;
2. 50% of DoN installations will be net zero (i.e., over the course of a FY, an installation matches or exceeds the electrical energy it consumes ashore with electrical energy generated from alternative energy sources) (DoN, 2011).

The DoN's goals and energy strategy are in sync with renewable energy policies being developed throughout the federal government and contained in the following executive order and statutes:

- Executive Order (EO) 13514, Federal Leadership in Environmental, Energy, and Economic Performance (2009): This EO requires federal agencies to set percentage reduction targets for GHG emissions for FY 2020. Agencies are instructed to consider measures for the targets by increasing energy efficiency, reducing use of fossil fuels, and increasing use of renewable energy, as well as implementing renewable energy generation projects on agency property.
- Energy Policy Act of 2005 (EPAct) (42 U.S.C. 15852): Section 203 of the EPAct requires that the federal government consume not less than 7.5% of its electricity from renewable sources after FY 2013.
- Title 10 U.S.C. 2911(e): This statute requires the submission of an energy performance master plan and performance goals, including the goal to produce or procure 25% of the total quantity of energy consumed within its facilities from renewable sources by 2025 and each FY thereafter.

In December 2013, President Obama signed a presidential memorandum that requires federal agencies to produce or procure from renewable sources 20% of electricity consumed by facilities by FY 2020 and each FY thereafter, an amount that represents a more aggressive goal than under the EPAct or 10 U.S.C. 2911(e). The memorandum also establishes interim goals of 10% by 2015, 15% by 2016, and 17.5% by 2018. The memorandum states that the renewable energy consumption target be achieved by: 1) installing agency-funded renewable energy on-site at federal facilities, or 2) contracting for energy that includes the installation of a renewable energy project on-site at a federal facility. The memorandum implements the goal outlined by President Obama in the June 2013 Climate Action Plan. As part of this effort, agencies are instructed "to consider opportunities to the extent economically feasible and technically practical, to install or contract for energy installed on current or formerly contaminated lands, landfills, and mine sites." The DoD is currently working with the CEQ, the U.S. Office of Management and Budget, and the Department of Energy (DoE) to provide guidance on the 20% renewable energy goal under the presidential memorandum (DoD, 2014).

In support of EPAct and 10 U.S.C. 2911(e) renewable energy goals, SECNAV created the 1 gigawatt (GW) Initiative—named for the amount of renewable energy generation capacity to be deployed by 2015 (DoN, 2012), either on or near DoN installations. This goal was initially stated in the President's 2012 State of the Union Address and is consistent with SECNAV's 2009 alternative energy goal and the 2013 presidential memorandum.

With the 1 GW Initiative, the DoN took a more aggressive approach to implement cost-effective and mission-compatible projects at its shore facilities. To achieve 1 GW of renewable energy generation capacity by 2015, the DoN recognized the need to develop opportunities for large-scale projects that would be attractive to local commercial utilities. The DoN established the Renewable Energy Program Office (REPO) specifically to work with local commercial utilities to use private-sector funds to construct renewable energy facilities on DoN land. Three Regional Program Offices were established to implement the projects at shore facilities across the country and abroad; Guam projects are being administered by the Naval Facilities Engineering Command (NAVFAC) Pacific's Program Office.

## 1.3 Purpose and Need

The purpose of the proposed action is to reduce energy costs and fuel oil dependency, and increase the energy security, operational capability, strategic flexibility and resource availability at DoN installations through the development of renewable energy generating assets on Guam. The proposed action is required to meet the renewable energy standards put forth by the 1 GW Initiative, EPAct, 10 U.S.C. 2911(e), the 2013 presidential memorandum, and SECNAV, to include the requirement to produce 50% of the DoN's shore-based energy requirements from alternative sources.

## 1.4 Project Locations

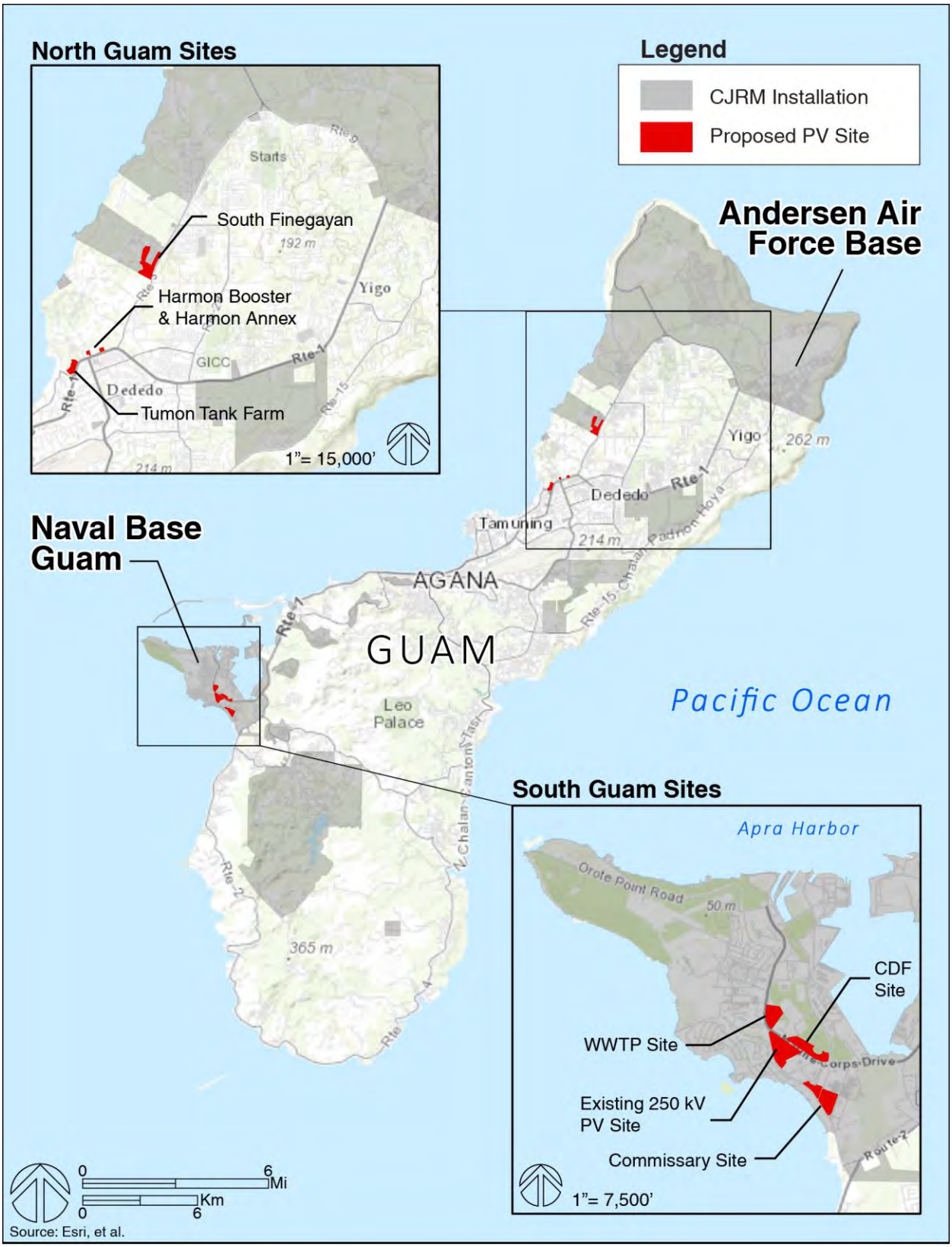
CJRM encompasses approximately 22,537 acres of land and water on the island of Guam, and includes significant land holdings at U.S. Naval Base Guam (NBG), Naval Munitions Site, Nimitz Hill, NBG Transmitter Station Barrigada, NBG Transmitter Station Finegayan, Andersen Air Force Base (AAFB), Andersen South, Andersen Communications Annex Barrigada, and other outlying areas (DoN, November 2010). U.S. Naval Base Guam joined with AAFB to become CJRM in 2009, combining the 2 bases into a single joint installation to support both DoN and Department of the Air Force (DAF) missions in the Pacific. CJRM serves as the home base for the Air Force's 36th Wing, Submarine Squadron 15, and dozens of Pacific Command, U.S. Pacific Fleet, and Seventh Fleet units. In addition, CJRM hosts a number of tenant commands that support the DoN, DAF, and other missions in the Pacific Region.

The solar PV systems are proposed at eight locations on CJRM properties including four sites in Northern Guam and four sites in Southern Guam at NBG (Figure 1-1). The locations, land areas, and energy potential for each of the proposed sites is shown in Table 1-1.

**Table 1-1: PV Site Locations, Land Areas, and Energy Potential**

| Site Location | Village (Installation) | Approximate Land Area | Energy Potential* (MW DC) |
|---|---|---|---|
| **Northern Guam** | | | |
| South Finegayan | Dededo | 71 acres | 16.2 |
| Harmon Annex | Tamuning | 4 acres | 0.9 |
| Harmon Booster Station | Tamuning | 4 acres | 0.9 |
| Former Tumon Tank Farm | Tamuning | 20 acres | 4.5 |
| **Southern Guam** | | | |
| Wastewater Treatment Plant (WWTP) Site | Santa Rita (NBG) | 16 acres | 3.7 |
| Existing 250kW PV Site | Santa Rita (NBG) | 31 acres | 7.1 |
| Confined Disposal Facility (CDF) Site | Santa Rita (NBG) | 21 acres | 4.7 |
| Commissary Site | Santa Rita (NBG) | 25 acres | 5.6 |
| **Total** | ----- | 192 acres | 43.8 |

*Energy Potential based on GPA-provided output estimates (GPA, 2014). Total Energy Potential is slightly larger than the sum of each individual site due to rounding.




**Regional Location Map**
Environmental Assessment for PV Systems
Commander, Joint Region Marianas

**Figure 1-1**

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## 1.5 Scope of the EA

This EA evaluates the reasonably foreseeable potential environmental effects of the DoN's plan to lease land for the construction, operation, and decommissioning of potential solar PV systems and associated battery energy storage system (BESS) facilities.

Resource areas that could be potentially affected by the Proposed Action include the following.

- Air Quality
- Topography and Soils
- Biological Resources
- Visual Resources
- Utilities
- Socio Economic Conditions
- Noise
- Water Resources
- Cultural Resources
- Glint and Glare
- Land Use

## 1.6 Agency Coordination and Permit Requirements

As part of the NEPA compliance process, the DoN has engaged in coordination, consultation, and permitting with regulatory agencies to ensure that all applicable laws, rules, regulations, and policies have been satisfied with respect to the proposed action. Potential permits, approvals, and consultation requirements for the project include but are not limited to those listed in Table 1-2

**Table 1-2: List of Potential Permits, Approvals, and Required Consultations**

| Oversight Agency | Permit, Approval, or Consultation |
|---|---|
| Guam State Historic Preservation Officer (SHPO) | Section 106 consultation for properties listed or eligible for the National Register of Historic Places (NRHP) pursuant to the National Historic Preservation Act (NHPA) of 1966 (Public Law 89-665; 16 U.S.C. §470 et seq.); 36 CFR 800 (Protection of Historic Properties) |
| Guam Environmental Protection Agency | National Pollutant Discharge Elimination System (NPDES) Permit for construction-related stormwater discharge for land disturbance equal or greater than 1-acre pursuant to the Clean Water Act of 1972 (33 U.S.C. 121 et seq.) |
| Guam Bureau of Statistics and Plans (BSP) | Negative Determination of effects to Guam's defined coastal zone per CFR Part 930 §930.35, and pursuant to the Coastal Zone Management Act (CZMA) of 1972 (as amended) (16 U.S.C. §1451 et seq.) |

In accordance with DoD and DoN policies and instructions for implementing NEPA, public comments will be solicited for the Draft EA. Copies of the Draft EA will be provided to public libraries on Guam and will be available on the Internet. Notice of Availability (NOA) of the Draft EA will be published in local newspapers of general distribution on Guam. All comments received during the Draft EA comment period will be fully considered by the DoN prior to rendering a decision on the proposed action.

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# Chapter 2 Proposed Action and Alternatives

The DoN established REPO to spearhead its efforts to secure 1 GW of renewable energy generation capacity by 2015. With support from NAVFAC Pacific and GPA, REPO conducted a survey of suitable sites on DoD installations and lands on Guam for the development of renewable energy facilities and identified eight potential PV sites that possess the necessary site characteristics for solar PV development.

## 2.1 Proposed Action

### 2.1.1 Overview of the Proposed Action

To facilitate the development of the PV systems, the Commander, Joint Region Marianas (CJRM) would lease approximately 192 acres of DoD land to GPA, the local electrical utility company. GPA would then select a renewable energy contractor(s) to build and operate the solar PV systems which are expected to generate approximately 43.8 MW of DC electrical power and would feed into GPA's electrical grid for public and military use. The land underlying the PV sites would be leased for up to 37 years after which time the leases may be renewed or the facilities could be decommissioned.

### 2.1.2 Solar PV Technology

Solar PV panels utilize a packaged assembly of solar cells to harness solar energy (photons) from the sun and generate electricity. The panels generate DC electricity, which is converted to alternating current (AC) electricity for transmission on the electrical grid and ultimate end-use in AC form. The conversion from DC to AC occurs at inverters mounted on concrete pads that are strategically located throughout the PV array. Each inverter would have its own medium voltage transformer, and the medium voltage power output from each of these inverter/transformer blocks (approx. 10 feet square by 10 feet high) would be carried through electrical cables to the PV system's substation. Each PV system may include some type of BESS facility to provide dispatchable energy to balance fluctuations in energy generation caused by weather, seasons, and nighttime darkness. The BESS is typically located near the PV system's substation. The substation and a transmission line extending to the nearest point of connection (POC), would transfer the power generated by the PV system to the electrical grid.

### 2.1.3 Description of the Proposed Action

The proposed action involves the construction of solar PV systems at various locations on Guam. A description of the PV system's components and operations is provided below, followed by a review of each of the eight proposed sites.

Glass-cased PV panels would be used for the PV array. The panels would be darkly colored to minimize light reflection and would each be approximately 3.5 feet wide and 5 feet long. The PV panels would be attached to metal racking structures before being placed upon a mounting system. Generally, the mounting systems are installed in the ground; however, a ballasted system would be utilized where ground disturbance is a concern. The type of racking structure (stationary versus adjustable) would be determined by GPA's PV Contractor(s) during the project's final engineering design. A stationary racking structure is one in which the PV panels are attached to a fixed assembly which locks the tilt and orientation of the panels.

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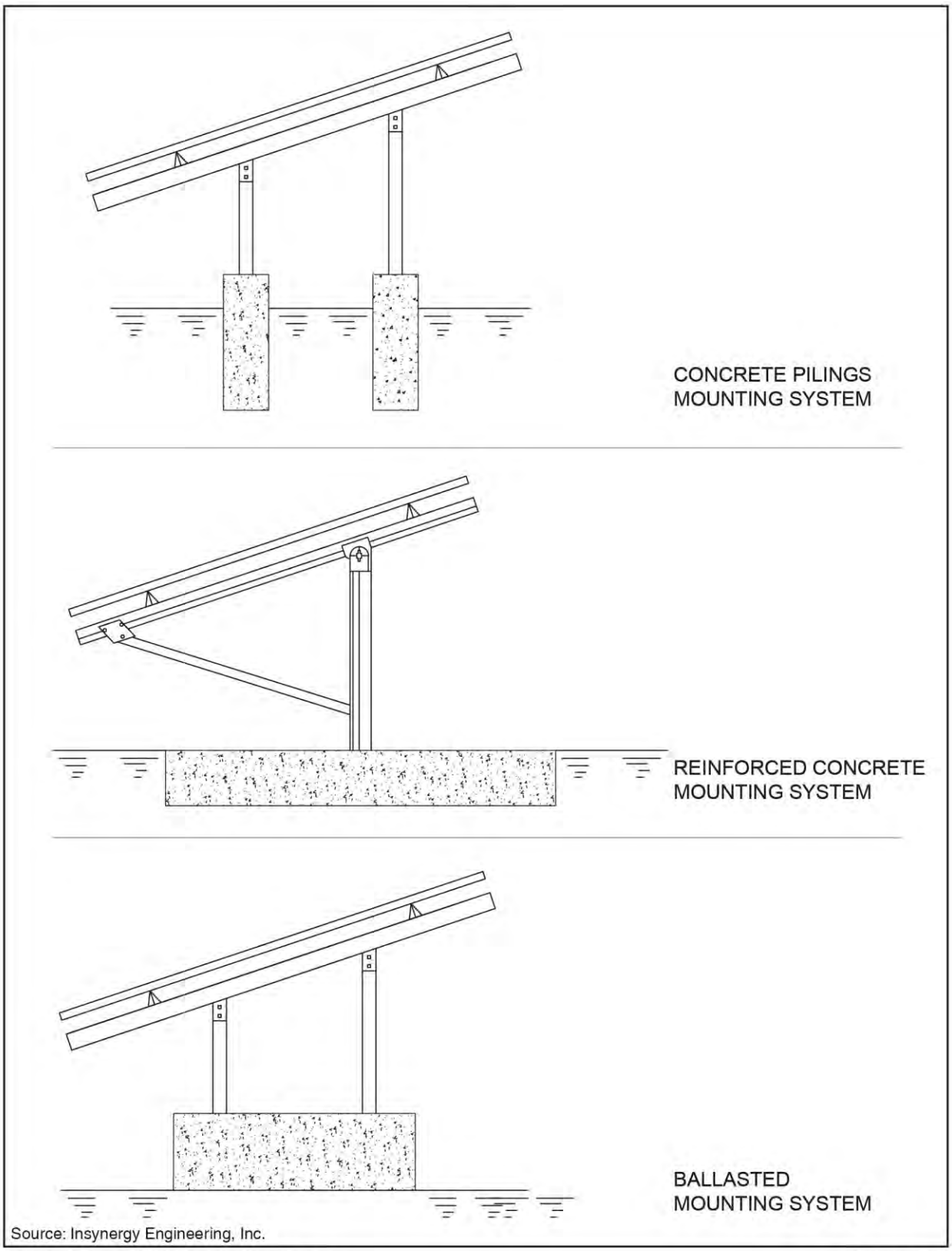



Source: Insynergy Engineering, Inc.

**Ground Mount PV Foundation Types** **Figure 2-1**

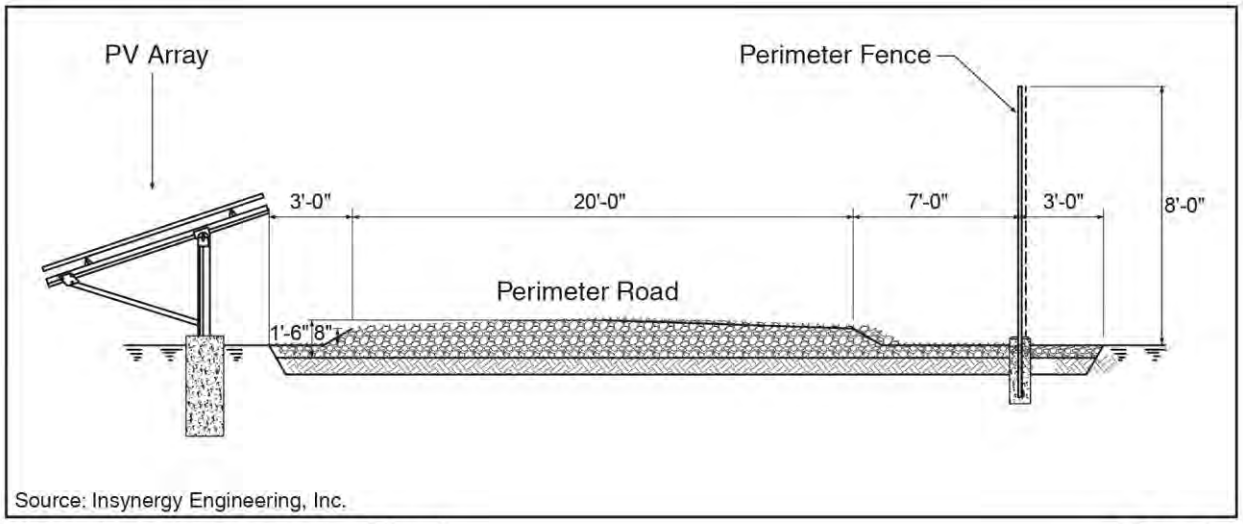
The optimal exposure for a stationary racking structure in Guam is a tilt of 13.5 degrees (°) and an orientation pointing due south. However, the PV Contractor(s) may adjust the tilt and orientation of the PV array, to better accommodate the shape and topography of each site. The actual tilt and orientation of the panels would be established during final engineering design. An adjustable racking structure is one in which the panels are attached to a solar tracking assembly which allows the panels to follow the path of the sun throughout the day in a vertical and/or horizontal direction – which increases the efficiency of the system but also increases cost. The installed top edge height of the ground-mounted PV panels (regardless of the racking structure) is projected to be approximately 4 feet from ground level to the top edge of the panel.

Mounting systems constructed of concrete pilings, poured reinforced concrete, or concrete ballasted systems would be used to support the racking structures (Figure 2-1). The racking structures would be designed to comply with all applicable wind load criteria. Where possible, the racking structures would adapt to ground contours to minimize site work and ground disturbance. The racking systems would also be designed to facilitate the efficient placement, replacement, maintenance, and cleaning of the PV panels.

Electrical cabling would be used to connect the individual PV modules and the larger electrical system. Where practical, cabling would be placed in trays above ground. In the event cable routing requires underground installation, cables (in conduits) would be buried directly in excavations of minimal cross section with a required depth per DoD Unified Facility Criteria and the National Electrical Code 70 (typically 36 inches below grade). The conduit would then be covered with backfill and tamped to the appropriate level of compaction. Where conduit would cross under on-site service roads, concrete encasement would be used around conduits for mechanical protection against vehicular traffic.

The construction of several electrical system components would require concrete slab foundations. The inverter/transformer stations located throughout the PV array would be pad mounted on concrete foundations and their placement would be determined during final engineering design. These stations are generally sized at 1.0 MW, therefore there would be approximately 1 station for every 1 MW of PV energy development proposed at each site. Additionally, each substation complex would be located as close as practicable to the nearest POC to minimize transmission line length. Each substation complex would include its own transformers as well as, switchgear, a BESS facility, and a maintenance building, all of which would require concrete foundations. Prefabricated buildings would likely be used to house some of this equipment (i.e., maintenance building and BESS facility). In addition to providing storage space for equipment, the maintenance building will contain a supervisory control and data acquisition (SCADA) system which will be used to remotely monitor and operate the PV system, therefore, no full-time personnel would be required at each PV site.

The PV sites would be contained within an 8-foot-high perimeter fence to restrict access and ensure security. PV arrays would occupy most of the space within the fenced enclosure. A perimeter maintenance road would be located directly inside of the security fence, and would generally be 20 feet wide (Figure 2-2). Access roads within the array would typically be 10 feet wide. All site roads would be constructed per final design but likely would consist of a gravel or similar base that would be trucked on site.




**PV Site Typical Perimeter Road Detail** **Figure 2-2**

### 2.1.4 Site Preparation and Construction Activities

The island of Guam was a World War II battleground and unexploded ordnance (UXO) can still be found today. Potential adverse effects from UXO are not expected and are capable of being avoided or minimized through the use of BMPs. Site preparation and construction activities for the proposed action would comply with all applicable UXO regulatory requirements and protocols.

During site preparation, surface vegetation in the areas to be developed would be cleared and grubbed (i.e., roots and stumps extracted), and the ground would be excavated and compacted where load-bearing foundations are proposed. Ground disturbance during construction would include site grading to establish positive drainage control, installation of the PV racking system and mounting systems, trenching for underground electrical cables, installation of overhead transmission line poles, foundation work for electrical equipment and site buildings, and miscellaneous civil works (i.e., perimeter fencing post holes and access roads). BMPs for soil erosion and sedimentation control would be implemented in accordance with project-specific drainage and erosion control plans which would comply with applicable NPDES requirements for construction-related activities. In addition, BMPs will be implemented, and retention basins or dry wells will be utilized as necessary, to ensure that stormwater runoff is retained on site and allowed to percolate into the ground or be discharged at a rate that would not exceed pre-development runoff or adversely affect adjacent and downstream properties.

During construction, materials would be transported to the project sites by truck, where they would be stored, assembled (as necessary), and moved into place. Temporary construction laydown areas for materials, equipment, and parking would be provided on each site or on adjacent DoD Property. Prior to construction, site boundaries or limits of disturbance would be surveyed and staked to identify areas where construction activities would occur. Dust barriers would be erected around active construction areas to minimize the effects of fugitive dust on adjacent land uses in the area.

### 2.1.5 PV Substations and Interconnections

The PV substation located at each solar PV site is where power is transformed to match the specification for interconnection with the electrical grid. An electrical transmission line would be installed either overhead or underground (based on final engineering design) to connect the PV system substation to the electrical grid. In cases where the proposed connection lines would require a new ROW within DoD property, the width of the ROW would be determined by GPA. The ROW would likely be cleared of vegetation and may be graded to provide maintenance access. Final siting of utility lines would be subject to review by CJRM and GPA personnel prior to construction.

### 2.1.6 Operation and Maintenance

The solar PV systems would require minimal maintenance. Cleaning with hand tools or spray washing the surfaces of the PV panels with water would be undertaken periodically to remove accumulated dust and dirt. Connections to DAF and DoN systems will be made to provide water for fire protection for the BESS and substation complex at each of the PV sites. Water trucks would also be used for cleaning purposes.

Periodic maintenance of the PV system's electrical equipment would involve checking the equipment and testing the connections, replacing air filters in the inverters, and sampling the oil in the transformers. Maintenance for the BESS facility would involve checking the batteries and electrical equipment and testing the connections.

Surface vegetation lying beneath, and adjacent to the panels, would be regularly trimmed to ensure that grass, plants, and weeds do not overhang or cast shadows upon the panels. As warranted, herbicides would be used for vegetation control in accordance with applicable government regulations and manufacturer's guidelines. Maintenance roads would be maintained as needed to ensure that vehicular access and mobility are maintained.

### 2.1.7 Lease Agreement

The land underlying each solar PV site would be leased to for up to 37 years including renewal options. After the expiration of the lease, the lease may be renewed or the facility could be decommissioned. In accordance with 10 U.S.C. §2667, the leases shall provide for consideration (rent) to be paid in an amount not less than the fair market value of the leasehold interest, either in cash or in kind.

Although the proposed action addresses the known impacts of the federal lease action, details regarding the specific method of consideration to be employed, to include the design, construction, management and maintenance of any potential in-kind consideration projects or efforts, have not been developed at this time. Therefore, these projects may be subject to further site-specific planning, environmental planning, and engineering analysis as necessary.

### 2.1.8 Removal of Equipment

If decommissioning is required, a plan would be prepared to decommission the PV system and supporting infrastructure. The plan would be prepared in accordance with DoN requirements and would ensure that the closure of these sites would be conducted in accordance with conditions established in the lease agreement.

In general, the decommissioning process would involve compliance with mutually agreed upon conditions for the removal of structures, restoration of topsoil, and the re-vegetation of the sites. Best management practices (BMPs) would be used during the decommissioning phase to control soil erosion, sedimentation, and stormwater runoff.

### 2.1.9 PV System Site Screening Criteria

Several important criteria must be considered when identifying and evaluating potential sites for PV system development. These factors include, but are not limited to: (1) land area; (2) topography, (3) proximity to public access or roadways; (4) proximity to transmission lines or substations; and (5) land use compatibility. Working with GPA, REPO utilized these criteria to guide their site assessment process. After completing this screening process, REPO is proposing the development of solar PV systems at eight sites on the island of Guam described below.

### 2.1.10 Proposed PV System Sites

NBG

Four PV systems are proposed for NBG (Figure2-3). NBG encompasses the entire Orote Peninsula along Apra Harbor's southern shoreline. The extent of GPA's electrical grid at NBG consists of three 34.5 kV transmission lines, which run to their Orote Substation. The distribution level electrical grid at NBG is owned by the DoN. The proposed PV Systems at NBG consist of the sites described below and shown in the accompanying figures.

*WWTP site*. This approximately 16-acre site is relatively flat with vegetation composed of disturbed, secondary forest community interspersed with areas of open canopy. The site is bordered to the west by Marine Corps Drive and to the southeast by a wastewater treatment plant. It is located in the vicinity of both the existing 250kW PV site and the CDF site along Marine Corps Drive. The proposed PV system substation would be located in the south corner of the site. A proposed transmission line would link the WWTP site with the existing 250kW PV site and connect to GPA's existing electrical grid (Figure 2-3).

*Existing 250kW PV site*. This approximately 31-acre expansion site is relatively flat with an uphill slope towards the south end, and is covered with mostly scrub vegetation. It surrounds an existing 250kW PV solar facility, and is located in the vicinity of both WWTP site and the CDF site along Marine Corps Drive. The proposed PV system substation would be located in the eastern corner of the site along Marine Corps Drive. A proposed transmission line would connect this substation to GPA's existing electrical grid (Figure 2-3).

*CDF site*. This approximately 21-acre site contains pockets of relatively flat terrain, but a pronounced ridge runs through much of the site. It is undeveloped and with vegetation composed of disturbed, secondary forest community interspersed with areas of open canopy. Various military facilities lie to the south of the site. Marine Corps Drive borders the site on the southwest and Sumay Drive borders on the east. The proposed PV system substation would be located at the east end of the site with access provided from Sumay Drive, and a proposed transmission line would connect the substation to GPA's existing electrical grid (Figure 2-3).

*Commissary site*. This approximately 25-acre site consists of two separate parcels that are both relatively flat with vegetation composed of disturbed scrub forest. The site is bordered to the south by Shoreline Drive and is bisected by an unnamed local access Road. The proposed PV system substation would be located in the cleared area along the northern border of the site with access provided off of the unnamed road and a proposed transmission line would connect the substation to GPA's existing electrical grid (Figure 2-4).

Northern Guam

Four (4) PV systems are proposed for DoD properties in Northern Guam. Of these systems, three are located in the Tamuning District, and one is located in the Dededo District. Each of these sites is described below and shown in the accompanying figures.

*Harmon Annex*. This approximately 4-acre site is relatively flat and encompasses GPA's existing Harmon electrical substation. The site is located in the Tamuning District along Marine Corps Drive to the east of the proposed PV system sites at the Harmon Booster Station and former Tumon Tank Farm. The proposed PV system would include a small PV array and/or BESS system located in the cleared grassy area around the existing substation and within the boundary fence. A proposed transmission line would connect the proposed PV substation to GPA's existing electrical grid. Access to the site would be provided by an existing driveway off of Marine Corps Drive (Figure 2-5).

*Harmon Booster Station*. This approximately 4-acre site is relatively flat and its vegetation is characterized by a disturbed scrub community. It is bordered to the south by Marine Corps Drive, and surrounds an existing booster station for Guam's water distribution system. The proposed PV system substation would be located to the east of the existing booster station along Marine Corps Drive, and a proposed transmission line would connect the substation to GPA's existing electrical grid. (Figure 2-5).

*Former Tumon Tank Farm*. This site encompasses approximately 20 acres and is the largest of the three Tamuning District sites located along Marine Corps Drive. An unmaintained access road loops through the site and connects to Marine Corps Drive at both the northeast and southeast corners of the site. While the road area is relatively flat and clear, the adjacent terrain consists of slight hills and ridges. Vegetation is composed of a disturbed, secondary scrub community interspersed with areas of open grassland. The proposed PV system substation would be located at the northeast corner of the site, and a proposed transmission line would connect the substation to GPA's existing electrical grid (Figure 2-5).

*South Finegayan*. At approximately 71 acres, this site represents the largest of the proposed PV systems. The site consists of relatively flat and gently sloping terrain, and consists of a maintained grassy field. It is located in the Dededo District adjacent to the former Royal Palms Navy family housing area along Route 3. The proposed PV system substation would be located near the corner of Control Tree Drive and Route 3. A proposed transmission line would connect the substation to GPA's existing electrical grid (Figure 2-6).

## 2.2 Alternatives Considered but Dismissed

As indicated in its *Strategy for Renewable Energy* (DoN, October 2012), the Navy will consider all sources of renewable energy to attain its goal of procuring 1 GW of renewable energy capacity by 2015. Renewable energy can be described as energy that comes from sources which are naturally replenished on a human timescale such as sunlight, wind, geothermal heat, and ocean waves, tides, and currents. Because some renewable energy technologies may be appropriate for some locations, while others may not be well suited, each DoN installation and region must prepare an energy plan to evaluate which technology is most appropriate and cost-effective for their particular area. Given Guam's remote location and its dependence on fossil fuels, it was imperative that the DoN find an appropriate, long-term renewable energy source that would be efficient, dependable, and cost-effective. The following renewable energy technologies were considered by the DoN, but were subsequently dismissed from further consideration for development within the 2015 time frame set for the 1 GW goal.

### 2.2.1 Wind Energy

Wind-based power generation is a mature technology that uses airflows to run wind turbines and drive electrical generators. As the wind speed rises, power output increases up to the maximum capacity of the turbine. Wind turbines are usually developed in areas with strong, steady winds. Wind is an intermittent energy source. The manufacturing and installation of wind turbines requires significant upfront investments in both time and cost. Additionally, the lands underlying the PV sites are not optimal locations for large-scale wind turbine facilities. In light of the foregoing, the wind energy alternative was dismissed from consideration.

### 2.2.2 Geothermal Energy

Geothermal energy is generated by natural heat stored in the Earth. The temperature difference between the Earth's core and its surface drives a continuous conductive process where molten rock (magma) inside the Earth heats rock and water to produce geothermal heat. The heat produced by a geothermal source is to generate electric power via heat exchangers and turbines. Where available, geothermal sources would produce full-time baseload power unlike the intermittent energy provided by solar and wind. In April 2010, a team from the National Renewable Energy Laboratory and the U.S. Navy's Geothermal Program Office in China Lake, California, conducted a reconnaissance assessment of the geothermal potential for the island of Guam (Baring Gould, et al. 2011). Their assessment found potential signs of geothermal activity that indicated further investigation would be warranted, but utility scale geothermal energy production does not represent a feasible alternative at this time.

### 2.2.3 Ocean Energy

Sometimes referred to as marine energy, this renewable energy source is created by ocean waves and currents. The global movement of ocean water creates a vast store of kinetic energy which can be harnessed to generate electric power. Ocean energy conversion is a fledgling technology. The DoN recently selected a private developer to test its wave-to-energy technology in Kaneohe Bay, Oahu, Hawaii for at least 12 months beginning in the second half of 2016. Because it is a budding technology, the environmental effects and long-term performance of ocean energy projects have yet to be determined. High development costs coupled with the need for suitable site characteristics for a commercial-grade facility must also be considered. In light of the foregoing, ocean energy was dismissed as a feasible energy source at this time.

### 2.2.4 Alternative PV Sites

The proposed PV sites were screened from a larger pool of potential sites identified by REPO. With GPA's assistance, REPO was able to identify and objectively evaluate all of the potential sites based on criteria that included: (1) land area; (2) topography, (3) proximity to public access or roadways; (4) proximity to transmission lines or substations; and (5) land use compatibility. Some of the potential sites scored well on a portion of these criteria, but were eventually dismissed because of significant challenges associated with one or more criteria. The site assessment criteria used to identify and evaluate potential PV sites is shown in Table 2-1.

**Table 2-1: Site Assessment Criteria**

| Category | 1 Point | 5 Points | 10 Points |
|---|---|---|---|
| Land Size (acreage) | 1 to 10 acres | 11 to 49 acres | 50 acres or more |
| Topography (degree of slope) | More than 10% | 10% or less | Flat |
| Distance from Public Access or Roadways | 5 miles or more | 0.5 to 5 miles | Within 0.5 mile |
| Distance from Transmission Lines or Nearest Substation | 5 or more miles | 0.5 to 5 miles | Within 0.5 mile |
| Compatibility of Property for PV System Use | --- | No | Yes |

As a result of the screening process, the DoN determined that the eight sites included in the proposed action represent the most feasible approach to contribute towards its goal of 1 GW of renewable energy capacity by 2015 and help the DoN produce 50% of its shore-based energy requirements from alternative energy sources.

## 2.3 No Action Alternative

In accordance with NEPA and CEQ regulations, the No Action Alternative and any associated potential impacts, must be taken into account and evaluated.

Under the No Action Alternative, the development and use of the solar PV systems on Guam would not occur on DoD lands and near-term federal goals for renewable energy generation and use would not occur. The No Action Alternative does not address the DoN's strategy for renewable energy nor would it meet the purpose and need of the proposed action as described in Section 1.2 and Section 1.3 of this document.

Although the No Action Alternative does not address the DoN's purpose and need, the inclusion of this Alternative is prescribed by CEQ regulations and is brought forward and analyzed in this EA. The No Action Alternative also serves as a baseline against which the impacts of the proposed action can be measured and evaluated.

## 2.4 Summary of Potential Impacts to Resource Areas

The effect the Proposed Action and No Action alternatives will have on various facets of the natural and man-made environment is summarized in Table 2-2. Potential impacts associated with the construction and operational phase are covered separately when warranted.

**Table 2-2: Summary of Potential Impacts to Resource Areas**

| Resource | Proposed Action | No Action |
|---|---|---|
| Air Quality | Construction: Temporary effects from fugitive dust and soil erosion. Slight increase in GHG emissions due to use of construction equipment, machinery and vehicles.<br><br>Operations: Vehicular emissions from occasional trips to the PV sites for system maintenance will have a minimal, temporary effect. Decrease in GHG emissions during operations due to reduction of fossil fuel used to produce electricity. | No reduction in fossil fuel use and GHG emissions would be realized under this alternative. |
| Noise | Construction: Temporary increase in ambient noise from equipment, machinery and vehicles.<br><br>Operations: Minimal noise from cooling fans and transformers. | No impact. |
| Topography and Soils | Construction: Temporary effects from fugitive dust and soil erosion and sedimentation.<br><br>Operations: No significant impact. | No impact. |
| Water Resources | **Hydrology**<br>Construction: Hazardous materials (coolants, fluids, oils) from equipment, machinery, and vehicles would be managed in accordance with applicable regulations and maintenance practices to minimize the potential for release.<br><br>Operations: There are no water resources located within or in proximity of the proposed PV sites.<br><br>**Drainage**<br>Construction: Introduction of impervious surfaces will alter existing drainage conditions and could increase stormwater runoff potential.<br><br>Operations: No significant drainage impact<br>. | No impact.<br><br>No impact. |
| Biological Resources | Construction: No listed or proposed species were located at the proposed sites nor are any sites located within a critical habitat.<br><br>Operations: Shaded areas below the PV panels could shelter feral animals. Orientation and spacing of panels would minimize the potential for birds to mistake them for a body of water. Lighting would be down-ward facing and shielded to minimize the potential for seabirds disorientation. | No impact. |

| Resource | Proposed Action | No Action |
|---|---|---|
| Cultural Resources | Construction: Archaeological inventory-level surveys and subsurface testing of the PV sites did not locate any cultural deposits or materials that are eligible for listing on the NRHP. No historic properties would be affected by the project.<br><br>Operations: No historic properties would be affected by the project. | No impact. |
| Visual Resources | Construction: The construction equipment would be visible from adjacent roads and properties; however, this impact is consistent with standard construction activities and would cease upon completion of the PV installation.<br><br>Operations: Due to their location and distance, the PV systems would not have any effect on views from scenic vantage points. The PV systems at NBG would have no effect on public view planes or the local landscape since their location on DoD property restricts public access and therefore limits their visibility. | No impact. |
| Glint and Glare | Construction and Operations: Aircraft and adjacent properties could be affected by sunlight reflecting off the PV panels (glint and glare). Glare hazard analyses determined that none of the PV sites will have adverse glare impacts to Won Pat International Airport and that the South Finegayan site potential glare impact will be avoided by not orienting PV panels to the southeast. | No impact. |
| Hazardous Materials and UXO | **Hazardous Materials**<br>Construction: No significant impact. Undetected hazardous materials may be present at the PV sites; however, any unanticipated materials encountered would be disposed of in accordance with all applicable regulations.<br><br>Operations: No significant Impact. The PV operator will be required to implement all required engineering controls and BMPs to minimize the potential for material releases from inverters or transformers.<br><br>**UXO**<br>Construction: Potential adverse effects UXO are not expected and are capable of being avoided or minimized through the use of BMPs and compliance with applicable regulatory requirements and protocols.<br><br>Operations: No significant impact. | No impact.<br><br>No impact. |

| Resource | Proposed Action | No Action |
|---|---|---|
| Land Use | Construction: Construction-related activities would have temporarily impact surrounding land uses; however, the impact would be short-term and cease upon completion of the construction activities.<br><br>Operations: The use of DoD property for the PV systems would preclude other land uses during the term of the lease agreements. However, the site development is generally consistent with DoD land use planning for these locations. | No impact. |
| Roadways and Utilities | **Roadways**<br>Construction: Vehicle trips by construction workers; deliveries of PV system components; and disposal of construction waste materials would have a short-term effect on traffic.<br><br>Operations: The PV systems will be unmanned facilities. Occasional vehicle trips to the PV sites for system maintenance would have little effect on traffic.<br><br>**Potable Water**<br>Construction: Temporary construction-related impacts for the installation of new water lines.<br><br>Operations: No significant impact.<br><br>**Electrical Power**<br>Construction: Temporary construction-related impacts for the connection of new transmission lines would be short-term, cease upon completion of the construction activities, and would not adversely affect overall service delivery.<br><br>Operations: Decrease fossil fuel dependency through the increase in renewable energy generation and meet the renewable energy goals set forth by SECNAV and the federal government.<br><br>**Telecommunications**<br>Construction: Temporary construction-related impacts for the connection of new telecommunications lines would be short-term, cease upon completion of the construction activities, and would not adversely affect overall service delivery.<br><br>Operations: No significant impact. | No impact.<br><br>No impact.<br><br>No reduction in fossil fuel dependency for electrical power generation.<br><br>No impact. |

| Resource | Proposed Action | No Action |
|---|---|---|
| Roadways and Utilities (continued) | **Solid Waste Disposal**<br>Construction: Surface vegetation will be removed in areas where the PV arrays, equipment pads, substation complex, and maintenance/access roads will be built. The removed vegetation will be deposited in authorized green waste repositories<br><br>Operations: No significant impact. | No impact. |
| Socioeconomic Conditions | Construction: Construction-related employment and spending will benefit the economy.<br><br>Operations: Wages and the purchase of goods and services for PV system operations and maintenance will benefit the economy. | No impact. |

1

1

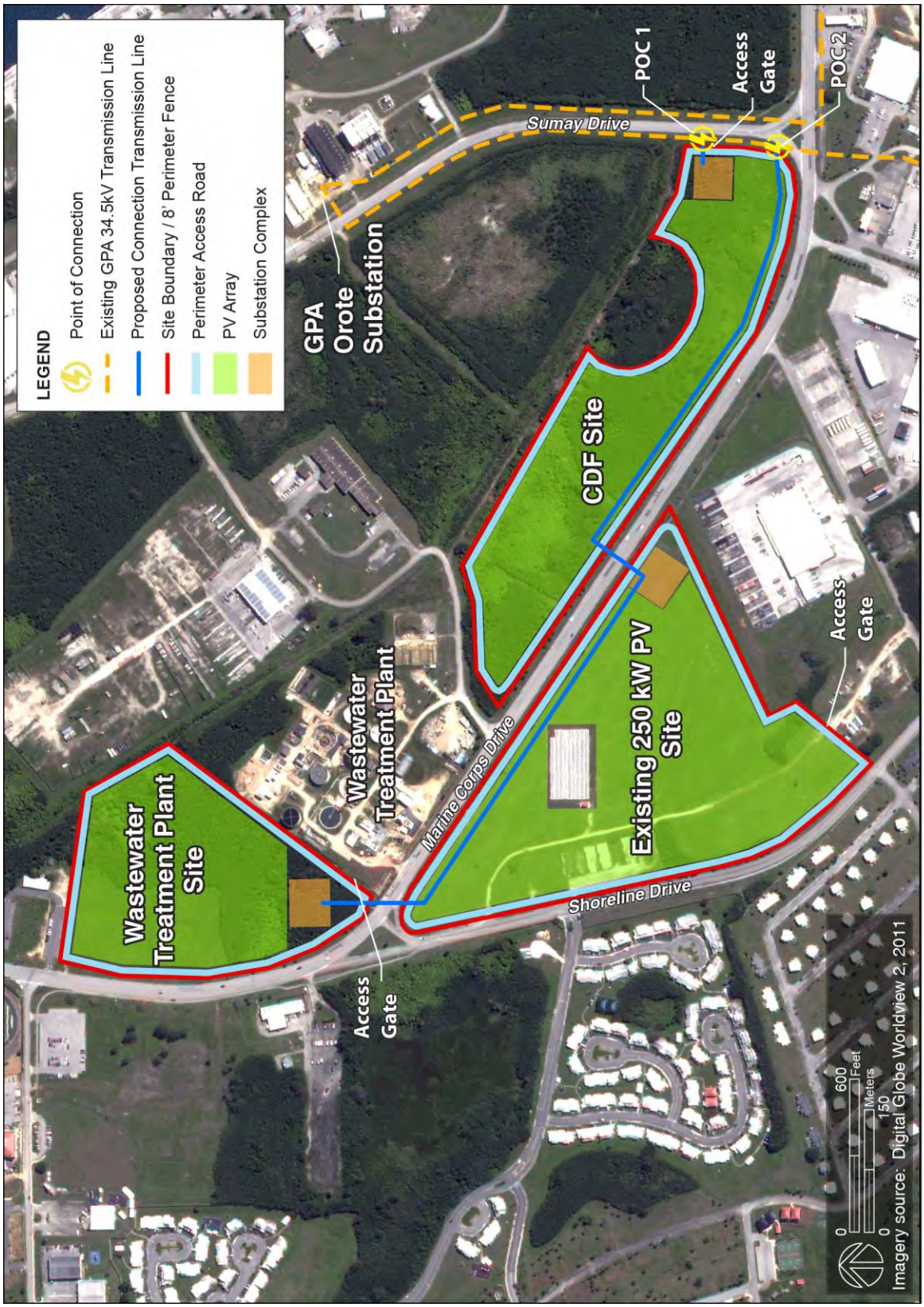



**Figure 2-3**
**Wastewater Treatment Plant, Existing 250 kV PV, and CDF Project Sites Map**
Environmental Assessment for PV Systems
Commander, Joint Region Marianas

2


**Figure 2-4**
**Commissary Project Site Map**
Environmental Assessment for PV Systems
Commander, Joint Region Marianas

1

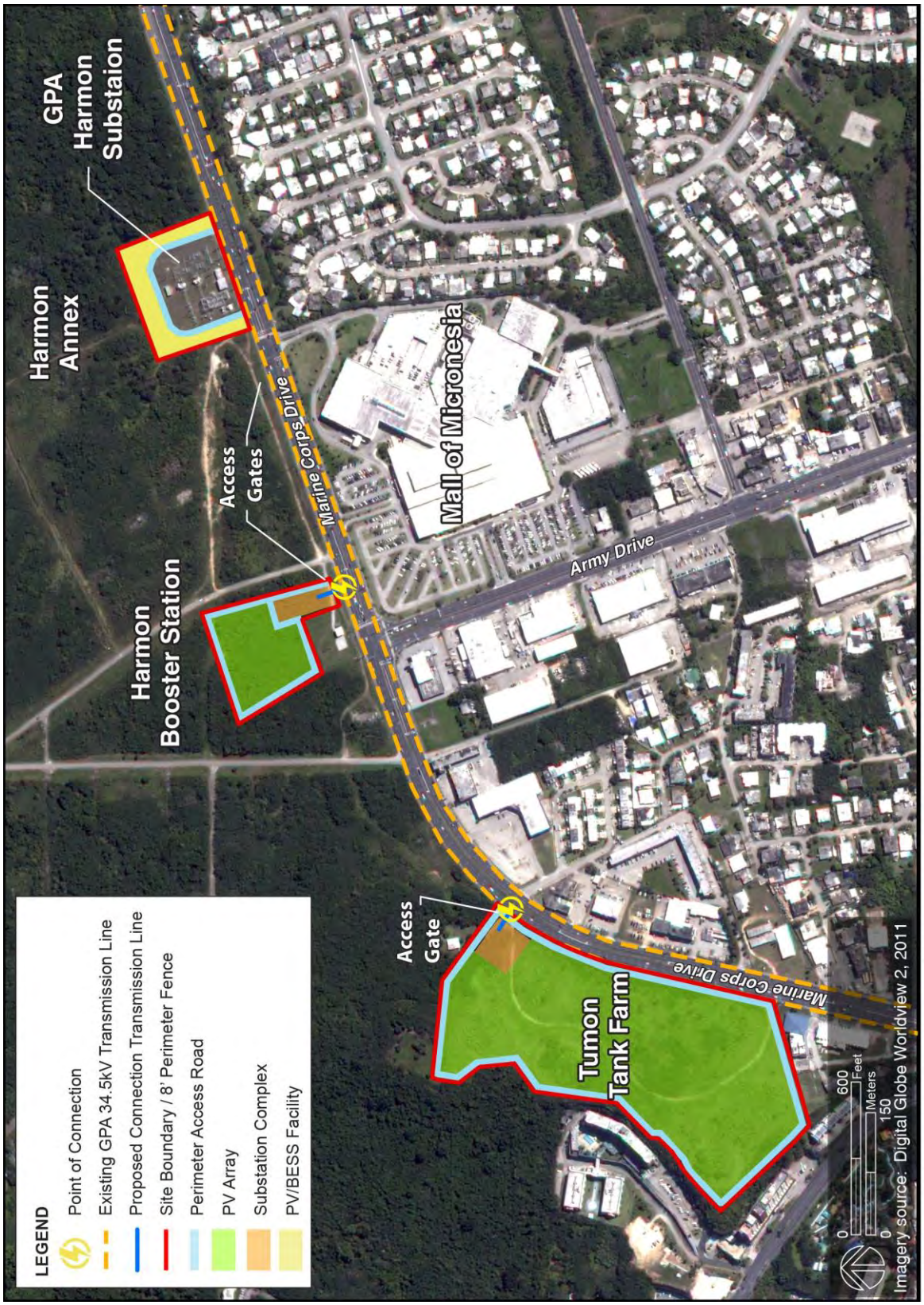



**Figure 2-5**

**Tumon Tank Farm, Harmon Booster Station, and Harmon Annex Project Site Maps**
Environmental Assessment for PV Systems
Commander, Joint Region Marianas

2

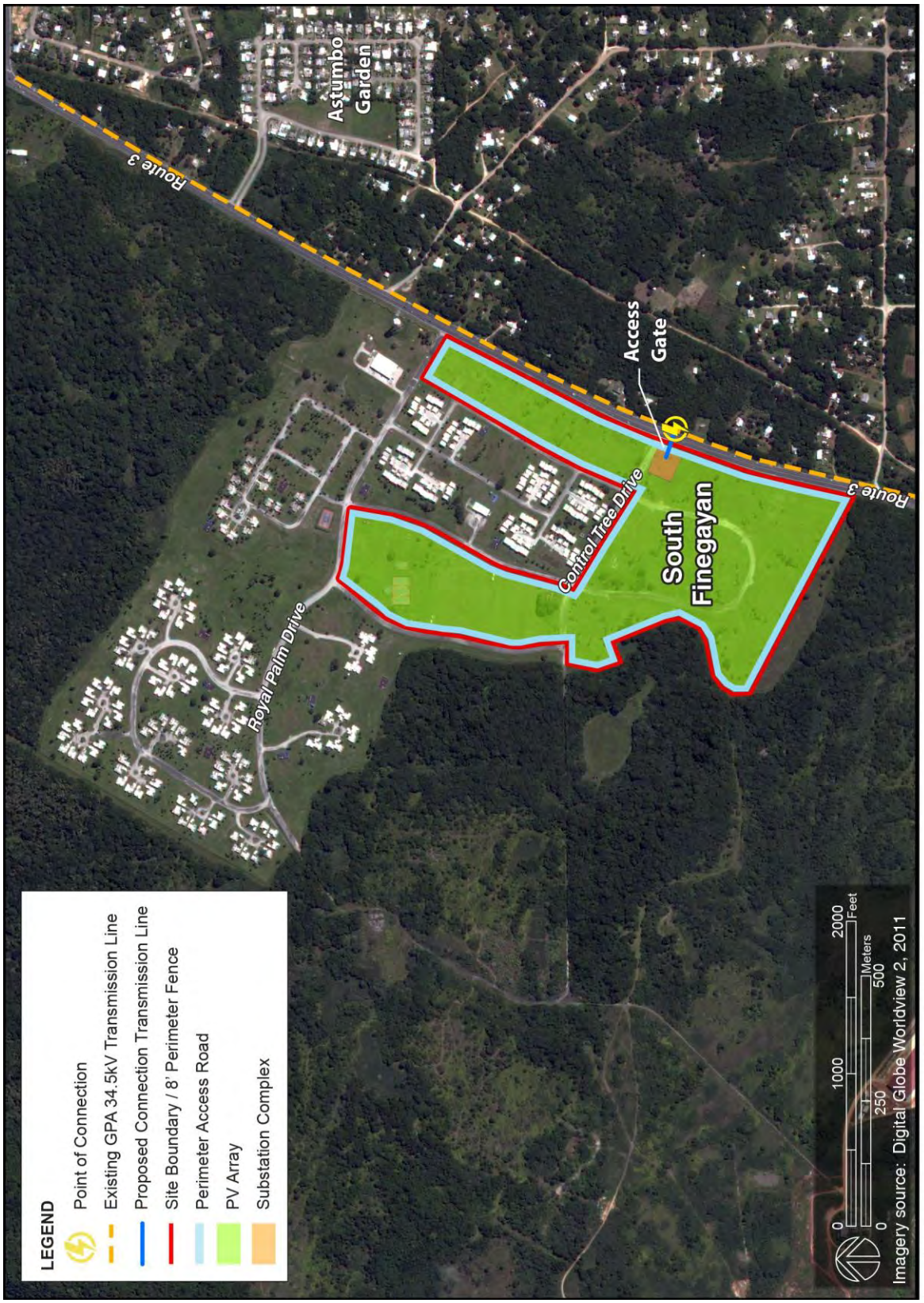



**Figure 2-6**
**South Finegayan Project Site Map**
Environmental Assessment for PV Systems
Commander, Joint Region Marianas

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# Chapter 3 Affected Environment and Environmental Consequences

This chapter describes the existing environmental setting and establishes baseline conditions for the environmental resources with the potential to be directly or indirectly affected by the proposed action. This chapter also evaluates potential environmental consequences of the proposed action including the potential direct, indirect, short-term, long-term, and cumulative impacts on relevant environmental resources. This chapter is organized by resource topic (e.g., air quality, noise, geology and soils, etc.). The discussion under each topic begins with an overview of existing conditions related to that topic. Where appropriate, the discussion encompasses a larger environmental setting (e.g., the island of Guam). In other cases the focus is more regional (e.g., Northern Guam, Southern Guam, NBG) or applies to a particular site (e.g., South Finegayan site).

In accordance with CEQ guidance 40 CFR 1501.7(3), only resources/areas that have the potential to be affected are discussed in this EA. Therefore, the following resources/areas will not be evaluated.

Climate. Guam's tropical climate is pleasantly warm throughout the year. Temperatures range between 74° and 92° Fahrenheit with a mean annual temperature of 83°. Average annual rainfall is 85 to 100 inches with average humidity at 72% to 86%. As noted by the government of Guam (GovGuam), the island of Guam has two seasons: a rainy season from June through November and a dry season from December through May (GovGuam, 2014). Due to its location in the Western Pacific, Guam has the highest risk of being hit by a typhoon or hurricane of any state or territory in the United States, and it is susceptible to being hit by the world's largest and most intense tropical cyclones (Guard et al., 1999). The PV systems will not have a significant effect on the local or regional climate of Guam.

Flood Hazard Areas. The PV systems will not be built in areas that are subject to 1% annual chance coastal or inland flooding nor will they affect flood hazard parameters or increase flood hazard potential.

Marine Resources. The proposed action will not involve any work in the shoreline area or within the nearshore marine environment.

Public Health and Safety. The proposed action does not pose a risk to public health and safety. Access to the PV sites will be restricted and security fencing and lighting have been incorporated into the design of the project.

Public Services. The PV sites will be unmanned facilities and would not increase the service area limits for police or fire protection nor would it generate a demand for health, educational, or recreational services or facilities.

Transportation. The proposed action will not directly affect air or ocean transportation facilities. Most of the materials to be used for the project would be imported by sea. However, the volume of cargo passing through these facilities amounts to a fraction of their capacity and is well within their capabilities. Roadway traffic is covered below in Section 3.11 (Roadways and Utilities).

Wastewater. The proposed action will not require any wastewater connections. The PV systems will be unmanned facilities without restrooms and would not generate wastewater flows.

Wetlands. The PV systems will be constructed in upland, dry areas. The sites do not intersect with any wetlands identified by the 2013 Wetland Mapping Final Report in Support of the Guam and Commonwealth of the Northern Marianas Military Relocation Supplemental Environmental Impact Statement (SEIS), and the proposed action will not affect any wetlands in the vicinity of the project sites.

Resources that could be potentially affected by the proposed action include: air quality; noise; topography and soils; water resources; biological resources; cultural resources; visual resources; land use; roadways; potable water, electrical, telecommunications, and solid waste disposal systems; and socioeconomic conditions. Potential effects from glint and glare and hazardous materials and UXO are also discussed in this EA.

Due to similarities in their affected environments, the PV sites proposed in Northern Guam and at NBG have been grouped together and evaluated as such since the sites are located in built-up areas with similar affected environments. Where additional details are warranted, site-specific discussions of affected resource areas and potential impacts are provided by location.

## 3.1 Air Quality

### 3.1.1 Affected Environment

Guam has a landmass that is 30 miles long and 4 to 8 miles wide. It is approximately 212 square miles and is the largest and southernmost of the Mariana Islands. Guam is situated between Hawaii and the Philippines at 13°28 minutes (') north latitude and 144°44' east longitude. Located in the Western Pacific, Guam serves as the gateway to Micronesia and a crossroad to Asia (GovGuam, 2014).

Trade winds from the east dominate the wind pattern on Guam during the drier months. Trade wind speeds are typically less than 10 miles per hour (mph), but are variable in late summer. An average of three tropical storms (40 to 75 mph wind speeds) or typhoons (greater than 75 mph) have passed within 180 nautical miles of Guam each year between 1945 and 2004 (DoN, 2014). Typhoon Vongfong was the most recent storm, passing through the Mariana Islands in October 2014.

The island of Guam is designated a National Ambient Air Quality (NAAQS) attainment area, with the exception of areas surrounding the Tanguisson Power Plant in Northern Guam and the Piti Power Plant in Southern Guam which are considered by the Environmental Protection Agency (EPA) as non-attainment areas for sulfur dioxide. The non-attainment area extends 2.2 miles from the center of each plant. None of the proposed PV sites are located within these non-attainment areas (DoN, 2014).

### 3.1.2 Potential Impacts

The PV sites are within attainment areas that currently meet NAAQS for criteria pollutants and, therefore, would not be subject to the Clean Air Act's General Conformity Rule (DoN, 2014).

Emissions from heavy equipment (e.g., bulldozers, excavators, dump trucks, etc.) will temporarily affect ambient air quality during the construction phase. In addition, ground disturbing activities such as site clearing; grading for the mounting systems for the PV arrays, substation complex, and maintenance roads; and trenching for fence posts, utility poles, and underground utility lines would temporarily generate fugitive dust. To minimize the effects of fugitive dust during construction, dust suppression methods using water trucks would be implemented in accordance with all applicable regulatory requirements.

A slight increase in GHG emissions is anticipated during construction. This increase would be attributed primarily to diesel-powered equipment and trucks, along with fossil fuel-powered delivery trucks and vehicles of workers and visitors commuting to and from the project sites. However, the short-term increase in GHG emissions during construction would be compensated by the generation of electricity from solar energy once the PV systems are in operation.

During the operational period, none of the PV system components emit air pollutants of any kind. Some emissions will result from vehicles to and from the PV sites for periodic maintenance but these effects would involve relatively short distances and brief periods of time. The proposed action would provide long-term beneficial effects on air quality and GHG emissions, since the use of fossil fuels would be reduced. The use of PV systems to generate electricity reduces dependence on fossil fuels that emit GHG (See Section 3.13 for a discussion of the cumulative effects of GHG and climate change).

No adverse impacts are anticipated during the decommissioning process. Dust from the removal of structures and improvements, and emissions from vehicles and equipment used to perform this work will be temporary in duration. The same BMPs as used during the construction period will be implemented during decommissioning to control fugitive dust.

No Action Alternative. No impacts to air quality would occur because no construction activities would take place and existing site conditions would continue to be maintained. However, the beneficial impacts associated with the proposed action's long-term reduction in fossil fuel use and GHG emissions would not be realized under the No Action Alternative.

## 3.2 Noise

### 3.2.1 Affected Environment

The level of ambient noise is an important indicator of environmental quality. Noise from vehicle traffic, aircraft flights, industrial land uses, and construction activities can impact ambient noise levels based on their proximity to noise-sensitive receptors (e.g., occupied structures). Chronically high noise levels can impact personal health and quality of life in an area.

The PV sites in Northern Guam are located in urbanized settings with ambient noise levels that correspond to this type of environment. The Harmon Annex, Harmon Booster Station, and Tumon Tank Farm sites lie along Route 1 which is bordered by high-density residential, commercial, and light industrial development, while the South Finegayan site along Route 3 is proximate to single-family housing. Ambient noise levels at NBG are typical of most established naval stations with waterfront operations located largely along the shoreline, adjacent areas used for ship berthing and mission support activities, and housing and individual/family support functions located inland from the waterfront. At NBG, the Harbor View and South Tipalao family housing areas are located across the street (Shoreline Drive) from the existing 250kW PV site.

The NBG sites are located along the major collector roads serving the installation and are exposed to regular vehicle noise. With the exception of the Harbor View and South Tipalao family housing areas at NBG, approximately 160 feet away from the existing 250kW PV site at the closest point, there are no other noise-sensitive receptors in the vicinity of the proposed PV sites.

Noise in the vicinity of the PV sites is primarily attributable to vehicles along adjacent roadways or aircraft operations.

### 3.2.2 Potential Impacts

Construction period noise would temporarily affect the occupants in the vicinity of the PV sites. Noise from construction vehicles, machinery, equipment, and power tools would be the dominant source of construction noise. Measures to minimize noise include the use of sound-dampening devices (e.g., baffles, mufflers) and properly maintaining all equipment, vehicles, and machinery. The PV Contractor(s) would be responsible for compliance with all applicable regulatory requirements for noise control. To minimize noise impacts, construction activities will be limited to normal daylight hours in residential areas.

During the operational period, the proposed action is not expected to result in adverse noise impacts. The PV system components will make little or no sound except for noise from cooling fans in the inverters and a low hum from transformers mounted on each equipment pad. Vehicles used for periodic maintenance activities will generate noise on a limited, temporary basis. Given the primarily urbanized settings of the project sites, the noise sources would generally be consistent with existing ambient noise levels.

No long-term adverse impacts are anticipated during the decommissioning process. Noise from the removal of structures and improvements, and emissions from vehicles and equipment used to perform this work will be temporary in duration. The same BMPs as during the construction period will be implemented during decommissioning to minimize work-related noise.

No Action Alternative. No impacts to ambient noise levels would occur because no construction activities would take place and existing site conditions would continue to be maintained.

## 3.3 Topography and Soils

### 3.3.1 Affected Environment

Guam is the largest and southernmost island in the Mariana Islands archipelago, which is located in the western Pacific Ocean at approximately 13°25’ north latitude and 144° 45’ east longitude. It is approximately 30 miles long and varies between 4 and 8 miles wide. The volcanic archipelago resulted from subduction of the Pacific Tectonic Plate beneath the Philippine Tectonic Plate at the Mariana trench, which is east of Guam. Two (2) separate emergent mountains fused to form the Island of Guam. Volcanic hills that rise to 1,334 feet above mean sea level (AMSL) form Southern Guam, while the central and northern sections of the island consist of a limestone plateau reaching a height of 600 feet AMSL. This high plateau creates steep cliffs dropping down to a narrow coastal shelf (Joint Region Marianas, 2012).

The soils of Guam are derived from the two types of parent material, volcanic and coralline limestone. The volcanic material forms poorly drained, acidic, lateritic soils. The limestone forms thin (only a few inches thick) basic soils. Mixing of the two sources results in a clay formation that is found chiefly in the central and some southern parts of the island. Heavy black soils accumulate in valley bottoms along streams and in estuarial swamps in the southern part of the island (Young, 1988).

The project parcels in the northern part of the island (South Finegayan, Harmon Annex, and former Tumon Tank Farm) overlie the main Marianas Limestone Formation and the related Barrigada Limestone Formation. Those on the Orote Peninsula of the Navy Main Base, which extends into the ocean off the western coast of the south part of the island, are located on a plateau of an upraised reef of the Marianas Limestone.

The proposed PV sites generally consist of relatively flat and gently sloping terrain, with the exception of the following sites:

Former Tumon Tank Farm. A relatively flat access road loops through the site, but the land surrounding the roadway consists of slight hills and ridges that rise up to 10 feet higher than the roadway surface.

CDF site. The site contains pockets of relatively flat terrain, but a pronounced ridge runs along the southern boundary of the site. The terrain reaches a high point of approximately 70 feet AMSL along the southern boundary (Marine Corps Drive), and drops down to an elevation of around 10 feet AMSL along the northern boundary.

### 3.3.2 Potential Impacts

No significant impacts to topography and soils would occur at any of the proposed PV sites. Site preparation would involve selective grubbing, grading, and vegetation removal in areas where the mounting systems for the PV arrays, substation complex, and maintenance roads would be located. Earthwork for maintenance roads, fence posts, utility poles, and underground utility lines is expected to be minimal. Cut and fill quantities will be balanced on site to make use of excavated earth although not all of this material may be suitable for structural fill. As necessary, the PV Contractor(s) may need to import appropriate fill material (e.g., gravel, rock, sand) to create a strong and stable foundation for PV system components.

Ground-altering construction activities will comply with all applicable regulatory requirements. A NPDES Permit for general coverage would be obtained from the Guam EPA for the discharge of stormwater associated with construction activities such as grubbing and grading. To the extent possible, earthwork will be balanced to maintain existing drainage patterns and bare ground shall be hydro mulched or planted with ground cover to minimize erosion and runoff. If necessary, water trucks or temporary irrigation systems would be utilized to facilitate plant growth. Green waste from the site clearing process will be transported to a composting facility and excavated earth from site work shall be retained on site or disposed of in accordance with all applicable regulations. The PV Contractor(s) will be responsible for implementing BMPs to control soil erosion and sedimentation during construction activities.

During the operational period, the PV systems are not expected to have an adverse impact upon topography and soils. The PV systems would operate passively with no active components which would disturb topography or soils. Periodic maintenance to clean and maintain the area around the PV panels would involve the use of small vehicles along established roads. These activities would be limited in

duration and would not result in any additional soil compaction beyond the initial construction phase. No adverse impacts are anticipated during the decommissioning process. Dust from the removal of structures and improvements, and emissions from vehicles and equipment used to perform this work will be temporary in duration. The same BMPs as used during the construction period will be implemented during decommissioning to control soil erosion, sedimentation, and stormwater runoff.

No Action Alternative. No impacts to topography and soils would occur because no construction activities would take place and existing site conditions would continue to be maintained.

## 3.4 Water Resources

### 3.4.1 Affected Environment

Hydrology. The hydrology of Northern and Southern Guam is quite varied with the distribution of fresh water largely controlled by local geology and topography. Guam is limited in freshwater resources and its freshwater environments are comparatively small, fragile, and extremely important (WERIWP/IREI, 2014).

The northern part of the island is a limestone plateau with virtually no streams or rivers. Rocks in Northern Guam are water permeable and soluble, and the rain percolates into the ground instead of flowing on the surface. Driven by gravity, the water moves underground through air-filled fractures, voids, and conduits, and enlarges and connects them by dissolution. When the water reaches sea level, it accumulates and forms a groundwater body known as the freshwater lens. This lens-shaped body floats on top of the underlying seawater, which also easily moves through limestone. The “lens” is thickest in the island's interior and thinnest along its perimeter. The body of fresh water is known as the Northern Guam Lens Aquifer (NGLA) and is the primary source of drinking water on Guam. The NGLA is recharged by rainfall and discharges water to the surrounding ocean through springs along the coast (WERIWP/IREI, 2014).

Fresh water from the NGLA is pumped upwards by production wells to provide approximately 80% of Guam’s population with potable drinking water. In 1978, the EPA designated the NGLA as a Sole Source Aquifer, which means an aquifer which is the "sole or principal drinking water source for the area.”(WERIWP/IREI, 2014).

Naval Base Guam is located on the Orote Peninsula which is a raised limestone plateau. The peninsula lies approximately four miles south of the southern extent of the NGLA. It consists of primarily porous coralline limestone and disturbed or created land, and there is no named aquifer system under the peninsula (INRMP, 2012).

Drainage. Drainage characteristics in Northern Guam are reflective of local geological and topographic conditions. The limestone plateau underlying Northern Guam and the Orote Peninsula cannot support long-term surface water flow. Instead of collecting on the surface, rainwater is conveyed underground through subsurface voids in the rock caused by dissolution which ultimately forms a complex underground drainage system. The replacement of surface drainage by underground drainage is one of the defining features of karst topography and why karst areas usually lack surface streams. (WERIWP/IREI, 2014).

### 3.4.2 Potential Impacts

Hydrology. There are no water resources located within or in proximity of the proposed PV sites. During the construction phase, water will be dispensed by water trucks or temporary irrigation systems to control fugitive dust and wet down any exposed ground. No significant impacts to groundwater are expected.

During the operational period, PV system operations will not require significant water use nor would it affect groundwater withdrawals. The PV systems would be unmanned facilities and would not generate a regular demand for water use. The PV systems will require minimal maintenance which would involve periodically washing the PV panels with water to remove accumulated dust and dirt. Water would also be required to provide fire protection for the substation complex. To provide water for PV system maintenance and fire suppression, connection to a water line within the adjacent roadway ROW is proposed.

The proposed PV systems would not impact groundwater resources as they would have a negligible effect on groundwater. While some hazardous materials are contained within equipment like the inverters, transformers, and BESS, they are housed in closed, properly-maintained systems (see Section 2.12). During construction, BMPs such as proper storage of hazardous materials and immediate cleanup of any leaks or spills will be implemented to prevent contamination of groundwater resources.

Drainage. Section 438 of the Energy Independence and Security Act of 2007 established strict stormwater runoff requirements for federal development and redevelopment projects. The provision requires that "The sponsor of any development or redevelopment project involving a federal facility with a footprint that exceeds 5,000 square feet shall use site planning, design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible, the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow." The proposed action will comply with these and all other applicable regulatory requirements for stormwater management.

The proposed action is not expected to have an adverse effect on drainage. Construction of the PV systems would alter existing drainage and groundwater recharge conditions through the introduction of impervious surfaces. However, the increase in runoff, and subsequent decrease in groundwater recharge for each PV site is expected to be minimal as the impervious surfaces would be limited to the mounting systems for the PV arrays, equipment pads, and substation complex. These impervious surfaces represent a relatively small area when compared to the overall land area of each site. BMPs will be implemented, and retention basins or dry wells will be utilized as necessary, to ensure that stormwater runoff is retained on site and allowed to percolate into the ground or be discharged at a rate that would not exceed predevelopment runoff or adversely affect adjacent and downstream properties. An NPDES Permit for stormwater discharge associated with construction activities will be obtained where site work (grubbing, grading) is 1-acre or more.

During the operational period, the PV systems will require minimal maintenance which would involve periodically washing the PV panels with water to remove accumulated dust and dirt. These activities would be limited in duration and would not involve any discharges that have the potential to affect surface or groundwater quality.

No adverse impacts are anticipated during the decommissioning process which will be limited in duration. BMPs will be implemented during decommissioning to ensure that the removal of structures and improvements does not impact surface and groundwater.

No Action Alternative. No impacts to water resources would occur because no construction activities would take place and existing site conditions would continue to be maintained.

## 3.5 Biological Resources

### 3.5.1 Affected Environment

Many of the animals found on Guam today were brought there intentionally by humans. Pigs and chickens were brought in for food, while carabao (water buffalo) was brought to help farmers. Domesticated dogs and cats were brought in as pets; some of them escaped and now live in the wild. Animals native to Guam include the Mariana fruit bat, the flightless Guam rail, and the Mariana crow. Other wildlife such as rats, snakes, and lizards were brought in accidentally through cargo shipments. Some of these introduced species have become pests and either eat or compete with native species. For example, the Brown tree snake has destroyed many of Guam's native birds and lizards since it appeared in the 1940s. Because it has no natural predators, the snakes multiplied, spread throughout the island, and ate most of Guam's native birds. The Mariana fruit bat and Guam rail are almost extinct because of the brown tree snake, while the Mariana crow is extinct in the wild (Bess Press, 2006).

Biological resource surveys at the proposed action sites were undertaken between October 2014 and December 2014 to document potential impacts that the proposed action could have on Endangered Species Act (ESA)-listed species and proposed species; Guam-listed endangered species; and wetlands (SWCA Environmental Consultants, 2015).

The existing vegetation structure at each of the proposed PV sites is summarized below.

South Finegayan. Onsite vegetation is consists of open, grassy parkland interspersed with palm trees and other tree species. No ESA-listed or proposed species were observed during the surveys.

Harmon Annex. Onsite vegetation is composed of a disturbed secondary forest containing various tree species. Understory vegetation is dominated by a dense ground cover of native ferns. Various herbaceous weed species occupy open disturbed vehicle trails and forest edges No ESA-listed or proposed species were observed during the surveys.

Harmon Booster Station. Onsite vegetation is composed of a disturbed scrub community consisting of various tree species and herbaceous weeds at gaps and sunlight edges. Understory vegetation is dominated by a dense ground cover of native ferns. Herbaceous weeds vegetate gaps and sunlight edge niches No-ESA listed or proposed species were observed during the surveys.

Former Tumon Tank Farm. Onsite vegetation is composed of disturbed, secondary scrub community consisting of various tree species interspersed with areas of open grassland. Understory vegetation consists of an array of grasses and herbaceous weeds. No ESA-listed or proposed species were observed during the surveys.

WWTP Site. Onsite vegetation is composed of a disturbed, secondary forest community consisting of various tree species interspersed with areas of open canopy containing the invasive vine (*Antigonon leptopus*). Understory vegetation is dominated by a dense ground cover of native ferns. The invasive vines *Antigonon leptopus* and *Mikania scandens* occupy canopy gaps and forest edges. Herbaceous weeds vegetate small forest gaps and sunlight edge niches. No ESA-listed or proposed species were observed during the surveys.

Existing 250kW PV Expansion Site. Onsite vegetation mostly consists of uncut grassy areas and low-lying shrubs interspersed with occasional palm trees and stands of tangan-tangan (*Leucaena leucocephala*), an invasive tree species. No ESA-listed or proposed species were observed during the surveys.

CDF Site. Onsite vegetation is composed of disturbed, secondary forest community interspersed with areas of open canopy containing the invasive vine (*Antigonon leptopus*). Understory vegetation is dominated by a dense ground cover of native ferns. Herbaceous weeds vegetate forest gaps and sunlight edge niches. No ESA-listed or proposed species were observed during the surveys.

Commissary site. Onsite vegetation is composed of a disturbed scrub forest containing various tree species. Understory vegetation is dominated by a dense ground cover of native ferns. Herbaceous weeds vegetate surrounding sunlight edge niches. No ESA-listed or proposed species were observed during the surveys.

A summary of the biological resources encompassed by the surveys follows below.

Birds. Eight (8) bird species are ESA listed or Guam listed as threatened or endangered. These birds include the Nightingale reed warbler, Guam swiftlet, Mariana crow, Mariana moorhen, Guam Micronesian kingfisher, Micronesian megapode, Guam rail, and Brindled white-eye. Of these birds, the Nightingale reed warbler, Micronesian megapode, and Brindled white-eye are extirpated from Guam. The Guam rail and Guam Micronesian kingfisher occur only in captivity. A discussion of the 3 remaining avian species follows.

- Mariana Crow (*Corvus kubaryi*). The Guam and federally-endangered crow was once found throughout native limestone forests on Guam. However, its population has been severely impacted by the introduction of the Brown tree snake (*Boiga irregularis*). Infertility, predation by rats (*Rattus spp*.) and monitor lizards (*Varanus indicus*), and displacement by drongos (*Dicrurus macroercus*) have also contributed to their decline. A recovery plan was drafted by the U.S. Fish and Wildlife Service in 1990 and crow habitat has been protected by the Guam National Wildlife Refuge since 1992. Despite these recovery efforts the Mariana crow is not present on Guam, nor is it present at any of the proposed sites.

- Mariana Common Moorhen (*Gallinula chloropus guami*). The Guam and federally-endangered moorhen is also protected by the Migratory Bird Treaty Act (MBTA) and is found primarily in freshwater wetlands and occasionally in brackish wetlands. Habitat loss, water pollution, and predation by Brown tree snakes, feral pigs, and introduced fish have impacted its population. The moorhen is not likely to be present at any of the proposed sites.

- Guam Swiftlet (*Aerodramus vanikorensis bartschi*). The Guam and federally-endangered swiftlet lives in a variety of habitats including cave dwellings, savanna, and ravine forests. The swiftlet has historically been found throughout Guam, however, habitat destruction, pesticides, and predation by the Brown tree snake have impacted its population. Since 1992, only caves in southern Guam are known to have had swiftlet populations. The swiftlet is not likely to be present at any of the proposed sites.

Mammals. Two (2) mammals, the Little Mariana fruit bat (*Pteropus tokudae*) and the Mariana fruit bat (*Pteropus m. mariannus*) are federally-listed species. The little fruit bat is believed to be extinct. The Mariana fruit bat, which is Guam listed as endangered and federally listed as threatened, is known to forage and roost in native limestone and ravine forests. The population of the Mariana fruit bat is threatened by illegal hunting, predation by the Brown tree snake, and habitat loss. Critical habitat has been designated for the Mariana fruit bat in the fee-title lands of the Guam National Wildlife Refuge. However, none of the proposed sites are located within the Guam National Wildlife Refuge.

Reptiles. Seven (7) skink and gecko species are listed as endangered on Guam and are candidates for federal listing. These species include the Snake-eyed skink (*Cryptoblepharus poecilopleurus*), Tide-pool skink (*Emoia cyanura*), Azure-tailed skink (*Emoia cyanura*), Slevin's skink (*Emoia slevini*), Moth skink (*Lipinia noctua*), Pacific slender-footed gecko (*Nactus pelagicus*), and Micronesian gecko *(Perochirus ateles)*. Skink and gecko species have been impacted by the introduction of the Brown tree snake; however competition from introduced species, feral cats, flat worms, habitat loss, and wild fires have also caused their populations to decline. Of the seven species listed, the Snake eye skink, Pacific slender footed skink, moth skink, and Azure-tailed skink are believed to be extirpated from the wild. The remaining reptile species are discussed below.

- Micronesian Gecko. Little information is available about the Micronesian gecko; however, it is believed to be present in limestone forest and beach strands. The Harmon Annex and Harmon Booster Station sites contain potential habitat for these species; however no occurrences or indicators of their presence, were identified during field surveys.

- Slevin's Skink. This species is found on the forest floor, in old fields, and low on tree trunks. Because little is known about the ecology of this skink, further study is warranted. Slevin's skink is known only from the Mariana Islands and was last recorded on Guam in 1945 before the introduction of the Brown tree snake. The skink has been detected on Cocos Island, off the southwest coast of Guam, and is present on the northern islands in the CNMI (IUCN, 2015).

- Tide-Pool Skink. Tide-pool skinks are found in intertidal strands and are therefore unlikely to be found at any of the proposed PV sites.

Insects. Two (2) butterfly species, the Mariana eight-spot butterfly (*Hypolimnas octocula mariannensis*) and the Mariana wandering butterfly (*Vagrans eqistina*) are proposed species for federal listing as endangered. Habitat loss for host plants, *Procris pendunculata* and predation of caterpillars by ichneumoid wasp (*Ichneumon sarcitorius*) have impacted the Mariana eight-spot butterfly. No host plants for the Mariana eight spot butterfly were observed at any of the proposed sites.

Mollusks. Three (3) mollusk species are Guam listed as endangered and are proposed species for federal listing. These species include the Guam tree snail (*Partula radiolata*), the humped head tree snail, and the fragile tree snails. All tree snails species have been observed on host plants; however, habitat conditions include cool, shaded forests with high humidity. Populations of all three snails have been impacted by human activity as well as predation by flat worms (*Platydemus manokwari*), and the giant African snail (*Achitina fulica*). None of the three tree snail species were observed during comprehensive surveys of host plants at the PV sites.

Plants. Hayun lagu (*Serianthes nelsonii*) is a federally-listed endangered species that grows in limestone forests at elevations ranging from 400 to 575 feet. The primary threats to this tree are lack of regeneration caused by feral ungulates, insect damage, and typhoons. There is one mature Hayun lagu and one sapling at AAFB and 31 saplings at the Guam National Wildlife Refuge. None of these trees are located within any of the proposed project sites.

The following 14 species are candidates for federal listing as threatened or endangered species: *Bulbophyllum guamense, Cycas micronesica, Dendrobium guamense, Eugenia bryani, Hedyotis megalantha, Heririera longipetiolata, Maesa walkeri, Nervilia jacksoniae, Phyllanthus saffordi, Psychtria malaspinae, Solanum guamense, Tabernae montana rotensis, Tinospora homosepala, Tuberolabium guamense.* Threats to these plant species vary and include fires, typhoons, climate change, habitat loss, direct destruction, urban development, agricultural activities, non-native plants and animals, predation by non-native invertebrates, and failure to regenerate due to seedling loss. None of the ESA listed or candidate plant species were identified during surveys at the proposed sites.

### 3.5.2 Potential Impacts

No ESA or Guam listed or proposed species were observed at the surveyed sites during field work for the biological resources surveys. In addition, none of the sites are located within critical habitat, and none of the sites falls within the limits of the Guam National Wildlife Refuge. The findings and conclusions of the biological resource surveys and effects analysis are summarized below.

Birds and Mammals. Critical habitat at the Guam National Wildlife Refuge includes 22,821 acres of land which offer protection to the Mariana crow and the Mariana fruit bat. None of the proposed sites is located within this critical habitat. The Mariana crow is not present on Guam, and the Mariana fruit bat is not likely to be present at any of the proposed sites. As such, the proposed action would have no effect on the Mariana fruit bat. No Mariana common moorhen were observed during the surveys. Because the proposed sites do not include wetland habitats which would attract the moorhen, the proposed action is expected to have no effect upon this species.

Reptiles. The total potential land disturbance for the Harmon Annex and Harmon Booster Station sites totals 8 acres. These 2 sites may be potential habitat for the Micronesian gecko; however, none were observed during reptile surveys therefore, it is not likely that the proposed sites are occupied by these species. The proposed action will have no effect on the Micronesian gecko.

Insects. The Harmon Annex and Harmon Booster Station sites may be suitable habitat for the Mariana eight-spot butterfly and Mariana wandering butterfly; however, no host plants for the Mariana eight-spot butterfly were observed at any of the sites which makes it unlikely that they are occupied by the species. The proposed action will have no effect on the Mariana eight-spot butterfly or the Mariana wandering butterfly.

Mollusks. Host plants for tree snail species were abundant at all proposed sites, however the tree snail species require complex canopy structures with overstory, understory, and layers in between to maintain an environment with high humidity. Generally, disturbed forests do not become re-vegetated with the canopy structure needed for these species to survive. No evidence of tree snails was present and it is not likely that they are occupied by these species. The proposed action will have no effect on tree snails.

Plants. None of the ESA-listed or candidate plant species were identified at any of the proposed sites. It is not likely that the proposed action will adversely affect any of the surveyed plant species.

The proposed action would not have a significant impact upon biological resources during the construction phase. Clearing of vegetation and potential habitat conversion would occur under the proposed action at the Harmon Booster Station, Tumon Tank Farm, CDF, Wastewater Treatment Plant, and Commissary Sites. However, all of these sites have been previously disturbed, and are dominated by introduced and herbaceous species. Localized impacts to species residing in these vegetative areas would occur, but the long-term impact would not be significant and no population level impacts would occur.

Should nests of any MBTA species (e.g., Mariana common moorhen) be found in areas where PV arrays are planned, the installation of equipment at that location will be delayed until after the nest fledges or naturally fails on its own accord. To ensure that all parties are aware of this procedure, a coordination meeting with the PV Contractor(s), construction workers, and resource specialist shall be held for instructional purposes prior to the start of construction.

During the operational period, the proposed action will have no effect on ESA-listed and proposed species.

There are no known federally-listed threatened or endangered species or important habitat that would be affected by the proposed action. As necessary, skirting would be placed around the PV arrays to prevent the shaded area underneath the panels from becoming a habitat for feral animals.

None of the PV arrays are located in areas where large numbers water birds are known to congregate. It is possible, however, that birds could mistake the PV arrays for a body of water (“lake effect”) instead of a solid surface and strike the panels when attempting to land on them. Because the PV panels have an anti-reflective coating and will be placed at an angle instead of a horizontal position, the potential of birds mistaking it for a body of water would be minimized. The design of PV systems will not include any guy wires that would create a strike hazard to birds, and barbed wire will not be used in the fences to minimize the potential for bird strike hazards and subsequent harm to avian species.

Any migratory birds that may pass through or use the PV sites for foraging or loafing could be displaced by the installation of the PV arrays. This would not have an adverse effect on these species since they would relocate to adjacent areas with suitable habitat.

To minimize the potential of seabird fallout or disorientation, permanent outdoor lighting shall be fully shielded, utilize light-emitting diodes, and comply with International Dark-Sky Association standards.

The decommissioning of the PV systems is not expected to result in any adverse impacts. BMPs such as those utilized during the construction and operational phases will be implemented as necessary.

No Action Alternative. No impacts to biological resources would occur because the PV systems would not be built and existing site conditions would continue to be maintained.

## 3.6 Cultural Resources

### 3.6.1 Affected Environment

In October and November 2014, an archaeological inventory survey and subsurface testing was conducted at the proposed action sites by Leppard, et al. (2015), to document existing conditions and the potential for impacts the proposed action could have on cultural resources, including NRHP-eligible sites. Prior to this field work, archival research was completed to assist in identifying cultural resources at the proposed action sites (Leppard et al. 2015). None of the features documented during the archaeological inventory surveys and subsurface testing meet the criteria to be eligible for the NRHP, and no other types of cultural resources were identified at the project sites through archival research. A historical summary and presentation of efforts to identify cultural resources are described in this section. Much of this summary has been drawn from the Leppard et al. 2015 report.

Archaeological data indicates that the main Mariana Islands were settled about 1,500 years Before Christ, although some paleo-environmental and archaeological evidence suggests that initial settlement of Guam and Saipan may have occurred 300 to 900 years earlier (Athens and Ward 2004). Archaeological, biological, and linguistic evidence all point to Southeast Asia, and most strongly to the Philippine Islands, as the place of origin of the first Mariana islanders.

The early settlement period of the Mariana Islands is labeled as the Pre-Latte Period and spans the time from initial settlement to *Anno Domini* (AD) 1000. The basic settlement pattern is one of small population groups living along sandy coastlines. Subsistence practices included ocean resources (e.g., shellfish, reef fish) and agricultural crops that could be easily grown and were highly stress resistant (e.g., coconuts, breadfruit, taro). Occasional forays into the interior of the island were made to obtain resources (e.g., birds, fruit bats) that were not available near the coast. Caves and rock overhangs were used for shelter.

The Latte Period (AD 1000-1521) came next and is distinguished by the presence of latte stone structures and a notable change in pottery technology. Latte are large upright limestone pillars topped by a semi-hemispherical capstone. Latte sets served as foundations for homes and storage structures and were also associated with burials. The deceased were buried beneath latte sets within the area demarcated by the pillars or surrounding homes, as well as in non-habitation areas. Latte sites typically consist of clusters containing up to 18 individual structures and are common along the coastline of the major Mariana Islands. Inland latte sites are found in productive agricultural areas and in upland areas of southern Guam near streams and lakes. During the Latte Period, the population increased and settlement areas expanded beyond the coastal environments.

The late Latte Phase covers the period from Ferdinand Magellan's landing on Guam in 1521 until the beginning of full Spanish colonization in 1668. In 1565, Miguel Lopez de Legazpi became the first person to make a round-trip between the Americas and the western Pacific. On his westward trip from Mexico, he landed on Guam and claimed the Mariana Islands for Spain. In the following years, Spanish contact with the Marianas remained limited, with no major changes to Chamorro culture and society except for the introduction of iron tools and Spanish galleons stopping at Guam for provisions during their annual voyages to Manila to exchange silver from Mexico for silks, porcelains, and other luxury goods from

China (via the Philippines). A major consequence of contact with the Spanish galleons was the introduction of European and Asian diseases which the Chamorro were very aware of and referred to it as the "sickness of the ships".

During the late Latte period, settlements existed at the foot of each stream and river valley, as well as inland areas suitable for cultivation. The population of the Marianas was perhaps 40,000 at this time, with at least 20,000 people living on Guam. The economy of the islands was subsistence-based and dependent on fishing, gardening, and gathering.

In 1668, Spanish (Jesuit) missionaries arrived on Guam to convert the Chamorro to Christianity. Jesuit attempts to change Chamorro culture led to conflict and eventual violence. By the end of the 17th century, Chamorro society was radically changed. The impact the Spanish had on the island's people and ecosystem was devastating. New diseases, to which the Chamorro had no in-built immunity, reduced the estimated pre-Contact population of 20,000-40,000 to just 1,800 in 1690 and to less than 1,600 within a 25 year span.

The Spanish established a rigid hierarchical system in which Hagatna was the center of religious and political power. Umatac, with its excellent harbor and freshwater source, had the status of a village with a special charter. The remaining population was concentrated in four parish villages (Pago, Inarajan, Merizo, Agat) which were under the control of the Spanish missionaries and military. The island's subsistence economy was transformed to one of trade with islanders raising crops and livestock to provision the Spanish galleons and ships bringing in clothing and other items from the outside world. The introduction of large animals (e.g., cattle, carabao, pigs, goats, deer) and the clearing of forests for pasture land also impacted the environment and Chamorro culture. Along with clustering the native population in parish villages, free-roaming animals contributed to the neglect and abandonment of traditional Chamorro gardens. The Chamorro's specialized knowledge of deep-sea fishing and long-distance navigation diminished, as "virgin soil" epidemics (e.g., introduced diseases) killed many traditional knowledge holders before their skills that were accumulated over many generations could be passed on and shared.

The greatest influence the Spanish had on Guam's culture was through the Catholic Church, which has been the center of village activity since the 17$^{th}$ century. Today, every village has its own patron saint whose feast day is celebrated with an elaborate fiesta to which the entire island is invited (Guampedia, 2015). As part of their policy of *reduccion* (i.e., forced cultural change), Spanish missionaries forced islanders to wear European-style clothing. The Spanish also established schools where students received lessons in Christian doctrine, reading, writing, arithmetic, penmanship, Spanish grammar, geography, history, and etiquette. By 1887, approximately 35% of the population had received primary instruction in the local schools and 11% had learned to read and write (Guam-Online, 2015). Spanish architectural influence can still be seen on Guam as various buildings, bridges, forts, and churches that were built during their occupation still remain. For example, the San Antonio Bridge was constructed in the 1800s to span the Hagatna River while the Taliafak Bridge was built along the old Spanish Coastal Road between Hagatna and Umatac. The Plaza de Espana in Hagatna was the location of the Governor's Mansion during the Spanish occupation. Most of the palace was destroyed during WWII but three structures still remain standing: the three-arch gate, the back porch, and the Chocolate House. The Dulce Nombre de Maria (Sweet Name of Mary) Cathedral-Basilica was built in Hagatna in 1669 but was destroyed during WWII. A new church was constructed on the same site in the 1950s. Located in the Umatac area, and restored in 1995, Fort Nuestra Senora de la Soledad was one of the last forts build in the 19$^{th}$ century to support the Spanish galleon trade (Guam-Online, March 2015).

Early in the 19th century, Spanish trade in the Pacific ceased as Spain's colonies in the New World gained their independence. The administration and financial support for the Marianas was transferred to the Philippines which had strengthened their connection with the islands in the late 1700s. The easing of Spanish policy in the 1770s led to an increased number of foreign ships stopping at Guam. As a result, subsidies to Guam were reduced and the population was allowed to trade freely. This liberalization resulted in three decades of trade with the Pacific whaling fleet, which resupplied 30 British ships at Guam every year between 1823 and 1853. By the late 1840s, the American fleet became dominant and ports in Hawaii, Pohnpei, and Kosrae replaced Guam as a stop for provisions. Despite the efforts of various governors, the agricultural economy of Guam changed little and all but a very few of Guam's inhabitants were still engaged in a strictly subsistence economy. The rice and corn harvests remained low because of extensive crops damage caused by rats. Wild cotton and indigo were occasionally harvested but never became financially successful. Except for livestock and sweet potatoes that were raised to supply ships, only coffee and cacao were grown in quantities for export. Although trade had been loosened in the 1770, it was still firmly under the control of the Spanish governor and the very few wealthy individuals that he favored. If any islanders were producing crops and livestock to provision the Galleons, it was done so on the basis of taxes that were collected by the governor. Guam's population increased during the 19th century, but occasional epidemics still resulted in high mortality. According to official census records, the population increased from 4,158 in 1800 to 8,775 to the mid-1800s. A virulent smallpox epidemic in 1855-1856 reduced the population to 5,241. In 1886, the population climbed to 8,176.

During the Spanish-American War, the U.S. Navy cruiser *Charleston* sailed into Apra Harbor in June 1898. Without any ammunition, the Spanish surrendered, and the Americans took control of the island. Spain ceded Guam to the United States at the end of the war and the Navy became responsible for the administration of the island. Guam remained under American control for the next 40 years. During this time, the island served as a fueling station for ships traveling from the U.S. to Asia; as the site of the trans-Pacific cable station; the base of a strategic naval radio station; and a landing place for the Pan American Airlines trans-Pacific Clipper service between San Francisco and Hong Kong.

On December 8, 1941, Japanese planes attacked Guam a few hours after attacking Pearl Harbor. Japanese forces landed on Guam two days later, and for two years, the Japanese Navy controlled Guam. During this time, the Japanese attempted to acculturate the native population, conscripted them into forced labor, and eventually forced them into internment camps. In July 1944, the United States began an intensive bombardment of Guam that lasted 13 days. On July 21$^{st}$, U.S. Marines landed on Asan Beach with the U.S. Army following the next day. Fierce fighting ensued and by and by August 10$^{th}$ all organized resistance ended.

The recapture of Guam was followed by a massive build-up of American forces to support air attacks on Japan and prepare for an invasion of the country. New facilities were also constructed on the island and included a major port and ship repair facility at Apra Harbor, three airfields, a hospital, and multiple fuel storage facilities. After the war, many of these facilities continued to be used, and additional facilities were added in response to military needs during the Cold War, Korean War, and Vietnam War.

During the post-war period, Guam fell under U.S. Navy administration for a few years. In 1949, a civilian government was established, and in 1950 Guam was made a U.S. territory. Hagatna was rebuilt after almost being completely destroyed during WWII. Since the 1960s, tourism, particularly from Japan and other Asian countries, has become the mainstay of the Guam economy, with resort development centered around Tumon Bay on the Guam's west coast. The American military presence on the island has also remained significant.

The eight PV sites encompass 192 acres and constitute the area of potential effect for the proposed action. Four (4) of the PV sites are located in Northern Guam, while four of the sites lie within NBG. The locations and areas of these sites are shown in Table 1-1 and Figures 2-3 through 2-6. Inventory (pedestrian) surveys were conducted with parallel transect lines spaced between 6 to 50 feet apart, depending on the density of vegetation and ground visibility. Stratigraphic test pit (STP) locations for subsurface testing were selected according to a hierarchical sampling strategy. Excavation of the STPs proceeded by strata using arbitrary 4-inch levels within layers (Leppard et al. 2015).

A summary of investigations to identify cultural resources in each of the proposed PV sites is presented below.

South Finegayan. Leppard et al. (2015) completed a surface survey and subsurface investigations on a 290-acre parcel at this location; however, only 71 acres of the surveyed area are currently being carried forward for a potential PV system. Given its prior use as a housing area, the site has been subject to extensive surface and shallow subsurface disturbance. Leppard et al. (2015) did not document any archaeological sites within the proposed PV site, although a displaced Chamorro pot sherd was collected from a fill deposit in one of the stratigraphic test pits. A concrete platform that may be a component of Site 66-08-2317, a post-WWII military complex, was recorded beyond the boundaries of the proposed PV system; however, Site 66-08-2317 was previously determined to lack sufficient integrity for NRHP eligibility (Welch 2010).

There have been several other recent systematic archaeological studies in the vicinity of the South Finegayan housing complex but outside the footprint of the proposed PV system (Reinman 1967; Olmo et al. 2000; Welch 2010). The most proximate study is Welch (2010), which undertook intensive pedestrian survey on the adjacent GLUP 77 Parcel and Naval Computer and Telecommunications Station (NCTS) Finegayan, also referred to as Finegayan North and identified several sites within a 0.6-mile radius of the South Finegayan site: a latte site (Site 66-08-0141); a historical military installation (Site 66-08-2317); a Japanese military complex (Site 66-08-2316); Latte Period, Spanish Period, and military sites 66-08-2311–2316), a military complex (Site 66-08-2318), and two well installation sites. Olmo et al. (2000) recorded the Hila'an Complex to the west of the South Finegayan site, below the limestone escarpment. This complex includes at least 19 latte sets and the Hila'an cave (Reinman 1967).

Harmon Annex, Harmon Booster Station, and former Tumon Tank Farm. These three proposed PV sites are located in close proximity to each other (Figure 2-5) and therefore considered collectively for identification of cultural resources. Leppard et al. (2015) did not identify any archaeological resources on the Harmon Annex or the Tumon Tank Farm. One concrete pad (Feature 005) was identified at the Harmon Booster Station; however, this feature lacks integrity characteristics and is not considered significant under any NRHP criteria.

Prior to Leppard et al. (2015), limited systematic archaeological work has been undertaken at the Harmon Annex site with no reported findings of significance (DeFant 2008). No previous systematic archaeological work has been undertaken on the Harmon Booster Station and Tumon Tank Farm sites. Additional studies have occurred within 0.6-mile of the proposed PV sites; however, the immediate context for pre-Contact (and immediately post-Contact) archaeological resources is a large and contiguous Latte Period settlement which does not extend to the karst plateau on which the proposed PV systems are situated. None of the Annex infrastructure to the North was found to be eligible for the NRHP (Schilz et al. 1996: Table 1). Burtchard (1991) reported an absence of archaeological material to the immediate northwest of the proposed PV systems. On the karst plateau to the south, outside the project areas, two Japanese fortifications have been identified (Site 66-01-2132 and Site 66-04-1182, Bulgrin 2006).

WWTP Site. A previous pedestrian survey by Hunter-Anderson and Moore (2002) included the WWTP site as part of a larger survey parcel and no archaeological sites were identified within the boundary of the proposed PV system. Leppard et al. (2015) completed subsurface investigations on the proposed PV location and did not identify any archaeological resources.

Existing 250kW PV Site. The expansion area for this existing PV site has not been subject to previous archaeological investigations; therefore, Leppard et al. (2015) represents the first systematic investigation of this location. No archaeological resources were identified during the pedestrian survey and subsurface investigation.

The surrounding area has been previously investigated (Hunter-Anderson and Moore 2002; Carucci 1993; Craib and Yoklavich 1996; and Lauter-Reinman 1998) and Craib and Yoklavich (1996) recorded two historic Quonset huts (Map Nos 294 and 295) adjoining the west side of the Expansion site area. They also recorded additional Quonset huts (Map Nos 297-300) and post-WWII sports fields (Map Nos 179 and 220), which Lauter-Reinman (1998) added to Map Nos 178 and 320), farther from the project area. Hunter-Anderson and Moore (2002) recorded 11 post-WWII Sites to the northeast (Sites C-6 to C-16; two of these sites had prehistoric components, one consisting of an artifact scatter of pottery, lithic flakes, and marine shell (Sites C-11) and one a rock shelter (Site C- 12) in which pottery sherds and marine shell were found in a test unit. Carucci (1993) documented the remnants of multiple concrete structure (Sites TN-3 to TN-7). Carucci (1993) recorded multiple Japanese defensive positions (Sites 66-02-1129, 1301, and 1306 to 1310), Camp Bright (Site 66-02-1300), caves (Site 66-02-1312), and various post-WWII structure/remnants (Sites TN-2, 9, 10, 22-25). Tipalao Marsh (Site 66-03-1827) and Tuparao Village (Site 66-02-1311) were documented in the area.

CDF Site. A previous survey by Hunter-Anderson and Moore (2002) included the CDF Disposal Area and identified five archaeological sites within the proposed PV boundary. These included one pre-Contact site, a rock shelter containing pottery sherds and marine shell. The prehistoric deposits had been extensively disturbed by WWII use and landfilling, and pre-Contact and historical period materials were found mixed together. One late Pre-Latte sherd and several probable Latte Period sherds were recovered (Hunter-Anderson and Moore 2002:52, 99; Welch et al. 2009:78). Because of the extensive disturbance, the DoN has determined the site to be ineligible for the NRHP.

The other four sites are all WWII or post-WWII US military sites (Hunter-Anderson and Moore 2002, Volume 2): a WWII and post war limestone quarry; a complex of post-war military structures, consisting of a main concrete slab, smaller slabs, and associated sidewalks; a post-war military structure, consisting of a T-shaped concrete slab; and two adjacent post-war concrete slabs. None of these sites were determined to be eligible for the NRHP. Leppard et al. (2015) completed subsurface investigations on the proposed CDF area and did not identify any archaeological resources.

A fifth site, Site 66-03-1856, is located adjacent to the proposed CDF site and contains a series of post-WWII structures that belonged to Guam Dredging Contractors, who held a contract to dredge Apra harbor from 1946-1950. Site 66-03-1856 was determined eligible for the NRHP (Hunter-Anderson and Moore, 2002). Leppard et al. (2015) confirmed the site's integrity and a 30 meter (m) buffer will be maintained between the site and the proposed PV system."

Commissary Site. Portions of the Commissary site have been subject to previous investigations by Carucci (1993) and Craib and Yoklavich (1996); however, Leppard et al. (2015) is the first investigation of the western portion of the proposed PV site. Carucci (1993) documented multiple concrete pads (Site TN-8) in the southern component, and Craib and Yoklavich (1996) plotted the northeastern half of what may have been Orote Village (Map No 267) within this parcel. However, a subsequent study by Dixon et al. (2011) investigated the area directly adjacent to the commissary site between Shoreline Drive and Dadi Beach. Their investigation found that if the Orote Village Site had extended beyond Dadi Beach, it had been disturbed by later earthmoving associated with Camp Bright and no intact resources would occur (Dixon et al. 2011). Numerous other nearby sites have been identified; however, they are all outside the disturbance footprint of the proposed PV system and would therefore not be affected by the project.

Leppard et al. (2015) did not identify any archaeological sites within the parcel during the pedestrian survey or subsurface testing. Specifically, the subsurface investigations conducted by Leppard et al. (2015) evaluated the extent of the previously identified concrete pads by Carucci (1993) and the proposed Orote Village area suggested by Craib and Yoklavich (1996). Their investigation did not identify any archaeological findings and primarily encountered sandy fill with some graded limestone, very shallow topsoil, and push berm evidence suggesting anthropogenic degradation. This disturbance is further evidenced by the presence of Shoreline Drive bisecting the proposed Orote Village boundary as defined in the 1996 study, and confirms the findings of Dixon et al. that the area has been previously disturbed. In summary, Leppard et al. (2015) determined the disturbance was such that no material deriving from the Orote Village remains within the boundary of the proposed Commissary Site.

Summary. Previous investigations for the proposed PV sites did not document any historic features eligible for the NRHP within the proposed site boundaries. Except for the concrete pad (Feature 005) that was located on the Harmon Substation site, no other previously unrecorded archaeological sites or features were documented on any of the proposed PV sites during recent investigations by Leppard et al. (2015). Feature 005 lacks integrity and is not considered eligible for listing on the NRHP. In addition, Leppard et al. (2015) did not locate any architectural resources within the proposed PV sites that are eligible for listing on the NRHP.

Table 3-1 lists the archaeological resources that were identified on the proposed PV sites.

**Table 3-1: Archaeological Resources Identified on the Proposed PV Sites**

| Proposed PV Site | Archaeological Resources Identified | NRHP Eligibility |
|---|---|---|
| South Finegayan | No findings | Not Applicable |
| Harmon Booster Station | Feature 005 by Leppard et al. (2015) | Ineligible |
| Harmon Annex | No findings | Not Applicable |
| Former Tumon Tank Farm | No findings | Not Applicable |
| WWTP Site | No findings | Not Applicable |
| 250kW PV Site | No findings | Not Applicable |
| CDF Site | Features C-6, C-8, C-12, C-13, and C-14 by Hunter-Anderson and Moore (2002) | Ineligible |
| Commissary Site | Craib and Yoklavich (1996) plotted the northeastern half of what may have been an Orote Village within this area. Subsequent investigation found that if the Orote Village Site had extended beyond Dadi Beach, it had been disturbed by later earthmoving associated with Camp Bright and no intact resources would occur (Dixon et al. 2011 & Leppard et al. 2015). | Not Applicable |

None of the sites and features documented during previous and recent surveys on the proposed PV sites are properties that are eligible for listing on the NRHP, the nation's official list of properties that recognizes those that are significant in American history, architecture, archaeology, engineering, and culture.

### 3.6.2 Potential Impacts

The archaeological inventory surveys and subsurface testing at the proposed PV sites did not locate any cultural resources that meet the criteria for inclusion in the NRHP. The likelihood of such resources being present within these sites remains small since surface observations and the results of subsurface testing documented significant 20th century land alterations at all of the sites. As such, the meager cultural materials resulting from the archaeological investigations supports an assessment that the potential for future historic properties and cultural deposits to be discovered at the proposed PV sites is low.

The Section 106 Consultation Process is ongoing with the SHPO and interested parties. The SHPO is reviewing the DoN determination that the proposed action would result in "no historic properties affected." This determination is based on the findings that no archaeological surveys have identified any historic properties within the boundaries of the proposed PV sites.

Because none of the features documented during the archaeological inventory surveys and subsurface testing meet the significance and integrity criteria to be eligible for the NRHP, and since no other types of cultural resources were identified at the project sites through archival research, the proposed action is not expected to negatively impact cultural resources.

No Action Alternative. No impacts to cultural resources would occur because the PV systems would not be built and existing site conditions would continue to be maintained.

# 3.7 Visual Resources

## 3.7.1 Affected Environment

Guam's natural beauty and historical landmarks provide points of scenic interest. Latte, pillars which served as foundations for the thatched huts of the Chamorros, can be found in parks and remote areas of the jungle. The remnants of Spanish buildings such as the Plaza De Espana, and stone bridges may be seen in Hagatna, Guam's capital. In other locations throughout the island, the Spanish influence is clearly visible in the architectural design of homes and villages in Southern Guam (GovGuam, 2014).
Well-known scenic vantage points on Guam include Two Lovers Point located along the coastline at the north end of Tumon Bay in the village Tamuning, and the Asan Bay Overlook located along Route 6 and approximately 1.6 miles east of Piti in the village of Asan-Maina. PV sites in Tamuning include the former Tumon Tank Farm, Harmon Annex, and Harmon Booster Station. These sites are located from 1.2 to 1.3 miles southeast of Two Lovers Point. There are no PV sites in Asan-Maina; the closest PV location is the CDF site at NBG which lies approximately 4.6 miles southwest of the Asan Bay Overlook.

The urban character of the areas adjoining the PV sites in Northern Guam and at NBG is briefly described below.

Northern Guam. The PV sites in Northern Guam are located in highly urbanized settings. The Harmon Annex, Harmon Booster Station, and Tumon Tank Farm sites lie along Route 1 which is bordered by high-density residential, commercial, and light industrial development. The South Finegayan site along Route 3 is bordered by large-scale residential development to the east (across Route 3); forest stands to the south-southwest; and the vacant South Finegayan military housing complex to the north-northwest.

NBG. The installation has a land use pattern that is typical of most established naval stations. Industrial-type waterfront operations are largely along the shoreline, areas adjacent to ship berths are primarily used for mission or related support activities, and individual/family support functions are generally located inland from the waterfront.

All of the PV sites are covered with varying degrees of trees and/or scrub vegetation. The WWTP and CDF sites lie in an area bounded by Route 1 (Marine Corps Drive), Sumay Drive, and an unnamed local access road. Facilities within this area are industrial in nature and include the WWTP, a vehicle storage area, a conforming storage complex, an operations vehicle garage, a recycling warehouse, and various smaller buildings. The existing 250kW PV site is triangular shaped and bounded by Route 1, Shoreline Drive, and a general warehouse facility. Family housing areas lie to the west of the site. The Commissary site consists of two parcels that are bisected by an unnamed local access road. Shoreline Drive borders both parcels on the south and Exchange Road borders the larger parcel on the east. The existing Commissary and Transportation Equipment Maintenance Shop lie to the north of the large and small lots, respectively.

## 3.7.2 Potential Impacts

Because of their locations, distance, and topography the proposed PV systems would not affect views from scenic vantage points such as Two Lovers Point and the Asan Bay Overlook. The Harmon Booster Station, Tumon Tank Farm, and Harmon Annex sites are located just over a mile south east of Two Lovers Point, but topographic features shield the proposed sites from the viewpoint. The PV systems at NBG are located over 4.5 miles east of the Asan Bay Overlook, and would be partially shielded from the overlook by vegetation and topographic features.

The PV systems at NBG will not have an adverse effect on public view planes or the local landscape since their location on DoD property restricts public access and therefore limits their visibility. The PV systems proposed at NBG are not expected to have an adverse impact on the visual character of the installation. However, due to their large footprint and locations, the PV systems would be visible from public roadways and areas adjacent to the sites.

The PV panels have a relatively low profile (approx. 4 feet above grade) and comprise the vast majority of equipment to be installed on the site. When panels are installed on a level site, only the panels closest to the viewer would be visible. When they are installed on a sloping site, a greater number of panels would be visible from the roadway or adjacent areas. Regardless of any intervening onsite vegetation and the low-lying appearance of the PV arrays, the sheer number of panels would create a new visual presence where previously only trees and scrub vegetation existed.

Perimeter/security fencing (8 feet) would be set back from the roadway rights-of-way to minimize streetscape impacts. Pad-mounted inverter/transformer blocks (approx. 10 feet square by 10 feet high) would be distributed throughout the PV arrays. Based upon final engineering design, any new transmission lines for the PV systems would be installed either overhead or underground along existing roadways. Typically, any new overhead transmission lines would be suspended on approximately 40-foot tall utility poles spaced at about 200-foot intervals. Any new overhead transmission lines are not expected to result in any adverse visual effects since their appearance would blend in and be consistent with those of pre-existing transmission lines in the area.

The substation complex, outdoor light poles (30 feet), and any overhead utility poles and transmission lines would be more visible than the PV panels and pad-mounted inverter/transformers. All permanent outdoor lighting would be fully shielded and downward directed to be compliant with the International Dark Sky Association standards. Along roadways and adjacent areas beyond the limits of DoD property, visual barriers will screen the PV sites from view. The visual barriers may consist of new or existing landscape features (trees, shrubs), manmade structures (fences) or natural features (topography).

During the operational period, the visual barriers would screen the PV panels and most of the improvements from view so they would not be prominent in views from public roadways and adjacent areas.

The decommissioning process would remove all proposed action structures and improvements, and will not have an adverse effect on visual resources.

No Action Alternative. No impacts to visual resources would occur because the PV systems would not be built and existing site conditions would continue to be maintained.

## 3.8 Glint and Glare

PV systems introduce the possibility of light being reflected off the surface of the PV panels, into the eyes of individuals. As noted by the Federal Aviation Agency (FAA), this condition is commonly referred to glint and glare, and can cause disorientation and a brief loss of vision also known as flash blindness (FAA, November 2010). However, solar PV systems employ glass panels that are designed to maximize light absorption and minimize reflection. The panels are constructed with dark, light-absorbing materials and covered with an anti-reflective coating which reflect as little as 2% of the incoming sunlight depending on the angle of the sun (FAA, November 2010). PV systems do not generally pose a glint and glare risk for the general public as individuals must view the panels from elevation to gain the angle of reflection needed to experience glare impacts. However, there is the potential for glint and glare to impact air traffic, specifically pilots and air traffic controllers.

### 3.8.1 Affected Environment

The island of Guam is currently served by two active airports, including Andersen Airfield at AAFB and the Antonio B. Won Pat International Airport (Won Pat). Andersen Airfield is located on AAFB which encompasses approximately 17,000 acres at the northern end of Guam. AAFB serves as the home base for the Air Force's 36th Wing, and supports CJRM missions in the Pacific Region. The airfield itself comprises approximately 1,750 acres on the east side of the installation. It consists of two parallel runways aligned in an east northeast/west southwest orientation. The northern runway is identified as runway 06L/24R, and the southern runway is identified as runway 06R/24L.

Won Pat is the civilian airport that serves the island of Guam. It is located in the Tamuning Village approximately 3 miles east from Guam's capital city of Hagatna and approximately 1 mile south from the main tourist center at Tumon Bay. It consists of two parallel runways aligned in an east northeast/ west southwest orientation. Similar to Andersen Airfield, the northern runway is identified as runway 06L/24R, and the southern runway is identified as runway 06R/24L.

The proposed PV sites at NBG are located approximately 10 and 20 miles south west from Won Pat and Andersen Airfield respectively. The proposed PV sites in Northern Guam are generally located in between the two airports. The Tumon Tank Farm site is the closest site to Won Pat, located approximately 1.5 miles due north. South Finegayan is the closest site to Andersen Airfield, located approximately 5.3 miles to the southeast. Currently the proposed PV sites consist of undeveloped vegetative land, and do not create glint or glare effects for aircraft or residents in the surrounding area.

### 3.8.2 Potential Impacts

In order to assess the potential for glint and glare effects from proposed PV systems near airports, the Sandia National Laboratories has developed the Solar Glare Hazard Analysis Tool (SGHAT). This tool determines when and where solar glare can occur throughout the year from a proposed PV system as viewed from user-specified observation points (e.g., flight tracks) (SGHAT User Manual 2014). The tool accounts for PV system configurations (e.g., tilt, orientation, height, etc.) to determine the potential glare impacts.

In October 2013, the FAA released an interim policy for solar energy system projects on federally obligated airports. Under this policy, the FAA specifies that glint and glare impacts to airport facilities must be limited to "no potential" for glint glare impacts at air traffic control towers, and "no potential" for glare or "low potential for after image" along the final approach path for any existing or planned

landing threshold (FAA 2013). The FAA also identified the SGHAT as the acceptable tool to be used to determine glare impacts and requires that it be used to demonstrate compliance with the standards for measuring ocular impact for any solar energy proposed at a federally obligated airport.

Although the proposed action does not involve a solar energy system for a federally obligated airport, SGHAT was used to assess potential glare hazard analysis associated with the proposed action. The glare analysis was conducted for all applicable runways at Won Pat and Andersen Airfield. Also, the PV Contractor(s) will be selecting the final layout and panel orientation of the proposed PV system, so the analysis incorporated a range of panel orientation from southeast (150°) to due south (180°) and southwest (210°). An orientation of due south would provide for the greatest panel efficiency, however, orienting slightly to the east or west may allow the panel layout to best fit the shape of a site.

The SGHAT analysis confirmed that none of the proposed PV sites will cause significant glare impacts to Won Pat. Specifically, none of the proposed sites were shown to cause any glare impacts to the ATCT at Won Pat, and only the Tumon Tank Farm site was found to cause "low potential for after image" glare to Won Pat runways. For Andersen Airfield, only the South Finegayan site was found to have the potential to cause glare impacts. This site is discussed below.

South Finegayan. The SGHAT analysis confirmed that a panel orientation of due south or southwest at the South Finegayan PV site will cause no glare impacts to Andersen Airfield. However, if the panels were oriented to the southeast, they do have the potential to cause "low potential for after image" glare to the air traffic control tower and both flight tracks. Under FAA policy, this level of glare is acceptable for the flight tracks, but it is unacceptable for the air traffic control tower. Therefore, in order to avoid glare impacts to the Andersen Airfield site, the South Finegayan site should not be oriented toward the southeast and the shape of the proposed South Finegayan PV site lends itself to a south southwest orientation.

The SGHAT analysis shows that potential impacts from glint and glare will not be significant and are within the approved standards set forth by the FAA. For those that have the potential to cause glare impacts, measures can be taken through the orientation of the panels to avoid any significant glare impacts.

The decommissioning of the PV systems will remove any potential effects from glint and glare.

No Action Alternative. No impacts from glint and glare would occur because the PV systems would not be built and existing site conditions would continue to be maintained.

## 3.9 Hazardous Materials and UXO

### 3.9.1 Affected Environment

Hazardous Materials. Most of the proposed PV sites are covered with varying degrees of trees and/or scrub vegetation. As shown in Table 3-2, a few of the PV sites, in whole or in part, were utilized for hazardous material storage or solid waste disposal in the past and are subject to specific Land Use Controls (LUC) for the affected area in order to be utilized.

**Table 3-2: Past Use of PV Sites for Solid Waste Disposal and Hazardous Materials Storage**

| PV Site | Previous Use | Present Use or Status | Effect on PV Systems |
|---|---|---|---|
| South Finegayan | Majority of site used for Navy family housing. A 9.5-acre Construction Battalion (CB) Landfill site used for construction shop waste from 1944 to 1957 when it was closed. | The housing has been abandoned and is pending demolition. LUC are in place for the former CB Landfill site. | No adverse effect. Former CB Landfill site located in forested area, approx. 300 ft. from nearest PV array. PV arrays to be placed in previously graded and open areas of the former housing site. |
| Tumon Tank Farm | Fuel storage site | Site is unoccupied. | No adverse effect. No unacceptable risks to public health or welfare or the environment were identified at Sites 44 or 46 (Tumon Tank Farm) (DoN, November 2009). |
| PV Site | Previous Use | Present Use or Status | Effect on PV Systems |
| Existing 250kW PV Site | From the 1960s to the 1980s, a small part of the site was used for temporary storage. Stored materials included electrical transformers containing PCBs, which were no longer accepted after 1985. | Remedial action and studies were subsequently undertaken. Samples were also collected and no traces of arsenic and PCBs were detected | No adverse effect. Guam EPA granted conditional closure in October 2004 which require, among other stipulations, Institutional Controls for the PCB contaminated soil beneath the concrete caps (DoN, October 2014). |

UXO. The island of Guam was a World War II battleground with air, land, and naval combat occurring almost everywhere military operations took place. Due to the large number of residual, UXO there is a significant likelihood of encountering UXO on DoD land. The UXO Likelihood Map for Guam identifies all DoD properties on Guam as having a low, moderate, or high probability of encountering UXO. This map shows that the PV sites have a moderate likelihood of an encounter.

DoD policy calls for an Explosive Safety Submission (ESS) whenever ground-disturbing activities such as excavation, soil boring, or soil sampling occur on DoD land that have a moderate to high likelihood of encountering UXO. The ESS covers explosives safety, as well as environmental and human health and safety risks posed by UXO. The ESS also sets forth procedures to follow when personnel must enter unmaintained lands that have a moderate to high likelihood of encountering UXO.

### 3.9.2 Potential Impacts

Hazardous Materials. The proposed action may require the removal and disposal of hazardous materials or waste that may be undetected and present in the soils underlying the sites. If the existence of hazardous materials or waste is suspected, the PV Contractor(s) will ensure that an Environmental Site Assessment is conducted prior to construction to determine the presence or absence of any hazardous materials or waste on the site. Should any such materials or waste be identified in the ESA, they will be contained, removed, and disposed of by qualified personnel in accordance with applicable DoD requirements. The affected area would undergo remedial cleanup prior to any further use of the area.

During the construction phase, the PV Contractor(s) shall be responsible for ensuring that temporary, secondary containment measures are employed, to ensure that any accidental releases of hazardous substances (e.g., anti-freeze, petroleum, oils, lubricants) are prevented or limited in scope. Portable catch basins, portable containment berms, and other similar measures would be used for refueling equipment. The PV Contractor(s) would ensure that spill kits are kept on site to ensure that response and cleanup actions are promptly undertaken should a spill occur. All construction workers will be trained on spill prevention and notification measures in accordance with DoD pollution control requirements to reduce the potential for accidental spills.

With a few exceptions, the equipment associated with PV systems do not pose a threat of hazardous waste. However, coolant used in inverters, mineral oil used in transformers, and substances (e.g., anti-freeze, petroleum, oils, lubricants) used by construction vehicles are considered hazardous substances. Both the inverters and transformers utilize closed systems, and the hazardous materials could only be spilled if there was physical damage to the equipment.

Additionally, the batteries used in the BESS will contain hazardous substances. Lead-acid, sodium sulfur, and lithium-ion batteries represent the more robust technologies available, however, the specific battery technology used for the proposed system would be decided during the project design process. Batteries are typically housed entirely within a battery container system (BCS), and multiple BCS would be located within the BESS main building. The BCS will include the container, battery enclosures, control system, internal wiring, cooling system, fire suppression system, battery rack system and interfaces for battery management system. Fire risk presents the main safety concern with respect to BESS.

In response to the growing demand for energy storage systems, including BESS, the DOE has recently released, December 2014, an Energy Storage Safety Strategic Plan. In the plan they outline two basic sets of controls that should be used to minimize the risk of fires at BESS facilities. Engineered controls provide the first step in ensuring the safety of a BESS and include designing the system to the highest possible level of safety. Administrative controls includes the implementation of emergency preparedness plans and the appropriate facility signage, processes, and procedures (DOE, 2014).

During the design, construction, and operation of the PV system, including the BESS, the PV Contractor(s) will be required to implement both engineering and administrative controls to minimize the risk of hazardous substance release.

No adverse impacts are anticipated during the decommissioning process. Appropriate measures will be implemented during decommissioning to control any hazardous materials or waste, including the proper disposal or recycling of batteries.

UXO. Because all of the proposed PV sites are identified as having either a moderate or high likelihood of encountering UXO, all ground disturbing activities will utilize BMPs and comply with applicable UXO regulatory requirements and protocols. For example, this would include compliance with ESS standards which currently include surface and subsurface survey and clearance by a certified UXO Contractor who would conduct a visual and below ground survey of the area. Since the survey only indicates the possible presence of UXO, any anomalies will require further investigation by the UXO Contractor. As necessary, the UXO Contractor would remain on site to monitor all ground-disturbing construction activities.

In the event a possible UXO object is encountered during construction or anytime thereafter, its location would be noted and anyone in the area must retreat. After reporting the finding to authorities, military Explosive Ordnance Disposal (EOD) personnel would classify the object and determine disposal requirements. Typical UXO render safe procedure calls for recovering the UXO object and moving it offsite for disposal. However, if the UXO object is unstable, the object may need to be disposed of in place.

No adverse impacts are anticipated during the decommissioning process. Appropriate BMPs and ESS screening will be implemented during decommissioning should any hazardous materials or UXO be encountered.

No Action Alternative. Because no construction activities would take place and existing site conditions would continue to be maintained, there would be no impacts to hazardous materials or wastes.

## 3.10 Land Use

### 3.10.1 Affected Environment

The island of Guam is approximately 212 square miles in size (135,680 acres) and is divided into 19 municipalities which are commonly called villages.

North and Central Guam, which has an urban character and western-style development, is predicted to absorb much of Guam's future growth. The southern portion of the island contains large expanses of undeveloped land and has a more traditional culture and lifestyle. DOD land holdings on Guam occupy 36,276 acres with approximately 17,370 acres under CJRM control. DoD is planning to relocate approximately 5,000 Marines and 1,300 dependents to Guam in connection with the realignment of U.S. military personnel based in Okinawa (DoN, April 2014). The time frame for the relocation is contingent upon the completion of the federal environmental review process and the release of federal construction funds to accommodate the move. A Draft SEIS was completed in 2014 and a Final SEIS and Record of Decision are anticipated in 2015.

Because much of this future growth is expected to occur in North and Central Guam, the government of Guam, with the participation of an interagency working group, prepared the "North and Central Guam Land Use Plan" (GovGuam, September 2009). The Plan established a vision and created goals and policies to guide future growth and development in North and Central Guam and maintain the island's quality of life. Although the Plan was initially limited to North and Central Guam, its vision, goals, and policies are intended to have island-wide application as island's remaining villages would be included in a later planning phase (GovGuam, September 2009). The Plan also includes a range of land use categories for Guam that are not intended to be used as zoning designations but are meant to establish a land use pattern that is consistent with the goals and policies of the Plan. The Plan includes a "Federal Land" category which includes "all properties owned and managed by the federal government for military and other uses." All of the proposed PV sites are designated "Federal Land" with the exception of the Tumon Tank Farm site which is designated "Residential," the Harmon Annex site which is designated "Industrial" and Harmon Booster Station site which is partially designated "Industrial" and partially "Commercial".

The current zoning code for Guam regulates land uses, heights, setbacks, lot coverage, parking, and signage. The zoning code establishes various zones including: (1) Rural, (2) Residential, (3) Commercial, (4) Automobile Parking, (5) Light Industrial, (6) Heavy Industrial, (7) Limited Commercial, (8) Hotel-Resort, (9) School, and (10) Public Facility (GovGuam, September 2009). Since local zoning does not regulate federal lands, the DoD lands on Guam are not zoned.

The four PV sites in Northern Guam are located in two villages: Dededo and Tamuning. A summary description of these villages and the land uses in the vicinity of each of the PV sites follows below.

Dededo. The island's second largest and most populous village occupies 30 square miles in northwestern Guam. As with other northern villages, Dededo is located on Guam's limestone plateau. The main sections of Dededo lie along Route 1 (Marine Corps Drive), Guam's principal roadway. This village, which is a major residential and commercial center, is home to the Micronesia Mall, the largest shopping mall in Micronesia (GovGuam, 2014).

- South Finegayan. Residential areas (Astumbo Garden, Lower Astumbo) lie approximately 800 feet to the east of the site. Astumbo Elementary School and Astumbo Middle School lie approximately 0.7 mile east of the site, while Finegayan Elementary School lies 1.4 miles to the northeast.

Tamuning. This village encompasses the areas of Tamuning, Tumon, and Harmon. The main geographic features of this region are the low plateau of Oka Point which divides Tumon and Hagatna Bays, and the area around Tumon Bay which is enclosed by high cliffs leading to relatively flat areas in Upper Tumon and Harmon. Tumon, with its beautiful white sand beaches and protected waters, has become the focal point of Guam's visitor industry, while Tamuning has become a major commercial and residential area. Harmon, the site of a post-World War II airfield, is now an industrial park (GovGuam, 2014). The three proposed action sites below all front on the island's major commercial arterial, Marine Corps Drive.

- Harmon Annex. The Micronesia Mall and areas of large-scale residential development lie immediately south of the site. Lands to the immediate north, east, and west of the site are basically undeveloped and covered with trees and scrub vegetation. The Guam Regional Medical Center (under construction) lies approximately 0.2 miles to the east of the site, while lands to the southwest are industrial in nature.

- Harmon Booster Station. At its closest point, the Harmon Annex lies 0.2 miles northeast of the site. The Micronesia Mall and business/industrial-type development lie immediately south of the site. Lands to the north, east, and west of the site are basically undeveloped and mostly covered with trees and scrub vegetation.

- Former Tumon Tank Farm. Business/ industrial-type development lie immediately east of the site. Land uses to the west and south of the site appear to be tourist oriented. Lands to the north of the site are basically undeveloped and mostly covered with trees and scrub vegetation.

The four PV systems proposed at NBG are located in the village of Santa Rita. A summary description of this village and the land uses in the vicinity of each of the PV sites follows below.

Santa Rita. Excluding NBG, Naval Munitions Site (NMS), and military housing areas, this is one of Guam's smallest villages. Most of the village's activities revolve around Our Lady of Guadalupe Church, as well as the baseball field, Mayor's Office, and new Senior Citizen's Center. Located within the NMS, the Fena Reservoir was initially intended for Navy use but now serves as the main drinking water source for most of Southern Guam. In 2007, the Santa Rita Springs Booster Pump underwent a $1.5 million upgrade to support the growing demand for water (GovGuam, 2014).

NBG is located on the south side of Apra Harbor along the island's west coast. Approximately 4,300 acres in size, NBG provides waterfront, berthing, munition, and other logistical services to support various fleet units and operational forces. A summary description of the existing land uses in the vicinity of each of the proposed PV sites follows below.

- WWTP site. The WWTP site and following two sites front on Marine Corps Drive, NBG's main collector road. The existing wastewater treatment plant borders the site to the south. Various military facilities and small pockets of undeveloped land are located in the surrounding area.

- Existing 250kW PV site. The Harbor View and South Tipalao family housing areas lie west of and across the street (Shoreline Drive) from the site. Undeveloped land and the existing WWTP lie to the north and east of the site. Various military facilities and small pockets of undeveloped lands lie to the south of the site.

- CDF site. The existing 250kW PV solar facility lies to the west of the site. Undeveloped lands lie to the east of the site and various military facilities lie to the south.

- Commissary site. This site consists of two parcels that are bisected by unnamed local access road. Shoreline Drive borders both parcels on the south and Exchange Road borders the larger parcel on the east. The existing Commissary and Transportation Equipment Maintenance Shop respectively border the large and small lots on the north. An 18-acre area in the eastern portion of the larger parcel is currently being considered as a potential disaster debris management area. Should this be implemented, this portion of the PV site will be reduced accordingly.

### 3.10.2 Potential Impacts

The use of DoD land for the proposed PV systems would temporality preclude the use of the property for other uses. While this would foreclose the use of this land for other purposes during the operational life of the PV systems, the proposed action will have a positive overall effect on Guam's environment and energy production since it would provide clean, renewable energy and lessen the demand for energy produced from non-renewable sources.

The proposed action will not have an adverse effect on surrounding land use during the construction phase. BMPs and appropriate mitigation measures will be implemented during construction in accordance with all applicable regulatory requirements to minimize construction-related impacts to the surrounding area.

During the operational period, the operation and maintenance of the PV systems are not expected to impact surrounding land uses. The PV systems represent a benign, productive use of DoD land that is compatible with surrounding land uses in the area, as well as future land use plans. In addition to addressing SECNAV's goals for renewable energy production, the proposed use of DoD land for the PV

systems will provide positive effects which will accrue to the island community by producing clean, renewable solar energy; reducing the island's dependence on imported foreign oil; and improving the overall quality of life for island residents.

The proposed PV sites are generally compatible with the future land uses proposed in the "North and Central Guam Land Use Plan," as most DoD properties continue to be identified as federal lands. However, the proposed PV site at the former Tumon Tank Farm is identified in the plan as a future residential land use, which conflicts at least in the short to mid-term with the proposed use of the site for a PV system (the area could ultimately become residential in the long term). The Harmon Annex site is identified as a future industrial land use, and the Harmon Booster Station site is partially identified as future industrial and future commercial land use. The industrial designation is consistent with the proposed action, but the proposed PV system conflicts in the short to medium term with the commercial designation for the portion of the Harmon Booster Station site. However, in the long term, it could still support commercial use.

There are slight discrepancies between the proposed PV sites and the future land uses identified for the Tumon Tank Farm and Harmon Booster Station sites. However, these discrepancies would only exist during the short to medium term (up to 37 years), and this potential conflict would be outweighed by the proposed action's beneficial impacts to Guam's environment and renewable energy production. In general, proposed action is consistent with the following goals and policies of the "North and South Guam Land Use Plan."

- Goal LU 2. Promote sustainable community development.

- Policy LU 5. Promote environmental sustainability through a variety of measures. Examples of possible measures include green building design, green spaces in urban areas, green infrastructure, greenway and conservation land networks, transit-oriented development, improved networks for walking and wheeling, site design to promote renewable energy use, and other measures.

- Goal LU 3. Promote and protect the long-term health, character, and identity of the village communities.

- Policy LU 10. Provide for incremental growth in already developed areas to take advantage of existing investments in transportation and utility systems and to reduce impacts on the Northern Aquifer. In providing for infill growth, assure the adequacy of water, roads, and other public services.

The decommissioning process is not expected to have an adverse effect on land use because decommissioning would involve the removal of all applicable structures and improvements, the sites are expected to revert to their pre-development, open space condition.

No Action Alternative. No impacts to land use would occur because the PV systems would not be built and existing site conditions would continue to be maintained.

# 3.11 Roadways and Utilities

## 3.11.1 Affected Environment

Utilities are basic services that are provided to the general public and include roadways, potable water, electrical power, telecommunications, and wastewater and solid waste disposal. These utilities largely lie within or utilize Guam's roadway ROW. Some DoD installations on Guam have utilities located along local and installation roadways and whose service areas extend off base. The proposed action will require connections to existing water, electrical and telecommunications lines within the roadway ROW.

As previously noted, the proposed action will not require any wastewater connections. The PV systems will be unmanned facilities without restrooms and would not generate any wastewater flows. As such, this section does not include a discussion on wastewater. A summary description of the utilities that are discussed in this section follows below.

Roadways. There are approximately 155 miles of federal-aid highways on Guam with 860 miles of other roadways. The primary circulation route, Route (Rte) 1 or Marine Corps Drive, is a 4-lane highway extending from Apra Harbor through the capitol Hagatna to AAFB in the north. Route 16 is a 4-lane roadway which diverts from Marine Corps Drive at Hagatna, loops to Barrigada and reconnects to Marine Corps Drive near Dededo. Route 3, another 4-lane road, branches from Marine Corps Drive in Dededo north towards Finegayan. Past Finegayan, Route 3 transitions to Route 9 along the southern boundary of AAFB. Route 15 is the coastal access road to the back gate of AAFB (DoN, November 2010).

The proximity of the proposed PV sites to the closest roadways in the vicinity, their site access points, and the utility service connections to be made for each of the sites are shown in Table 3-3.

**Table 3-3: PV Sites, Nearest Roads, Site Access Points, and Utility Connections**

| PV Site | Nearest Roadway(s) | Proximity to Site | Site Access | Utility Service Connections | Water Service Provider |
|---|---|---|---|---|---|
| South Finegayan Site | Rte 3 | Adjacent | Control Tree Drive (off Rte 3) | E, W, T | DoN |
| Harmon Booster Station Site | Rte 1 | Adjacent | Frontage Road (off Rte 1) | E, W, T | DAF |
| Harmon Annex Site | Rte 1 | Adjacent | Frontage Road (off Rte 1) | E, W, T | DAF |
| Tumon Tank Farm Site | Rte 1 | Adjacent | Loop Road (off Rte 1) | E, W, T | DAF |
| WWTP Site | Route 1 | Adjacent | Rte 1 | E, W, T | DoN |
| Existing 250kW PV Site | Rte 1, Shoreline Drive | Adjacent | Rte 1 | E, W, T | DoN |
| CDF Site | Rte 1, Sumay Drive | Adjacent | Rte 1 | E, W, T | DoN |
| Commissary Site | Unnamed Road, Shoreline Drive | Adjacent | Unnamed Road | E, W, T | DoN |

***Key:*** E (electrical); W (water); T (telecommunications)

Potable Water. There are 3 separate domestic drinking water systems on Guam: 1 serves the civilian population and is owned and operated by the Guam Waterworks Authority (GWA), while 2 serve the military on Guam and are owned and operated by DoD. These water systems include

production wells, surface impoundments, springs, transmission lines, water treatment facilities, pump stations, storage tanks, and distribution lines. Groundwater wells fed by the NGLA supply most of the drinking water in north and central Guam, while springs and impounded surface water (i.e., reservoirs) provides most of the potable water for south Guam (DoN, April 2014). As of this time, GWA provides water service to more than 41,000 customers throughout Guam (GWA, 2014).

The DoN's system is island-wide and serves NBG, South Finegayan, and various DoN lands. Fena Water Treatment Plant is the primary source for this system which conveys water to storage tanks in different service zones and then transfers it to other DoD land across Guam (DoN, July 2010). Andersen Northwest Field and Andersen South are the primary water sources for the DAF system which supplies AAFB and their other lands. The system includes an off-base water supply; disinfection, storage, and transmission system; and an on-base water distribution system. Water for AAFB is provided by seven off-base production wells which draw water from the NGLA (DoN, July 2010).

Electrical Power. GPA provides all the electricity used on Guam by both civilians and the military (DoN, April 2014). GPA has 663 miles of transmission and distribution lines and 29 substations, as well as two steam power plants, one slow speed diesel plant, four medium speed diesel plants, and five combustion turbine plants. All GPA power generation units provide energy to an electrical grid which is interconnected throughout Guam. This interconnection allows power to be conveyed over a wide geographical area and not just a limited area. In conjunction with Independent Power Producers (IPP) – Pruvient Energy Guam, Marianas Energy Company, and Taiwan Electrical and Mechanical Engineers Services – GPA produces approximately 550MW of available and emergency (standby) power.

As of this time, GPA provides electrical service to more than 44,000 customers throughout Guam (GPA, 2014). DoD owns and operates substations and distribution lines serving many of their installations. In the event of local or island-wide power outages, DoD has dedicated standby generators to maintain power to important DoD facilities (DoN, April 2014).

GPA, IPPs, and DoD generate power for the regions where the proposed PV sites are located. Concrete poles with overhead conductors and wood cross arms are used to convey power at most locations while the primary service voltage is supplied by pole-mounted transformers provided with lightning surge arresters to protect downstream equipment. GPA utilizes crude oil to generate power and provides a full range of electrical services to its customers (DoN, July 2010).

The proximity of the proposed PV sites to the nearest points of connections and substations in the vicinity of the sites are shown in Table 3-4.

**Table 3-4: PV Sites, Distance to POC, and Electrical Grid Connection**

| Region | PV Sites | POC Location | Approx. Distance to PV Substation |
|---|---|---|---|
| Northern Guam | South Finegayan Site | Rte 3 | 80 ft. |
| | Harmon Booster Station Site | Rte 1 | 150 ft. |
| | Harmon Annex Site | Rte 1 | 150 ft. |
| | Tumon Tank Farm Site | Rte 1 | 200 ft. |
| NBG | WWTP Site | Sumay Drive | 3,900 ft. |
| | Existing 250 kW250kW PV Site | Sumay Drive | 2,000 ft. |
| | CDF Site | Sumay Drive | 50 ft. |
| | Commissary Site | Unnamed Road | 50 ft. |

Telecommunications. The two main providers of telecommunication services (i.e., telephone, television, and fiber optics) on Guam are GTA Teleguam (GTA) and Marianas Cable Vision Broadband (MCVB). GTA is headquartered in Tamuning and provides telephone, mobile, internet, and television service to Guam's residents (GTA, 2014). MCVB is headquartered in Dededo and specializes in cable television, telephone, and broadband internet service providers. In addition to serving the Northern Mariana Islands, MCVB serves Guam and the military installations on the island (DOCOMO Pacific Guam, 2014). Most of the transmission of telephone and television lines throughout Guam is through overhead transmission lines. Portions of the telephone and television lines and all of the fiber optic lines are buried underground. Main transmission and distribution lines are aligned along all of the existing major roadways in northern Guam (DoN, July 2010).

Solid Waste Disposal. In August 2011, the unlined municipal landfill (Ordot Dump) was closed and the new Layon Landfill at Dandan officially opened. The new landfill is owned by the Guam Solid Waste Authority and operated by Herzog Environmental, Inc. This modern, high-tech landfill handles non-hazardous municipal solid waste and was built with an engineered liner and a leachate collection and removal system. With a capacity in excess of 15.8 million cubic yards, the Layon Landfill is expected to serve Guam for more than 30 years (GovGuam, 2014).

The NBG Landfill is an unlined facility occupying 60 acres in the southeastern part of the base and has been in use since 1965 (DoN, July 2010). The landfill receives waste that is not accepted at the Layon Landfill such as green waste, wood waste, construction and demolition (C&D) waste, asbestos, and dried sewage sludge. The DoN does not plan to close the municipal solid waste area of the NBG Landfill (DoN, April 2014).

### 3.11.2 Potential Impacts

During the construction phase, the proposed action will involve the use of roadways and solid waste disposal, as well as connections to electrical, water, and telecommunications lines along adjacent or nearby roadways. BMPs will be implemented for the installation of water, electrical, and telecommunication lines to control soil erosion and surface runoff during construction activities within the roadway ROW.

Roadways. The proposed action will require the use of local and installation roadways to transport construction materials; provide construction and maintenance workers with access to and from the PV sites; and haul green waste and construction waste materials away for disposal. The proposed action will also require connections to electrical, water, and telecommunications lines within the roadway ROW.

To minimize traffic-related impacts during construction, appropriate traffic management measures will be implemented to control material deliveries and work. Construction vehicles, equipment, and materials may be stored and secured onsite to minimize vehicle movement. The PV Contractor(s) would ensure that construction vehicles do not impede traffic along local roadways and would obtain the necessary approval to transport any oversized and/or overweight material on Guam's highways. At NBG, current DoD standoff distance protocols would be implemented during construction to ensure that force protection capabilities continue to be maintained.

The operation and maintenance of the PV systems will require periodic maintenance trips to each site to clean the PV panels, trim overgrown vegetation, and check the PV panels and equipment. Since the PV systems are unmanned facilities, they will not generate any additional vehicle trips or involve any activities that could potentially affect traffic.

Potable Water. Potable water from the DAF and DoN systems will be used for fire protection for the BESS and substation complex at each of the PV sites. The layout and installation of the new water lines will be coordinated with the appropriate potable water provider (DoN, DAF or GovGuam) to ensure that all applicable design and operational criteria are addressed. Construction drawings will be prepared during final engineering design and submitted to the water service provider for review and approval prior to the commencement of construction. During the operational period, the operation and maintenance of the PV systems will not have an adverse effect on potable water systems.

Electrical Power. The layout and installation of the new electrical lines and equipment required to service the proposed PV systems will be coordinated with the appropriate electrical power provider (GPA, DoN) to ensure that all applicable design and operational criteria are addressed. Construction drawings will be prepared during final engineering design and submitted to the electrical power provider for review and approval prior to the commencement of construction.

During the operational period, the PV systems will have a positive overall effect on Guam's environment and energy use since it would help reduce the amount of fuel oil that is burned for power generation and reduce the island's dependence on foreign oil and fossil fuels. In addition to providing end users with clean, renewable energy, the proposed action would also lessen the demand for energy produced from non-renewable sources and meet the renewable energy goals established by SECNAV and the federal government.

Telecommunications. To monitor and control the PV systems using SCADA, the proposed action will require connections to existing GTA or MCVB telecommunications lines (overhead or underground) along adjacent or nearby roadway rights-of-way. New telecommunications lines required to service the proposed PV systems will be installed overhead or underground in accordance with GTA or MCVB requirements. The layout and installation of the new lines will be coordinated with the telecommunications provider (GTA or MCVB) to ensure that all applicable design and operational criteria are addressed. Construction drawings will be prepared during final engineering design and submitted to the telecommunications provider for review and approval prior to the commencement of construction.

During the operational period, the operation and maintenance of the PV systems will not have an adverse effect on GTA or MCVB's telecommunications systems.

Solid Waste Disposal. During the construction phase, the disposal of green waste and construction waste materials will be the responsibility of the PV Contractor(s) who would likely use a commercial waste hauler to transport any non-hazardous municipal solid waste to a Hauler Transfer Station. Cleared vegetation, including brush and tree limbs, will be hauled to a green waste facility for disposal and mulching. If feasible, tree branches could be mulched in place and used to control ground vegetation. Similarly, construction waste materials would be hauled to a construction and demolition C&D waste disposal facility. For example, a commercial disposal facility such as Primo's Northern Hardfill in Yigo accepts green and C&D waste materials for disposal (GSWA, 2014).

During the operational period, solid waste generated by the operation and maintenance of the PV systems would is expected to be very minimal and will be the responsibility of the PV Contractor(s) who would utilize a commercial waste disposal service.

The decommissioning of the PV systems is not expected to result in any adverse impacts. For roadways, traffic management measures will be implemented to ensure that local roadways and traffic are not impacted during this process. Solid waste disposal will be the responsibility of the PV Contractor(s) who would hire a commercial waste service to transport the waste to an appropriate disposal facility. For potable water, electrical power, and telecommunications, BMPs will be implemented to control soil erosion, sedimentation, and stormwater runoff. The PV Contractor(s) will be responsible for ensuring that water, power, and telecommunications services to others are not disrupted and that other utility lines in the roadway ROW are not disturbed.

No Action Alternative. No impacts to roadways, potable water, electrical power, telecommunications, and solid waste disposal would occur because the PV systems would not be built and existing site conditions would continue to be maintained.

## 3.12 Socioeconomic Conditions

### 3.12.1 Affected Environment

Guam experienced a lengthy period of investment-driven growth through the 1980's and early 1990's which saw the private sector overtaking the public sector in economic importance. Employment data provided by the Guam Department of Labor shows there were 61,930 jobs in March 2011, a slight decline from 62,200 jobs the previous year. By employer, 74.42% of the jobs were provided by the private sector, 6.36% by the Federal Government, and 19.22% by GovGuam. By economic sector, 27.76% of the employed individuals were in Services (including 8.85% in Hotel and Other Lodging Accommodations), 18.44% were in Retail Trade; 10.27% were in Construction; 7.14% were in Transport and Public Utilities; 4.28% in Financial, Insurance and Real Estate, 3.39% in Wholesale Trade, 2.71% in Manufacturing and 0.44% in Agriculture. By gender, employees were 56% male, 44% female. Guam's unemployment rate was 13.3% in March 2011. The number of unemployed increased from 6,510 persons (9.3%) in September 2009 to 9,970 persons (13.3%) in March 2011 (GovGuam, 2011).

According to the Guam Bureau of Labor Statistics, Guam's average household income for calendar year 2010, was $49,263, an increase of $3,477 or 7.1% from $45,786 in 2008. Per capita income for 2010 was $12,864, a decrease of $225 or 1.7% from calendar year 2008 2011 (GovGuam, 2011). Economic estimates for Guam show that real Gross Domestic Product increased 1.7% to $3.9 billion in 2009. Guam's tourism industry is the island's single largest economic sector and generates approximately 60% of Guam's annual business revenue. This economic activity generated $378 million in local wages and 10,412 full- and part-time jobs. About 90% of all Guam's visitors are from Asia, with the balance made up of visitors from the U.S., neighboring Pacific islands, and other areas. Visitors from Japan comprise the largest share of Guam's market mix with close to 80% of all arrivals to Guam. Guam's market share in 2010 was 5.4% of the Japanese tourist market, a total of 16.6 million outbound travelers (GovGuam, 2011).

Guam has a large U.S. military presence, which includes DoN and DAF bases and lands that encompass nearly 27% of the island's land mass. DoD plans to relocate 5,000 Marines and 1,300 dependents from Okinawa to Guam at an estimated cost of $10.27 billion. It is estimated that up to 20,000 temporary workers may be needed to support the relocation, and approximately 6,000 civilian workers may be added to the island's population after the relocation is complete. Major funding for the buildup effort is being contributed by DoD, U.S. Department of Agriculture and the Government of Japan. Defense spending on Guam is about $700-800 million a year, with 6,500 active duty personnel and approximately 7,000 dependents. There were 3,600 federal civilian employees and federal taxes returned to Guam were $45 million (GovGuam, 2011).

According to U.S. Census data for 2010, Guam's population was 159,358 and is projected to increase to 168,323 in 2020. For those of one race, the Chamorro is the largest ethnic group on Guam at 59,381 or approximately 37% of the population. Filipinos at 41,944, account for 26% of the population, followed by Caucasians at 11,321 with 7%. The remaining population is composed of Asian Americans at 51,381, African Americans at 1,540, Hispanics at 1,201, those of other ethnic origins at 404, and those of two more ethnic origins at 14,929 (GovGuam, 2012).

Most of the island's population lives in Northern Guam and is most dense in the north and central regions. Villages that comprise the northern half of the island are home to 80% of Guam's overall population. The four most populous municipalities - Dededo, Yigo, Tamuning, and Mangilao - are all in Northern Guam (WERIWP/IREI, 2014). According to 2010 census data, the average population density in the Northern Guam municipalities is 716 people per square kilometer. For comparison, population density in Southern Guam municipalities is 113 people per square kilometer (WERIWP/IREI, 2014).

### 3.12.2 Potential Impacts

The proposed action is not expected to result in any adverse socioeconomic impacts because it will not alter population and demographic characteristics nor would it result in inconsistent population growth or have any disproportionate impacts upon housing and employment markets. Construction-related employment would have a positive impact on the local economy due to spending by those employed in construction jobs and businesses providing goods and services to the construction industry. Construction-related spending would also benefit businesses in other commercial sectors (e.g., stores, restaurants), while construction-related tax revenues would benefit the local economy. During the operational period, the PV systems would continue contributing to the local economy through periodic maintenance work and the purchase of goods and services for the operation and maintenance of the PV systems.

No adverse impacts are anticipated during the decommissioning of the PV systems. The decommissioning work will provide employment opportunities and contribute to the local economy through direct and indirect spending.

No Action Alternative. No impacts to socioeconomic conditions would occur because the PV systems would not be built and existing site conditions would continue to be maintained.

## 3.13 Cumulative Impacts

Cumulative impacts on environmental resources are the result of two or more individual impacts that, when considered together, compound or increase the overall impact of a particular action. Cumulative impacts can arise from the individual effects of a single action or from the combined effects of past, present and reasonably foreseeable future actions. Cumulative impacts can result from individually minor actions that collectively amount to significant impacts over time.

The proposed and potential future PV systems are part of a world-wide shift toward renewable energy sources. This growth is attributable to rising fossil fuel costs, an awareness of fossil fuel dependency and energy independence, and energy efficient improvements in PV technology (i.e., improved energy density), as well as federal renewable energy policies and the availability of federal tax credits.

Guam is somewhat unique from the continental U.S. (CONUS) due to its geographic location and heavy reliance on fossil fuel. Guam is also different from CONUS in that it cannot benefit from redundant and oftentimes competitive electrical grids, accessibility to natural gas, and availability of other types of fuel (e.g., coal, hydro, large scale geothermal, etc.).

In addition to recent renewable energy projects, Table 3-5 lists past, present, and reasonably foreseeable future projects on Guam (organized by proponent).

**Table 3-5: Construction Projects Considered in the Cumulative Impact Analysis**

| Proponent | Project Name | Description | Status |
|---|---|---|---|
| Guam Power Authority | 2013 Integrated Resource Plan Recommendations | Work with EPA on resolving Clean Air Act non-attainment issues. Construct a new 60-120MW LNG Power Plant in Harmon area – and retire a number of older technology Power Plants. Increase electrical production to support the pending DoD buildup and its economic consequences Procure an additional 40MW of renewable energy Investigate potential for geothermal, ocean thermal energy conversion and sea water air conditioning technologies Institute rules for net metering | Various |
| | Energy Storage Systems (ESS) | 40MW Battery ESS at Hagatna Substation | Feasibility |
| | Dandan project | 26MW PV Farm and Windfarm in Dandan | Under construction |
| | Pole Hardening | harden power poles to make them more wind resistant | Programmed |
| | Lateral Conversion of Power Lines to Underground Lines | convert overhead lines to underground lines | Programmed |
| | Redesign Orote substation and include transformer connections to existing diesel power plant (NBG) | Prioritized for funding and construction | Under construction |
| | NBG Substation Transformer Upgrades | GPA to undertake transformer upgrades | Prioritized for funding and construction |

| Proponent | Project Name | Description | Status |
|---|---|---|---|
| Guam Housing and Urban Renewal Authority | Lada Estates | Affordable, low-income 240-unit housing built in Dededo | Completed |
| Guam Healthcare Development, Inc. | Guam Regional Medical Center | Guam Regional Medical Center (private 130-bed hospital) in Dededo | 2015 |
| Guam Economic Development Authority | Hotel Occupancy Tax Revenue Bond Projects ($90M) | New museum and cultural center and other Hagatna improvements<br>New Farmer's Co-op in Dededo<br>Other cultural and recreational improvements around the island | Funded; some projects underway |
| Guam Solid Waste Authority | Layon Landfill | A new integrated municipal solid waste landfill was built at Dandan | Completed |
| University of Guam, Center for Island Sustainability | Yigo Research Farm | Wind turbines and roof and ground mount PV projects | Completed |
| GIA Authority | Terminal improvements | The airport's grounds, main terminal, industrial park, airfield, and south ramp are being upgraded | Ongoing |
| Private Sector | Hemlani Apartments at Tumon | 300-unit apartment complex was built behind the Acanta Mall | Completed |
| | Bayview Luxury Hotel at Tumon | 28-story, 400-room hotel | Complete |
| | Tumon Amusement Park | Amusement park providing rides, food, and beverages | Completed |
| USAF | AAFB Infrastructure Construction | Construction, alteration, repair, and maintenance of the airfield's asphalt concrete roads and parking areas | Undetermined |
| DoN Island wide | Guam and Commonwealth of the Northern Mariana Islands (CNMI) Relocation | Relocation of 5,000 Marines and 1,300 dependents from Okinawa to Guam | Pending completion of NEPA process and release of federal funds |
| | Future PV projects (14.3MW) | Potts Junction; 19ac, 3MW<br>Nimitz Hill; 6 ac, 1.6MW<br>GLUP 77; 61ac, 9.7MW | Potential future sites |
| DoN NBG | North Tipalao Family Housing | Infrastructure improvements | Completed |
| | NEX Mini-mart and Gas Station | Infrastructure improvements | Completed |

### 3.13.1 Air Quality and Climate

A significant focus of GPA's long range plan is to retire aging power plants burning heavy residual fuel (considered the source of the two non-attainment areas around the Tanguisson and Cabras power plants) and replacing that generating capacity with a cleaner burning new Power Plant in the Harmon area -- and supplementing that with renewable energy sources including ongoing and planned PV and wind farms and future OTEC, SWCA and geothermal projects. From a cumulative perspective, the proposed action will assist GovGuam improve air quality and conformance with the federal Clean Air Act and move the territory towards greater energy security and reliability.

Renewable energy technologies, by definition, replace fossil-fuel generated power. These technologies require fossil fuels to support the manufacture, transport, construction and servicing of the equipment, but during the operational period, the technologies generate clean power. According to researchers at the Brookhaven National Laboratory, regardless of the specific technology, PV systems generate significantly fewer harmful air emissions (at least 89% less per kW) than conventional fossil fuel fired technologies (Good Company ND, 2014).

Though individual projects are unlikely to have significant impacts on global climate change, they collectively may have cumulative effects when their individual GHG emissions are combined over time. The proposed and potential future PV systems would generate GHG emissions in the manufacture, assembly, transport, and installation of the PV systems and energy transmission networks. However, most of the GHG emissions associated with the proposed and potential future PV systems would be temporary in nature. Once they are installed, the operation of these PV systems is not expected to generate levels of GHGs that would significantly impact global, regional or local climate conditions when considered together with other local or regional projects (operations and maintenance activities will involve the use of fossil-fueled vehicles and equipment).

By offsetting the future demand for fossil fuel-based energy production, the development of PV systems have the potential to ultimately contribute to the reduction of regional and overall GHG emissions. The development of PV systems represent an important step towards reaching federal and DoD renewable energy goals that, from a cumulative impact perspective, represent a modest, positive impact on the environment in conjunction with other past, present, and reasonably foreseeable future actions.

Global sea levels are expected to rise over the coming century due to the effects of projected climate change. Islands and coastal areas are especially vulnerable since the sea level around Guam is expected to rise by 24 to 31 inches by the end of this century (Oak Ridge National Laboratory, 2014). The proposed and potential future PV systems would be located well above the projected sea level rise and would therefore not be affected.

### 3.13.2 Topography and Soils

The proposed action, combined with past, present and foreseeable projects has the potential to alter topography and cause soil erosion which can have vast effects on the ecosystem. In gross terms, the proposed 192 acres of PV farms represents less than 0.2% of Guam's land mass. The economics of PV farms require compact, relatively flat sites to keep site development costs at a minimum– so extensive grading and land alteration is not a factor in this type of development. The proposed action sites will follow best practice erosion and sediment control plans to minimize potential for airborne dust, soil erosion and stormwater runoff. Therefore, the proposed action will not significantly contribute to a cumulative effect to topography and soils.

In regards to the past, present, and reasonably foreseeable projects listed in Table 3-4. The vast majority of these projects and their cumulative effects were thoroughly addressed in the Guam and CNMI Military Relocation SEIS in 2012. This analysis identified that these large scale development projects do have the potential to adversely affect topography and soils. However, all of the DoD projects will be required to comply with all DoD BMPs and regulations to mitigate potential impacts. Similarly, the non-DoD projects would be required to implement erosion control plans to mitigate potential impacts as required by GovGuam (DoN, April 2014). Accordingly, the proposed action, combined with past present, and reasonably foreseeable projects would not cause a significant cumulative impact on topography and soils.

### 3.13.3 Water Resources

The proposed action could impact surface and groundwater resources by altering site drainage and groundwater recharge. However, federal renewable energy systems are required to maintain pre-development onsite hydrology to the maximum extent possible. The proposed action will meet this requirement, and therefore will not contribute to a cumulative effect on groundwater recharge or stormwater quality. The proposed action is not a water intensive land use. They will draw water from the DAF and DoN water systems, but only for fire protection and periodic cleaning/maintenance. Therefore, the proposed action will not significantly contribute to a cumulative effect on groundwater resources or hydrology.

In regards to the past, present, and reasonably foreseeable projects listed in Table 3-4. The vast majority of these projects and their cumulative effects were thoroughly addressed in the Guam and CNMI Military Relocation SEIS in 2012. This analysis identified that by implementing large scale construction projects, increasing impervious surfaces, and increasing the demand for potable water, the projects have the potential to adversely affect water resources. However, all construction projects will be required to comply with stormwater management best practices, and low impact development measures would be used, in compliance with local and federal regulations, to minimize the potential impacts to water resources (DoN, April 2014). As such, the proposed action, combined with past present, and reasonably foreseeable projects would not cause a significant cumulative impact on water resources.

### 3.13.4 Biological Resources

As noted, the proposed PV sites are generally located on previously disturbed properties without significant biological resources and would not present a significant direct or indirect adverse effect on biological resources. The proposed action in combination with past, present, and reasonably foreseeable projects would result in further cumulative reduction in available habitat; however, as described above, the proposed PV projects are generally located on previously disturbed areas with low potential for biological resources. Therefore, the proposed action's contribution to the cumulative effects on available habitat would be minimal.

Additionally, the proposed action would have no effect on species listed or eligible for listing under the Endangered Species Act; therefore, there would be no potential for cumulative impacts.

### 3.13.5 Cultural Resources

The volume of development and DoD projects on Guam have the potential to have cumulative impacts on cultural resources; however, the review processes required under NHPA Section 106 incorporate broad consideration of effects to historic properties. These review processes help to create a mitigative filter that substantially reduces the potential for cumulative impacts. Additionally, no historic properties would be affected by the proposed action. Therefore, the proposed action, in conjunction with past, present, and reasonably foreseeable future actions does not have the potential to contribute to a cumulative impact on Guam's cultural resources.

### 3.13.6 Visual Resources and Land Use

The proposed action, in combination with past, present, and reasonably foreseeable future projects could impact visual resources especially by changing Guam's open space landscapes. The proposed PV sites are located either on DoD installations or in urbanized areas along Guam's main highways and represent less than 0.2% of the total land area. Their proposed development does not pose a significant impact to Guam's open space or visual resources. From a cumulative perspective, the proposed action represents one part of a significant number of federal and GovGuam initiatives to improve energy security and reliability, and to address existing deficiencies and accommodate projected economic growth. Simply put, Guam's transition towards increased energy self-reliance will require open space to be used for the production of renewable energy. This transition will require tradeoffs to determine proper siting for renewable energy projects, and the type of technology that would be best suited. Locating renewable energy facilities near existing GPA transmission lines is a key economic feasibility factor, and these transmission lines typically run along the major roads, increasing the visibility of these facilities. While the open space landscape and associated visual resources on Guam will change as foreseeable growth occurs, the effect of the proposed action (because the acreage is relatively small and largely restricted to previously developed sites), will play a small and insignificant role.

The proposed PV systems are considered an interim land use (i.e., not permanent), on federal land, and compatible with surrounding land uses. Regardless, the proposed PV sites are generally consistent with GovGuam's land use plan which is very supportive of sustainable community development, including promotion of renewable energy. While land use patterns on Guam will change as foreseeable growth occurs, the effect of the proposed action will play a small and insignificant role.

### 3.13.7 Hazardous Materials and Waste

The proposed action, in combination with past, present, and reasonably foreseeable future projects could generate or otherwise involve hazardous materials and waste. From a cumulative perspective, the use of hazardous chemicals in the manufacture of PV panels poses a potential biological impact. Improper disposal of the panels at the end of their useful life presents an environmental, health, and safety concern (a number of PV panel manufacturers have recycling programs). Extracting raw materials such as crystalline silica to manufacture the panels, can also pose a similar hazard. The proposed and potential future PV systems will not require the extraction of materials or manufacture of panels on Guam.

Potential biological effects during the operational phase would be minimal and limited to rare and infrequent events. With effective regulation, enforcement, and vigilance any danger to workers, the public, and the environment can be minimized. The benefits of PV systems tend to far outweigh risks especially when compared to conventional fossil fuel technologies (Good Company ND, 2014).

### 3.13.8 Socioeconomic Conditions

The proposed action, in combination with past, present, and reasonably foreseeable future projects show the ongoing investment in infrastructure and development that has the potential to impact Guam's socioeconomic conditions. In itself, the pending relocation of 5,000 Marines and 1,300 dependents to Guam has the potential to create significant economic development and population growth. Guam's focus on transitioning towards renewable sources for energy production also has the potential to influence socioeconomic conditions.

Continued growth in the renewable energy industry, including the proposed PV systems, would result in continued job growth and increased disposable income due to attendant energy savings. Overall, the proposed PV systems, in conjunction with other past, present, and reasonably foreseeable future actions, would have a beneficial cumulative effect on Guam's economy.

### 3.13.9 Cumulative Impacts Summary

The construction, operation, and decommissioning of the proposed PV systems in combination with past, present, and reasonably foreseeable future projects are not expected to result in any significant cumulative impacts upon air quality; noise; topography and soils; water resources; biological resources; cultural resources; visual resources; land use; electrical and water utilities; and socioeconomic conditions. Potential adverse effects from glint and glare and hazardous materials and UXO are not expected and are capable of being avoided or minimized through the use of BMPs and compliance with applicable regulatory requirements and protocols. During the operational period, beneficial cumulative effects upon air quality would be realized as more renewable energy projects are developed on Guam.

No Action Alternative. No adverse cumulative impacts to the natural or manmade environment in the area around the proposed and potential future PV systems would occur because the PV systems would not be built and existing site conditions would continue to be maintained.

## 3.14 Relationship between Short-Term Use and Long-Term Productivity

This section lists the trade-offs between short-term and long-term gains and losses due to the proposed action. "Short-term" refers to the construction period; "long-term" refers to the post-construction (operation and potential decommissioning) period.

The proposed action would have the following short- and long-term gains and losses:

Short-term

- Short-term construction period impacts on air quality, noise, traffic, and stormwater runoff.
- Short-term economic benefits associated with the employment created by construction contracts.

Long-term

- Long-term improvements in energy security and reduction of fossil fuel use.

The proposed action would have the long-term benefit of producing approximately 43.8 MW DC of clean, renewable energy for the island of Guam. Additional long-term benefits include increasing the energy security, operational capability, strategic flexibility and resource availability for DoD installations and lands on Guam through the development of renewable-energy on Guam. In addition, the proposed action would also help meet the renewable energy standards set forth by the federal government and SECNAV's 1 GW Initiative and goal to produce 50% of the DoN's shore-based energy requirements from alternative sources.

The minimal short-term construction period impacts associated with the proposed action are more than justified by the potential long-term benefits that will be realized through improvements to energy security and reduction of fossil fuel use.

No Action Alternative. Under this scenario, the PV systems would not be built and existing site conditions would continue to be maintained.

## 3.15 Irreversible and Irretrievable Commitments of Resources

Irreversible and irretrievable resource commitments are defined as the use of non-renewable resources and the effects the use of these resources have on future generations. Irreversible effects result from the use or destruction of a specific resource, such as fossil fuels or minerals that cannot be replaced within a reasonable period. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the proposed action, such as a significant archaeological site.

Irreversible resources that would be consumed by the proposed action include energy needed to manufacture the PV system components (e.g., PV panels, cables, batteries, and inverters); transport the components from the manufacturer to the PV sites; and operate the construction equipment to install the PV systems. Other irreversible resource commitments include materials needed to manufacture the PV components. Construction and operation of the PV arrays and the placement of associated electrical equipment and cables would be an irretrievable commitment of various resources, such as labor, capital, energy, and land, by the PV Contractor(s). Use of the land for the PV systems is not an irreversible or irretrievable resource commitment because the systems can be removed at the end of the lease period.

No Action Alternative. There would be no irreversible and irretrievable resource commitments. However, DoD installations and lands on Guam would continue to use non-renewable energy and, during the operational period, would consume a greater amount of irreversible resources by using energy produced by fossil fuels.

## 3.16 Compliance with Executive Orders

### 3.16.1 Executive Order 12898, Environmental Justice in Minority Populations and Income Populations.

Executive Order 12898 (February 11, 1994), and SECNAV's Notice 5090 (May 27, 1994) requires the DoN to identify and address the potential for disproportionately high and adverse human health and environmental effects of their actions on minority and low-income populations. Because the PV systems will be located on DoD property with controlled access, exposure and risk to the general public would be limited. In addition, since the proposed action is not expected to have an adverse effect upon environmental resources, it would not create any environmental health or safety risks that would disproportionately affect minorities or disadvantaged populations. The construction and operation of the PV systems would not disrupt the structure or cohesion of the community since the proposed action would occur on DoD land. The proposed action could potentially provide benefits to minority and low-income populations by providing employment opportunities for the local workforce.

As such, no adverse environmental justice impacts are anticipated because there would be no significant changes in land use or aesthetics and there would be no disproportionate human health or environmental impacts to low income or minority populations.

Under the No Action Alternative, no construction activities would take place and existing site conditions would continue to be maintained.

### 3.16.2 Executive Order 13045, Protection of Children from Environmental Health Risks and Safety Risks

Executive Order 13045 (April 21, 1997) and its policies, programs, activities, and standards requires federal agencies to make it a high priority to identify and address disproportionate risks to children that result from environmental health or safety risks. During construction, access to each PV site would be restricted to authorized personnel. Temporary fences and other access control measures would be utilized to prevent accidental entry by children or other individuals who reside or work on or near military installations or DoD land. Noise generated by construction activities near residential areas would have a short term effect on children due to their limited duration during daylight hours. Safety precautions employed during construction to minimize construction noise, would not be hazardous to the safety and health of children. After their completion, the PV systems would be screened from children living in nearby homes by fences and locked gates to prevent accidental entry and exposure to electrocution or other safety and health hazards. No long-term adverse impacts on children living near the PV sites are anticipated.

Under the No Action Alternative, no construction activities would take place and existing site conditions would continue to be maintained.

### 3.16.3 Executive Order 13423, Strengthening Federal Environmental, Energy, and Transportation Management

Executive Order 13423 (January 24, 2007) consolidates and strengthens a number of prior EOs (13101, 13123, 13134, 13148 and 13149) by establishing new and updated goals, practices, and reporting requirements for environmental, energy and transportation performance and accountability. EO 13423 establishes goals for federal agencies to implement the policy of conducting environmental, transportation, and energy-related activities in support of their respective missions in an environmentally, economically and fiscally sound, integrated, continuously improving, efficient and sustainable manner. Goals relevant to the proposed action include:

- Improving baseline energy efficiency and reducing GHG emissions by certain numerical targets and timelines.

- Ensuring that at least half of the statutorily required renewable energy consumed by the agency in a fiscal year comes from new renewable sources, and to the extent feasible, implements renewable energy generation projects on agency property for agency use.

In accordance with NAVFACINST 9830.1, current DoN policy is for new construction to meet Leadership in Energy and Environmental (LEED) certification levels set forth by the U.S. Green Building Council (USGBC). As such, the proposed action will be guided by LEED standards and directives to

employ efficient and environmentally-sensitive sustainable design standards and minimize energy use and water consumption during PV system operations.

Under the No Action Alternative, no construction activities would take place and existing site conditions would continue to be maintained.

### 3.16.4 Executive Order 13514, Federal Leadership in Environmental, Energy, and Economic Performance

Executive Order 13514 (October 5, 2009) builds on and expands the energy reduction and environmental requirements of EO 13423 by making GHG reductions a federal priority, setting targets for the reduction of GHG emissions by FY 2020, and requiring federal agencies to develop plans focused on cost-effective projects and programs. Under this EO, agencies are required to measure, manage, and reduce GHG emissions toward agency-defined targets, and meet a number of energy, water, and waste reduction targets and sustainability requirements. The proposed action will increase renewable energy and renewable energy generation on federal land, thereby helping to meet sustainability requirements and reduce GHG emissions.

Under the No Action Alternative, no construction activities would take place and existing site conditions would continue to be maintained.

## 3.17 Coastal Zone Management Act

The proposed action would be located entirely on DoD property that by definition is excluded from Guam's coastal zone per 15 CFR 923, §923.33(a), and would not result in spillover effects extending into Guam's coastal zone per 15 CFR §923(b).

The DoN has determined that the proposed action would not have reasonably foreseeable direct or indirect effects on any coastal use or resource of Guam's coastal zone. The DoN informed Guam BSP of its negative determination; however, the consultation process with Guam BSP is ongoing.

# Chapter 4 List of Preparers

This Environmental Assessment was prepared by Naval Facilities Engineering Command (NAVFAC) Pacific.

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# Appendix A

## NHPA Section 106

## Consultation Correspondence

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**NAVAL FACILITIES ENGINEERING COMMAND MARIANAS**
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**FPO AP 96540-2937**

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Ser OPS/2015-002
06 May 15

Ms. Lynda Bordallo Aguon
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SUBJ: INSTALLATION AND OPERATION OF PHOTOVOTAIC SYSTEMS AT EIGHT SITES ON GUAM

Dear Ms. Lynda Bordallo Aguon,

The Naval Facilities Engineering Command (NAVFAC) requests your review of a proposed development of eight renewable energy generation assets, via solar photovoltaic (PV) systems, at Naval Base Guam (NBG). Pursuant to Section 106 of the National Historic Preservation Act (NHPA), we have reviewed the proposed project scope and determined proposed development of each asset is an undertaking as defined in 36 CFR 800.16(y). Concurrently, the DoN is requesting a 30-day review of the attached 2014 draft report by Leppard et al. (Enclosure 1), Letter for Archaeological Feature and Site Re-Location and Assessment at the CDF Area in Support of Navy Renewable Energy Projects on Guam (Enclosure 2), and consulting on the eligibility of properties for inclusion in the National Register of Historic Places (NRHP).

The proposed project has undergone multiple scope updates during development. As a result, Leppard et. al. (2014) surveyed three (3) additional locations (two at Andersen Air Force Base [AAFB]; one on NBG) beyond those for which a Determination of Effect under Section 106 of the NHPA has been made. Additionally, Leppard et. al.'s surveyed boundary of the South Finegayan Housing area exceeds the revised PV project area for which a Determination of Effect was made. To facilitate the multiple, concurrent reviews requested in this letter, the following table identifies the sites surveyed for eligibility in Leppard et. al. (2014) and the proposed sites for which concurrence with Determinations of Effect for the construction and operation of PV is requested.

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**Table 1. Summary of Requested Actions**

| Site Name | Review requested in Leppard et. al., 2014 | Concurrence with PV Determination of Effect requested |
|---|---|---|
| Andersen AFB Landfill/Utility Corridor | Yes | No |
| Andersen AFB South Lot "A" | Yes | No |
| South Finegayan Housing | Yes | Yes* |
| Orote Landfill | Yes | No |
| NBG Existing 250 kW PV Site | Yes | Yes |
| Commissary Site | Yes | Yes |
| Harmon Annex | Yes | Yes |
| Harmon Booster Station | Yes | Yes |
| Tumon Tank Farm | Yes | Yes |
| Wastewater Treatment Plant | Yes | Yes |
| Confined Disposal Facility | Yes | Yes |

*Surveyed area (Leppard et. al., 2014) exceeds the proposed boundary of the PV site

**Project Description:** This project proposes to lease up to 192 acres of DoD land, at 8 separate locations, to Guam Power Authority (GPA) to construct and operate solar photovoltaic (PV) systems producing solar-generated energy for transmission to the GPA electrical grid. Specifically, GPA would select a renewable energy contractor to develop eight (8) PV sites: South Finegayan Housing, NBG existing 250 kilowatt PV site, Commissary Site, Harmon Annex, Harmon Booster Station, Tumon Tank Farm, Wastewater Treatment Plant area, and the Confined Disposal Facility (CDF) Site (see enclosures 3 and 4). It should be noted that the potential exists for the Harmon Annex and Booster Station sites to also be used for Battery Energy Storage Systems (BESS).

The land underlying the PV sites would be leased for up to 37 years after which time the leases may be renewed or the facilities could be decommissioned. In accordance with 10 U.S.C. §2667, the leases shall provide for consideration (rent) to be paid in an amount not less than the fair market value of the leasehold interest, either in cash or in kind. Although the proposed action addresses the known impacts of the federal lease action, details regarding the specific method of consideration to be employed, to include the design, construction, management and maintenance of any potential in-kind consideration projects or efforts, have not been developed at this time. Once the specific considerations are identified, a new review process under Section 106 of the NHPA will be completed to determine if these considerations would have the potential to affect cultural resources; therefore, determinations of effect for these considerations are not addressed in this letter.

The purpose of the proposed action is to reduce energy costs and fuel oil dependency, and increase the energy security, operational capability, strategic flexibility and resource availability

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of DoN installations through the development of renewable energy generating assets on Guam. The proposed action is required to meet the renewable energy standards put forth by the 1 GW Initiative, EPAct, 10 U.S.C. 2911(e), the 2013 presidential memorandum, and SECNAV, to include the requirement to produce 50 percent of DoN's shore-based energy requirements from alternative sources.

Solar PV panels utilize a packaged assembly of solar cells to harness solar energy (photons) from the sun and generate electricity. The system includes inverters, mounted on concrete pads located throughout the PV array, with its own medium voltage transformer which transmits the power to the PV system's on-site substation. Each PV system may include some type of BESS to balance fluctuations in energy generation caused by weather, seasons, and nighttime darkness. The BESS is located onsite near the PV system's substation. If the two Harmon sites are pursued for BESS without on-site PV, the configuration and components would be comparable. Once all the electricity is collected, the power is transferred via a transmission line to the nearest point of connection (POC) to the GPA utility grid.

The PV panels would be approximately 3.5 foot wide and 5 foot long glass-encased, darkly colored to minimize light reflection. The PV panels would be attached to metal racking structures on foundations. The type of racking structure (stationary versus adjustable) would be determined by the PV contractor during the project's final engineering design. See enclosure (5) for examples of the types of racking structures being considered for this project. During site preparation, surface vegetation would be cleared and grubbed, and where load-bearing foundations are proposed, the ground would be excavated and compacted. Ground disturbance would include the installation of the PV racking system on foundations or piers, trenching for underground electrical cables or installation of transmission line poles, power centers with inverters, substations, foundation work for electrical equipment, site buildings, and miscellaneous civil works (i.e., perimeter fencing post holes, typically 4 foot deep, to support a 8-foot high chain link fence enclosure and gates). A new perimeter road and smaller access roads would be constructed to access the solar array in order to maintain the elevated and sloped photovoltaic panels.

**Area of Potential Effect:** The proposed undertakings include the construction and operation of eight (8) PV systems wholly within current DoD property on Guam, encompassing a total of 192 acres. These eight individual project areas constitute the Areas of Potential Effect (APEs) for this undertaking and are depicted on the maps in enclosure (4).

**Identification of Historic Properties**: The proposed project includes construction of eight independent PV systems. However, as described above, the project originally included 11 sites as surveyed by Leppard et. al. (2014), of which three are no longer being considered. The following discussion provides the results of the 11 sites surveyed by Leppard et. al. (2014), including the 8 proposed PV sites; a recommendation of eligibility for any potential archaeological resources identified by Leppard et. al. (2014); and a summary of the previous surveys/investigations.

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Andersen AFB Landfill and Utility Corridor
***This site is no longer under consideration for construction of a PV system.***

Systematic archaeological investigation in the vicinity of the AAFB Landfill and Utility Corridor has been limited and current knowledge of historic resources in the area is correspondingly underdeveloped. Leppard et. al. (2014) is the sole investigation of the utility corridor and no archaeological resources were documented during survey and subsurface testing. Subsurface testing occurred only within the utility corridor, as the project site is an existing landfill and subsurface investigations were not warranted.

Andersen South Lot "A"
***This site is no longer under consideration for construction of a PV system.***

Leppard et. al. (2014) is the first systematic archaeological work undertaken on the Andersen South Lot "A" Site. Two post-WWII features were recorded within the proposed PV site – a bottle dump and the remnants of a metal container. As archaeological sites, neither feature is considered eligible for listing on the NRHP.

South Finegayan Housing
Leppard et. al. (2014) completed a surface survey and subsurface investigations on a 290-acre parcel at this location; however, only 71 acres of the surveyed area are currently being carried forward for a potential PV system. Given its prior use as a housing area, the site has been subject to extensive surface and shallow subsurface disturbance. Leppard et. al. (2014) did not document any archaeological sites within the proposed PV site.

One traditional Chamorro bodysherd (severely abraded) from a coarseware pottery vessel was recovered with no surviving surface treatment. This sherd was located between 0-2 cm below the surfaces and was the only deposit encountered in the unit when it was closed at 60 cm below the surface. The sherd was located within a clay loam fill with occasional small plastic inclusions indicating the sherd had been redeposited from its original position, and is not representative of cultural activity within the immediate vicinity. Excavation continued with the entirety of the deposit sieved with a 1/8-inch screen, but no further cultural material was encountered.

Orote Landfill
***This site is no longer under consideration for construction of a PV system.***

This site has not been subject to previous archaeological investigation. Leppard et. al. (2014) did not identify any archaeological resources during the pedestrian survey and, as the site is a capped landfill, did not complete any subsurface investigations. However, the northern corner of the Landfill intrudes into the boundary for Orote Airfield (Site 66-03-1066), which was listed on the NRHP in 1975.

NBG Existing 250 kW PV Site Expansion
The expansion area for this existing PV site has not been subject to previous archaeological investigations; therefore, Leppard et. al. (2014) represents the first systematic investigation of

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this location. No archaeological sites were identified during the pedestrian survey and subsurface investigation.

Commissary Site

Portions of the Commissary site have been subject to previous investigations by Carucci (1993), Craib and Yoklavich (1996), and Dixon, Walker, and Carson (2011); however, Leppard et. al. (2014) is the first investigation of the western portion of the proposed PV site. Carucci (1993) documented multiple concrete pads (Site TN-8) in the southern component, and Craib and Yoklavich (1996) plotted the northeastern half of what may have been Orote Village (Map No 267) within this parcel. A subsequent study (Dixon, Walker, and Carson, 2011) evaluated the area between Shoreline Drive and Dadi Beach, determining that the construction and subsequent demolition of Camp Bright had disturbed the surface and subsurface sediments such that no intact archaeology remained in the areas immediately adjacent to the project location. Camp Bright extended from Shoreline Drive into the proposed PV Commissary Site; therefore, it is unlikely that intact remnants of the Orote Village extend into this area

Leppard et. al. (2014) did not identify any archaeological sites within the parcel during the pedestrian survey or subsurface testing. Specifically, the subsurface investigations conducted by Leppard et. al. (2014) evaluated the extent of the previously identified concrete pads by Carucci (1993) and the proposed Orote Village area suggested by Craib and Yoklavich (1996). Their investigation did not identify any archaeological findings and primarily encountered sandy fill with some graded limestone, very shallow topsoil, and push berm evidence suggesting anthropogenic degradation. This disturbance is further evidenced by the presence of Shoreline Drive bisecting the proposed Orote Village boundary as defined in the 1996 study. In summary, Leppard et. al. (2014) determined the disturbance was such that no material deriving from the Orote Village remains within the boundary of the proposed Commissary Site. The Navy recommends the boundary of the potential Orote Village, as described by Craib and Yoklavich, be revised to only include the Dadi beach area.

Harmon Annex, Harmon Booster Station, and Tumon Tank Farm

These three sites are located in close proximity to each other (see enclosures 3 and 4) and therefore considered collectively for identification of historic properties. Leppard et. al. (2014) did not identify any archaeological resources on the Harmon Annex or the Tumon Tank Farm. One concrete pad was identified at the Harmon Booster Station; however, this feature lacks integrity characteristics and is not considered significant under any NRHP criteria.

Prior to Leppard et. al. (2014), limited systematic archaeological work has been undertaken at the Harmon Annex site with no reported findings of significance (DeFant 2008). No previous systematic archaeological work has been undertaken on the Harmon Booster Station and Tumon Tank Farm sites.

Waste Water Treatment Plant (WWTP)

A previous pedestrian survey by Hunter-Anderson and Moore (2002) included the Waste Water Treatment Plant as part of a larger survey parcel and no archaeological sites were identified

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within the boundary of the proposed PV system. Leppard et. al. (2014) completed subsurface investigations on the proposed PV location and did not identify any archaeological resources.

CDF Site
A previous survey by Hunter-Anderson and Moore (2002) included the CDF Disposal Area and identified six archaeological sites within the proposed PV boundary. These included one pre-Contact site, a rockshelter containing pottery sherds and marine shell. The prehistoric deposits had been extensively disturbed by WWII use and landfilling, and pre-Contact and historical period materials were found mixed together. One late Pre-Latte sherd and several probable Latte Period sherds were recovered (Hunter-Anderson and Moore 2002:52, 99; Welch et al. 2009:78). Because of the extensive disturbance, this site was not recommended as eligible for the NRHP.

The other five sites are all WWII or post-WWII US military sites (Hunter-Anderson and Moore 2002, Volume 2): a WWII and post war limestone quarry; a complex of post-war military structures, consisting of a main concrete slab, smaller slabs, and associated sidewalks; a post-war military structure, consisting of a T-shaped concrete slab; and two adjacent post-war concrete slabs. None of these sites were determined to be eligible for the NRHP. Site 66-03-1856, immediately north of the proposed PV site, contains a series of post-WWII structures that belonged to Guam Dredging Contractors, who held a contract to dredge the harbor from 1946-1950. The remains consist of concrete slabs, steps, and decorative concrete and rock walls on an artificially terraced slope. Site 66-03-1856 was determined eligible for the NRHP.

Leppard et. al. (2014) completed subsurface investigations on the proposed CDF area and did not identify any archaeological resources. Additionally, Leppard et. al. re-surveyed Site 66-03-1856 and verified that it still retained the integrity and characteristics for eligibility for the NRHP. To avoid the potential for adverse effects to this site, a 30-meter buffer from the proposed undertaking was placed around Site 66-03-1856.

Summary
Leppard et. al. (2014) documented four mid- to late-20th century features within the APE—a bottle dump, remains of a large metal container, and two concrete pads. The bottle dump and remnants of a metal container were recorded within Andersen South Lot "A", and concrete pads were documented within the Harmon Booster Station and South Finegayan parcels. In addition, a single displaced Chamorro pot sherd was recovered from a fill deposit at the South Finegayan parcel. The Navy has determined that none of these features, as archaeological sites, are eligible for listing on the NRHP. In addition, Leppard et. al. (2014) did not locate any architectural resources within the proposed PV sites that are recommended as eligible for listing on the NRHP.

**Determination of Effect:** As indicated above, eight of the eleven areas surveyed in Leppard et. al. (2014) for the construction and operation of PV systems are considered undertakings. For these eight sites Leppard et. al. (2014) documented two mid- to late-20th century concrete pads. The concrete pads were documented within the Harmon Booster Station and South Finegayan parcels. The Navy has determined these sites are not eligible for the NRHP and requests concurrence with that determination. In addition, Leppard et. al. (2014) did not identify any

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architectural resources on the proposed PV sites as eligible for listing on the NRHP and requests concurrence that the Orote Village boundary does not extend onto the Commissary parcel. Leppard et. al. (2014) confirmed the previous investigations at the post-WWII Guam Dredging Contractor complex (Site 66-03-1856) as eligible for the NRHP and the proposed undertaking includes a 30 m buffer between Site 66-03-1856 and the proposed CDF APE.

Based on the factors discussed above, the Navy has made a finding of "no historic properties affected" for the eight (8) undertakings and requests your concurrence. In accordance with 36 CFR 800.5(c)(1), if we receive no response from your office within 30 days of receipt of this letter, the Navy will assume no objections to the determination of effect and eligibility. Should you have any questions, our point of contact is Mr. Lon Bulgrin NAVFAC Marianas, who can be reached by phone at (671) 339-2093, or by e-mail at Lon.Bulgrin@fe.navy.mil.

Sincerely,

MARK BONSAVAGE
Environmental Business Line Coordinator
By Direction of the Commanding Officer

Enclosures: (1) Leppard, T., D. Welch, and T. M. Rieth. 2014. *Archaeological Inventory Survey and Subsurface Testing at Multiple Locations in Support of Navy Renewable Energy Projects on Guam.* Prepared for Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawai'i. International Archaeological Research Institute, Inc. Honolulu.
(2) Letter for Archaeological Feature and Site Re-Location and Assessment at the CDF Area in Support of Navy Renewable Energy Projects on Guam
(3) Location Map
(4) Site Maps
(5) Typical Detail, PV Racking Structures

References:

1. Bulgrin, Lon. 2006. *Subsurface Testing and Documentation for Site No. 66-01-2132, a Japanese World War II Cave, Tamuning, Guam.* Prepared for United Seas Overseas Investment Company. Manuscript on file, International Archaeological Research Institute, Inc., Honolulu.

2. Carucci, James. 1993. *The Archaeology of Orote Peninsula: Phase I and II Archaeological Inventory Survey of Areas Proposed for Projects to Accommodate Relocation of Navy Activities from the Philippines to Guam, Mariana Islands.* With contributions by H. David Tuggle, D. Colt Denfeld, J. Stephen Athens, Jerome V. Ward, and Stephen K. Wickler, and with the assistance of Jolie Liston, Richard K. Olmo, and

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Wendy L. Goodman. Prepared for Belt Collins and Associates. International Archaeological Research Institute, Inc., Honolulu.

3. Craib, John L., and Ann K. Yoklavich. 1996. *Cultural Resources Management Overview Survey, US Naval Activities, Guam Waterfront Annex, Mariana Islands, Territory of Guam*. Prepared for Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawai'i. Ogden Environmental and Energy Services Co., Inc., Honolulu.

4. DeFant, David G. 2008. Early Human Burials from the Naton Beach Site, Tumon Bay, Island of Guam, Mariana Islands. *Journal of Island and Coastal Archaeology* 3:149-153.

5. Dixon, Boyd, Sam Walker, and Mike Carson. 2011. *Cultural Resources Investigations conducted in the Territory of Guam supporting the Joint Guam Build-up Environmental Impact Statement: Final Archaeological Surveys on Guam 2008-2009 at Air Force Barrigada, Proposed Live Fire Training Range, Andersen South, and Naval Base Guam.* Prepared for Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawai'i. TEC, Inc. and Richard Flores Taitano Micronesian Area Research Center, University of Guam.

6. Hunter-Anderson, Rosalind L., and Darlene R. Moore. 2002. *Phase I and Phase II Archaeological Survey at Waterfront Annex and Ordnance Annex, Territory of Guam. Volume I: Narrative*. With contributions by Judith R. Amesbury, Shawn K. Collins, Deborah M. Pearsall, Michael W. Kaschko, Gail M. Murakami, Craig E. Skinner, Jerome V. Ward, and Eleanor F. Wells. Prepared for International Archaeological Research Institute, Inc. and Department of the Navy, Pacific Division, Naval Facilities Engineering

7. Kaschko, Michael W., and David J. Welch. 2002. *Cultural Resources Assessment for Marine Forces Pacific, Andersen South Training Area, Andersen Air Force Base, Mariana Islands, Guam*. Prepared for the Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawai'i. International Archaeological Research Institute, Inc., Honolulu.

8. Lauter-Reinman, Gloria. 1998. *Cultural Resources Management Plan for the Apra Harbor Naval Complex, Guam*. Prepared for Department of the Navy, Pacific Division, Naval Facilities Engineering Command. Ogden Environmental and Energy Services Co., Inc., Honolulu.

9. Moore, Darlene R. 2002. *Guam's Prehistoric Pottery and Its Chronological Sequence*. Prepared for the Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawai'i. Micronesian Archaeological Research Services, Guam, under contract to International Archaeological Research Institute, Inc., Honolulu.

10. Olmo, Richard K., Tina Mangieri, David J. Welch, and Thomas S. Dye. 2000. *Phase II Archaeological Survey and Detailed Recording at Commander, US Forces Marianas (COMNAVMARIANSA) Communication Annex (formerly Naval Computer and*

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*Telecommunications Are Master Station, Western Pacific), Territory of Guam, Mariana Islands*. Prepared for the Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawai'i. International Archaeological Research Institute, Inc., Honolulu.

11. Reinman, Fred M. 1967. *Notes on an Archaeological Survey of Guam, Marianas Islands, 1965-66, Preliminary Report, National Science Foundation Grant 65-662.* Unpublished ms. on file, Department of Anthropology, Field Museum of Natural History, Chicago.

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13. Welch, David J. (Ed.) 2010. *Archaeological Survey and Cultural Resource Studies Conducted in 2007 on the Island of Guam in Support of the Join Guam Build-Up Environmental Impact Statement*. 2 volumes Prepared for the Department of the Navy, Pacific Division, Naval Facilities Engineering Command, Pearl Harbor, Hawai'i. International Archaeological Research Institute, Inc., Honolulu.

Copy to:
NAVFAC MAR PWD (L. Bulgrin)
Anderson AFB EV (W. Arnold)
NAVFAC PAC EV21 (C. Chang)

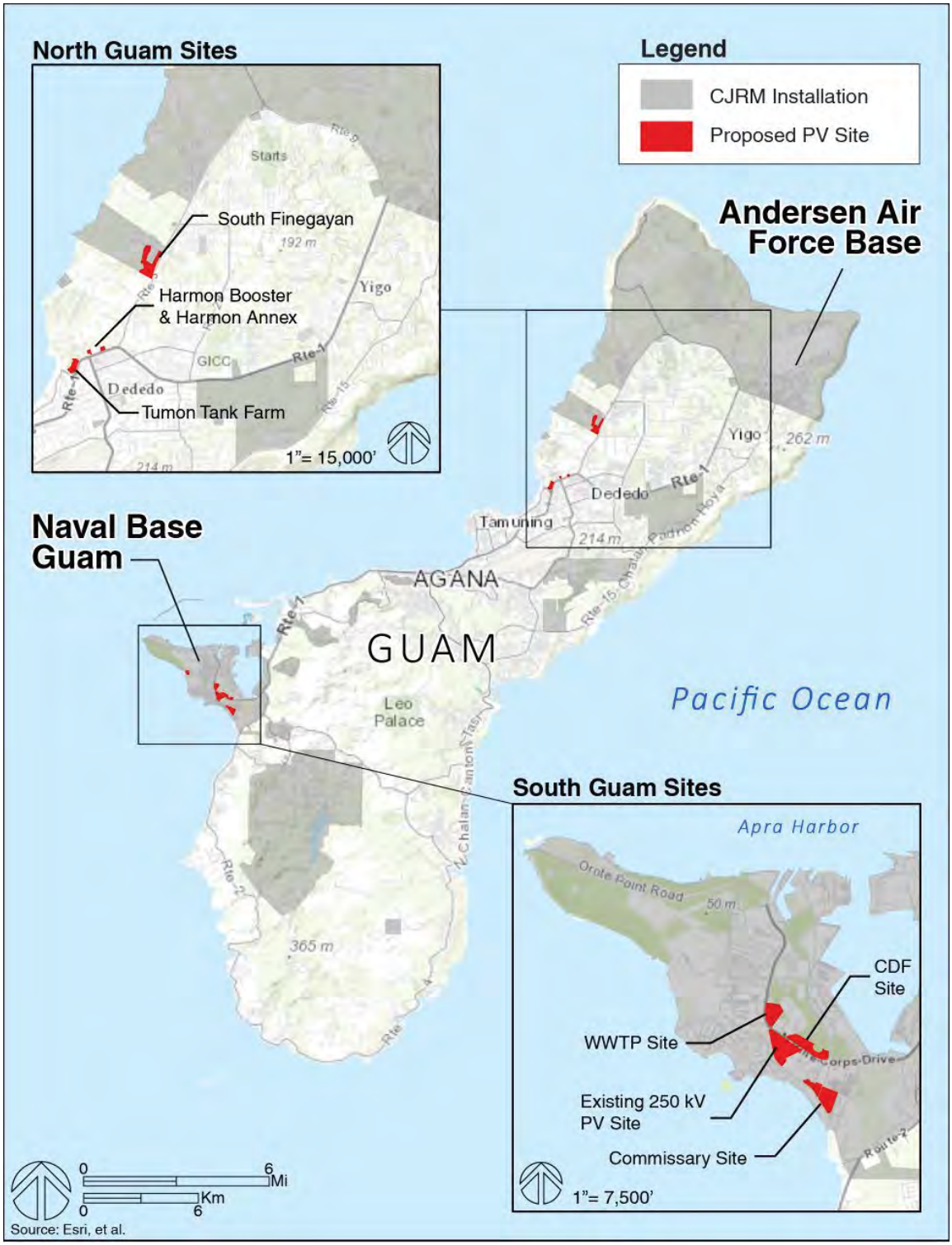
Enclosure 1: Archaeological Inventory Survey and Subsurface Testing at Multiple Locations in Support of Navy Renewable Energy Projects on Guam

**Per National Historic Preservation Act Section 304 this enclosure is not provided**

Enclosure 2: Letter for Archaeological Feature and Site Re-Location and Assessment at the CDF Area in Support of Navy Renewable Energy Projects on Guam

**Per National Historic Preservation Act Section 304 this enclosure is not provided**

Enclosure 3: Site Overview Map



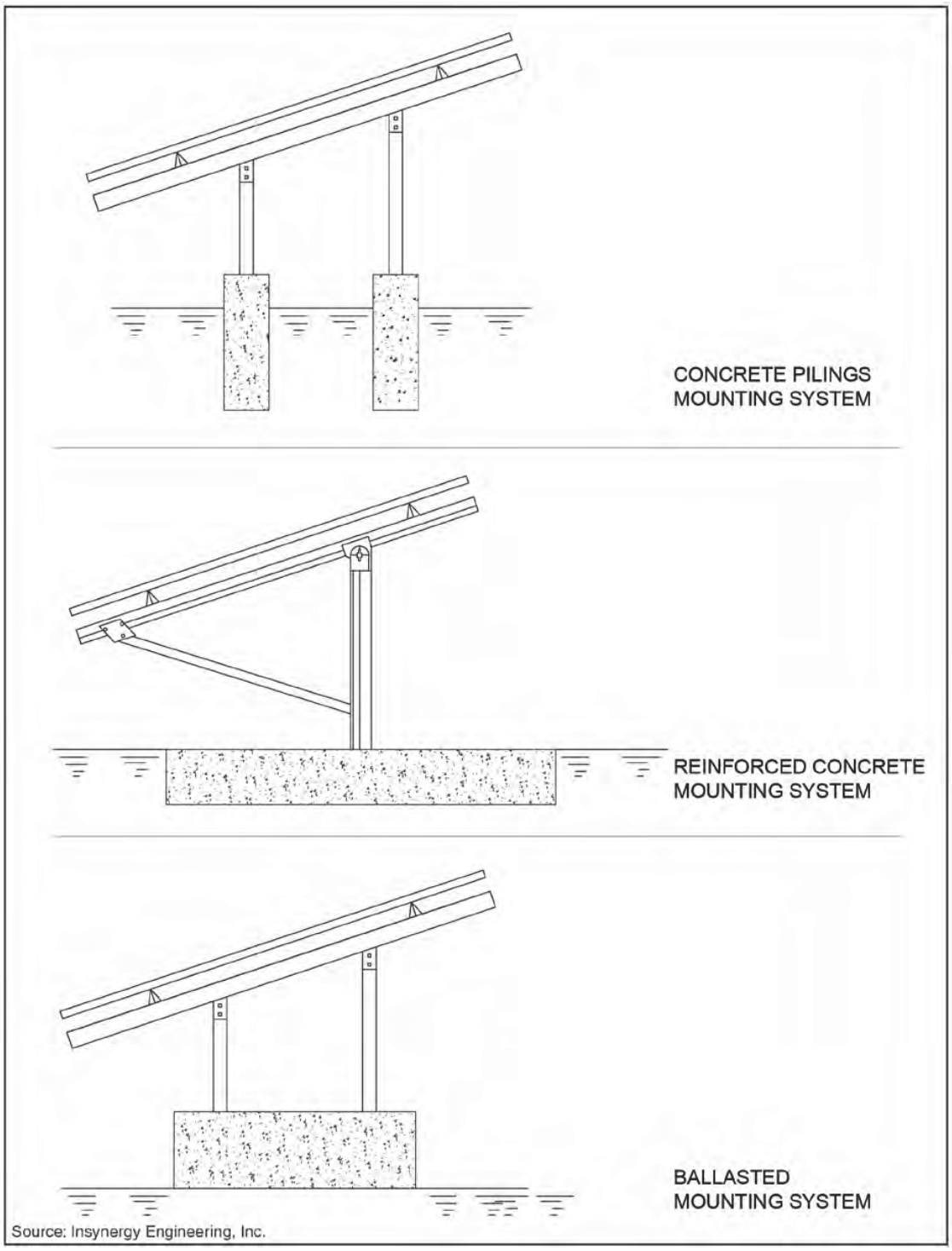
Enclosure 4: Location Maps


LEGEND
Point of Connection
Existing GPA 34.5kV Transmission Line
Proposed Connection Transmission Line
Site Boundary / 8' Perimeter Fence
Perimeter Access Road
PV Array
Substation Complex
GPA Orote Substation
POC 1
POC 2
Access Gate
Somay Drive
CDF Site
Existing 250 kV PV Site
Wastewater Treatment Plant
Wastewater Treatment Plant Site
Marine Corps Drive
Shoreline Drive
Access Gate
Access Gate
Imagery source: Digital Globe Worldview 2, 2011
0
600
Feet
0
150
Meters


Exchange Road
Project Substation
POC
Access Gates
Commissary Site
Shoreline Drive
Agat Bay
LEGEND
Point of Connection
Existing GPA 34.5kV Transmission Line
Proposed Connection Transmission Line
Site Boundary / 8' Perimeter Fence
Perimeter Access Road
PV Array
Substation Complex
0
400
Feet
0
100
Meters
Imagery source: Digital Globe Worldview 2, 2011


GPA Harmon Substaion
Harmon Annex
Access Gates
Marine Corps Drive
Mall of Micronesia
Army Drive
Harmon Booster Station
Access Gate
Tumon Tank Farm
Marine Corps Drive
LEGEND
Point of Connection
Existing GPA 34.5kV Transmission Line
Proposed Connection Transmission Line
Site Boundary / 8' Perimeter Fence
Perimeter Access Road
PV Array
Substation Complex
PV/BESS Facility
0 600 Feet
0 150 Meters
Imagery source: Digital Globe Worldview 2, 2011

Enclosure 5. Racking Structures



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# Appendix B

## CZMA Correspondence

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DEPARTMENT OF THE NAVY
NAVAL FACILITIES ENGINEERING COMMAND MARIANAS
PSC 455, BOX 195
FPO AP 96540-2937

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Ms. Lorilee T. Crisotomo
Director
Bureau of Statistics and Plans
P.O. Box 2950
Hagatna, Guam 96932

Subject: NEGATIVE DETERMINATION FOR THE PROPOSED INSTALLATION AND OPERATION OF PHOTOVOTAIC SYSTEMS AT EIGHT SITES ON GUAM

Dear Ms. Crisostomo,

The Navy proposes a federal agency activity at eight (8) sites located on federally-owned lands. The Navy determined that the proposed federal activity is a development project outside of Guam's defined coastal zone. This letter provides documentation that the Navy has determined that the proposed activity would not have foreseeable coastal effects to Guam's defined coastal zone per 15 CFR 930, §930.35.

The Navy proposes to lease up to 192 acres of DoD land, on eight separate sites, to Guam Power Authority (GPA) to construct and operate solar photovoltaic (PV) systems producing up to 43.8 MW (direct current [DC]) of solar-generated energy for transmission to the GPA electrical grid. Specifically, GPA would then select a renewable energy contractor to develop eight (8) PV sites: South Finegayan, the existing 250 kilowatt PV site, Commissary Site, Harmon Annex, Harmon Booster Station, Tumon Tank Farm, Wastewater Treatment Plant area, and the Confined Disposal Facility (CDF) Site) (see enclosures 1 and 2). It should be noted that the potential exists for the Harmon Annex and Booster Station sites to also be used for Battery Energy Storage Systems (BESS).

The land underlying the PV sites would be leased for 37 years after which time the lease may be renewed or the facilities would be decommissioned. As a statutory requirement of the lease agreement, the Navy will receive in-kind consideration for the leased property. It is intended that this consideration will address the energy security at Naval Base Guam and Andersen Air Force Base through surveys, studies, repair, replacement, or upgrades (or a combination thereof) of the existing electrical distribution systems; distribution system controls to provide the installations with direct access to the renewable generation asset; or other energy conservation measures and maintenance to existing infrastructure at the installations. While the specific scope of the in-kind consideration will be determined through lease negotiation, it is anticipated that these activities would occur within the existing infrastructure or distribution system footprints

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such that no new potential for impact to the Guam Coastal Zone are anticipated. Once the specific considerations are identified, a new review process will be completed to determine if these considerations would have the potential to affect the Guam Coastal Zone.

The purpose of the proposed action is to reduce energy costs and fuel oil dependency, and increase the energy security, operational capability, strategic flexibility and resource availability of DoN installations through the development of renewable energy generating assets on Guam. The proposed action is required to meet the renewable energy standards put forth by the 1 GW Initiative, EPAct, 10 U.S.C. 2911(e), the 2013 presidential memorandum, and SECNAV, to include the requirement to produce 50 percent of DoN's shore-based energy requirements from alternative sources.

Solar PV panels utilize a packaged assembly of solar cells to harness solar energy (photons) from the sun and generate electricity. The system includes inverters, mounted on concrete pads located throughout the PV array, with its own medium voltage transformer which transmits the power to the PV system's on-site substation. Each PV system may include some type of battery energy storage system (BESS) to balance fluctuations in energy generation caused by weather, seasons, and nighttime darkness. The BESS is located onsite near the PV system's substation. If the two Harmon sites are pursued for BESS without on-site PV, the configuration and components would be comparable. Once all the electricity is collected, the power is transferred via a transmission line to the nearest point of connection (POC) to the GPA utility grid.

The PV panels would be approximately 3.5 foot wide and 5 foot long glass-encased, darkly colored to minimize light reflection. The PV panels would be attached to metal racking structures on foundations. The type of racking structure (stationary versus adjustable) would be determined by the PV contractor during the project's final engineering design. See enclosure (3) for examples of the types of racking structures being considered for this project. During site preparation, surface vegetation would be cleared and grubbed, and where load-bearing foundations are proposed, the ground would be excavated and compacted. Ground disturbance would include the installation of the PV racking system on foundations or piers, trenching for underground electrical cables or installation of transmission line poles, power centers with inverters, substations, foundation work for electrical equipment, site buildings, and miscellaneous civil works (i.e., perimeter fencing post holes, typically 4' deep, to support a 8-foot high chain link fence enclosure and gates.) A new perimeter road and smaller access roads would be constructed to access the solar array in order to maintain the elevated and sloped photovoltaic panels.

The Navy is preparing an Environmental Assessment and has completed an "effects" test per 15 CFR Part 930 §930.33(a)(1). The Navy assessed reasonably foreseeable direct and indirect effects on Guam's coastal use or resources, reviewed relevant management program enforceable policies, and determined that the project does not have foreseeable coastal effects to Guam's defined coastal zone per 15 CFR 930, §930.35. This notification of negative determination is based on:

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1. The proposed federal activity is located entirely within federal property that by definition is excluded from Guam's coastal zone per 15 CFR 923, §923.33(a), and would not result in spillover effects extending into Guam's coastal zone per 15 CFR 923, §923(b).

2. For the four (4) projects in Southern Guam (see Enclosure 1), the nearest coastal zone is located approximately 3,000 ft (914 m) southeast of the nearest proposed federal activities (Commissary Site). For the four (4) projects in Northern Guam (see Enclosure 1), the nearest coastal zone is immediately adjacent to the proposed sites as these locations share boundaries with non-federal property, which are part of the Coastal Zone per 15 CFR 930, §930.35. However, none of the proposed activities at these locations would spill-over to the adjacent parcels. See Enclosure (2).

3. The proposed federal development is consistent with existing land uses as military mission support.

4. The use of Best Management Practices, such as use of silt containment devises during construction; development of a contingency plan to control and contain spills; daily inspections of equipment for cleanliness and leaks; and implementation of dust suppression measures on all temporary roadways and dump trucks.

5. The proposed activities are similar to previous Navy activities that have been determined to have no coastal effects.

If no response is received from your office within 60 days, the Navy shall presume concurrence with the negative determination per 16 CFR §930.35(c). If you have questions or require additional information about the proposed project, please contact the Kevin Brindock by e-mail at kevin.brindock@fe.navy.mil.

Sincerely,

MARK BONSAVAGE
Environmental Business Line Coordinator
By Direction of the Commanding Officer

Enclosures: (1) Site Overview Map
(2) Location Maps
(3) Racking Structures

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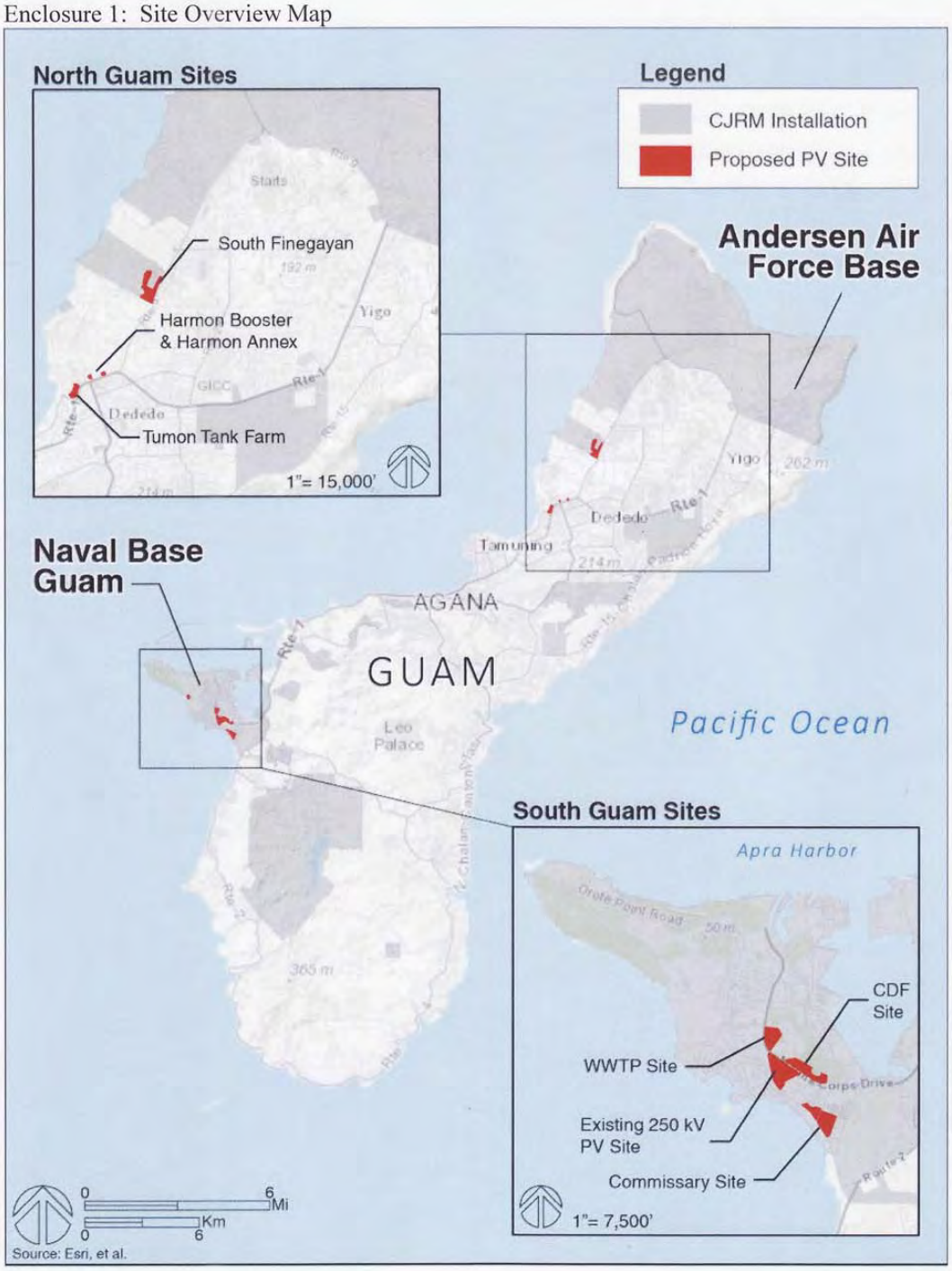
Enclosure 1: Site Overview Map



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Enclosure 2: Location Maps

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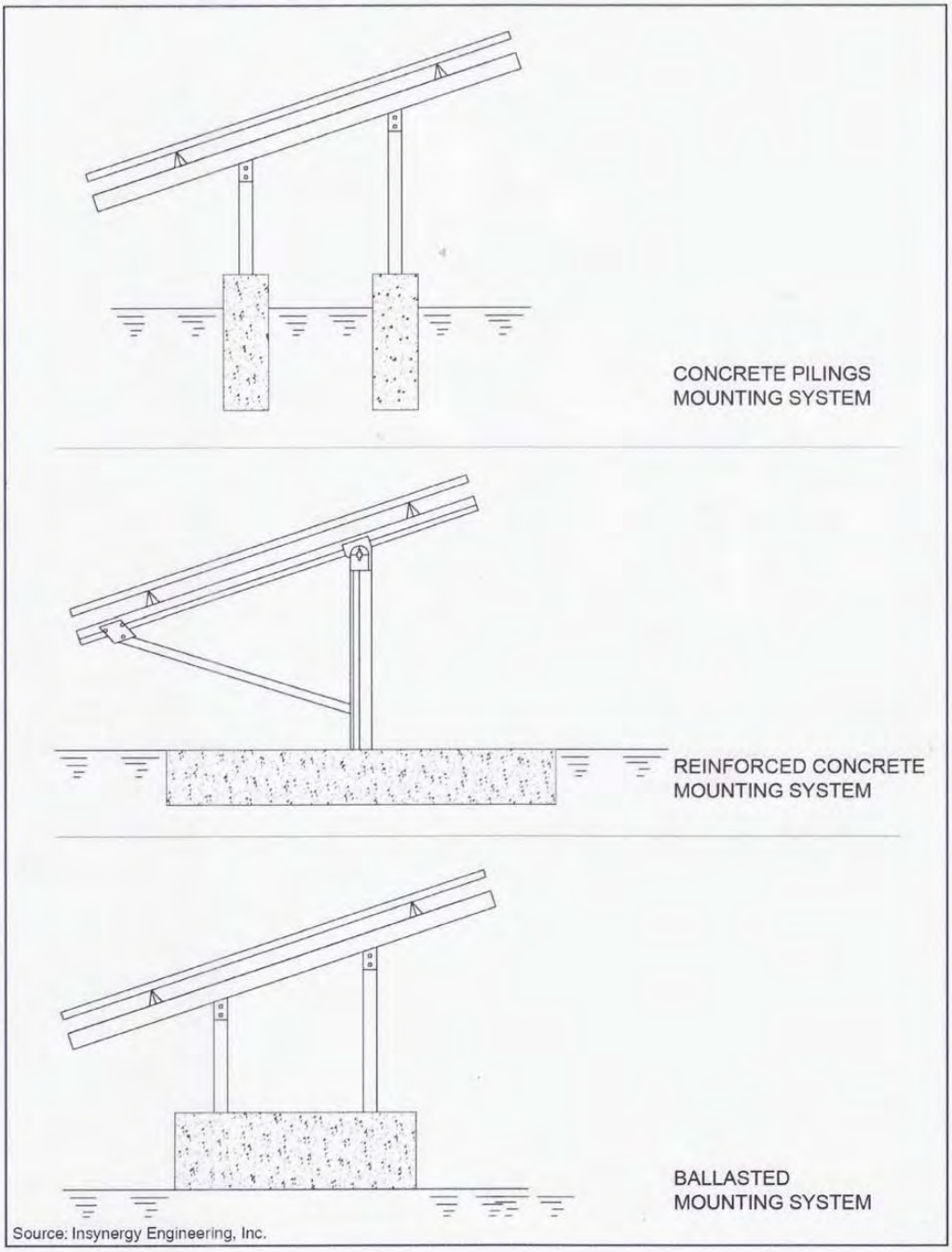
Enclosure 3. Racking Structures




Source: Insynergy Engineering, Inc.

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# Appendix C

## SGHAT Glint and Glare Analysis

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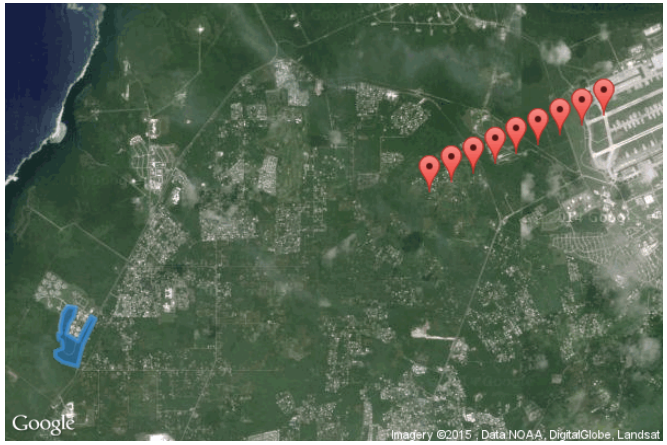
# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 14, 2015, 3:40 p.m.

## Flight path: AAFB 6L

## Glare found

Print








## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | AAFB. **south. finegayan** |
| PV array axis tracking | none |
| Orientation of array (deg) | 150.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 66.2 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5495476799 | 144.836035967 | 372.43 | 4.0 | 376.43 |
| 2 | 13.5499231678 | 144.835349321 | 366.07 | 4.0 | 370.07 |
| 3 | 13.5476285102 | 144.834018946 | 344.38 | 4.0 | 348.38 |
| 4 | 13.5461682621 | 144.833289385 | 347.06 | 4.0 | 351.06 |
| 5 | 13.547232158 | 144.831508398 | 333.74 | 4.0 | 337.74 |
| 6 | 13.5487341207 | 144.831851721 | 331.03 | 4.0 | 335.03 |
| 7 | 13.5499023073 | 144.832645655 | 340.84 | 4.0 | 344.84 |
| 8 | 13.5512790914 | 144.83296752 | 344.32 | 4.0 | 348.32 |
| 9 | 13.5514876943 | 144.831701517 | 330.1 | 4.0 | 334.1 |
| 10 | 13.5504655381 | 144.830950499 | 331.52 | 4.0 | 335.52 |
| 11 | 13.5483377704 | 144.830521345 | 331.53 | 4.0 | 335.53 |
| 12 | 13.5473364613 | 144.830585718 | 327.88 | 4.0 | 331.88 |
| 13 | 13.54729474 | 144.830156565 | 332.37 | 4.0 | 336.37 |
| 14 | 13.5463768695 | 144.830263853 | 315.4 | 4.0 | 319.4 |
| 15 | 13.5462517051 | 144.830735922 | 314.8 | 4.0 | 318.8 |
| 16 | 13.5450626397 | 144.830886126 | 314.89 | 4.0 | 318.89 |
| 17 | 13.5446037006 | 144.829705954 | 319.6 | 4.0 | 323.6 |
| 18 | 13.5437692635 | 144.829770327 | 320.02 | 4.0 | 324.02 |
| 19 | 13.5429556846 | 144.83084321 | 330.42 | 4.0 | 334.42 |
| 20 | 13.5423298528 | 144.833225012 | 337.2 | 4.0 | 341.2 |





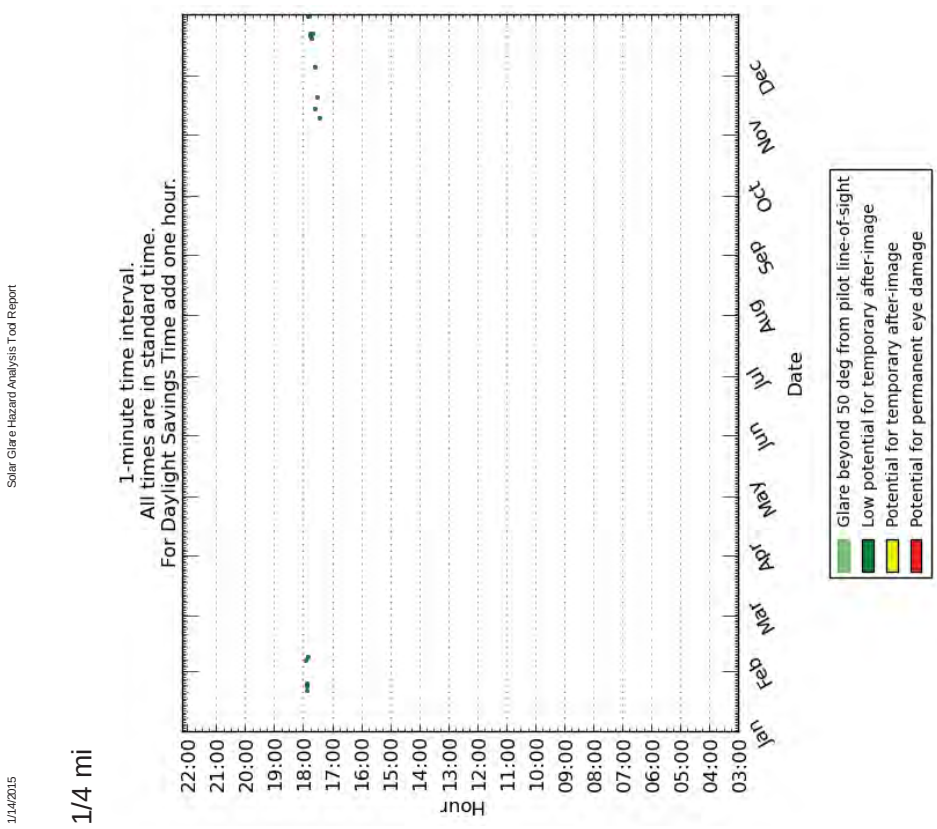
| | | | | | |
|---|---|---|---|---|---|
| 21 | 13.5454172738 | 144.834018946 | 352.49 | 4.0 | 356.49 |

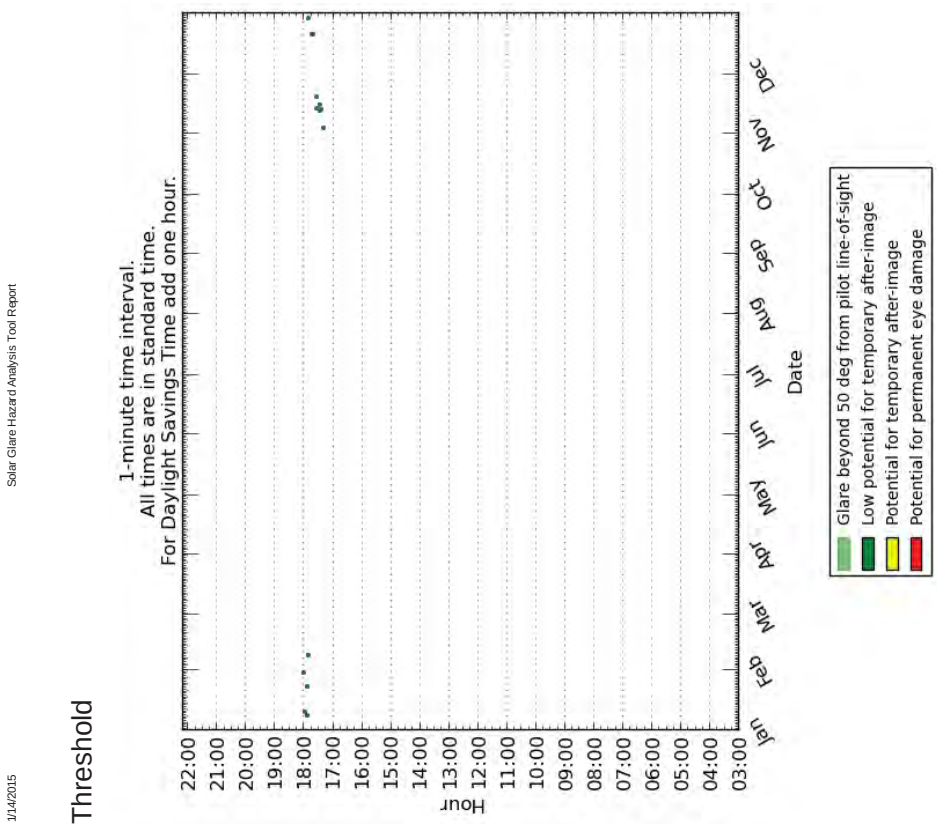
## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.5803670034 | 144.915637225 | 530.11 | 50.0 | Yes |
| 1/4 mi | 13.5789086942 | 144.912231715 | 526.63 | 122.64 | Yes |
| 1/2 mi | 13.577450385 | 144.908826204 | 490.92 | 227.55 | Yes |
| 3/4 mi | 13.5759920758 | 144.905420694 | 505.34 | 282.29 | Yes |
| 1 mi | 13.5745337666 | 144.902015184 | 523.62 | 333.19 | Yes |
| 1 1/4 mi | 13.5730754574 | 144.898609674 | 550.42 | 375.58 | Yes |
| 1 1/2 mi | 13.5716171481 | 144.895204163 | 596.06 | 399.11 | Yes |
| 1 3/4 mi | 13.5701588389 | 144.891798653 | 599.62 | 464.74 | Yes |
| 2 mi | 13.5687005297 | 144.888393143 | 584.03 | 549.51 | Yes |

## Glare occurrence plots

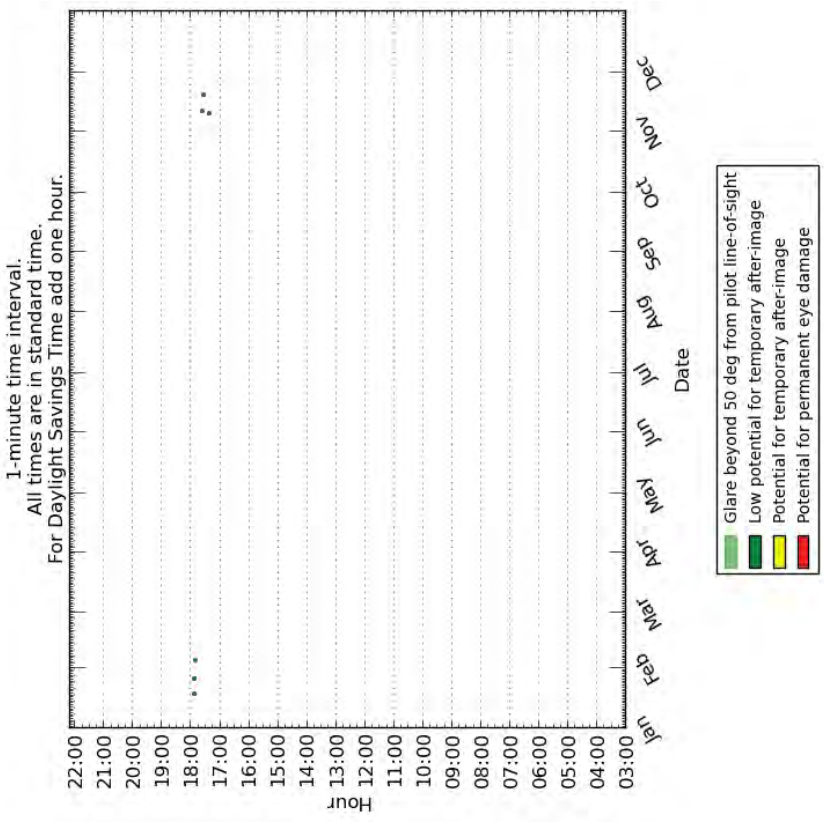
All times are in standard time. For Daylight Savings Time add one hour.


1/14/2015
Solar Glare Hazard Analysis Tool Report
1/4 mi
1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
Hour
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage
https://share.sandia.gov/phlux/sghat/
6/14


1/14/2015
Solar Glare Hazard Analysis Tool Report
Threshold
1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
Hour
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage
https://share.sandia.gov/phlux/sghat/
5/14

1/14/2015 Solar Glare Hazard Analysis Tool Report

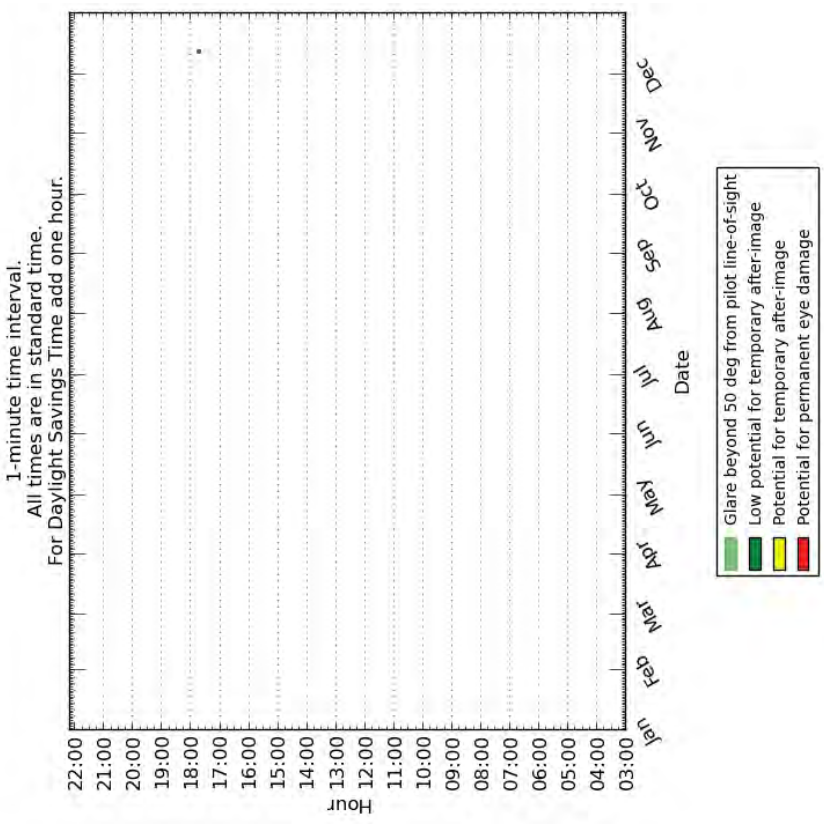
1/2 mi




https://share.sandia.gov/phlux/sghat/ 7/14

1/14/2015 Solar Glare Hazard Analysis Tool Report

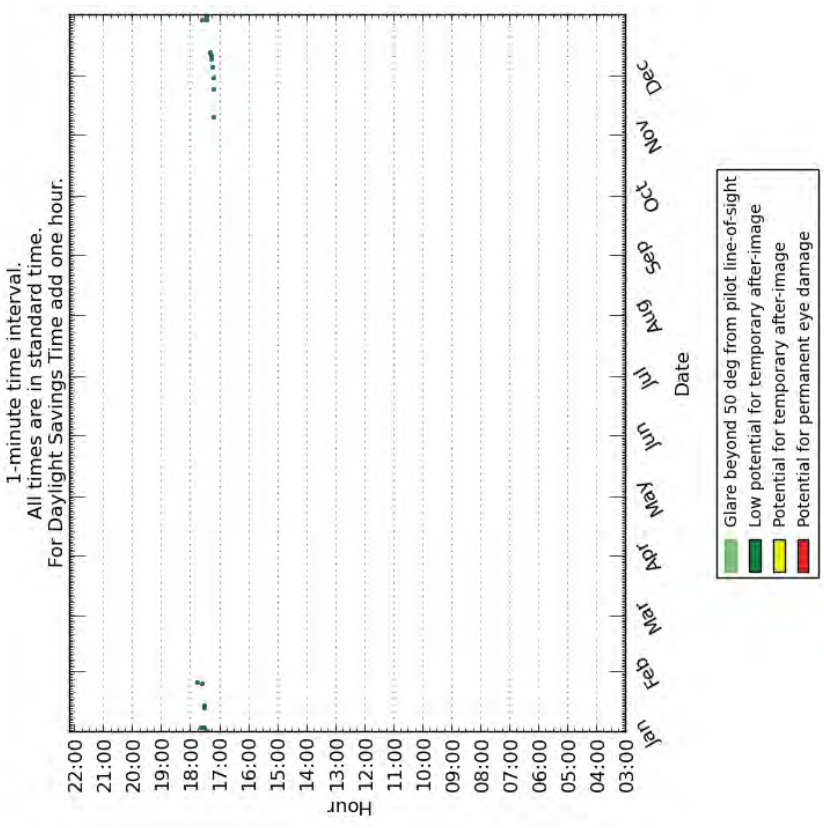
3/4 mi




https://share.sandia.gov/phlux/sghat/ 8/14

1/14/2015 Solar Glare Hazard Analysis Tool Report

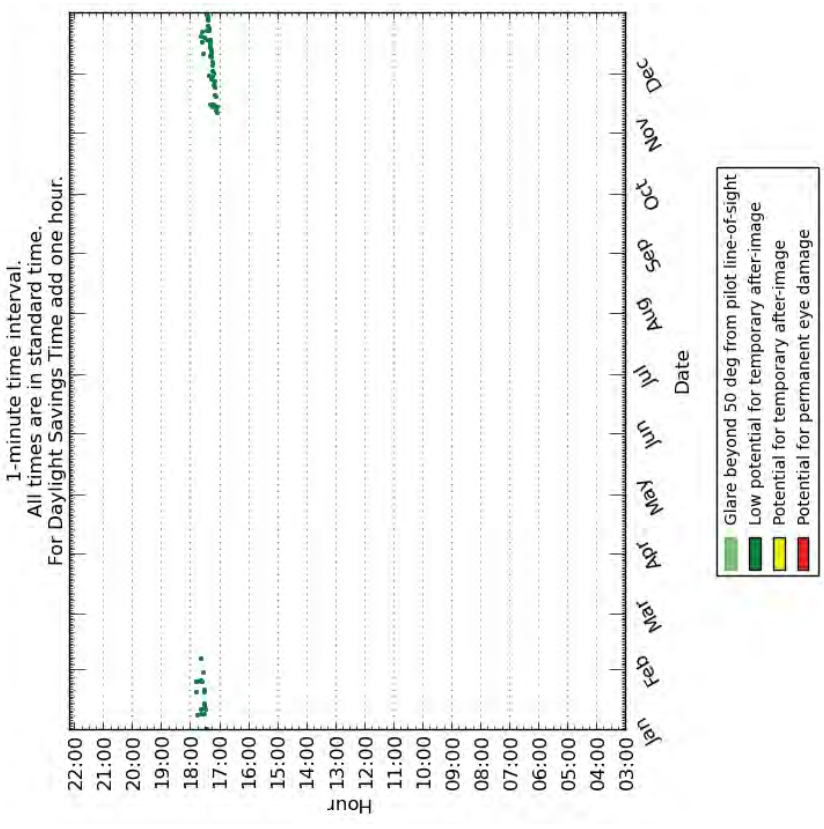
1 mi



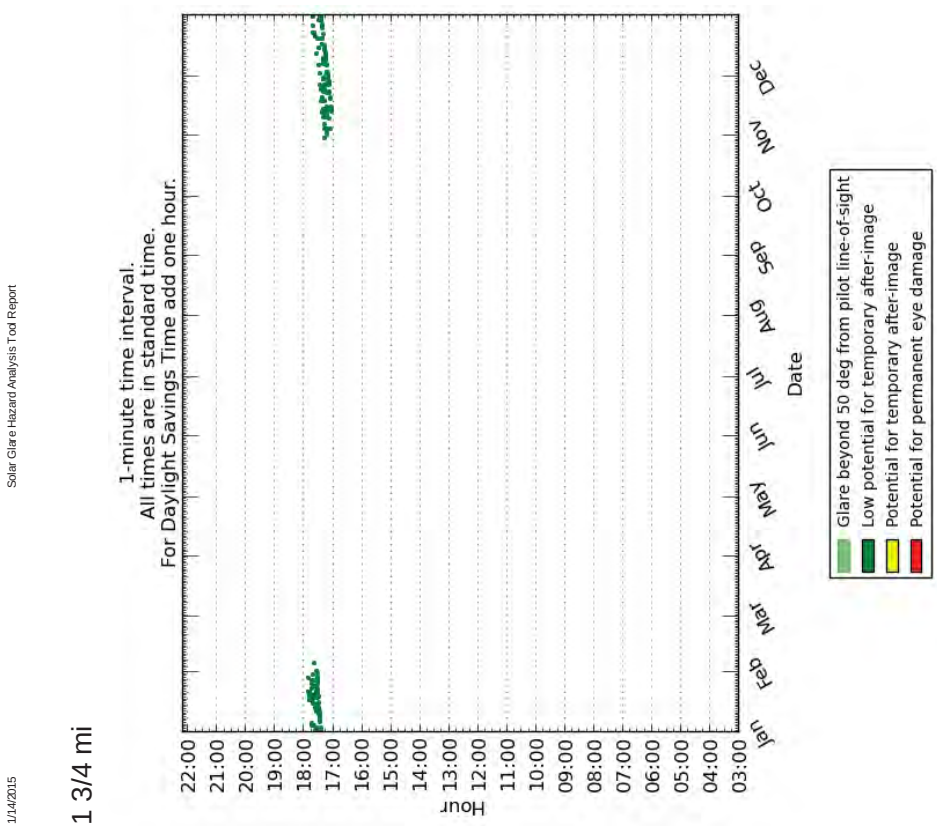

https://share.sandia.gov/phlux/sghat/ 9/14

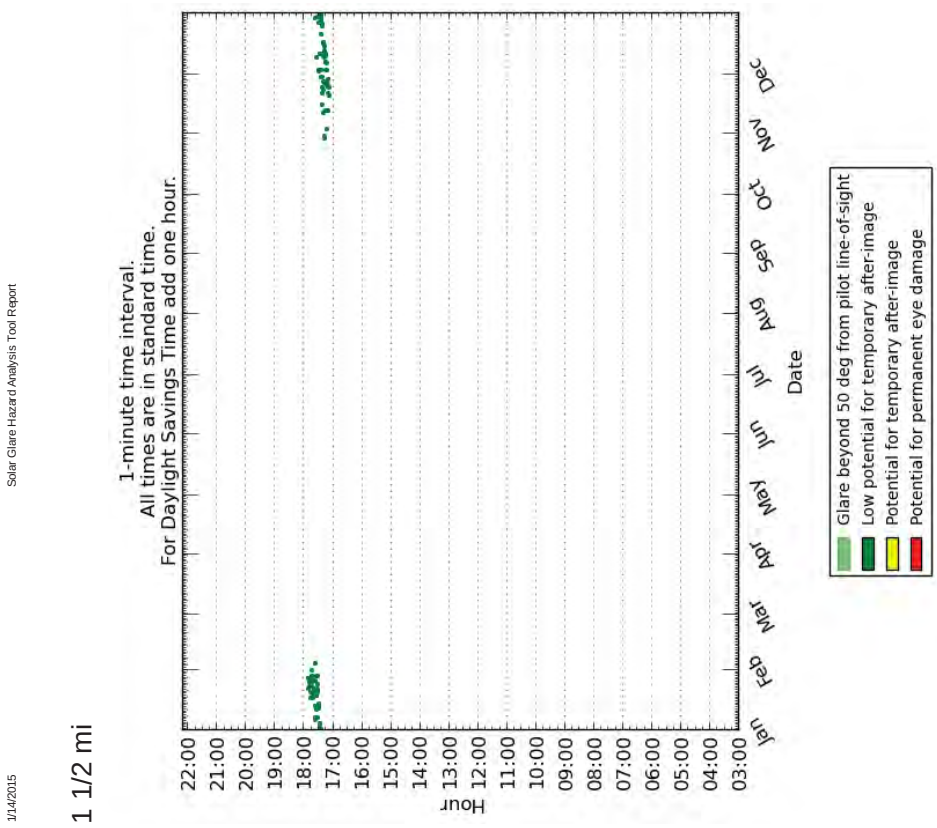
1/14/2015 Solar Glare Hazard Analysis Tool Report

1 1/4 mi

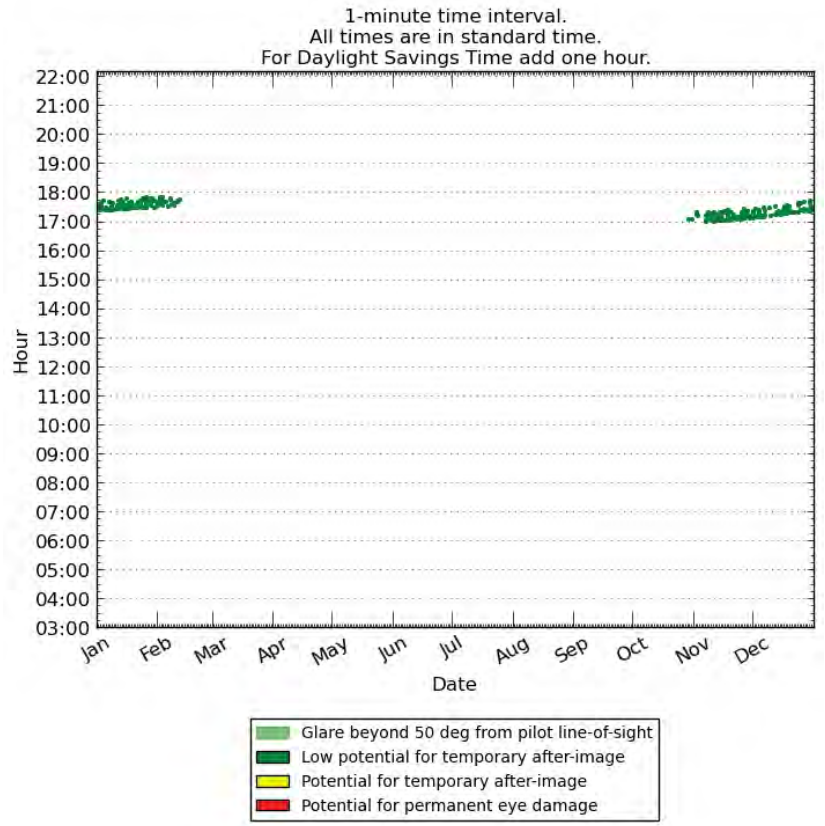



https://share.sandia.gov/phlux/sghat/ 10/14


1/14/2015
Solar Glare Hazard Analysis Tool Report
1 3/4 mi
1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
Hour
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage
12/14
https://share.sandia.gov/phlux/sghat/


1/14/2015
Solar Glare Hazard Analysis Tool Report
1 1/2 mi
1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
Hour
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage
11/14
https://share.sandia.gov/phlux/sghat/

2 mi










# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 14, 2015, 3:40 p.m.

## Flight path: AAFB 6R

## Glare found

Print

# Analysis & PV array parameters

| | |
|---|---|
| Analysis name | AAFB**. south. finegayan** |
| PV array axis tracking | none |
| Orientation of array (deg) | 150.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

# Flight path parameters

| | |
|---|---|
| Direction (deg) | 66.2 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





# PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5495476799 | 144.836035967 | 372.43 | 4.0 | 376.43 |
| 2 | 13.5499231678 | 144.835349321 | 366.07 | 4.0 | 370.07 |
| 3 | 13.5476285102 | 144.834018946 | 344.38 | 4.0 | 348.38 |
| 4 | 13.5461682621 | 144.833289385 | 347.06 | 4.0 | 351.06 |
| 5 | 13.547232158 | 144.831508398 | 333.74 | 4.0 | 337.74 |
| 6 | 13.5487341207 | 144.831851721 | 331.03 | 4.0 | 335.03 |
| 7 | 13.5499023073 | 144.832645655 | 340.84 | 4.0 | 344.84 |
| 8 | 13.5512790914 | 144.83296752 | 344.32 | 4.0 | 348.32 |
| 9 | 13.5514876943 | 144.831701517 | 330.1 | 4.0 | 334.1 |
| 10 | 13.5504655381 | 144.830950499 | 331.52 | 4.0 | 335.52 |
| 11 | 13.5483377704 | 144.830521345 | 331.53 | 4.0 | 335.53 |
| 12 | 13.5473364613 | 144.830585718 | 327.88 | 4.0 | 331.88 |
| 13 | 13.54729474 | 144.830156565 | 332.37 | 4.0 | 336.37 |
| 14 | 13.5463768695 | 144.830263853 | 315.4 | 4.0 | 319.4 |
| 15 | 13.5462517051 | 144.830735922 | 314.8 | 4.0 | 318.8 |
| 16 | 13.5450626397 | 144.830886126 | 314.89 | 4.0 | 318.89 |
| 17 | 13.5446037006 | 144.829705954 | 319.6 | 4.0 | 323.6 |
| 18 | 13.5437692635 | 144.829770327 | 320.02 | 4.0 | 324.02 |
| 19 | 13.5429556846 | 144.83084321 | 330.42 | 4.0 | 334.42 |
| 20 | 13.5423298528 | 144.833225012 | 337.2 | 4.0 | 341.2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 21 | 13.5454172738 | 144.834018946 | 352.49 | 4.0 | 356.49 | |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.5753298037 | 144.916500896 | 547.63 | 50.0 | Yes |
| 1/4 mi | 13.5738714945 | 144.913095458 | 559.89 | 106.92 | Yes |
| 1/2 mi | 13.5724131853 | 144.90969002 | 523.25 | 212.75 | Yes |
| 3/4 mi | 13.5709548761 | 144.906284582 | 501.74 | 303.43 | Yes |
| 1 mi | 13.5694965669 | 144.902879144 | 580.27 | 294.07 | Yes |
| 1 1/4 mi | 13.5680382577 | 144.899473706 | 599.31 | 344.22 | Yes |
| 1 1/2 mi | 13.5665799485 | 144.896068268 | 588.27 | 424.43 | Yes |
| 1 3/4 mi | 13.5651216393 | 144.89266283 | 615.54 | 466.35 | Yes |
| 2 mi | 13.5636633301 | 144.889257392 | 586.71 | 564.35 | Yes |

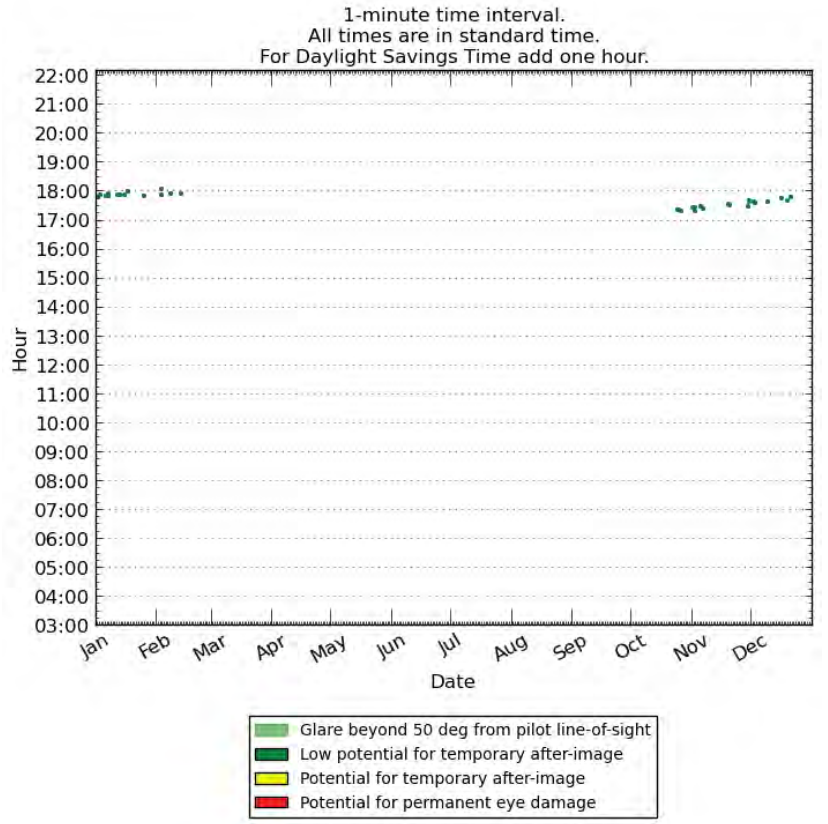
## Glare occurrence plots

All times are in standard time. For Daylight Savings Time add one hour.



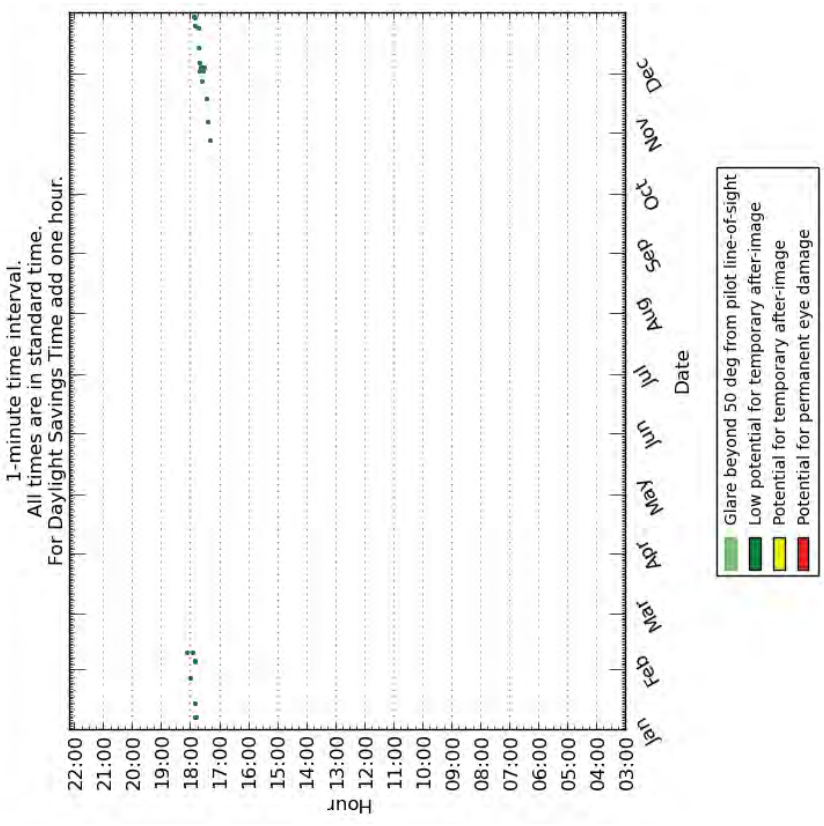


### Threshold



1/14/2015 Solar Glare Hazard Analysis Tool Report

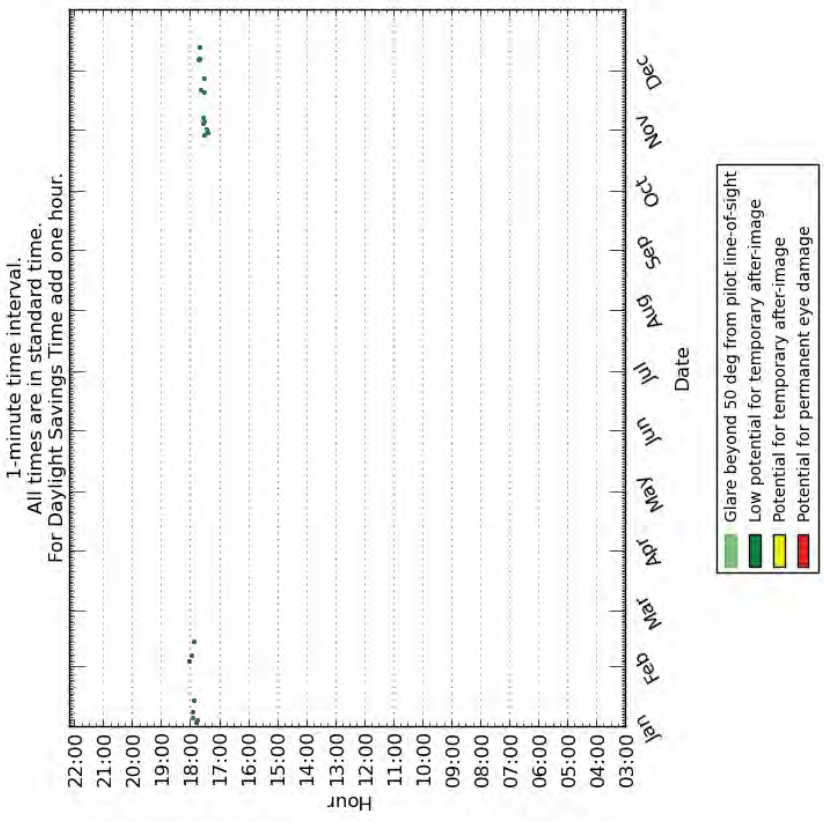
1/4 mi




https://share.sandia.gov/phlux/sghat/ 6/14

1/14/2015 Solar Glare Hazard Analysis Tool Report

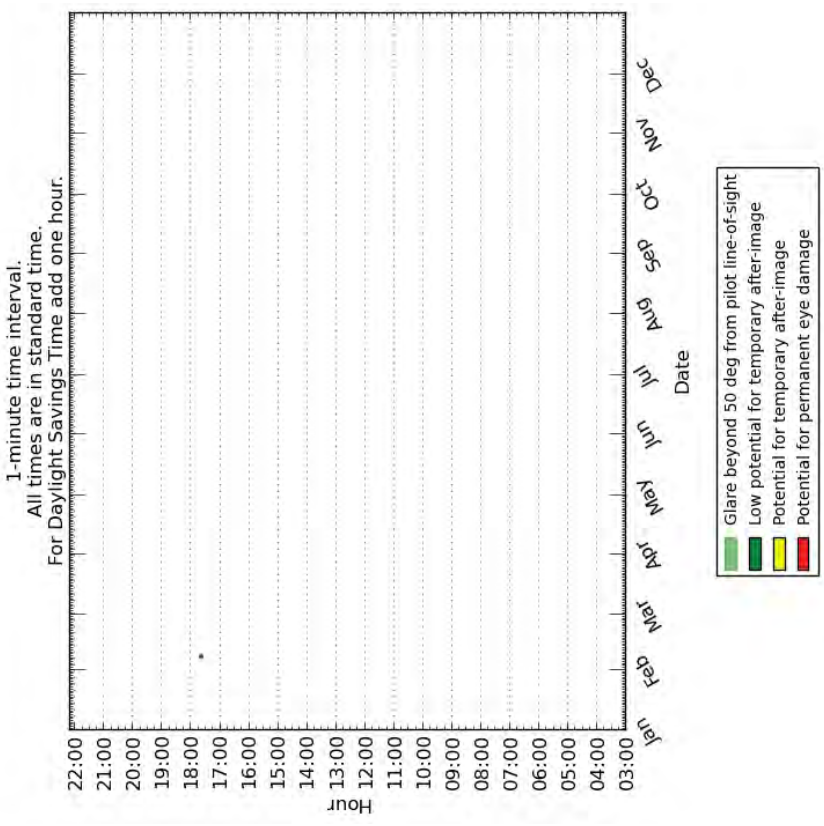
1/2 mi




https://share.sandia.gov/phlux/sghat/ 7/14

1/14/2015 Solar Glare Hazard Analysis Tool Report

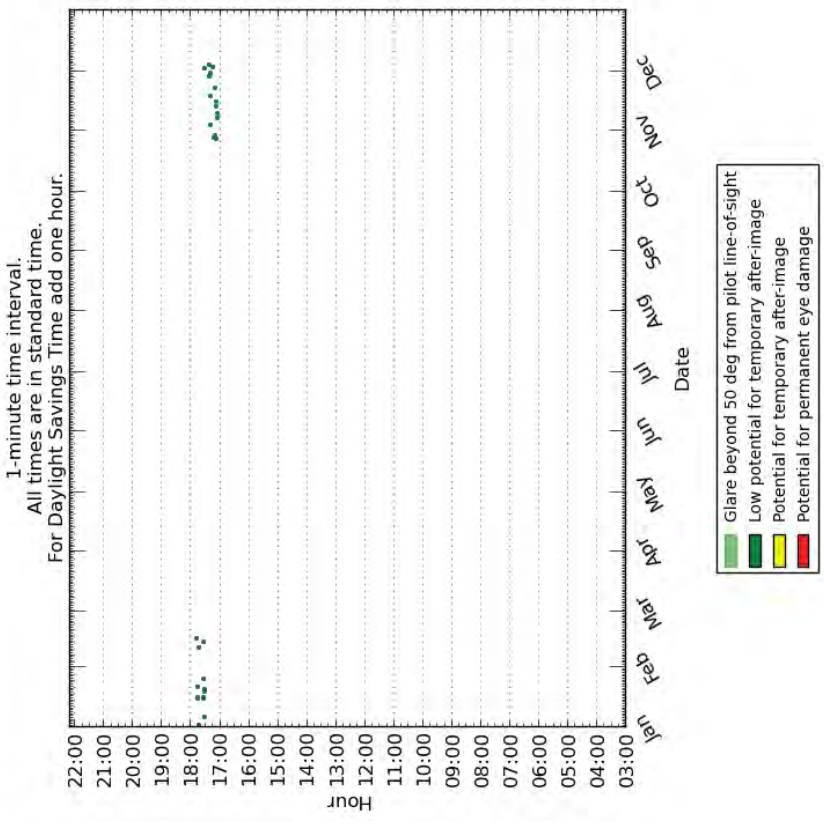
3/4 mi




https://share.sandia.gov/phlux/sghat/ 8/14

1/14/2015 Solar Glare Hazard Analysis Tool Report

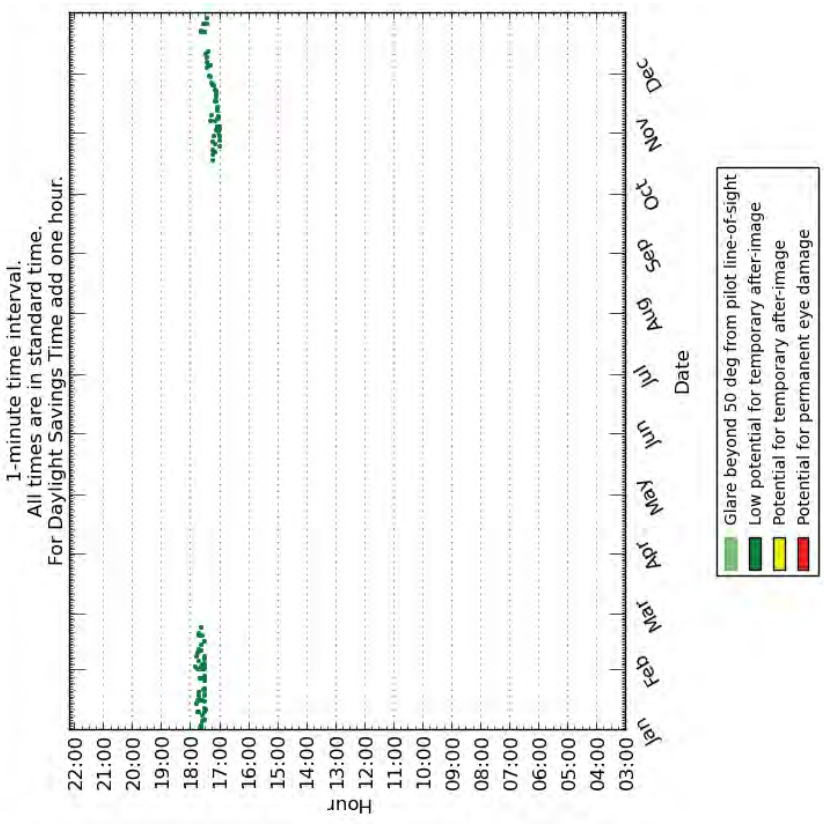
1 mi




https://share.sandia.gov/phlux/sghat/ 9/14

1/14/2015 Solar Glare Hazard Analysis Tool Report

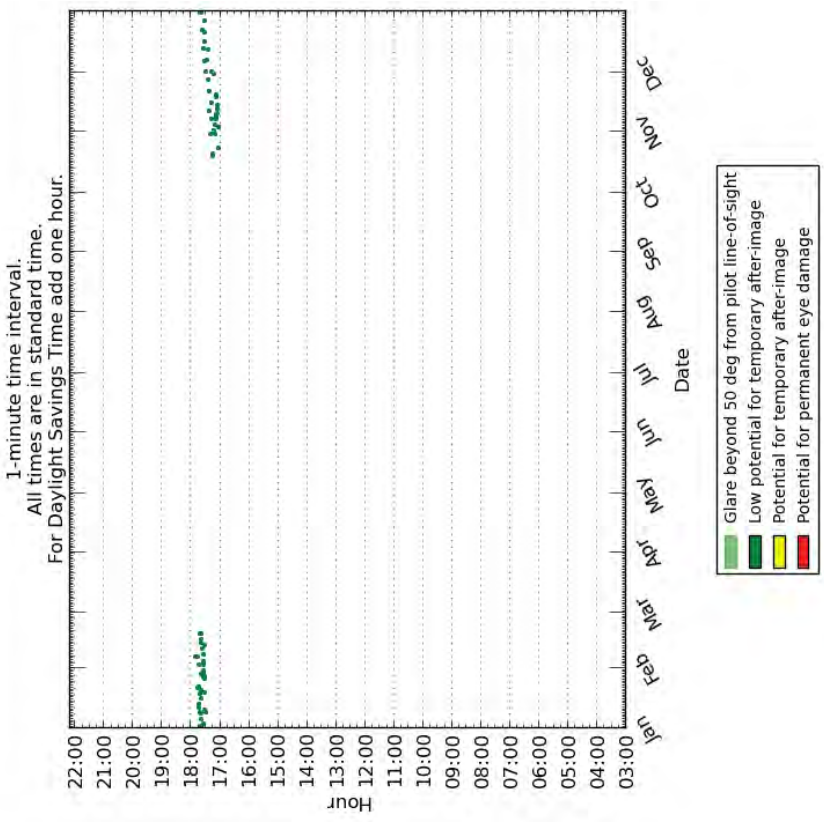
1 1/2 mi



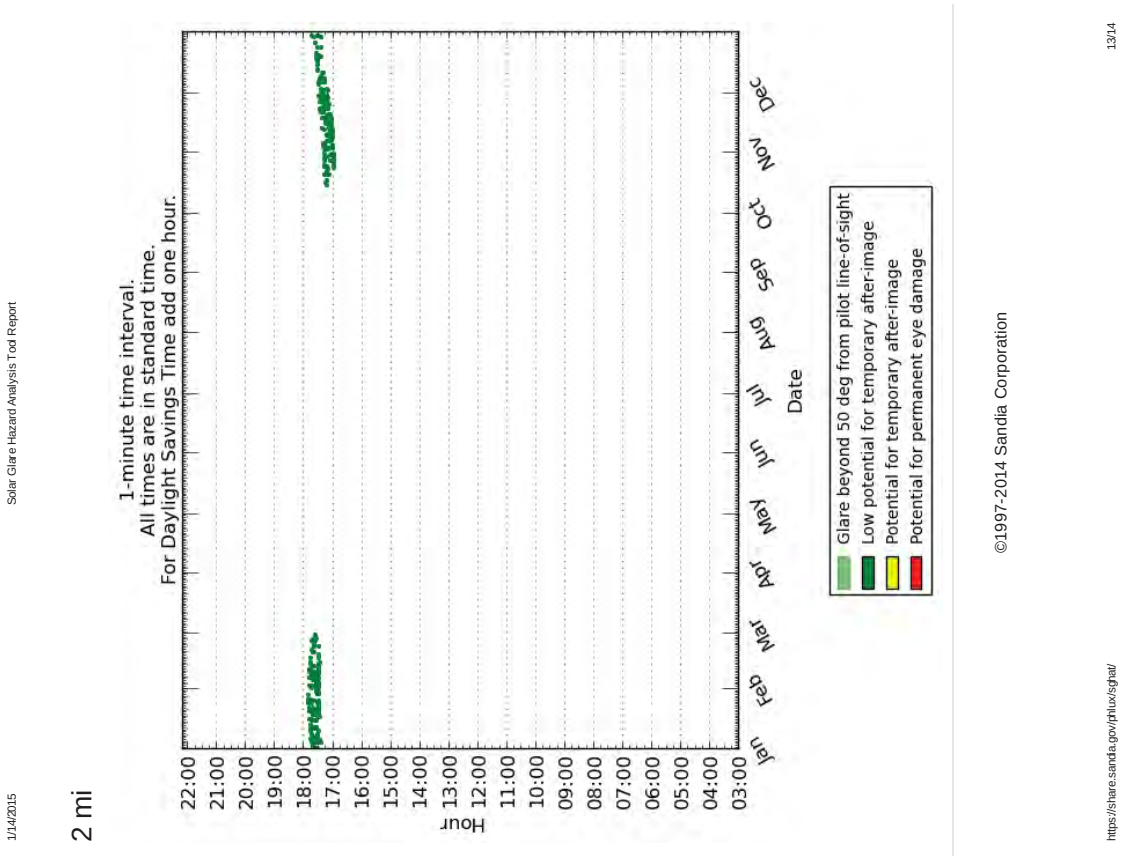

https://share.sandia.gov/phlux/sghat/ 11/14

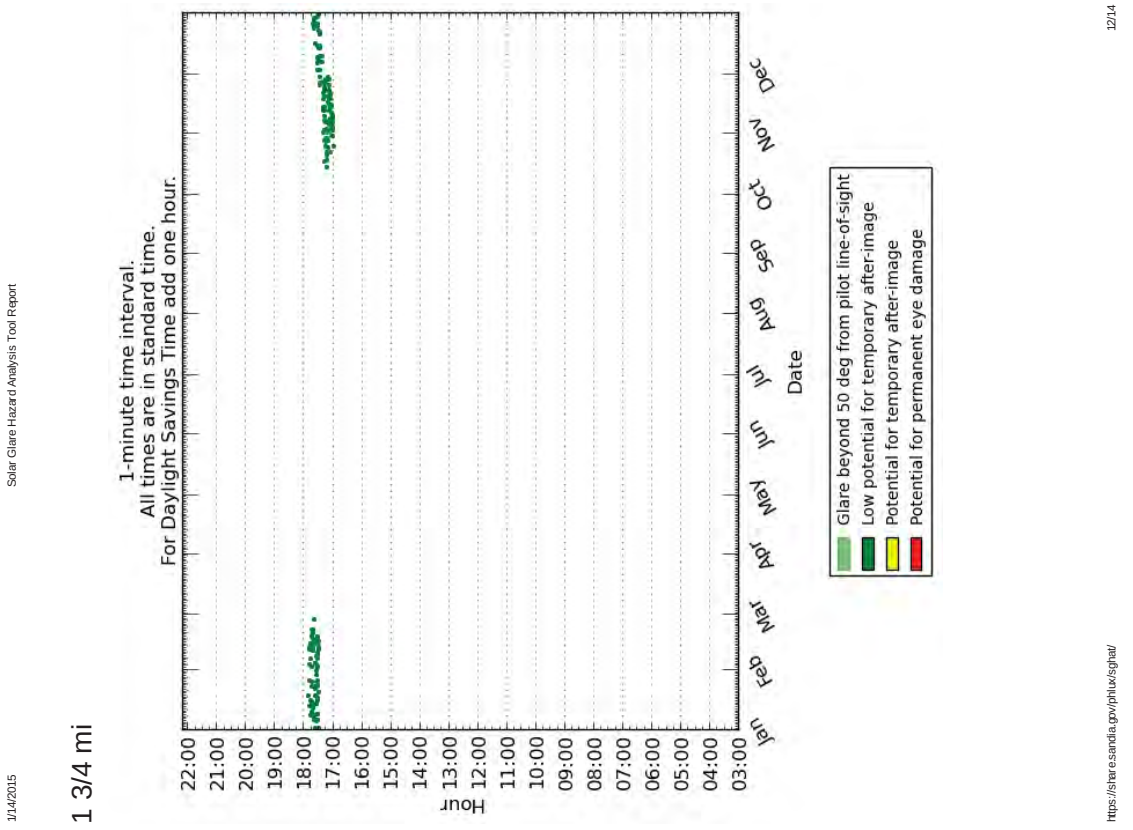
1/14/2015 Solar Glare Hazard Analysis Tool Report

1 1/4 mi




https://share.sandia.gov/phlux/sghat/ 10/14


1/14/2015
Solar Glare Hazard Analysis Tool Report
2 mi
1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
Hour
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage
©1997-2014 Sandia Corporation
https://share.sandia.gov/phlux/sghat/
13/14


1/14/2015
Solar Glare Hazard Analysis Tool Report
1 3/4 mi
1-minute time interval.
All times are in standard time.
For Daylight Savings Time add one hour.
Hour
Date
Glare beyond 50 deg from pilot line-of-sight
Low potential for temporary after-image
Potential for temporary after-image
Potential for permanent eye damage
https://share.sandia.gov/phlux/sghat/
12/14

# Solar Glare Hazard Analysis Report

Generated Jan. 14, 2015, 3:39 p.m.

## Glare found

Print

Google Map

## Inputs

| | |
|---|---|
| Analysis name | AAFB. **south. finegayan** |
| PV array axis tracking | none |
| Orientation of array (deg) | 150.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5495476799 | 144.836035967 | 372.43 | 4.0 | 376.43 |
| 2 | 13.5499231678 | 144.835349321 | 366.07 | 4.0 | 370.07 |
| 3 | 13.5476285102 | 144.834018946 | 344.38 | 4.0 | 348.38 |
| 4 | 13.5461682621 | 144.833289385 | 347.06 | 4.0 | 351.06 |
| 5 | 13.547232158 | 144.831508398 | 333.74 | 4.0 | 337.74 |
| 6 | 13.5487341207 | 144.831851721 | 331.03 | 4.0 | 335.03 |
| 7 | 13.5499023073 | 144.832645655 | 340.84 | 4.0 | 344.84 |

| | | | | | |
|---|---|---|---|---|---|
| 8 | 13.5512790914 | 144.83296752 | 344.32 | 4.0 | 348.32 |
| 9 | 13.5514876943 | 144.831701517 | 330.1 | 4.0 | 334.1 |
| 10 | 13.5504655381 | 144.830950499 | 331.52 | 4.0 | 335.52 |
| 11 | 13.5483377704 | 144.830521345 | 331.53 | 4.0 | 335.53 |
| 12 | 13.5473364613 | 144.830585718 | 327.88 | 4.0 | 331.88 |
| 13 | 13.54729474 | 144.830156565 | 332.37 | 4.0 | 336.37 |
| 14 | 13.5463768695 | 144.830263853 | 315.4 | 4.0 | 319.4 |
| 15 | 13.5462517051 | 144.830735922 | 314.8 | 4.0 | 318.8 |
| 16 | 13.5450626397 | 144.830886126 | 314.89 | 4.0 | 318.89 |
| 17 | 13.5446037006 | 144.829705954 | 319.6 | 4.0 | 323.6 |
| 18 | 13.5437692635 | 144.829770327 | 320.02 | 4.0 | 324.02 |
| 19 | 13.5429556846 | 144.83084321 | 330.42 | 4.0 | 334.42 |
| 20 | 13.5423298528 | 144.833225012 | 337.2 | 4.0 | 341.2 |
| 21 | 13.5454172738 | 144.834018946 | 352.49 | 4.0 | 356.49 |

## Observation Points

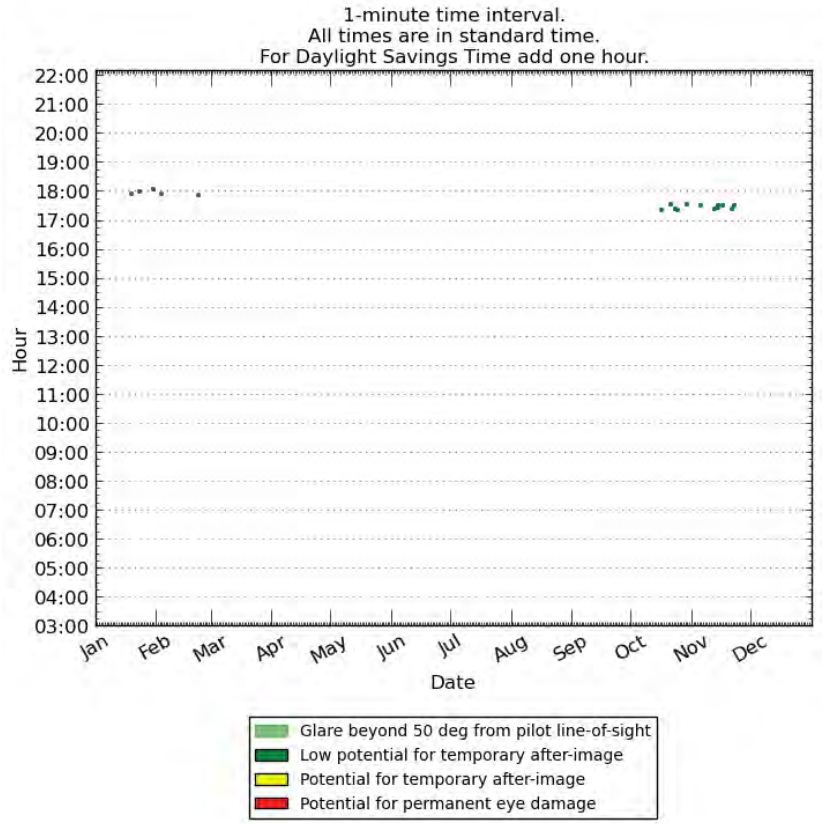
| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) |
|---|---|---|---|---|
| Air Traffic Control Tower | 13.5753428401 | 144.930805117 | 543.21 | 168.0 |

## Glare Occurrence Plot

All times are in standard time. For Daylight Savings Time add one hour.







# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 14, 2015, 3:17 p.m.

## Flight path: AAFB 6R

## No glare found

Print






## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | AAFB. **south. finegayan** |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 66.2 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5495476799 | 144.836035967 | 372.43 | 4.0 | 376.43 |
| 2 | 13.5499231678 | 144.835349321 | 366.07 | 4.0 | 370.07 |
| 3 | 13.5476285102 | 144.834018946 | 344.38 | 4.0 | 348.38 |
| 4 | 13.5461682621 | 144.833289385 | 347.06 | 4.0 | 351.06 |
| 5 | 13.547232158 | 144.831508398 | 333.74 | 4.0 | 337.74 |
| 6 | 13.5487341207 | 144.831851721 | 331.03 | 4.0 | 335.03 |
| 7 | 13.5499023073 | 144.832645655 | 340.84 | 4.0 | 344.84 |
| 8 | 13.5512790914 | 144.83296752 | 344.32 | 4.0 | 348.32 |
| 9 | 13.5514876943 | 144.831701517 | 330.1 | 4.0 | 334.1 |
| 10 | 13.5504655381 | 144.830950499 | 331.52 | 4.0 | 335.52 |
| 11 | 13.5483377704 | 144.830521345 | 331.53 | 4.0 | 335.53 |
| 12 | 13.5473364613 | 144.830585718 | 327.88 | 4.0 | 331.88 |
| 13 | 13.54729474 | 144.830156565 | 332.37 | 4.0 | 336.37 |
| 14 | 13.5463768695 | 144.830263853 | 315.4 | 4.0 | 319.4 |
| 15 | 13.5462517051 | 144.830735922 | 314.8 | 4.0 | 318.8 |
| 16 | 13.5450626397 | 144.830886126 | 314.89 | 4.0 | 318.89 |
| 17 | 13.5446037006 | 144.829705954 | 319.6 | 4.0 | 323.6 |
| 18 | 13.5437692635 | 144.829770327 | 320.02 | 4.0 | 324.02 |
| 19 | 13.5429556846 | 144.83084321 | 330.42 | 4.0 | 334.42 |
| 20 | 13.5423298528 | 144.833225012 | 337.2 | 4.0 | 341.2 |





| | | | | | |
|---|---|---|---|---|---|
| 21 | 13.5454172738 | 144.834018946 | 352.49 | 4.0 | 356.49 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.5753298037 | 144.916500896 | 547.63 | 50.0 | No |
| 1/4 mi | 13.5738714945 | 144.913095458 | 559.89 | 106.92 | No |
| 1/2 mi | 13.5724131853 | 144.90969002 | 523.25 | 212.75 | No |
| 3/4 mi | 13.5709548761 | 144.906284582 | 501.74 | 303.43 | No |
| 1 mi | 13.5694965669 | 144.902879144 | 580.27 | 294.07 | No |
| 1 1/4 mi | 13.5680382577 | 144.899473706 | 599.31 | 344.22 | No |
| 1 1/2 mi | 13.5665799485 | 144.896068268 | 588.27 | 424.43 | No |
| 1 3/4 mi | 13.5651216393 | 144.89266283 | 615.54 | 466.35 | No |
| 2 mi | 13.5636633301 | 144.889257392 | 586.71 | 564.35 | No |

No glare found.

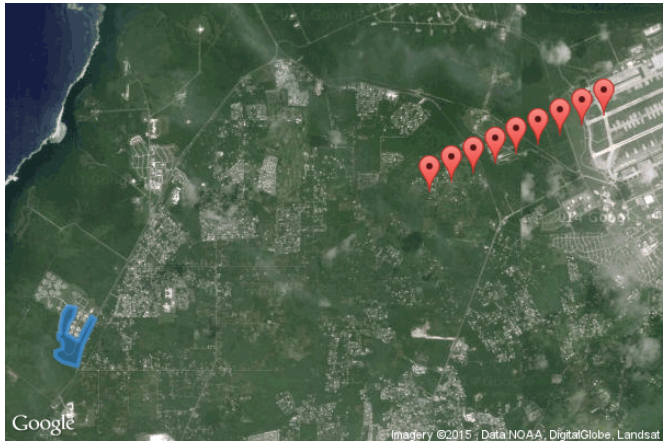
# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 14, 2015, 3:17 p.m.

## Flight path: AAFB 6L

## No glare found

Print








## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | AAFB. **south. finegayan** |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 66.2 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5495476799 | 144.836035967 | 372.43 | 4.0 | 376.43 |
| 2 | 13.5499231678 | 144.835349321 | 366.07 | 4.0 | 370.07 |
| 3 | 13.5476285102 | 144.834018946 | 344.38 | 4.0 | 348.38 |
| 4 | 13.5461682621 | 144.833289385 | 347.06 | 4.0 | 351.06 |
| 5 | 13.547232158 | 144.831508398 | 333.74 | 4.0 | 337.74 |
| 6 | 13.5487341207 | 144.831851721 | 331.03 | 4.0 | 335.03 |
| 7 | 13.5499023073 | 144.832645655 | 340.84 | 4.0 | 344.84 |
| 8 | 13.5512790914 | 144.83296752 | 344.32 | 4.0 | 348.32 |
| 9 | 13.5514876943 | 144.831701517 | 330.1 | 4.0 | 334.1 |
| 10 | 13.5504655381 | 144.830950499 | 331.52 | 4.0 | 335.52 |
| 11 | 13.5483377704 | 144.830521345 | 331.53 | 4.0 | 335.53 |
| 12 | 13.5473364613 | 144.830585718 | 327.88 | 4.0 | 331.88 |
| 13 | 13.54729474 | 144.830156565 | 332.37 | 4.0 | 336.37 |
| 14 | 13.5463768695 | 144.830263853 | 315.4 | 4.0 | 319.4 |
| 15 | 13.5462517051 | 144.830735922 | 314.8 | 4.0 | 318.8 |
| 16 | 13.5450626397 | 144.830886126 | 314.89 | 4.0 | 318.89 |
| 17 | 13.5446037006 | 144.829705954 | 319.6 | 4.0 | 323.6 |
| 18 | 13.5437692635 | 144.829770327 | 320.02 | 4.0 | 324.02 |
| 19 | 13.5429556846 | 144.83084321 | 330.42 | 4.0 | 334.42 |
| 20 | 13.5423298528 | 144.833225012 | 337.2 | 4.0 | 341.2 |
| 21 | 13.5454172738 | 144.834018946 | 352.49 | 4.0 | 356.49 |





## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.5803670034 | 144.915637225 | 530.11 | 50.0 | No |
| 1/4 mi | 13.5789086942 | 144.912231715 | 526.63 | 122.64 | No |
| 1/2 mi | 13.577450385 | 144.908826204 | 490.92 | 227.55 | No |
| 3/4 mi | 13.5759920758 | 144.905420694 | 505.34 | 282.29 | No |
| 1 mi | 13.5745337666 | 144.902015184 | 523.62 | 333.19 | No |
| 1 1/4 mi | 13.5730754574 | 144.898609674 | 550.42 | 375.58 | No |
| 1 1/2 mi | 13.5716171481 | 144.895204163 | 596.06 | 399.11 | No |
| 1 3/4 mi | 13.5701588389 | 144.891798653 | 599.62 | 464.74 | No |
| 2 mi | 13.5687005297 | 144.888393143 | 584.03 | 549.51 | No |

No glare found.

# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 14, 2015, 3:17 p.m.

## Flight path: AAFB 6R

## No glare found

Print






## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | AAFB. . **south. finegayan** |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 66.2 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5495476799 | 144.836035967 | 372.43 | 4.0 | 376.43 |
| 2 | 13.5499231678 | 144.835349321 | 366.07 | 4.0 | 370.07 |
| 3 | 13.5476285102 | 144.834018946 | 344.38 | 4.0 | 348.38 |
| 4 | 13.5461682621 | 144.833289385 | 347.06 | 4.0 | 351.06 |
| 5 | 13.547232158 | 144.831508398 | 333.74 | 4.0 | 337.74 |
| 6 | 13.5487341207 | 144.831851721 | 331.03 | 4.0 | 335.03 |
| 7 | 13.5499023073 | 144.832645655 | 340.84 | 4.0 | 344.84 |
| 8 | 13.5512790914 | 144.83296752 | 344.32 | 4.0 | 348.32 |
| 9 | 13.5514876943 | 144.831701517 | 330.1 | 4.0 | 334.1 |
| 10 | 13.5504655381 | 144.830950499 | 331.52 | 4.0 | 335.52 |
| 11 | 13.5483377704 | 144.830521345 | 331.53 | 4.0 | 335.53 |
| 12 | 13.5473364613 | 144.830585718 | 327.88 | 4.0 | 331.88 |
| 13 | 13.54729474 | 144.830156565 | 332.37 | 4.0 | 336.37 |
| 14 | 13.5463768695 | 144.830263853 | 315.4 | 4.0 | 319.4 |
| 15 | 13.5462517051 | 144.830735922 | 314.8 | 4.0 | 318.8 |
| 16 | 13.5450626397 | 144.830886126 | 314.89 | 4.0 | 318.89 |
| 17 | 13.5446037006 | 144.829705954 | 319.6 | 4.0 | 323.6 |
| 18 | 13.5437692635 | 144.829770327 | 320.02 | 4.0 | 324.02 |
| 19 | 13.5429556846 | 144.83084321 | 330.42 | 4.0 | 334.42 |
| 20 | 13.5423298528 | 144.833225012 | 337.2 | 4.0 | 341.2 |





| | | | | | |
|---|---|---|---|---|---|
| 21 | 13.5454172738 | 144.834018946 | 352.49 | 4.0 | 356.49 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.5753298037 | 144.916500896 | 547.63 | 50.0 | No |
| 1/4 mi | 13.5738714945 | 144.913095458 | 559.89 | 106.92 | No |
| 1/2 mi | 13.5724131853 | 144.90969002 | 523.25 | 212.75 | No |
| 3/4 mi | 13.5709548761 | 144.906284582 | 501.74 | 303.43 | No |
| 1 mi | 13.5694965669 | 144.902879144 | 580.27 | 294.07 | No |
| 1 1/4 mi | 13.5680382577 | 144.899473706 | 599.31 | 344.22 | No |
| 1 1/2 mi | 13.5665799485 | 144.896068268 | 588.27 | 424.43 | No |
| 1 3/4 mi | 13.5651216393 | 144.89266283 | 615.54 | 466.35 | No |
| 2 mi | 13.5636633301 | 144.889257392 | 586.71 | 564.35 | No |

No glare found.

# Solar Glare Hazard Analysis Report

Generated Jan. 14, 2015, 3:16 p.m.

## No glare found

Print

Google Map

## Inputs

| | |
|---|---|
| Analysis name | AAFB. **south. finegayan** |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5495476799 | 144.836035967 | 372.43 | 4.0 | 376.43 |
| 2 | 13.5499231678 | 144.835349321 | 366.07 | 4.0 | 370.07 |
| 3 | 13.5476285102 | 144.834018946 | 344.38 | 4.0 | 348.38 |
| 4 | 13.5461682621 | 144.833289385 | 347.06 | 4.0 | 351.06 |
| 5 | 13.547232158 | 144.831508398 | 333.74 | 4.0 | 337.74 |
| 6 | 13.5487341207 | 144.831851721 | 331.03 | 4.0 | 335.03 |
| 7 | 13.5499023073 | 144.832645655 | 340.84 | 4.0 | 344.84 |

| | | | | | |
|---|---|---|---|---|---|
| 8 | 13.5512790914 | 144.83296752 | 344.32 | 4.0 | 348.32 |
| 9 | 13.5514876943 | 144.831701517 | 330.1 | 4.0 | 334.1 |
| 10 | 13.5504655381 | 144.830950499 | 331.52 | 4.0 | 335.52 |
| 11 | 13.5483377704 | 144.830521345 | 331.53 | 4.0 | 335.53 |
| 12 | 13.5473364613 | 144.830585718 | 327.88 | 4.0 | 331.88 |
| 13 | 13.54729474 | 144.830156565 | 332.37 | 4.0 | 336.37 |
| 14 | 13.5463768695 | 144.830263853 | 315.4 | 4.0 | 319.4 |
| 15 | 13.5462517051 | 144.830735922 | 314.8 | 4.0 | 318.8 |
| 16 | 13.5450626397 | 144.830886126 | 314.89 | 4.0 | 318.89 |
| 17 | 13.5446037006 | 144.829705954 | 319.6 | 4.0 | 323.6 |
| 18 | 13.5437692635 | 144.829770327 | 320.02 | 4.0 | 324.02 |
| 19 | 13.5429556846 | 144.83084321 | 330.42 | 4.0 | 334.42 |
| 20 | 13.5423298528 | 144.833225012 | 337.2 | 4.0 | 341.2 |
| 21 | 13.5454172738 | 144.834018946 | 352.49 | 4.0 | 356.49 |

## Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) |
|---|---|---|---|---|
| Air Traffic Control Tower | 13.5753428401 | 144.930805117 | 543.21 | 168.0 |

## No glare found.





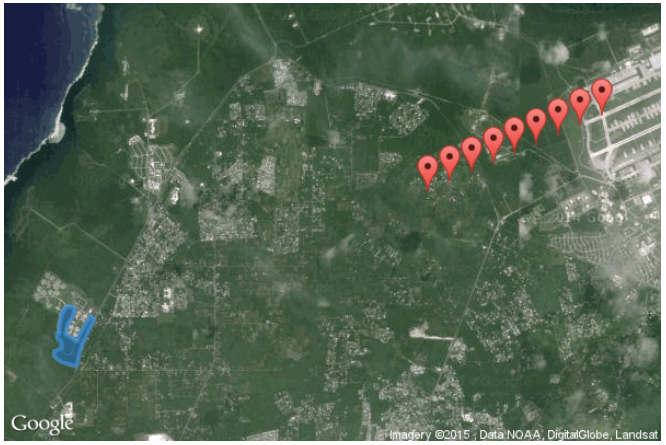
# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 14, 2015, 4:04 p.m.

## Flight path: AAFB 6L

## No glare found

Print



# Analysis & PV array parameters

| | |
|---|---|
| Analysis name | AAFB**. south. finegayan** |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

# Flight path parameters

| | |
|---|---|
| Direction (deg) | 66.2 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





# PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5495476799 | 144.836035967 | 372.43 | 4.0 | 376.43 |
| 2 | 13.5499231678 | 144.835349321 | 366.07 | 4.0 | 370.07 |
| 3 | 13.5476285102 | 144.834018946 | 344.38 | 4.0 | 348.38 |
| 4 | 13.5461682621 | 144.833289385 | 347.06 | 4.0 | 351.06 |
| 5 | 13.547232158 | 144.831508398 | 333.74 | 4.0 | 337.74 |
| 6 | 13.5487341207 | 144.831851721 | 331.03 | 4.0 | 335.03 |
| 7 | 13.5499023073 | 144.832645655 | 340.84 | 4.0 | 344.84 |
| 8 | 13.5512790914 | 144.83296752 | 344.32 | 4.0 | 348.32 |
| 9 | 13.5514876943 | 144.831701517 | 330.1 | 4.0 | 334.1 |
| 10 | 13.5504655381 | 144.830950499 | 331.52 | 4.0 | 335.52 |
| 11 | 13.5483377704 | 144.830521345 | 331.53 | 4.0 | 335.53 |
| 12 | 13.5473364613 | 144.830585718 | 327.88 | 4.0 | 331.88 |
| 13 | 13.54729474 | 144.830156565 | 332.37 | 4.0 | 336.37 |
| 14 | 13.5463768695 | 144.830263853 | 315.4 | 4.0 | 319.4 |
| 15 | 13.5462517051 | 144.830735922 | 314.8 | 4.0 | 318.8 |
| 16 | 13.5450626397 | 144.830886126 | 314.89 | 4.0 | 318.89 |
| 17 | 13.5446037006 | 144.829705954 | 319.6 | 4.0 | 323.6 |
| 18 | 13.5437692635 | 144.829770327 | 320.02 | 4.0 | 324.02 |
| 19 | 13.5429556846 | 144.83084321 | 330.42 | 4.0 | 334.42 |
| 20 | 13.5423298528 | 144.833225012 | 337.2 | 4.0 | 341.2 |

| | | | | | |
|---|---|---|---|---|---|
| 21 | 13.5454172738 | 144.834018946 | 352.49 | 4.0 | 356.49 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.5803670034 | 144.915637225 | 530.11 | 50.0 | No |
| 1/4 mi | 13.5789086942 | 144.912231715 | 526.63 | 122.64 | No |
| 1/2 mi | 13.577450385 | 144.908826204 | 490.92 | 227.55 | No |
| 3/4 mi | 13.5759920758 | 144.905420694 | 505.34 | 282.29 | No |
| 1 mi | 13.5745337666 | 144.902015184 | 523.62 | 333.19 | No |
| 1 1/4 mi | 13.5730754574 | 144.898609674 | 550.42 | 375.58 | No |
| 1 1/2 mi | 13.5716171481 | 144.895204163 | 596.06 | 399.11 | No |
| 1 3/4 mi | 13.5701588389 | 144.891798653 | 599.62 | 464.74 | No |
| 2 mi | 13.5687005297 | 144.888393143 | 584.03 | 549.51 | No |

No glare found.







# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 14, 2015, 4:05 p.m.

## Flight path: AAFB 6R

## No glare found

Print

# Analysis & PV array parameters

| | |
|---|---|
| Analysis name | AAFB. . south. finegayan |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

# Flight path parameters

| | |
|---|---|
| Direction (deg) | 66.2 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





# PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5495476799 | 144.836035967 | 372.43 | 4.0 | 376.43 |
| 2 | 13.5499231678 | 144.835349321 | 366.07 | 4.0 | 370.07 |
| 3 | 13.5476285102 | 144.834018946 | 344.38 | 4.0 | 348.38 |
| 4 | 13.5461682621 | 144.833289385 | 347.06 | 4.0 | 351.06 |
| 5 | 13.547232158 | 144.831508398 | 333.74 | 4.0 | 337.74 |
| 6 | 13.5487341207 | 144.831851721 | 331.03 | 4.0 | 335.03 |
| 7 | 13.5499023073 | 144.832645655 | 340.84 | 4.0 | 344.84 |
| 8 | 13.5512790914 | 144.83296752 | 344.32 | 4.0 | 348.32 |
| 9 | 13.5514876943 | 144.831701517 | 330.1 | 4.0 | 334.1 |
| 10 | 13.5504655381 | 144.830950499 | 331.52 | 4.0 | 335.52 |
| 11 | 13.5483377704 | 144.830521345 | 331.53 | 4.0 | 335.53 |
| 12 | 13.5473364613 | 144.830585718 | 327.88 | 4.0 | 331.88 |
| 13 | 13.54729474 | 144.830156565 | 332.37 | 4.0 | 336.37 |
| 14 | 13.5463768695 | 144.830263853 | 315.4 | 4.0 | 319.4 |
| 15 | 13.5462517051 | 144.830735922 | 314.8 | 4.0 | 318.8 |
| 16 | 13.5450626397 | 144.830886126 | 314.89 | 4.0 | 318.89 |
| 17 | 13.5446037006 | 144.829705954 | 319.6 | 4.0 | 323.6 |
| 18 | 13.5437692635 | 144.829770327 | 320.02 | 4.0 | 324.02 |
| 19 | 13.5429556846 | 144.83084321 | 330.42 | 4.0 | 334.42 |
| 20 | 13.5423298528 | 144.833225012 | 337.2 | 4.0 | 341.2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 21 | 13.5454172738 | 144.834018946 | 352.49 | | 4.0 | 356.49 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.5753298037 | 144.916500896 | 547.63 | 50.0 | No |
| 1/4 mi | 13.5738714945 | 144.913095458 | 559.89 | 106.92 | No |
| 1/2 mi | 13.5724131853 | 144.90969002 | 523.25 | 212.75 | No |
| 3/4 mi | 13.5709548761 | 144.906284582 | 501.74 | 303.43 | No |
| 1 mi | 13.5694965669 | 144.902879144 | 580.27 | 294.07 | No |
| 1 1/4 mi | 13.5680382577 | 144.899473706 | 599.31 | 344.22 | No |
| 1 1/2 mi | 13.5665799485 | 144.896068268 | 588.27 | 424.43 | No |
| 1 3/4 mi | 13.5651216393 | 144.89266283 | 615.54 | 466.35 | No |
| 2 mi | 13.5636633301 | 144.889257392 | 586.71 | 564.35 | No |

No glare found.







# Solar Glare Hazard Analysis Report

Generated Jan. 14, 2015, 4:04 p.m.

## No glare found

Print

Google Map



## Inputs

| | |
|---|---|
| Analysis name | AAFB. **south. finegayan** |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |

| | |
|---|---|
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5495476799 | 144.836035967 | 372.43 | 4.0 | 376.43 |
| 2 | 13.5499231678 | 144.835349321 | 366.07 | 4.0 | 370.07 |
| 3 | 13.5476285102 | 144.834018946 | 344.38 | 4.0 | 348.38 |
| 4 | 13.5461682621 | 144.833289385 | 347.06 | 4.0 | 351.06 |
| 5 | 13.547232158 | 144.831508398 | 333.74 | 4.0 | 337.74 |
| 6 | 13.5487341207 | 144.831851721 | 331.03 | 4.0 | 335.03 |
| 7 | 13.5499023073 | 144.832645655 | 340.84 | 4.0 | 344.84 |
| 8 | 13.5512790914 | 144.83296752 | 344.32 | 4.0 | 348.32 |
| 9 | 13.5514876943 | 144.831701517 | 330.1 | 4.0 | 334.1 |
| 10 | 13.5504655381 | 144.830950499 | 331.52 | 4.0 | 335.52 |
| 11 | 13.5483377704 | 144.830521345 | 331.53 | 4.0 | 335.53 |
| 12 | 13.5473364613 | 144.830585718 | 327.88 | 4.0 | 331.88 |
| 13 | 13.54729474 | 144.830156565 | 332.37 | 4.0 | 336.37 |
| 14 | 13.5463768695 | 144.830263853 | 315.4 | 4.0 | 319.4 |
| 15 | 13.5462517051 | 144.830735922 | 314.8 | 4.0 | 318.8 |
| 16 | 13.5450626397 | 144.830886126 | 314.89 | 4.0 | 318.89 |
| 17 | 13.5446037006 | 144.829705954 | 319.6 | 4.0 | 323.6 |
| 18 | 13.5437692635 | 144.829770327 | 320.02 | 4.0 | 324.02 |
| 19 | 13.5429556846 | 144.83084321 | 330.42 | 4.0 | 334.42 |
| 20 | 13.5423298528 | 144.833225012 | 337.2 | 4.0 | 341.2 |
| 21 | 13.5454172738 | 144.834018946 | 352.49 | 4.0 | 356.49 |

## Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) |
|---|---|---|---|---|
| Air Traffic Control Tower | 13.5753428401 | 144.930805117 | 543.21 | 168.0 |

## No glare found.

# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 2:44 p.m.

## Flight path: 24L

## No glare found

Print






## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 150.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.19 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5222815024 | 144.818387032 | 260.54 | 4.0 | 264.54 |
| 2 | 13.5235541326 | 144.817947149 | 269.06 | 4.0 | 273.06 |
| 3 | 13.5241591511 | 144.819749594 | 257.4 | 4.0 | 261.4 |
| 4 | 13.5231681717 | 144.82098341 | 267.14 | 4.0 | 271.14 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4876127569 | 144.807714522 | 290.95 | 50.0 | No |
| 1/4 mi | 13.4891291217 | 144.811091711 | 298.85 | 111.27 | No |
| 1/2 mi | 13.4906454865 | 144.8144689 | 334.43 | 144.88 | No |
| 3/4 mi | 13.4921618513 | 144.817846089 | 364.49 | 183.99 | No |
| 1 mi | 13.493678216 | 144.821223278 | 390.74 | 226.92 | No |
| 1 1/4 mi | 13.4951945808 | 144.824600468 | 350.32 | 336.52 | No |
| 1 1/2 mi | 13.4967109456 | 144.827977657 | 415.45 | 340.57 | No |
| 1 3/4 mi | 13.4982273104 | 144.831354846 | 425.23 | 399.98 | No |
| 2 mi | 13.4997436752 | 144.834732035 | 352.27 | 542.11 | No |

No glare found.





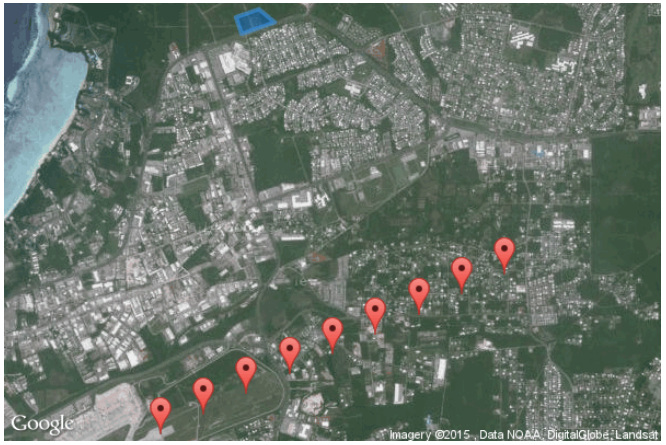
# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 2:44 p.m.

## Flight path: 24R

## No glare found

Print



## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 150.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.14 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5222815024 | 144.818387032 | 260.54 | 4.0 | 264.54 |
| 2 | 13.5235541326 | 144.817947149 | 269.06 | 4.0 | 273.06 |
| 3 | 13.5241591511 | 144.819749594 | 257.4 | 4.0 | 261.4 |
| 4 | 13.5231681717 | 144.82098341 | 267.14 | 4.0 | 271.14 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.491731124 | 144.812046289 | 305.52 | 50.0 | No |
| 1/4 mi | 13.4932503507 | 144.815422173 | 337.87 | 86.82 | No |
| 1/2 mi | 13.4947695774 | 144.818798057 | 374.97 | 118.91 | No |
| 3/4 mi | 13.4962888041 | 144.82217394 | 373.89 | 189.17 | No |
| 1 mi | 13.4978080309 | 144.825549824 | 380.28 | 251.95 | No |
| 1 1/4 mi | 13.4993272576 | 144.828925708 | 351.47 | 349.94 | No |
| 1 1/2 mi | 13.5008464843 | 144.832301591 | 268.52 | 502.06 | No |
| 1 3/4 mi | 13.5023657111 | 144.835677475 | 271.35 | 568.43 | No |
| 2 mi | 13.5038849378 | 144.839053359 | 283.63 | 625.32 | No |

No glare found.

# Solar Glare Hazard Analysis Report

Generated Jan. 13, 2015, 2:43 p.m.

## No glare found

Print


## Inputs

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 150.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |





| | |
|---|---|
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5222815024 | 144.818387032 | 260.54 | 4.0 | 264.54 |
| 2 | 13.5235541326 | 144.817947149 | 269.06 | 4.0 | 273.06 |
| 3 | 13.5241591511 | 144.819749594 | 257.4 | 4.0 | 261.4 |
| 4 | 13.5231681717 | 144.82098341 | 267.14 | 4.0 | 271.14 |

## Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) |
|---|---|---|---|---|
| 1 | 13.478828061 | 144.79699105 | 241.95 | 300.0 |

No glare found.







# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 2:57 p.m.

## Flight path: 24L

## No glare found

Print

## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.19 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5215513017 | 144.816316366 | 260.58 | 4.0 | 264.58 |
| 2 | 13.5210192969 | 144.814825058 | 258.85 | 4.0 | 262.85 |
| 3 | 13.5226570333 | 144.81434226 | 258.11 | 4.0 | 262.11 |
| 4 | 13.5231160147 | 144.81572628 | 270.0 | 4.0 | 274.0 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4876127569 | 144.807714522 | 290.95 | 50.0 | No |
| 1/4 mi | 13.4891291217 | 144.811091711 | 298.85 | 111.27 | No |
| 1/2 mi | 13.4906454865 | 144.8144689 | 334.43 | 144.88 | No |
| 3/4 mi | 13.4921618513 | 144.817846089 | 364.49 | 183.99 | No |
| 1 mi | 13.493678216 | 144.821223278 | 390.74 | 226.92 | No |
| 1 1/4 mi | 13.4951945808 | 144.824600468 | 350.32 | 336.52 | No |
| 1 1/2 mi | 13.4967109456 | 144.827977657 | 415.45 | 340.57 | No |
| 1 3/4 mi | 13.4982273104 | 144.831354846 | 425.23 | 399.98 | No |
| 2 mi | 13.4997436752 | 144.834732035 | 352.27 | 542.11 | No |

No glare found.

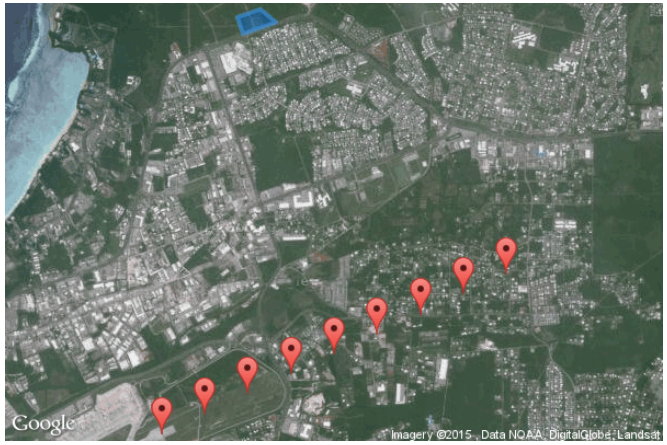
# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 2:56 p.m.

## Flight path: 24R

## No glare found

Print








## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.14 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5222815024 | 144.818387032 | 260.54 | 4.0 | 264.54 |
| 2 | 13.5235541326 | 144.817947149 | 269.06 | 4.0 | 273.06 |
| 3 | 13.5241591511 | 144.819749594 | 257.4 | 4.0 | 261.4 |
| 4 | 13.5231681717 | 144.82098341 | 267.14 | 4.0 | 271.14 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.491731124 | 144.812046289 | 305.52 | 50.0 | No |
| 1/4 mi | 13.4932503507 | 144.815422173 | 337.87 | 86.82 | No |
| 1/2 mi | 13.4947695774 | 144.818798057 | 374.97 | 118.91 | No |
| 3/4 mi | 13.4962888041 | 144.82217394 | 373.89 | 189.17 | No |
| 1 mi | 13.4978080309 | 144.825549824 | 380.28 | 251.95 | No |
| 1 1/4 mi | 13.4993272576 | 144.828925708 | 351.47 | 349.94 | No |
| 1 1/2 mi | 13.5008464843 | 144.832301591 | 268.52 | 502.06 | No |
| 1 3/4 mi | 13.5023657111 | 144.835677475 | 271.35 | 568.43 | No |
| 2 mi | 13.5038849378 | 144.839053359 | 283.63 | 625.32 | No |

No glare found.





# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 6:40 p.m.

## Flight path: 6L

## No glare found

Print

## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 0.0 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 64.94 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5222815024 | 144.818387032 | 260.54 | 4.0 | 264.54 |
| 2 | 13.5235541326 | 144.817947149 | 269.06 | 4.0 | 273.06 |
| 3 | 13.5241591511 | 144.819749594 | 257.4 | 4.0 | 261.4 |
| 4 | 13.5231681717 | 144.82098341 | 267.14 | 4.0 | 271.14 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4789245692 | 144.784057438 | 237.77 | 50.0 | No |
| 1/4 mi | 13.4773939063 | 144.780687216 | 208.62 | 148.32 | No |
| 1/2 mi | 13.4758632434 | 144.777316993 | 205.16 | 220.97 | No |
| 3/4 mi | 13.4743325805 | 144.773946771 | 175.68 | 319.62 | No |
| 1 mi | 13.4728019176 | 144.770576548 | 140.53 | 423.94 | No |
| 1 1/4 mi | 13.4712712546 | 144.767206326 | 74.93 | 558.73 | No |
| 1 1/2 mi | 13.4697405917 | 144.763836103 | 10.39 | 692.45 | No |
| 1 3/4 mi | 13.4682099288 | 144.760465881 | 13.44 | 758.59 | No |
| 2 mi | 13.4666792659 | 144.757095659 | 12.01 | 829.19 | No |

No glare found.

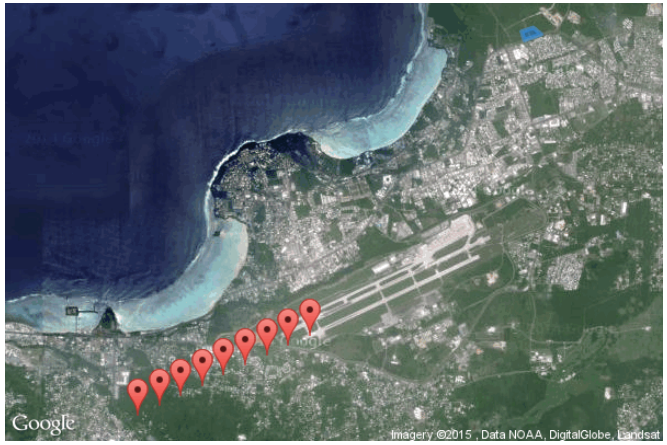
# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 6:40 p.m.

## Flight path: 6R

## No glare found

Print








## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 0.0 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 64.94 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5222815024 | 144.818387032 | 260.54 | 4.0 | 264.54 |
| 2 | 13.5235541326 | 144.817947149 | 269.06 | 4.0 | 273.06 |
| 3 | 13.5241591511 | 144.819749594 | 257.4 | 4.0 | 261.4 |
| 4 | 13.5231681717 | 144.82098341 | 267.14 | 4.0 | 271.14 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4771639403 | 144.78486076 | 229.31 | 50.0 | No |
| 1/4 mi | 13.4756332774 | 144.781490562 | 215.91 | 132.57 | No |
| 1/2 mi | 13.4741026145 | 144.778120365 | 195.79 | 221.88 | No |
| 3/4 mi | 13.4725719516 | 144.774750167 | 147.31 | 339.53 | No |
| 1 mi | 13.4710412887 | 144.771379969 | 112.33 | 443.69 | No |
| 1 1/4 mi | 13.4695106257 | 144.768009772 | 15.76 | 609.44 | No |
| 1 1/2 mi | 13.4679799628 | 144.764639574 | 31.29 | 663.09 | No |
| 1 3/4 mi | 13.4664492999 | 144.761269376 | 9.82 | 753.74 | No |
| 2 mi | 13.464918637 | 144.757899179 | 15.99 | 816.74 | No |

No glare found.





# Solar Glare Hazard Analysis Report

Generated Jan. 13, 2015, 2:55 p.m.

## No glare found

Print

## Inputs

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |

| | |
|---|---|
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5222815024 | 144.818387032 | 260.54 | 4.0 | 264.54 |
| 2 | 13.5235541326 | 144.817947149 | 269.06 | 4.0 | 273.06 |
| 3 | 13.5241591511 | 144.819749594 | 257.4 | 4.0 | 261.4 |
| 4 | 13.5231681717 | 144.82098341 | 267.14 | 4.0 | 271.14 |

## Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) |
|---|---|---|---|---|
| 1 | 13.478828061 | 144.79699105 | 241.95 | 300.0 |





# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 5:06 p.m.

## Flight path: 24L

## No glare found

Print

## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.19 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5222815024 | 144.818387032 | 260.54 | 4.0 | 264.54 |
| 2 | 13.5235541326 | 144.817947149 | 269.06 | 4.0 | 273.06 |
| 3 | 13.5241591511 | 144.819749594 | 257.4 | 4.0 | 261.4 |
| 4 | 13.5231681717 | 144.82098341 | 267.14 | 4.0 | 271.14 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4876127569 | 144.807714522 | 290.95 | 50.0 | No |
| 1/4 mi | 13.4891291217 | 144.811091711 | 298.85 | 111.27 | No |
| 1/2 mi | 13.4906454865 | 144.8144689 | 334.43 | 144.88 | No |
| 3/4 mi | 13.4921618513 | 144.817846089 | 364.49 | 183.99 | No |
| 1 mi | 13.493678216 | 144.821223278 | 390.74 | 226.92 | No |
| 1 1/4 mi | 13.4951945808 | 144.824600468 | 350.32 | 336.52 | No |
| 1 1/2 mi | 13.4967109456 | 144.827977657 | 415.45 | 340.57 | No |
| 1 3/4 mi | 13.4982273104 | 144.831354846 | 425.23 | 399.98 | No |
| 2 mi | 13.4997436752 | 144.834732035 | 352.27 | 542.11 | No |

No glare found.

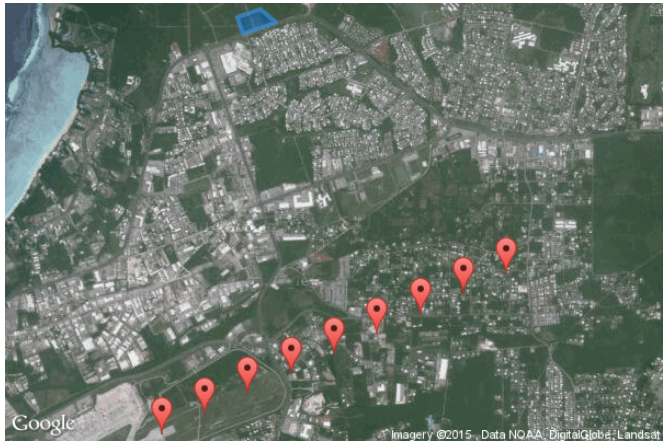
# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 5:06 p.m.

## Flight path: 24R

## No glare found

Print








## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.14 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5222815024 | 144.818387032 | 260.54 | 4.0 | 264.54 |
| 2 | 13.5235541326 | 144.817947149 | 269.06 | 4.0 | 273.06 |
| 3 | 13.5241591511 | 144.819749594 | 257.4 | 4.0 | 261.4 |
| 4 | 13.5231681717 | 144.82098341 | 267.14 | 4.0 | 271.14 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.491731124 | 144.812046289 | 305.52 | 50.0 | No |
| 1/4 mi | 13.4932503507 | 144.815422173 | 337.87 | 86.82 | No |
| 1/2 mi | 13.4947695774 | 144.818798057 | 374.97 | 118.91 | No |
| 3/4 mi | 13.4962888041 | 144.82217394 | 373.89 | 189.17 | No |
| 1 mi | 13.4978080309 | 144.825549824 | 380.28 | 251.95 | No |
| 1 1/4 mi | 13.4993272576 | 144.828925708 | 351.47 | 349.94 | No |
| 1 1/2 mi | 13.5008464843 | 144.832301591 | 268.52 | 502.06 | No |
| 1 3/4 mi | 13.5023657111 | 144.835677475 | 271.35 | 568.43 | No |
| 2 mi | 13.5038849378 | 144.839053359 | 283.63 | 625.32 | No |

No glare found.





# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 6:18 p.m.

## Flight path: 6L

## No glare found

Print

## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 0.0 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 64.94 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5222815024 | 144.818387032 | 260.54 | 4.0 | 264.54 |
| 2 | 13.5235541326 | 144.817947149 | 269.06 | 4.0 | 273.06 |
| 3 | 13.5241591511 | 144.819749594 | 257.4 | 4.0 | 261.4 |
| 4 | 13.5231681717 | 144.82098341 | 267.14 | 4.0 | 271.14 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4789245692 | 144.784057438 | 237.77 | 50.0 | No |
| 1/4 mi | 13.4773939063 | 144.780687216 | 208.62 | 148.32 | No |
| 1/2 mi | 13.4758632434 | 144.777316993 | 205.16 | 220.97 | No |
| 3/4 mi | 13.4743325805 | 144.773946771 | 175.68 | 319.62 | No |
| 1 mi | 13.4728019176 | 144.770576548 | 140.53 | 423.94 | No |
| 1 1/4 mi | 13.4712712546 | 144.767206326 | 74.93 | 558.73 | No |
| 1 1/2 mi | 13.4697405917 | 144.763836103 | 10.39 | 692.45 | No |
| 1 3/4 mi | 13.4682099288 | 144.760465881 | 13.44 | 758.59 | No |
| 2 mi | 13.4666792659 | 144.757095659 | 12.01 | 829.19 | No |

No glare found.

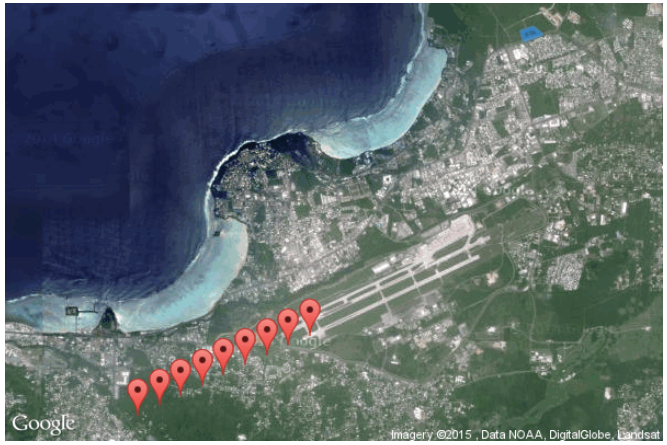
# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 6:18 p.m.

## Flight path: 6R

## No glare found

Print








## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 0.0 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 64.94 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5222815024 | 144.818387032 | 260.54 | 4.0 | 264.54 |
| 2 | 13.5235541326 | 144.817947149 | 269.06 | 4.0 | 273.06 |
| 3 | 13.5241591511 | 144.819749594 | 257.4 | 4.0 | 261.4 |
| 4 | 13.5231681717 | 144.82098341 | 267.14 | 4.0 | 271.14 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4771639403 | 144.78486076 | 229.31 | 50.0 | No |
| 1/4 mi | 13.4756332774 | 144.781490562 | 215.91 | 132.57 | No |
| 1/2 mi | 13.4741026145 | 144.778120365 | 195.79 | 221.88 | No |
| 3/4 mi | 13.4725719516 | 144.774750167 | 147.31 | 339.53 | No |
| 1 mi | 13.4710412887 | 144.771379969 | 112.33 | 443.69 | No |
| 1 1/4 mi | 13.4695106257 | 144.768009772 | 15.76 | 609.44 | No |
| 1 1/2 mi | 13.4679799628 | 144.764639574 | 31.29 | 663.09 | No |
| 1 3/4 mi | 13.4664492999 | 144.761269376 | 9.82 | 753.74 | No |
| 2 mi | 13.464918637 | 144.757899179 | 15.99 | 816.74 | No |

No glare found.





# Solar Glare Hazard Analysis Report

Generated Jan. 13, 2015, 5:05 p.m.

## No glare found

Print

## Inputs

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |

| | |
|---|---|
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5222815024 | 144.818387032 | 260.54 | 4.0 | 264.54 |
| 2 | 13.5235541326 | 144.817947149 | 269.06 | 4.0 | 273.06 |
| 3 | 13.5241591511 | 144.819749594 | 257.4 | 4.0 | 261.4 |
| 4 | 13.5231681717 | 144.82098341 | 267.14 | 4.0 | 271.14 |

## Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) |
|---|---|---|---|---|
| 1 | 13.478828061 | 144.79699105 | 241.95 | 300.0 |





# No glare found.

# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 2:45 p.m.

## Flight path: 24L

## No glare found

Print






## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 150.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.19 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5215513017 | 144.816316366 | 260.58 | 4.0 | 264.58 |
| 2 | 13.5210192969 | 144.814825058 | 258.85 | 4.0 | 262.85 |
| 3 | 13.5226570333 | 144.81434226 | 258.11 | 4.0 | 262.11 |
| 4 | 13.5231160147 | 144.81572628 | 270.0 | 4.0 | 274.0 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4876127569 | 144.807714522 | 290.95 | 50.0 | No |
| 1/4 mi | 13.4891291217 | 144.811091711 | 298.85 | 111.27 | No |
| 1/2 mi | 13.4906454865 | 144.8144689 | 334.43 | 144.88 | No |
| 3/4 mi | 13.4921618513 | 144.817846089 | 364.49 | 183.99 | No |
| 1 mi | 13.493678216 | 144.821223278 | 390.74 | 226.92 | No |
| 1 1/4 mi | 13.4951945808 | 144.824600468 | 350.32 | 336.52 | No |
| 1 1/2 mi | 13.4967109456 | 144.827977657 | 415.45 | 340.57 | No |
| 1 3/4 mi | 13.4982273104 | 144.831354846 | 425.23 | 399.98 | No |
| 2 mi | 13.4997436752 | 144.834732035 | 352.27 | 542.11 | No |

No glare found.





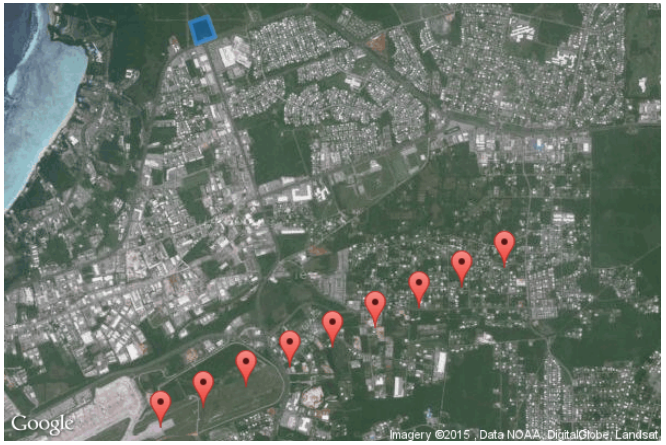
# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 2:45 p.m.

## Flight path: 24R

## No glare found

Print



## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 150.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.14 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5215513017 | 144.816316366 | 260.58 | 4.0 | 264.58 |
| 2 | 13.5210192969 | 144.814825058 | 258.85 | 4.0 | 262.85 |
| 3 | 13.5226570333 | 144.81434226 | 258.11 | 4.0 | 262.11 |
| 4 | 13.5231160147 | 144.81572628 | 270.0 | 4.0 | 274.0 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.491731124 | 144.812046289 | 305.52 | 50.0 | No |
| 1/4 mi | 13.4932503507 | 144.815422173 | 337.87 | 86.82 | No |
| 1/2 mi | 13.4947695774 | 144.818798057 | 374.97 | 118.91 | No |
| 3/4 mi | 13.4962888041 | 144.82217394 | 373.89 | 189.17 | No |
| 1 mi | 13.4978080309 | 144.825549824 | 380.28 | 251.95 | No |
| 1 1/4 mi | 13.4993272576 | 144.828925708 | 351.47 | 349.94 | No |
| 1 1/2 mi | 13.5008464843 | 144.832301591 | 268.52 | 502.06 | No |
| 1 3/4 mi | 13.5023657111 | 144.835677475 | 271.35 | 568.43 | No |
| 2 mi | 13.5038849378 | 144.839053359 | 283.63 | 625.32 | No |

No glare found.

# Solar Glare Hazard Analysis Report

Generated Jan. 13, 2015, 2:44 p.m.

## No glare found

Print

## Inputs

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 150.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |





| | |
|---|---|
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5215513017 | 144.816316366 | 260.58 | 4.0 | 264.58 |
| 2 | 13.5210192969 | 144.814825058 | 258.85 | 4.0 | 262.85 |
| 3 | 13.5226570333 | 144.81434226 | 258.11 | 4.0 | 262.11 |
| 4 | 13.5231160147 | 144.81572628 | 270.0 | 4.0 | 274.0 |

## Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) |
|---|---|---|---|---|
| 1 | 13.478828061 | 144.79699105 | 241.95 | 300.0 |

No glare found.







# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 7:11 p.m.

## Flight path: 2

## No glare found

Print

# Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 0.0 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

# Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.19 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





# PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5215513017 | 144.816316366 | 260.58 | 4.0 | 264.58 |
| 2 | 13.5210192969 | 144.814825058 | 258.85 | 4.0 | 262.85 |
| 3 | 13.5226570333 | 144.81434226 | 258.11 | 4.0 | 262.11 |
| 4 | 13.5231160147 | 144.81572628 | 270.0 | 4.0 | 274.0 |

# Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4876127569 | 144.807714522 | 290.95 | 50.0 | No |
| 1/4 mi | 13.4891291217 | 144.811091711 | 298.85 | 111.27 | No |
| 1/2 mi | 13.4906454865 | 144.8144689 | 334.43 | 144.88 | No |
| 3/4 mi | 13.4921618513 | 144.817846089 | 364.49 | 183.99 | No |
| 1 mi | 13.493678216 | 144.821223278 | 390.74 | 226.92 | No |
| 1 1/4 mi | 13.4951945808 | 144.824600468 | 350.32 | 336.52 | No |
| 1 1/2 mi | 13.4967109456 | 144.827977657 | 415.45 | 340.57 | No |
| 1 3/4 mi | 13.4982273104 | 144.831354846 | 425.23 | 399.98 | No |
| 2 mi | 13.4997436752 | 144.834732035 | 352.27 | 542.11 | No |

No glare found.

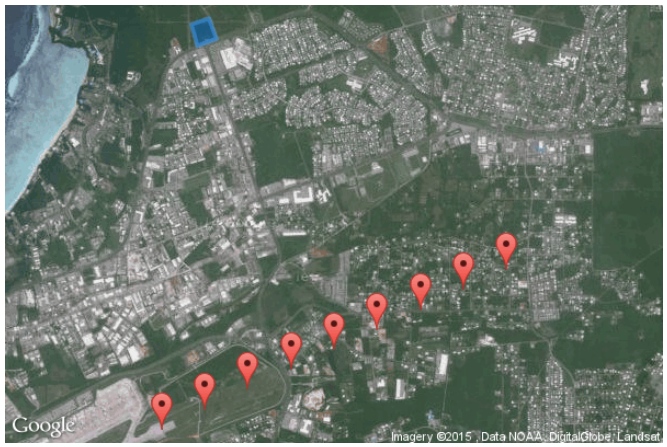
# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 2:57 p.m.

## Flight path: 24R

## No glare found

Print








## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.14 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5215513017 | 144.816316366 | 260.58 | 4.0 | 264.58 |
| 2 | 13.5210192969 | 144.814825058 | 258.85 | 4.0 | 262.85 |
| 3 | 13.5226570333 | 144.81434226 | 258.11 | 4.0 | 262.11 |
| 4 | 13.5231160147 | 144.81572628 | 270.0 | 4.0 | 274.0 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.491731124 | 144.812046289 | 305.52 | 50.0 | No |
| 1/4 mi | 13.4932503507 | 144.815422173 | 337.87 | 86.82 | No |
| 1/2 mi | 13.4947695774 | 144.818798057 | 374.97 | 118.91 | No |
| 3/4 mi | 13.4962888041 | 144.82217394 | 373.89 | 189.17 | No |
| 1 mi | 13.4978080309 | 144.825549824 | 380.28 | 251.95 | No |
| 1 1/4 mi | 13.4993272576 | 144.828925708 | 351.47 | 349.94 | No |
| 1 1/2 mi | 13.5008464843 | 144.832301591 | 268.52 | 502.06 | No |
| 1 3/4 mi | 13.5023657111 | 144.835677475 | 271.35 | 568.43 | No |
| 2 mi | 13.5038849378 | 144.839053359 | 283.63 | 625.32 | No |

No glare found.





# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 6:41 p.m.

## Flight path: 6L

## No glare found

Print

# Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 0.0 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

# Flight path parameters

| | |
|---|---|
| Direction (deg) | 64.94 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





# PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5215513017 | 144.816316366 | 260.58 | 4.0 | 264.58 |
| 2 | 13.5210192969 | 144.814825058 | 258.85 | 4.0 | 262.85 |
| 3 | 13.5226570333 | 144.81434226 | 258.11 | 4.0 | 262.11 |
| 4 | 13.5231160147 | 144.81572628 | 270.0 | 4.0 | 274.0 |

# Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4789245692 | 144.784057438 | 237.77 | 50.0 | No |
| 1/4 mi | 13.4773939063 | 144.780687216 | 208.62 | 148.32 | No |
| 1/2 mi | 13.4758632434 | 144.777316993 | 205.16 | 220.97 | No |
| 3/4 mi | 13.4743325805 | 144.773946771 | 175.68 | 319.62 | No |
| 1 mi | 13.4728019176 | 144.770576548 | 140.53 | 423.94 | No |
| 1 1/4 mi | 13.4712712546 | 144.767206326 | 74.93 | 558.73 | No |
| 1 1/2 mi | 13.4697405917 | 144.763836103 | 10.39 | 692.45 | No |
| 1 3/4 mi | 13.4682099288 | 144.760465881 | 13.44 | 758.59 | No |
| 2 mi | 13.4666792659 | 144.757095659 | 12.01 | 829.19 | No |

No glare found.

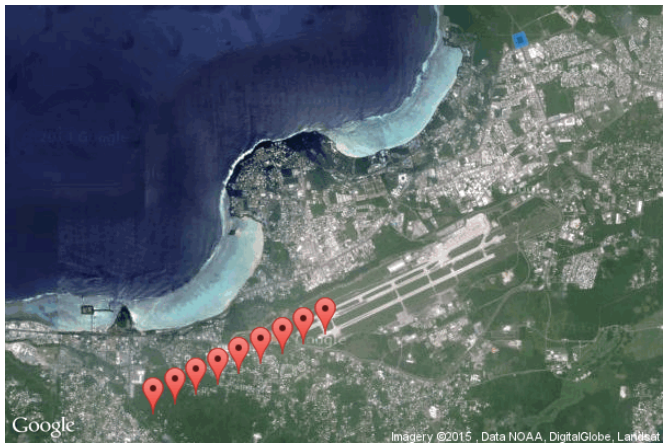
# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 6:41 p.m.

## Flight path: 6R

## No glare found

Print








## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 0.0 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 64.94 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5215513017 | 144.816316366 | 260.58 | 4.0 | 264.58 |
| 2 | 13.5210192969 | 144.814825058 | 258.85 | 4.0 | 262.85 |
| 3 | 13.5226570333 | 144.81434226 | 258.11 | 4.0 | 262.11 |
| 4 | 13.5231160147 | 144.81572628 | 270.0 | 4.0 | 274.0 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4771639403 | 144.78486076 | 229.31 | 50.0 | No |
| 1/4 mi | 13.4756332774 | 144.781490562 | 215.91 | 132.57 | No |
| 1/2 mi | 13.4741026145 | 144.778120365 | 195.79 | 221.88 | No |
| 3/4 mi | 13.4725719516 | 144.774750167 | 147.31 | 339.53 | No |
| 1 mi | 13.4710412887 | 144.771379969 | 112.33 | 443.69 | No |
| 1 1/4 mi | 13.4695106257 | 144.768009772 | 15.76 | 609.44 | No |
| 1 1/2 mi | 13.4679799628 | 144.764639574 | 31.29 | 663.09 | No |
| 1 3/4 mi | 13.4664492999 | 144.761269376 | 9.82 | 753.74 | No |
| 2 mi | 13.464918637 | 144.757899179 | 15.99 | 816.74 | No |

No glare found.





# Solar Glare Hazard Analysis Report

Generated Jan. 13, 2015, 2:56 p.m.

## No glare found

Print

## Inputs

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |

| | |
|---|---|
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5215513017 | 144.816316366 | 260.58 | 4.0 | 264.58 |
| 2 | 13.5210192969 | 144.814825058 | 258.85 | 4.0 | 262.85 |
| 3 | 13.5226570333 | 144.81434226 | 258.11 | 4.0 | 262.11 |
| 4 | 13.5231160147 | 144.81572628 | 270.0 | 4.0 | 274.0 |

## Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) |
|---|---|---|---|---|
| 1 | 13.478828061 | 144.79699105 | 241.95 | 300.0 |





# No glare found.

# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 5:07 p.m.

## Flight path: 24L

## No glare found

Print






## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.19 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5215513017 | 144.816316366 | 260.58 | 4.0 | 264.58 |
| 2 | 13.5210192969 | 144.814825058 | 258.85 | 4.0 | 262.85 |
| 3 | 13.5226570333 | 144.81434226 | 258.11 | 4.0 | 262.11 |
| 4 | 13.5231160147 | 144.81572628 | 270.0 | 4.0 | 274.0 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4876127569 | 144.807714522 | 290.95 | 50.0 | No |
| 1/4 mi | 13.4891291217 | 144.811091711 | 298.85 | 111.27 | No |
| 1/2 mi | 13.4906454865 | 144.8144689 | 334.43 | 144.88 | No |
| 3/4 mi | 13.4921618513 | 144.817846089 | 364.49 | 183.99 | No |
| 1 mi | 13.493678216 | 144.821223278 | 390.74 | 226.92 | No |
| 1 1/4 mi | 13.4951945808 | 144.824600468 | 350.32 | 336.52 | No |
| 1 1/2 mi | 13.4967109456 | 144.827977657 | 415.45 | 340.57 | No |
| 1 3/4 mi | 13.4982273104 | 144.831354846 | 425.23 | 399.98 | No |
| 2 mi | 13.4997436752 | 144.834732035 | 352.27 | 542.11 | No |

No glare found.





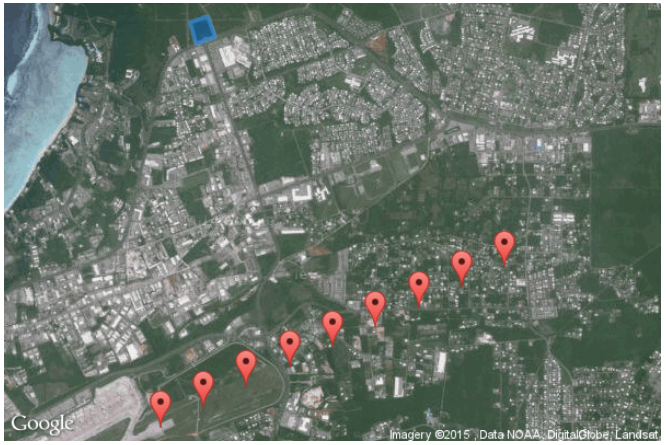
# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 5:07 p.m.

## Flight path: 24R

## No glare found

Print



## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.14 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5215513017 | 144.816316366 | 260.58 | 4.0 | 264.58 |
| 2 | 13.5210192969 | 144.814825058 | 258.85 | 4.0 | 262.85 |
| 3 | 13.5226570333 | 144.81434226 | 258.11 | 4.0 | 262.11 |
| 4 | 13.5231160147 | 144.81572628 | 270.0 | 4.0 | 274.0 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.491731124 | 144.812046289 | 305.52 | 50.0 | No |
| 1/4 mi | 13.4932503507 | 144.815422173 | 337.87 | 86.82 | No |
| 1/2 mi | 13.4947695774 | 144.818798057 | 374.97 | 118.91 | No |
| 3/4 mi | 13.4962888041 | 144.82217394 | 373.89 | 189.17 | No |
| 1 mi | 13.4978080309 | 144.825549824 | 380.28 | 251.95 | No |
| 1 1/4 mi | 13.4993272576 | 144.828925708 | 351.47 | 349.94 | No |
| 1 1/2 mi | 13.5008464843 | 144.832301591 | 268.52 | 502.06 | No |
| 1 3/4 mi | 13.5023657111 | 144.835677475 | 271.35 | 568.43 | No |
| 2 mi | 13.5038849378 | 144.839053359 | 283.63 | 625.32 | No |

No glare found.

# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 6:19 p.m.

## Flight path: 6L

## No glare found

Print






## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 0.0 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 64.94 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5215513017 | 144.816316366 | 260.58 | 4.0 | 264.58 |
| 2 | 13.5210192969 | 144.814825058 | 258.85 | 4.0 | 262.85 |
| 3 | 13.5226570333 | 144.81434226 | 258.11 | 4.0 | 262.11 |
| 4 | 13.5231160147 | 144.81572628 | 270.0 | 4.0 | 274.0 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4789245692 | 144.784057438 | 237.77 | 50.0 | No |
| 1/4 mi | 13.4773939063 | 144.780687216 | 208.62 | 148.32 | No |
| 1/2 mi | 13.4758632434 | 144.777316993 | 205.16 | 220.97 | No |
| 3/4 mi | 13.4743325805 | 144.773946771 | 175.68 | 319.62 | No |
| 1 mi | 13.4728019176 | 144.770576548 | 140.53 | 423.94 | No |
| 1 1/4 mi | 13.4712712546 | 144.767206326 | 74.93 | 558.73 | No |
| 1 1/2 mi | 13.4697405917 | 144.763836103 | 10.39 | 692.45 | No |
| 1 3/4 mi | 13.4682099288 | 144.760465881 | 13.44 | 758.59 | No |
| 2 mi | 13.4666792659 | 144.757095659 | 12.01 | 829.19 | No |

No glare found.





# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 6:19 p.m.

## Flight path: 6R

## No glare found

Print

## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 0.0 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 64.94 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5215513017 | 144.816316366 | 260.58 | 4.0 | 264.58 |
| 2 | 13.5210192969 | 144.814825058 | 258.85 | 4.0 | 262.85 |
| 3 | 13.5226570333 | 144.81434226 | 258.11 | 4.0 | 262.11 |
| 4 | 13.5231160147 | 144.81572628 | 270.0 | 4.0 | 274.0 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4771639403 | 144.78486076 | 229.31 | 50.0 | No |
| 1/4 mi | 13.4756332774 | 144.781490562 | 215.91 | 132.57 | No |
| 1/2 mi | 13.4741026145 | 144.778120365 | 195.79 | 221.88 | No |
| 3/4 mi | 13.4725719516 | 144.774750167 | 147.31 | 339.53 | No |
| 1 mi | 13.4710412887 | 144.771379969 | 112.33 | 443.69 | No |
| 1 1/4 mi | 13.4695106257 | 144.768009772 | 15.76 | 609.44 | No |
| 1 1/2 mi | 13.4679799628 | 144.764639574 | 31.29 | 663.09 | No |
| 1 3/4 mi | 13.4664492999 | 144.761269376 | 9.82 | 753.74 | No |
| 2 mi | 13.464918637 | 144.757899179 | 15.99 | 816.74 | No |

No glare found.

# Solar Glare Hazard Analysis Report

Generated Jan. 13, 2015, 5:06 p.m.

## No glare found

Print

## Inputs

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |





| | |
|---|---|
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5215513017 | 144.816316366 | 260.58 | 4.0 | 264.58 |
| 2 | 13.5210192969 | 144.814825058 | 258.85 | 4.0 | 262.85 |
| 3 | 13.5226570333 | 144.81434226 | 258.11 | 4.0 | 262.11 |
| 4 | 13.5231160147 | 144.81572628 | 270.0 | 4.0 | 274.0 |

## Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) |
|---|---|---|---|---|
| 1 | 13.478828061 | 144.79699105 | 241.95 | 300.0 |

No glare found.







# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 8:59 p.m.

## Flight path: 24L

## No glare found

Print

# Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 150.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

# Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.19 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





# PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.551466834 | 144.831669331 | 330.22 | 4.0 | 334.22 |
| 2 | 13.5512790914 | 144.832892418 | 343.26 | 4.0 | 347.26 |
| 3 | 13.5500066094 | 144.832634926 | 340.8 | 4.0 | 344.8 |
| 4 | 13.547232158 | 144.831433296 | 331.56 | 4.0 | 335.56 |
| 5 | 13.5462517051 | 144.833278656 | 347.23 | 4.0 | 351.23 |
| 6 | 13.549985749 | 144.835252762 | 364.84 | 4.0 | 368.84 |
| 7 | 13.5495268194 | 144.836046696 | 372.43 | 4.0 | 376.43 |
| 8 | 13.5458553506 | 144.834222794 | 355.16 | 4.0 | 359.16 |
| 9 | 13.5422255473 | 144.833192825 | 336.65 | 4.0 | 340.65 |
| 10 | 13.5430182677 | 144.830725193 | 329.45 | 4.0 | 333.45 |
| 11 | 13.5436858197 | 144.829759598 | 320.72 | 4.0 | 324.72 |
| 12 | 13.5443533698 | 144.829545021 | 317.34 | 4.0 | 321.34 |
| 13 | 13.5448331702 | 144.830231667 | 313.44 | 4.0 | 317.44 |
| 14 | 13.5454172738 | 144.83093977 | 311.36 | 4.0 | 315.36 |
| 15 | 13.5462517051 | 144.830703735 | 314.68 | 4.0 | 318.68 |
| 16 | 13.5466063375 | 144.830338955 | 316.97 | 4.0 | 320.97 |
| 17 | 13.5485255154 | 144.830510616 | 331.58 | 4.0 | 335.58 |
| 18 | 13.5504655381 | 144.830918312 | 331.74 | 4.0 | 335.74 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4876127569 | 144.807714522 | 290.95 | 50.0 | No |
| 1/4 mi | 13.4891291217 | 144.811091711 | 298.85 | 111.27 | No |
| 1/2 mi | 13.4906454865 | 144.8144689 | 334.43 | 144.88 | No |
| 3/4 mi | 13.4921618513 | 144.817846089 | 364.49 | 183.99 | No |
| 1 mi | 13.493678216 | 144.821223278 | 390.74 | 226.92 | No |
| 1 1/4 mi | 13.4951945808 | 144.824600468 | 350.32 | 336.52 | No |
| 1 1/2 mi | 13.4967109456 | 144.827977657 | 415.45 | 340.57 | No |
| 1 3/4 mi | 13.4982273104 | 144.831354846 | 425.23 | 399.98 | No |
| 2 mi | 13.4997436752 | 144.834732035 | 352.27 | 542.11 | No |

No glare found.







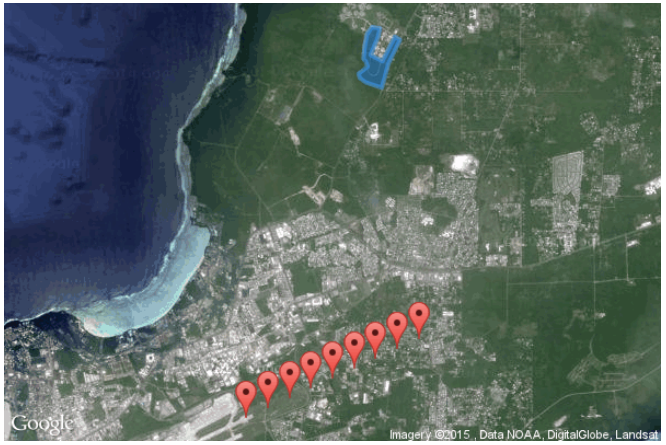
# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 8:58 p.m.

## Flight path: 24R

## No glare found

Print



# Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 150.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

# Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.14 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





# PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.551466834 | 144.831669331 | 330.22 | 4.0 | 334.22 |
| 2 | 13.5512790914 | 144.832892418 | 343.26 | 4.0 | 347.26 |
| 3 | 13.5500066094 | 144.832634926 | 340.8 | 4.0 | 344.8 |
| 4 | 13.547232158 | 144.831433296 | 331.56 | 4.0 | 335.56 |
| 5 | 13.5462517051 | 144.833278656 | 347.23 | 4.0 | 351.23 |
| 6 | 13.549985749 | 144.835252762 | 364.84 | 4.0 | 368.84 |
| 7 | 13.5495268194 | 144.836046696 | 372.43 | 4.0 | 376.43 |
| 8 | 13.5458553506 | 144.834222794 | 355.16 | 4.0 | 359.16 |
| 9 | 13.5422255473 | 144.833192825 | 336.65 | 4.0 | 340.65 |
| 10 | 13.5430182677 | 144.830725193 | 329.45 | 4.0 | 333.45 |
| 11 | 13.5436858197 | 144.829759598 | 320.72 | 4.0 | 324.72 |
| 12 | 13.5443533698 | 144.829545021 | 317.34 | 4.0 | 321.34 |
| 13 | 13.5448331702 | 144.830231667 | 313.44 | 4.0 | 317.44 |
| 14 | 13.5454172738 | 144.83093977 | 311.36 | 4.0 | 315.36 |
| 15 | 13.5462517051 | 144.830703735 | 314.68 | 4.0 | 318.68 |
| 16 | 13.5466063375 | 144.830338955 | 316.97 | 4.0 | 320.97 |
| 17 | 13.5485255154 | 144.830510616 | 331.58 | 4.0 | 335.58 |
| 18 | 13.5504655381 | 144.830918312 | 331.74 | 4.0 | 335.74 |

# Solar Glare Hazard Analysis Report

Generated Jan. 13, 2015, 8:58 p.m.

## No glare found

Print


## Inputs

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 150.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |





## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.491731124 | 144.812046289 | 305.52 | 50.0 | No |
| 1/4 mi | 13.4932503507 | 144.815422173 | 337.87 | 86.82 | No |
| 1/2 mi | 13.4947695774 | 144.818798057 | 374.97 | 118.91 | No |
| 3/4 mi | 13.4962888041 | 144.82217394 | 373.89 | 189.17 | No |
| 1 mi | 13.4978080309 | 144.825549824 | 380.28 | 251.95 | No |
| 1 1/4 mi | 13.4993272576 | 144.828925708 | 351.47 | 349.94 | No |
| 1 1/2 mi | 13.5008464843 | 144.832301591 | 268.52 | 502.06 | No |
| 1 3/4 mi | 13.5023657111 | 144.835677475 | 271.35 | 568.43 | No |
| 2 mi | 13.5038849378 | 144.839053359 | 283.63 | 625.32 | No |

No glare found.

| | |
|---|---|
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.551466834 | 144.831669331 | 330.22 | 4.0 | 334.22 |
| 2 | 13.5512790914 | 144.832892418 | 343.26 | 4.0 | 347.26 |
| 3 | 13.5500066094 | 144.832634926 | 340.8 | 4.0 | 344.8 |
| 4 | 13.547232158 | 144.831433296 | 331.56 | 4.0 | 335.56 |
| 5 | 13.5462517051 | 144.833278656 | 347.23 | 4.0 | 351.23 |
| 6 | 13.549985749 | 144.835252762 | 364.84 | 4.0 | 368.84 |
| 7 | 13.5495268194 | 144.836046696 | 372.43 | 4.0 | 376.43 |
| 8 | 13.5458553506 | 144.834222794 | 355.16 | 4.0 | 359.16 |
| 9 | 13.5422255473 | 144.833192825 | 336.65 | 4.0 | 340.65 |
| 10 | 13.5430182677 | 144.830725193 | 329.45 | 4.0 | 333.45 |





| | | | | | |
|---|---|---|---|---|---|
| 11 | 13.5436858197 | 144.829759598 | 320.72 | 4.0 | 324.72 |
| 12 | 13.5443533698 | 144.829545021 | 317.34 | 4.0 | 321.34 |
| 13 | 13.5448331702 | 144.830231667 | 313.44 | 4.0 | 317.44 |
| 14 | 13.5454172738 | 144.83093977 | 311.36 | 4.0 | 315.36 |
| 15 | 13.5462517051 | 144.830703735 | 314.68 | 4.0 | 318.68 |
| 16 | 13.5466063375 | 144.830338955 | 316.97 | 4.0 | 320.97 |
| 17 | 13.5485255154 | 144.830510616 | 331.58 | 4.0 | 335.58 |
| 18 | 13.5504655381 | 144.830918312 | 331.74 | 4.0 | 335.74 |

## Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) |
|---|---|---|---|---|
| 1 | 13.478828061 | 144.79699105 | 241.95 | 300.0 |

## No glare found.

# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 7:11 p.m.

## Flight path: 24L

## No glare found

Print






## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.19 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.551466834 | 144.831669331 | 330.22 | 4.0 | 334.22 |
| 2 | 13.5512790914 | 144.832892418 | 343.26 | 4.0 | 347.26 |
| 3 | 13.5500066094 | 144.832634926 | 340.8 | 4.0 | 344.8 |
| 4 | 13.547232158 | 144.831433296 | 331.56 | 4.0 | 335.56 |
| 5 | 13.5462517051 | 144.833278656 | 347.23 | 4.0 | 351.23 |
| 6 | 13.549985749 | 144.835252762 | 364.84 | 4.0 | 368.84 |
| 7 | 13.5495268194 | 144.836046696 | 372.43 | 4.0 | 376.43 |
| 8 | 13.5458553506 | 144.834222794 | 355.16 | 4.0 | 359.16 |
| 9 | 13.5422255473 | 144.833192825 | 336.65 | 4.0 | 340.65 |
| 10 | 13.5430182677 | 144.830725193 | 329.45 | 4.0 | 333.45 |
| 11 | 13.5436858197 | 144.829759598 | 320.72 | 4.0 | 324.72 |
| 12 | 13.5443533698 | 144.829545021 | 317.34 | 4.0 | 321.34 |
| 13 | 13.5448331702 | 144.830231667 | 313.44 | 4.0 | 317.44 |
| 14 | 13.5454172738 | 144.83093977 | 311.36 | 4.0 | 315.36 |
| 15 | 13.5462517051 | 144.830703735 | 314.68 | 4.0 | 318.68 |
| 16 | 13.5466063375 | 144.830338955 | 316.97 | 4.0 | 320.97 |
| 17 | 13.5485255154 | 144.830510616 | 331.58 | 4.0 | 335.58 |
| 18 | 13.5504655381 | 144.830918312 | 331.74 | 4.0 | 335.74 |





## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4876127569 | 144.807714522 | 290.95 | 50.0 | No |
| 1/4 mi | 13.4891291217 | 144.811091711 | 298.85 | 111.27 | No |
| 1/2 mi | 13.4906454865 | 144.8144689 | 334.43 | 144.88 | No |
| 3/4 mi | 13.4921618513 | 144.817846089 | 364.49 | 183.99 | No |
| 1 mi | 13.493678216 | 144.821223278 | 390.74 | 226.92 | No |
| 1 1/4 mi | 13.4951945808 | 144.824600468 | 350.32 | 336.52 | No |
| 1 1/2 mi | 13.4967109456 | 144.827977657 | 415.45 | 340.57 | No |
| 1 3/4 mi | 13.4982273104 | 144.831354846 | 425.23 | 399.98 | No |
| 2 mi | 13.4997436752 | 144.834732035 | 352.27 | 542.11 | No |

No glare found.

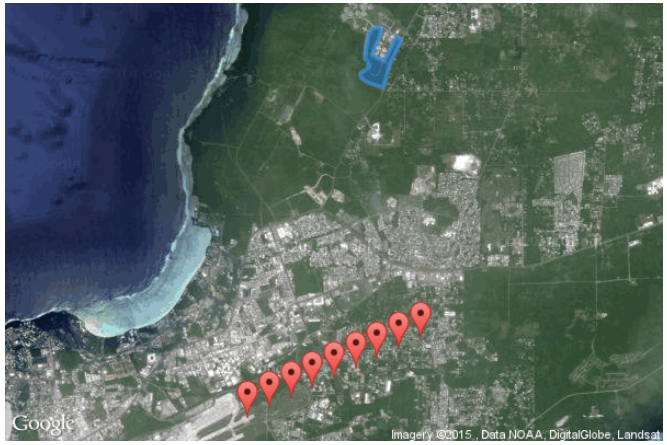
# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 7:10 p.m.

## Flight path: 24R

## No glare found

Print








## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.14 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.551466834 | 144.831669331 | 330.22 | 4.0 | 334.22 |
| 2 | 13.5512790914 | 144.832892418 | 343.26 | 4.0 | 347.26 |
| 3 | 13.5500066094 | 144.832634926 | 340.8 | 4.0 | 344.8 |
| 4 | 13.547232158 | 144.831433296 | 331.56 | 4.0 | 335.56 |
| 5 | 13.5462517051 | 144.833278656 | 347.23 | 4.0 | 351.23 |
| 6 | 13.549985749 | 144.835252762 | 364.84 | 4.0 | 368.84 |
| 7 | 13.5495268194 | 144.836046696 | 372.43 | 4.0 | 376.43 |
| 8 | 13.5458553506 | 144.834222794 | 355.16 | 4.0 | 359.16 |
| 9 | 13.5422255473 | 144.833192825 | 336.65 | 4.0 | 340.65 |
| 10 | 13.5430182677 | 144.830725193 | 329.45 | 4.0 | 333.45 |
| 11 | 13.5436858197 | 144.829759598 | 320.72 | 4.0 | 324.72 |
| 12 | 13.5443533698 | 144.829545021 | 317.34 | 4.0 | 321.34 |
| 13 | 13.5448331702 | 144.830231667 | 313.44 | 4.0 | 317.44 |
| 14 | 13.5454172738 | 144.83093977 | 311.36 | 4.0 | 315.36 |
| 15 | 13.5462517051 | 144.830703735 | 314.68 | 4.0 | 318.68 |
| 16 | 13.5466063375 | 144.830338955 | 316.97 | 4.0 | 320.97 |
| 17 | 13.5485255154 | 144.830510616 | 331.58 | 4.0 | 335.58 |
| 18 | 13.5504655381 | 144.830918312 | 331.74 | 4.0 | 335.74 |





## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.491731124 | 144.812046289 | 305.52 | 50.0 | No |
| 1/4 mi | 13.4932503507 | 144.815422173 | 337.87 | 86.82 | No |
| 1/2 mi | 13.4947695774 | 144.818798057 | 374.97 | 118.91 | No |
| 3/4 mi | 13.4962888041 | 144.82217394 | 373.89 | 189.17 | No |
| 1 mi | 13.4978080309 | 144.825549824 | 380.28 | 251.95 | No |
| 1 1/4 mi | 13.4993272576 | 144.828925708 | 351.47 | 349.94 | No |
| 1 1/2 mi | 13.5008464843 | 144.832301591 | 268.52 | 502.06 | No |
| 1 3/4 mi | 13.5023657111 | 144.835677475 | 271.35 | 568.43 | No |
| 2 mi | 13.5038849378 | 144.839053359 | 283.63 | 625.32 | No |

No glare found.

# Solar Glare Hazard Analysis Report

Generated Jan. 13, 2015, 7:09 p.m.

## No glare found

Print


## Inputs

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |





| | |
|---|---|
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.551466834 | 144.831669331 | 330.22 | 4.0 | 334.22 |
| 2 | 13.5512790914 | 144.832892418 | 343.26 | 4.0 | 347.26 |
| 3 | 13.5500066094 | 144.832634926 | 340.8 | 4.0 | 344.8 |
| 4 | 13.547232158 | 144.831433296 | 331.56 | 4.0 | 335.56 |
| 5 | 13.5462517051 | 144.833278656 | 347.23 | 4.0 | 351.23 |
| 6 | 13.549985749 | 144.835252762 | 364.84 | 4.0 | 368.84 |
| 7 | 13.5495268194 | 144.836046696 | 372.43 | 4.0 | 376.43 |
| 8 | 13.5458553506 | 144.834222794 | 355.16 | 4.0 | 359.16 |
| 9 | 13.5422255473 | 144.833192825 | 336.65 | 4.0 | 340.65 |
| 10 | 13.5430182677 | 144.830725193 | 329.45 | 4.0 | 333.45 |

| | | | | | |
|---|---|---|---|---|---|
| 11 | 13.5436858197 | 144.829759598 | 320.72 | 4.0 | 324.72 |
| 12 | 13.5443533698 | 144.829545021 | 317.34 | 4.0 | 321.34 |
| 13 | 13.5448331702 | 144.830231667 | 313.44 | 4.0 | 317.44 |
| 14 | 13.5454172738 | 144.83093977 | 311.36 | 4.0 | 315.36 |
| 15 | 13.5462517051 | 144.830703735 | 314.68 | 4.0 | 318.68 |
| 16 | 13.5466063375 | 144.830338955 | 316.97 | 4.0 | 320.97 |
| 17 | 13.5485255154 | 144.830510616 | 331.58 | 4.0 | 335.58 |
| 18 | 13.5504655381 | 144.830918312 | 331.74 | 4.0 | 335.74 |

## Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) |
|---|---|---|---|---|
| 1 | 13.478828061 | 144.79699105 | 241.95 | 300.0 |

## No glare found.







# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 9:14 p.m.

## Flight path: 24L

## No glare found

Print

# Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

# Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.19 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





# PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.551466834 | 144.831669331 | 330.22 | 4.0 | 334.22 |
| 2 | 13.5512790914 | 144.832892418 | 343.26 | 4.0 | 347.26 |
| 3 | 13.5500066094 | 144.832634926 | 340.8 | 4.0 | 344.8 |
| 4 | 13.547232158 | 144.831433296 | 331.56 | 4.0 | 335.56 |
| 5 | 13.5462517051 | 144.833278656 | 347.23 | 4.0 | 351.23 |
| 6 | 13.549985749 | 144.835252762 | 364.84 | 4.0 | 368.84 |
| 7 | 13.5495268194 | 144.836046696 | 372.43 | 4.0 | 376.43 |
| 8 | 13.5458553506 | 144.834222794 | 355.16 | 4.0 | 359.16 |
| 9 | 13.5422255473 | 144.833192825 | 336.65 | 4.0 | 340.65 |
| 10 | 13.5430182677 | 144.830725193 | 329.45 | 4.0 | 333.45 |
| 11 | 13.5436858197 | 144.829759598 | 320.72 | 4.0 | 324.72 |
| 12 | 13.5443533698 | 144.829545021 | 317.34 | 4.0 | 321.34 |
| 13 | 13.5448331702 | 144.830231667 | 313.44 | 4.0 | 317.44 |
| 14 | 13.5454172738 | 144.83093977 | 311.36 | 4.0 | 315.36 |
| 15 | 13.5462517051 | 144.830703735 | 314.68 | 4.0 | 318.68 |
| 16 | 13.5466063375 | 144.830338955 | 316.97 | 4.0 | 320.97 |
| 17 | 13.5485255154 | 144.830510616 | 331.58 | 4.0 | 335.58 |
| 18 | 13.5504655381 | 144.830918312 | 331.74 | 4.0 | 335.74 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4876127569 | 144.807714522 | 290.95 | 50.0 | No |
| 1/4 mi | 13.4891291217 | 144.811091711 | 298.85 | 111.27 | No |
| 1/2 mi | 13.4906454865 | 144.8144689 | 334.43 | 144.88 | No |
| 3/4 mi | 13.4921618513 | 144.817846089 | 364.49 | 183.99 | No |
| 1 mi | 13.493678216 | 144.821223278 | 390.74 | 226.92 | No |
| 1 1/4 mi | 13.4951945808 | 144.824600468 | 350.32 | 336.52 | No |
| 1 1/2 mi | 13.4967109456 | 144.827977657 | 415.45 | 340.57 | No |
| 1 3/4 mi | 13.4982273104 | 144.831354846 | 425.23 | 399.98 | No |
| 2 mi | 13.4997436752 | 144.834732035 | 352.27 | 542.11 | No |

No glare found.







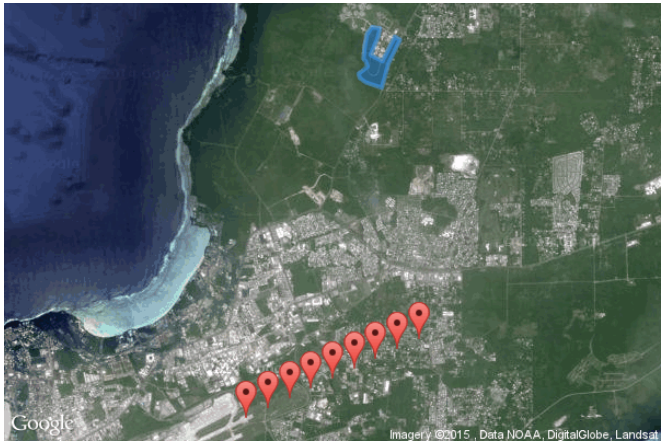
# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 9:13 p.m.

## Flight path: 24R

## No glare found

Print



# Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

# Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.14 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





# PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.551466834 | 144.831669331 | 330.22 | 4.0 | 334.22 |
| 2 | 13.5512790914 | 144.832892418 | 343.26 | 4.0 | 347.26 |
| 3 | 13.5500066094 | 144.832634926 | 340.8 | 4.0 | 344.8 |
| 4 | 13.547232158 | 144.831433296 | 331.56 | 4.0 | 335.56 |
| 5 | 13.5462517051 | 144.833278656 | 347.23 | 4.0 | 351.23 |
| 6 | 13.549985749 | 144.835252762 | 364.84 | 4.0 | 368.84 |
| 7 | 13.5495268194 | 144.836046696 | 372.43 | 4.0 | 376.43 |
| 8 | 13.5458553506 | 144.834222794 | 355.16 | 4.0 | 359.16 |
| 9 | 13.5422255473 | 144.833192825 | 336.65 | 4.0 | 340.65 |
| 10 | 13.5430182677 | 144.830725193 | 329.45 | 4.0 | 333.45 |
| 11 | 13.5436858197 | 144.829759598 | 320.72 | 4.0 | 324.72 |
| 12 | 13.5443533698 | 144.829545021 | 317.34 | 4.0 | 321.34 |
| 13 | 13.5448331702 | 144.830231667 | 313.44 | 4.0 | 317.44 |
| 14 | 13.5454172738 | 144.83093977 | 311.36 | 4.0 | 315.36 |
| 15 | 13.5462517051 | 144.830703735 | 314.68 | 4.0 | 318.68 |
| 16 | 13.5466063375 | 144.830338955 | 316.97 | 4.0 | 320.97 |
| 17 | 13.5485255154 | 144.830510616 | 331.58 | 4.0 | 335.58 |
| 18 | 13.5504655381 | 144.830918312 | 331.74 | 4.0 | 335.74 |

# Solar Glare Hazard Analysis Report

Generated Jan. 13, 2015, 9:13 p.m.

## No glare found

Print


## Inputs

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |





## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.491731124 | 144.812046289 | 305.52 | 50.0 | No |
| 1/4 mi | 13.4932503507 | 144.815422173 | 337.87 | 86.82 | No |
| 1/2 mi | 13.4947695774 | 144.818798057 | 374.97 | 118.91 | No |
| 3/4 mi | 13.4962888041 | 144.82217394 | 373.89 | 189.17 | No |
| 1 mi | 13.4978080309 | 144.825549824 | 380.28 | 251.95 | No |
| 1 1/4 mi | 13.4993272576 | 144.828925708 | 351.47 | 349.94 | No |
| 1 1/2 mi | 13.5008464843 | 144.832301591 | 268.52 | 502.06 | No |
| 1 3/4 mi | 13.5023657111 | 144.835677475 | 271.35 | 568.43 | No |
| 2 mi | 13.5038849378 | 144.839053359 | 283.63 | 625.32 | No |

No glare found.

| | |
|---|---|
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.551466834 | 144.831669331 | 330.22 | 4.0 | 334.22 |
| 2 | 13.5512790914 | 144.832892418 | 343.26 | 4.0 | 347.26 |
| 3 | 13.5500066094 | 144.832634926 | 340.8 | 4.0 | 344.8 |
| 4 | 13.547232158 | 144.831433296 | 331.56 | 4.0 | 335.56 |
| 5 | 13.5462517051 | 144.833278656 | 347.23 | 4.0 | 351.23 |
| 6 | 13.549985749 | 144.835252762 | 364.84 | 4.0 | 368.84 |
| 7 | 13.5495268194 | 144.836046696 | 372.43 | 4.0 | 376.43 |
| 8 | 13.5458553506 | 144.834222794 | 355.16 | 4.0 | 359.16 |
| 9 | 13.5422255473 | 144.833192825 | 336.65 | 4.0 | 340.65 |
| 10 | 13.5430182677 | 144.830725193 | 329.45 | 4.0 | 333.45 |





| | | | | | |
|---|---|---|---|---|---|
| 11 | 13.5436858197 | 144.829759598 | 320.72 | 4.0 | 324.72 |
| 12 | 13.5443533698 | 144.829545021 | 317.34 | 4.0 | 321.34 |
| 13 | 13.5448331702 | 144.830231667 | 313.44 | 4.0 | 317.44 |
| 14 | 13.5454172738 | 144.83093977 | 311.36 | 4.0 | 315.36 |
| 15 | 13.5462517051 | 144.830703735 | 314.68 | 4.0 | 318.68 |
| 16 | 13.5466063375 | 144.830338955 | 316.97 | 4.0 | 320.97 |
| 17 | 13.5485255154 | 144.830510616 | 331.58 | 4.0 | 335.58 |
| 18 | 13.5504655381 | 144.830918312 | 331.74 | 4.0 | 335.74 |

## Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) |
|---|---|---|---|---|
| 1 | 13.478828061 | 144.79699105 | 241.95 | 300.0 |

## No glare found.

# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 2:19 p.m.

## Flight path: 2

## No glare found

Print






## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 150.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.19 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5196944955 | 144.812529087 | 239.79 | 4.0 | 243.79 |
| 2 | 13.5207793728 | 144.811048508 | 257.77 | 4.0 | 261.77 |
| 3 | 13.51898515 | 144.810597897 | 221.59 | 4.0 | 225.59 |
| 4 | 13.5178168117 | 144.810061455 | 229.67 | 4.0 | 233.67 |
| 5 | 13.5172952302 | 144.80909586 | 187.01 | 4.0 | 191.01 |
| 6 | 13.5163981074 | 144.810279031 | 217.15 | 4.0 | 221.15 |
| 7 | 13.5166693309 | 144.811544034 | 227.5 | 4.0 | 231.5 |
| 8 | 13.5182236444 | 144.811823984 | 230.36 | 4.0 | 234.36 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4876127569 | 144.807714522 | 290.95 | 50.0 | No |
| 1/4 mi | 13.4891291217 | 144.811091711 | 298.85 | 111.27 | No |
| 1/2 mi | 13.4906454865 | 144.8144689 | 334.43 | 144.88 | No |
| 3/4 mi | 13.4921618513 | 144.817846089 | 364.49 | 183.99 | No |
| 1 mi | 13.493678216 | 144.821223278 | 390.74 | 226.92 | No |
| 1 1/4 mi | 13.4951945808 | 144.824600468 | 350.32 | 336.52 | No |
| 1 1/2 mi | 13.4967109456 | 144.827977657 | 415.45 | 340.57 | No |
| 1 3/4 mi | 13.4982273104 | 144.831354846 | 425.23 | 399.98 | No |





| | | | | | |
|---|---|---|---|---|---|
| 2 mi | 13.4997436752 | 144.834732035 | 352.27 | 542.11 | No |

No glare found.

# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 13, 2015, 2:19 p.m.

## Flight path: 1

## Glare found

Print






## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 150.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.14 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5196944955 | 144.812529087 | 239.79 | 4.0 | 243.79 |
| 2 | 13.5207793728 | 144.811048508 | 257.77 | 4.0 | 261.77 |
| 3 | 13.51898515 | 144.810597897 | 221.59 | 4.0 | 225.59 |
| 4 | 13.5178168117 | 144.810061455 | 229.67 | 4.0 | 233.67 |
| 5 | 13.5172952302 | 144.80909586 | 187.01 | 4.0 | 191.01 |
| 6 | 13.5163981074 | 144.810279031 | 217.15 | 4.0 | 221.15 |
| 7 | 13.5166693309 | 144.811544034 | 227.5 | 4.0 | 231.5 |
| 8 | 13.5182236444 | 144.811823984 | 230.36 | 4.0 | 234.36 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.491731124 | 144.812046289 | 305.52 | 50.0 | No |
| 1/4 mi | 13.4932503507 | 144.815422173 | 337.87 | 86.82 | No |
| 1/2 mi | 13.4947695774 | 144.818798057 | 374.97 | 118.91 | No |
| 3/4 mi | 13.4962888041 | 144.82217394 | 373.89 | 189.17 | No |
| 1 mi | 13.4978080309 | 144.825549824 | 380.28 | 251.95 | No |
| 1 1/4 mi | 13.4993272576 | 144.828925708 | 351.47 | 349.94 | No |
| 1 1/2 mi | 13.5008464843 | 144.832301591 | 268.52 | 502.06 | No |
| 1 3/4 mi | 13.5023657111 | 144.835677475 | 271.35 | 568.43 | No |



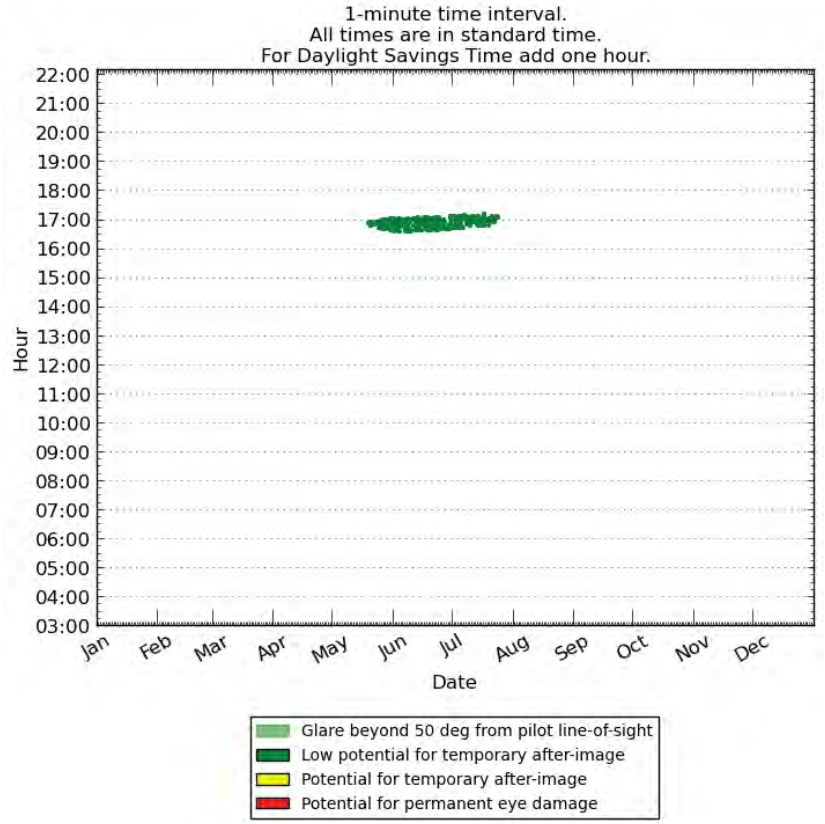


| | | | | | |
|---|---|---|---|---|---|
| 2 mi | 13.5038849378 | 144.839053359 | 283.63 | 625.32 | Yes |

## Glare occurrence plots

All times are in standard time. For Daylight Savings Time add one hour.

2 mi










# Solar Glare Hazard Analysis Report

Generated Jan. 13, 2015, 2:18 p.m.

## No glare found

Print

## Inputs

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 150.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |

| | |
|---|---|
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5196944955 | 144.812529087 | 239.79 | 4.0 | 243.79 |
| 2 | 13.5207793728 | 144.811048508 | 257.77 | 4.0 | 261.77 |
| 3 | 13.51898515 | 144.810597897 | 221.59 | 4.0 | 225.59 |
| 4 | 13.5178168117 | 144.810061455 | 229.67 | 4.0 | 233.67 |
| 5 | 13.5172952302 | 144.80909586 | 187.01 | 4.0 | 191.01 |
| 6 | 13.5163981074 | 144.810279031 | 217.15 | 4.0 | 221.15 |
| 7 | 13.5166693309 | 144.811544034 | 227.5 | 4.0 | 231.5 |
| 8 | 13.5182236444 | 144.811823984 | 230.36 | 4.0 | 234.36 |





## Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) |
|---|---|---|---|---|
| 1 | 13.478828061 | 144.79699105 | 241.95 | 300.0 |

## No glare found.

# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 7:08 p.m.

## Flight path: 2

## No glare found

Print






## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.19 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5196944955 | 144.812529087 | 239.79 | 4.0 | 243.79 |
| 2 | 13.5207793728 | 144.811048508 | 257.77 | 4.0 | 261.77 |
| 3 | 13.51898515 | 144.810597897 | 221.59 | 4.0 | 225.59 |
| 4 | 13.5178168117 | 144.810061455 | 229.67 | 4.0 | 233.67 |
| 5 | 13.5172952302 | 144.80909586 | 187.01 | 4.0 | 191.01 |
| 6 | 13.5163981074 | 144.810279031 | 217.15 | 4.0 | 221.15 |
| 7 | 13.5166693309 | 144.811544034 | 227.5 | 4.0 | 231.5 |
| 8 | 13.5182236444 | 144.811823984 | 230.36 | 4.0 | 234.36 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4876127569 | 144.807714522 | 290.95 | 50.0 | No |
| 1/4 mi | 13.4891291217 | 144.811091711 | 298.85 | 111.27 | No |
| 1/2 mi | 13.4906454865 | 144.8144689 | 334.43 | 144.88 | No |
| 3/4 mi | 13.4921618513 | 144.817846089 | 364.49 | 183.99 | No |
| 1 mi | 13.493678216 | 144.821223278 | 390.74 | 226.92 | No |
| 1 1/4 mi | 13.4951945808 | 144.824600468 | 350.32 | 336.52 | No |
| 1 1/2 mi | 13.4967109456 | 144.827977657 | 415.45 | 340.57 | No |
| 1 3/4 mi | 13.4982273104 | 144.831354846 | 425.23 | 399.98 | No |





| | | | | | |
|---|---|---|---|---|---|
| 2 mi | 13.4997436752 | 144.834732035 | 352.27 | 542.11 | No |

No glare found.

# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 7:08 p.m.

## Flight path: 1

## Glare found

Print






## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.14 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5196944955 | 144.812529087 | 239.79 | 4.0 | 243.79 |
| 2 | 13.5207793728 | 144.811048508 | 257.77 | 4.0 | 261.77 |
| 3 | 13.51898515 | 144.810597897 | 221.59 | 4.0 | 225.59 |
| 4 | 13.5178168117 | 144.810061455 | 229.67 | 4.0 | 233.67 |
| 5 | 13.5172952302 | 144.80909586 | 187.01 | 4.0 | 191.01 |
| 6 | 13.5163981074 | 144.810279031 | 217.15 | 4.0 | 221.15 |
| 7 | 13.5166693309 | 144.811544034 | 227.5 | 4.0 | 231.5 |
| 8 | 13.5182236444 | 144.811823984 | 230.36 | 4.0 | 234.36 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.491731124 | 144.812046289 | 305.52 | 50.0 | No |
| 1/4 mi | 13.4932503507 | 144.815422173 | 337.87 | 86.82 | No |
| 1/2 mi | 13.4947695774 | 144.818798057 | 374.97 | 118.91 | No |
| 3/4 mi | 13.4962888041 | 144.82217394 | 373.89 | 189.17 | No |
| 1 mi | 13.4978080309 | 144.825549824 | 380.28 | 251.95 | No |
| 1 1/4 mi | 13.4993272576 | 144.828925708 | 351.47 | 349.94 | No |
| 1 1/2 mi | 13.5008464843 | 144.832301591 | 268.52 | 502.06 | No |
| 1 3/4 mi | 13.5023657111 | 144.835677475 | 271.35 | 568.43 | No |



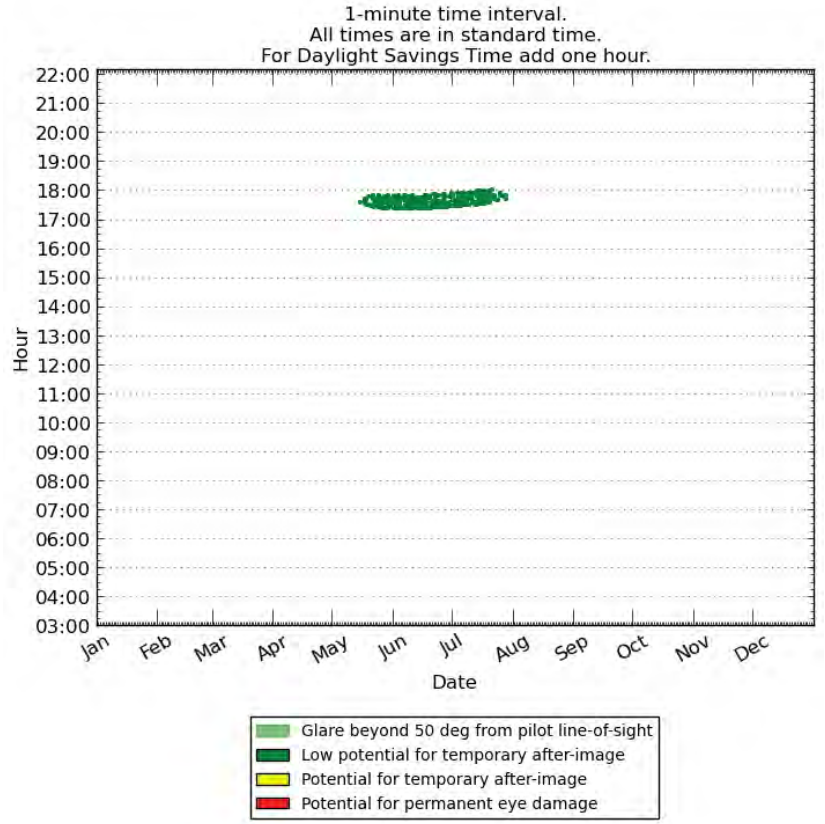


| | | | | | |
|---|---|---|---|---|---|
| 2 mi | 13.5038849378 | 144.839053359 | 283.63 | 625.32 | Yes |

## Glare occurrence plots

All times are in standard time. For Daylight Savings Time add one hour.

2 mi










# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 5:45 p.m.

## Flight path: 6L

## No glare found

Print

# Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

# Flight path parameters

| | |
|---|---|
| Direction (deg) | 64.94 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





# PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5196944955 | 144.812529087 | 239.79 | 4.0 | 243.79 |
| 2 | 13.5207793728 | 144.811048508 | 257.77 | 4.0 | 261.77 |
| 3 | 13.51898515 | 144.810597897 | 221.59 | 4.0 | 225.59 |
| 4 | 13.5178168117 | 144.810061455 | 229.67 | 4.0 | 233.67 |
| 5 | 13.5172952302 | 144.80909586 | 187.01 | 4.0 | 191.01 |
| 6 | 13.5163981074 | 144.810279031 | 217.15 | 4.0 | 221.15 |
| 7 | 13.5166693309 | 144.811544034 | 227.5 | 4.0 | 231.5 |
| 8 | 13.5182236444 | 144.811823984 | 230.36 | 4.0 | 234.36 |

# Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4789245692 | 144.784057438 | 237.77 | 50.0 | No |
| 1/4 mi | 13.4773939063 | 144.780687216 | 208.62 | 148.32 | No |
| 1/2 mi | 13.4758632434 | 144.777316993 | 205.16 | 220.97 | No |
| 3/4 mi | 13.4743325805 | 144.773946771 | 175.68 | 319.62 | No |
| 1 mi | 13.4728019176 | 144.770576548 | 140.53 | 423.94 | No |
| 1 1/4 mi | 13.4712712546 | 144.767206326 | 74.93 | 558.73 | No |
| 1 1/2 mi | 13.4697405917 | 144.763836103 | 10.39 | 692.45 | No |
| 1 3/4 mi | 13.4682099288 | 144.760465881 | 13.44 | 758.59 | No |

# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 5:46 p.m.

## Flight path: 6R

## No glare found

Print






| | | | | | |
|---|---|---|---|---|---|
| 2 mi | 13.4666792659 | 144.757095659 | 12.01 | 829.19 | No |

No glare found.

# Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

# Flight path parameters

| | |
|---|---|
| Direction (deg) | 64.94 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





# PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5196944955 | 144.812529087 | 239.79 | 4.0 | 243.79 |
| 2 | 13.5207793728 | 144.811048508 | 257.77 | 4.0 | 261.77 |
| 3 | 13.51898515 | 144.810597897 | 221.59 | 4.0 | 225.59 |
| 4 | 13.5178168117 | 144.810061455 | 229.67 | 4.0 | 233.67 |
| 5 | 13.5172952302 | 144.80909586 | 187.01 | 4.0 | 191.01 |
| 6 | 13.5163981074 | 144.810279031 | 217.15 | 4.0 | 221.15 |
| 7 | 13.5166693309 | 144.811544034 | 227.5 | 4.0 | 231.5 |
| 8 | 13.5182236444 | 144.811823984 | 230.36 | 4.0 | 234.36 |

# Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4771639403 | 144.78486076 | 229.31 | 50.0 | No |
| 1/4 mi | 13.4756332774 | 144.781490562 | 215.91 | 132.57 | No |
| 1/2 mi | 13.4741026145 | 144.778120365 | 195.79 | 221.88 | No |
| 3/4 mi | 13.4725719516 | 144.774750167 | 147.31 | 339.53 | No |
| 1 mi | 13.4710412887 | 144.771379969 | 112.33 | 443.69 | No |
| 1 1/4 mi | 13.4695106257 | 144.768009772 | 15.76 | 609.44 | No |
| 1 1/2 mi | 13.4679799628 | 144.764639574 | 31.29 | 663.09 | No |
| 1 3/4 mi | 13.4664492999 | 144.761269376 | 9.82 | 753.74 | No |

# Solar Glare Hazard Analysis Report

Generated Jan. 9, 2015, 5:45 p.m.

## No glare found

Print

## Inputs

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 180.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |





| | | | | | |
|---|---|---|---|---|---|
| 2 mi | 13.464918637 | 144.757899179 | 15.99 | 816.74 | No |

No glare found.

| | |
|---|---|
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5196944955 | 144.812529087 | 239.79 | 4.0 | 243.79 |
| 2 | 13.5207793728 | 144.811048508 | 257.77 | 4.0 | 261.77 |
| 3 | 13.51898515 | 144.810597897 | 221.59 | 4.0 | 225.59 |
| 4 | 13.5178168117 | 144.810061455 | 229.67 | 4.0 | 233.67 |
| 5 | 13.5172952302 | 144.80909586 | 187.01 | 4.0 | 191.01 |
| 6 | 13.5163981074 | 144.810279031 | 217.15 | 4.0 | 221.15 |
| 7 | 13.5166693309 | 144.811544034 | 227.5 | 4.0 | 231.5 |
| 8 | 13.5182236444 | 144.811823984 | 230.36 | 4.0 | 234.36 |





## Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) |
|---|---|---|---|---|
| 1 | 13.4788306694 | 144.796989709 | 241.95 | 300.0 |

## No glare found.

# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 7:56 p.m.

## Flight path: 2

## No glare found

Print






## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.19 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5196944955 | 144.812529087 | 239.79 | 4.0 | 243.79 |
| 2 | 13.5207793728 | 144.811048508 | 257.77 | 4.0 | 261.77 |
| 3 | 13.51898515 | 144.810597897 | 221.59 | 4.0 | 225.59 |
| 4 | 13.5178168117 | 144.810061455 | 229.67 | 4.0 | 233.67 |
| 5 | 13.5172952302 | 144.80909586 | 187.01 | 4.0 | 191.01 |
| 6 | 13.5163981074 | 144.810279031 | 217.15 | 4.0 | 221.15 |
| 7 | 13.5166693309 | 144.811544034 | 227.5 | 4.0 | 231.5 |
| 8 | 13.5182236444 | 144.811823984 | 230.36 | 4.0 | 234.36 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4876127569 | 144.807714522 | 290.95 | 50.0 | No |
| 1/4 mi | 13.4891291217 | 144.811091711 | 298.85 | 111.27 | No |
| 1/2 mi | 13.4906454865 | 144.8144689 | 334.43 | 144.88 | No |
| 3/4 mi | 13.4921618513 | 144.817846089 | 364.49 | 183.99 | No |
| 1 mi | 13.493678216 | 144.821223278 | 390.74 | 226.92 | No |
| 1 1/4 mi | 13.4951945808 | 144.824600468 | 350.32 | 336.52 | No |
| 1 1/2 mi | 13.4967109456 | 144.827977657 | 415.45 | 340.57 | No |
| 1 3/4 mi | 13.4982273104 | 144.831354846 | 425.23 | 399.98 | No |





| | | | | | |
|---|---|---|---|---|---|
| 2 mi | 13.4997436752 | 144.834732035 | 352.27 | 542.11 | No |

No glare found.

# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 7:56 p.m.

## Flight path: 1

## Glare found

Print






## Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## Flight path parameters

| | |
|---|---|
| Direction (deg) | 245.14 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5196944955 | 144.812529087 | 239.79 | 4.0 | 243.79 |
| 2 | 13.5207793728 | 144.811048508 | 257.77 | 4.0 | 261.77 |
| 3 | 13.51898515 | 144.810597897 | 221.59 | 4.0 | 225.59 |
| 4 | 13.5178168117 | 144.810061455 | 229.67 | 4.0 | 233.67 |
| 5 | 13.5172952302 | 144.80909586 | 187.01 | 4.0 | 191.01 |
| 6 | 13.5163981074 | 144.810279031 | 217.15 | 4.0 | 221.15 |
| 7 | 13.5166693309 | 144.811544034 | 227.5 | 4.0 | 231.5 |
| 8 | 13.5182236444 | 144.811823984 | 230.36 | 4.0 | 234.36 |

## Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.491731124 | 144.812046289 | 305.52 | 50.0 | No |
| 1/4 mi | 13.4932503507 | 144.815422173 | 337.87 | 86.82 | No |
| 1/2 mi | 13.4947695774 | 144.818798057 | 374.97 | 118.91 | No |
| 3/4 mi | 13.4962888041 | 144.82217394 | 373.89 | 189.17 | No |
| 1 mi | 13.4978080309 | 144.825549824 | 380.28 | 251.95 | No |
| 1 1/4 mi | 13.4993272576 | 144.828925708 | 351.47 | 349.94 | No |
| 1 1/2 mi | 13.5008464843 | 144.832301591 | 268.52 | 502.06 | No |
| 1 3/4 mi | 13.5023657111 | 144.835677475 | 271.35 | 568.43 | No |



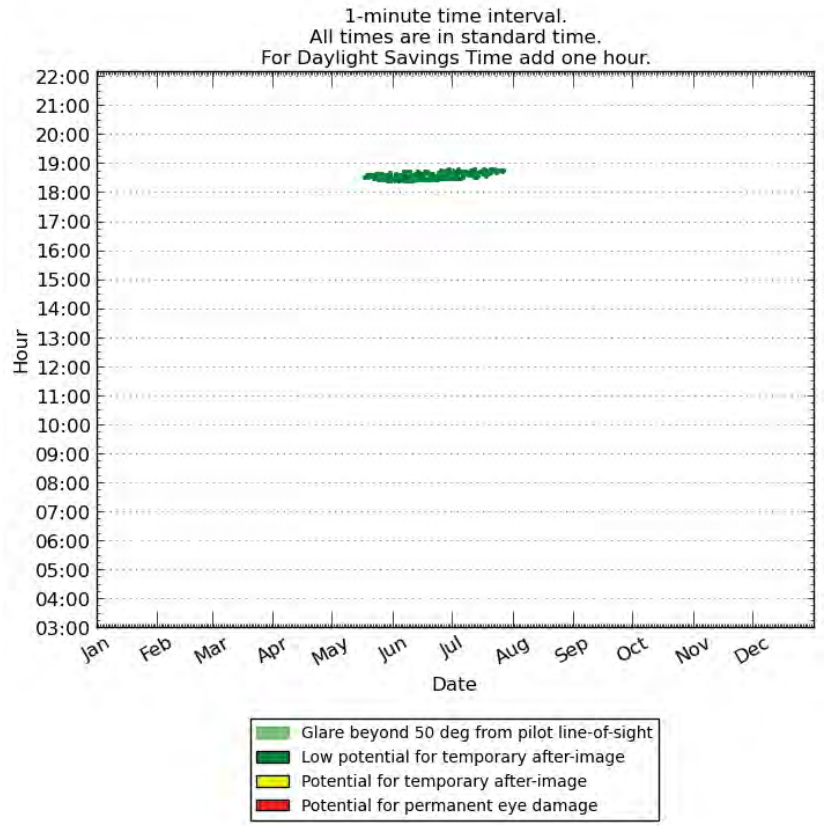


| | | | | | |
|---|---|---|---|---|---|
| 2 mi | 13.5038849378 | 144.839053359 | 283.63 | 625.32 | Yes |

## Glare occurrence plots

All times are in standard time. For Daylight Savings Time add one hour.

2 mi










# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 6:16 p.m.

## Flight path: 6L

## No glare found

Print

# Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

# Flight path parameters

| | |
|---|---|
| Direction (deg) | 64.94 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





# PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5196944955 | 144.812529087 | 239.79 | 4.0 | 243.79 |
| 2 | 13.5207793728 | 144.811048508 | 257.77 | 4.0 | 261.77 |
| 3 | 13.51898515 | 144.810597897 | 221.59 | 4.0 | 225.59 |
| 4 | 13.5178168117 | 144.810061455 | 229.67 | 4.0 | 233.67 |
| 5 | 13.5172952302 | 144.80909586 | 187.01 | 4.0 | 191.01 |
| 6 | 13.5163981074 | 144.810279031 | 217.15 | 4.0 | 221.15 |
| 7 | 13.5166693309 | 144.811544034 | 227.5 | 4.0 | 231.5 |
| 8 | 13.5182236444 | 144.811823984 | 230.36 | 4.0 | 234.36 |

# Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4789245692 | 144.784057438 | 237.77 | 50.0 | No |
| 1/4 mi | 13.4773939063 | 144.780687216 | 208.62 | 148.32 | No |
| 1/2 mi | 13.4758632434 | 144.777316993 | 205.16 | 220.97 | No |
| 3/4 mi | 13.4743325805 | 144.773946771 | 175.68 | 319.62 | No |
| 1 mi | 13.4728019176 | 144.770576548 | 140.53 | 423.94 | No |
| 1 1/4 mi | 13.4712712546 | 144.767206326 | 74.93 | 558.73 | No |
| 1 1/2 mi | 13.4697405917 | 144.763836103 | 10.39 | 692.45 | No |
| 1 3/4 mi | 13.4682099288 | 144.760465881 | 13.44 | 758.59 | No |

| | | | | | |
|---|---|---|---|---|---|
| 2 mi | 13.4666792659 | 144.757095659 | 12.01 | 829.19 | No |

No glare found.







# Solar Glare Hazard Analysis Flight Path Report

Generated Jan. 9, 2015, 6:17 p.m.

## Flight path: 6R

## No glare found

Print

# Analysis & PV array parameters

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

# Flight path parameters

| | |
|---|---|
| Direction (deg) | 64.94 |
| Glide slope (deg) | 3.0 |
| Consider pilot visibility from cockpit | False |





# PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5196944955 | 144.812529087 | 239.79 | 4.0 | 243.79 |
| 2 | 13.5207793728 | 144.811048508 | 257.77 | 4.0 | 261.77 |
| 3 | 13.51898515 | 144.810597897 | 221.59 | 4.0 | 225.59 |
| 4 | 13.5178168117 | 144.810061455 | 229.67 | 4.0 | 233.67 |
| 5 | 13.5172952302 | 144.80909586 | 187.01 | 4.0 | 191.01 |
| 6 | 13.5163981074 | 144.810279031 | 217.15 | 4.0 | 221.15 |
| 7 | 13.5166693309 | 144.811544034 | 227.5 | 4.0 | 231.5 |
| 8 | 13.5182236444 | 144.811823984 | 230.36 | 4.0 | 234.36 |

# Flight Path Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) | Glare? |
|---|---|---|---|---|---|
| Threshold | 13.4771639403 | 144.78486076 | 229.31 | 50.0 | No |
| 1/4 mi | 13.4756332774 | 144.781490562 | 215.91 | 132.57 | No |
| 1/2 mi | 13.4741026145 | 144.778120365 | 195.79 | 221.88 | No |
| 3/4 mi | 13.4725719516 | 144.774750167 | 147.31 | 339.53 | No |
| 1 mi | 13.4710412887 | 144.771379969 | 112.33 | 443.69 | No |
| 1 1/4 mi | 13.4695106257 | 144.768009772 | 15.76 | 609.44 | No |
| 1 1/2 mi | 13.4679799628 | 144.764639574 | 31.29 | 663.09 | No |
| 1 3/4 mi | 13.4664492999 | 144.761269376 | 9.82 | 753.74 | No |

# Solar Glare Hazard Analysis Report

Generated Jan. 9, 2015, 6:16 p.m.

## No glare found

Print

## Inputs

| | |
|---|---|
| Analysis name | Won Pot |
| PV array axis tracking | none |
| Orientation of array (deg) | 210.0 |
| Tilt of solar panels (deg) | 13.5 |
| Rated power (kW) | 0.0 |
| Vary reflectivity | True |





| | | | | | |
|---|---|---|---|---|---|
| 2 mi | 13.464918637 | 144.757899179 | 15.99 | 816.74 | No |

No glare found.

| | |
|---|---|
| PV surface material | Smooth glass without ARC |

| | |
|---|---|
| Timezone offset | 10.0 |
| Subtended angle of sun (mrad) | 9.3 |
| Peak DNI (W/m^2) | 1000.0 |
| Ocular transmission coefficient | 0.5 |
| Pupil diameter (m) | 0.002 |
| Eye focal length (m) | 0.017 |
| Time interval (min) | 1 |
| Slope error (mrad) | 10.0 |

## PV array vertices

| id | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Height of panels above ground (ft) | Total elevation (ft) |
|---|---|---|---|---|---|
| 1 | 13.5196944955 | 144.812529087 | 239.79 | 4.0 | 243.79 |
| 2 | 13.5207793728 | 144.811048508 | 257.77 | 4.0 | 261.77 |
| 3 | 13.51898515 | 144.810597897 | 221.59 | 4.0 | 225.59 |
| 4 | 13.5178168117 | 144.810061455 | 229.67 | 4.0 | 233.67 |
| 5 | 13.5172952302 | 144.80909586 | 187.01 | 4.0 | 191.01 |
| 6 | 13.5163981074 | 144.810279031 | 217.15 | 4.0 | 221.15 |
| 7 | 13.5166693309 | 144.811544034 | 227.5 | 4.0 | 231.5 |
| 8 | 13.5182236444 | 144.811823984 | 230.36 | 4.0 | 234.36 |





## Observation Points

| | Latitude (deg) | Longitude (deg) | Ground Elevation (ft) | Eye-level height above ground (ft) |
|---|---|---|---|---|
| 1 | 13.4788306694 | 144.796989709 | 241.95 | 300.0 |

## No glare found.